Mold in Cultural Collections©: North Carolina Preservation Consortium 2017 Annual Conference
Presented by:
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American Institute for Conservation (AIC)
FAIC: National Heritage Responders
AIC: Health and Safety Wiki
AIC: Mold Segment (Video)
AIC: Conservation On-Line Database: Mold

FEMA New Orleans, 2008 - 2014
Health and Safety

Enters by inhalation and through small breaks in the skin

Center for Disease Control (CDC)
Environmental Protection Agency (EPA)
Occupational Safety and Health Administration (OSHA)

Health and Safety

Nasal stuffiness, eye irritation, wheezing, skin irritation

Respiratory tract, lungs, stomach, intestines, cornea and skin

People with repeated exposure, allergies, immune suppression, or underlying lung disease, seniors, children, librarians
Health and Safety
Librarian’s Lung
Extrinsic allergic alveolitis
Hypersensitivity pneumonitis

Personal Protective Equipment
Respirator
Disposable respirator
Disposable gloves
Protective goggles
Protective clothing

OSHA: Respirators
Respirator, Fit tested
N95 or N100 disposable respirator
HEPA filter Rating
N100 or P100

OSHA: Respirators
Health and Safety
Personal Protective Equipment

OSHA: Gloves

Health and Safety
Personal Protective Equipment

Health and Safety
Personal Hygiene

No eating or smoking

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Identifying Mold

More than 100,000 types of mold

OSHA: Mold Recognition

Mold
Fungus growing as multicellular filaments called hyphae

Hyphae
Branching filaments of the mycelium of a fungus

Mycelium
The vegetative part of a fungus

The most common molds are:

Aspergillus    Alternaria    Cladosporium    Penicillium

Mold Growth
Contamination
Temperatures above 68°F
Relative Humidity above 55%
Dark Conditions
Stagnant Air
Contamination
Natural growth on organic materials
Influx through accession
Buildings and mechanical failures
Weather disaster

Mold Growth
Feeds on organic materials
Paper, cloth, starch, glues, skins, media binders, etc.

Excretes enzymes and acids
Digesting carbohydrates, proteins and fats into absorbable sugars, amino acids, fatty acids

Causes weakness and staining

Identifying Mold
Propagating
Geography and Site
Springs / Run-off / Irrigation
Broken water mains

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Propagating
Water seep
Basements and attics

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Propagating
Roofs

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Propagating
Downspouts and gutters

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Leaking and clogged pipes

Free-standing equipment

Heating Ventilating and Air Conditioning Systems

Moisture

Heating Ventilating and Air Conditioning Systems

Moisture
Mold spores vary in size from 4 - 40 microns in diameter. Most mold spores are less than 10 microns.
No regulations for mold contaminants

EPA
Environmental Protection Agency

NIOSH (CDC)
National Institute for Occupational Safety and Health

OSHA
Occupational Safety and Health Administration
OSHA Standard 29 CFR establishes contamination definitions and general guidance

It is not necessary to identify the fungal species in order to respond to an outbreak
It is necessary to identify
Extent of mold contamination
Quantity of contaminated items
Location of contaminated items
Potential cross-contamination
Value or replaceability of items

The only way to limit mold growth is through Stringent Climate Control

Prevention
Relative Humidity
45% - 55%

Temperature
below 68°F

Prevention
Work with qualified and specialized professionals
Consult, confer and train with colleagues
Undertake collections and buildings assessments
Identify key issues and solutions
Develop strategic plans

NPS Conservogram/Mold: Prevention Of Growth In Museum Collections
Museum of Western Australia: Mould Video
FEMA: Environmental and Historic Preservation
Prevention
Monitor Outside Conditions

Place dataloggers in every exhibit, storage, and workroom (as funds allow)

Prevention
Monitor Interior Conditions

Run HVAC equipment 24 hours every day

Prevention
Monitor Interior Conditions

Moisture Meters

<table>
<thead>
<tr>
<th>Temperature Range</th>
<th>Humidity Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>&gt;100°F (38°C)</td>
<td>Humid - High Humid</td>
</tr>
<tr>
<td>60-100°F (16-38°C)</td>
<td>Moderate - Very Low Humid</td>
</tr>
<tr>
<td>40-60°F (4-15°C)</td>
<td>Very Low</td>
</tr>
<tr>
<td>&lt;40°F (5°C)</td>
<td>Freezing</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Relative Humidity (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;30% (Dry)</td>
</tr>
<tr>
<td>30-60% (Comfortable)</td>
</tr>
<tr>
<td>&gt;60% (Humid)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Moisture Meters</th>
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<tbody>
<tr>
<td>2%</td>
</tr>
<tr>
<td>5%</td>
</tr>
<tr>
<td>10%</td>
</tr>
<tr>
<td>15%</td>
</tr>
<tr>
<td>20%</td>
</tr>
</tbody>
</table>

Moisture content of paper
Monitor building and site conditions
Anticipate projects and seek funding
Make strategic improvements
Upgrade or replace faulty equipment

Heating, Ventilating, and Air Conditioning (HVAC)
Work with qualified professionals
Establish a contract
Inspect and maintain equipment seasonally
Change filters quarterly (or more)
Use appropriate filters

Free-standing equipment
Be vigilant and monitor regularly
Use equipment sized properly for the space
Hard wire and plumb equipment

De-humidification
Drip pans under HVAC (chiller condensation and leaks)
Drip pans under vulnerable plumbing
Sump pumps
Water alarms
Emergency generators
Basements and attics
Avoid vulnerable locations

Prevention
Mechanical equipment rooms
Entry vestibules
Exterior walls
Plumbing
Windows / Doors
Bathrooms / Kitchens / Fireplaces

Monitor weather conditions
Be aware of seasonal issues, extreme weather conditions
Prepare in advance of anticipated disaster event

Prepare in advance of anticipated disaster event
Prevention
Prepare in advance of anticipated disaster event

Construction Projects
- Research contractors and understand contracts
- Anticipate potential problems
- Protect collections
- Review insurance policies and coverage
- Monitor work area and collections

Housekeeping
- Undertake on a regular schedule
- Employ quality cleaning materials and techniques
- Use as an opportunity to assess collections

BREAK
It is not necessary to identify the fungal species in order to respond to an outbreak.

It is necessary to identify:
- Extent of mold contamination
- Quantity of contaminated items
- Location of contaminated items
- Potential cross-contamination
- Value or replaceability of items
Outbreak Assessment

All outbreaks will require additional resources
  - Staff / Vendors
  - Work and storage space
  - Equipment and supplies
  - Funding

Outbreak Assessment

Not necessarily one approach to mold remediation
Circumstances are different for every outbreak
  - Type and extent of damage
  - Institutional capabilities and resources

Outbreak Assessment

Strategic Planning

Small to moderate outbreaks
  - Manageable in-house

Medium to large outbreaks
  - Professional services to assist with remediation

Outbreak Assessment

Value and/or replaceability affected materials
Outbreak Assessment
Effective Conservation Treatment

Outbreak Assessment
Accept Loss

National Park Service: Disaster Primer - Evaluation of Loss

Small Events - Accessions
Segregate and inspect before entry

Small Events - Accessions
Installing collections
Move collections through dirty room to cleaner rooms

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Large Events

Federal Emergency Management Agency (FEMA)

Using vendors

Disaster Response Companies

HVAC Engineers

Industrial Hygienists

Preservation Architects

Conservators

FEMA / Heritage Emergency National Task Force

Using vendors

Contract before events

Understand legal, financial and scheduling parameters

Use a Conservator as a consultant

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Large Events
Using disaster response companies
Understand:
- Offered services
- Capabilities of facilities and staff
- Procedures and materials used
- Predictable outcomes of services

Large Events
Using conservators before an event
Assessment, Prevention and Response
Strategic Planning

Large Events
Using conservators after an event

Outbreak Actions
Identify and eliminate the cause of the problem
Lower the temperature and relative humidity

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Outbreak Actions

Remove standing water

Outbreak Actions

Employ specialist vendors in large scale drying efforts

Outbreak Actions

Use properly sized dehumidifiers for the affected cubic area
Create air circulation, only if spores are not broadcast
Open windows if conditions are better outside

Outbreak Actions

Air scrubbers
Outbreak Actions

Housekeeping

Clean on a regular schedule
Use cleaning as an opportunity for assessment

Outbreak Actions

Housekeeping

Discard, clean, and/or paint building materials

Outbreak Actions

Chemical treatment

Fungstats inhibit but do not destroy mold growth
Fungicides deactivate mold but are harmful compounds

Outbreak Actions

Chemical treatment

Unsafe for most collections materials
Results in deterioration and discoloration
Health hazard
Outbreak Actions
Chemical treatment - Alcohol

Outbreak Actions
Chemical treatment - Quaternary ammonia

Outbreak Actions
Chemical treatment - Sunlight, lemon, vinegar
Unsafe for most collections materials
Causes fading or darkening
Lemons and vinegar are harmfully acidic

Outbreak Actions
Ozone and gamma radiation treatments
Unsafe for most collections materials
Collections susceptible to mold after treatment
Outbreak Actions

Odor Reduction

Charcoal
Baking Soda
Zeolite
Clay

Conservation OnLine (CoOL): Odor Reduction

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Outbreak Actions

Four drying methods used for drying wet collections
Air-Drying
Freeze Drying
Vacuum Freeze Drying
Vacuum Thermal Drying

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Air Drying Wet Collections - Advantages

- Gentle technique, useable for all collections types
- Low cost; simple or no equipment
- No risk of over-drying
- Easy to access collections during process

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Air Drying Wet Collections - Disadvantages

- Space, labor, time and supply intensive
- Risk of mold
- Flattening of items required
- Constant monitoring required - security and drying times

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**Outbreak Actions**

**Air Drying Wet Collections / Indoors - Advantages**

- Easy to access collections
- Better monitoring
- Controls inventory and provides security

**Outbreak Actions**

**Air Drying Wet Collections / Indoors - Disadvantages**

- Conditions must be better inside than outside
- Conditions must be consistent
- Fans create spore dispersal
- Room or HVAC system may be mold contaminated

**Drying Wet Collections**

**Vacuum Freeze Drying**

- Rapid freezing, followed by high vacuum
- Removes ice by sublimation
- Turns solid into gas without going through liquid stage

**Isolate Collections**

**Quarantine**
Mold Cleaning

High Efficiency Particulate Air (HEPA) Vacuum
Variable Speed

HEPA Vacuum Systems:
CHICORA: http://chicora.org/hepa_vacuums.htm
Conservation Treatment

Understand:
- Goals of conservation
- Resources needed
- Strategic planning to include more work in daily operations

Photographic Materials
Photographic Materials

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- Minnesota Historical Society: Salvage of Photographs and Transparencies

Film and Negatives

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- Minnesota Historical Society: Salvage of Magnetic Media: Microfiche
- Minnesota Historical Society: Microfilm and Motion Picture Film
- National Film and Sound Archives of Australia: Stabilizing Audio Visual Materials After the Flood

Magnetic Tape

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- Minnesota Historical Society: Salvage of Magnetic Media: Reel to Reel
- National Film and Sound Archives of Australia: Stabilizing Audio Visual Materials After the Flood

Analog and Digital

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- Canadian Conservation Institute: Disaster Recovery of Modern Information Carriers: Compact Disks, Magnetic Tapes, Magnetic Disks
- Minnesota Historical Society: Salvage of Record Albums/Vinyl, Shellac, and Acetate Disks
- Minnesota Historical Society: Salvage of Magnetic Media: Computer Diskettes
Objects

American Institute for Conservation: Corrosion Segment (Video)
Canadian Conservation Institute: Vacuum Freeze Drying Archaeological Artifacts, CCI Notes 4/2
Canadian Conservation Institute: Conservation of Wet Faunal Remains, Bone, Antler and Ivory, CCI Notes 4/3
Minnesota Historical Society: Salvage of Organic Materials/Bone, Hair, Horn Ivory, Shell
Minnesota Historical Society: Salvage of Inorganic Materials
National Park Service: Conserv O gram, Salvage at a Glance III, Objects

Textiles

Minnesota Historical Society: Salvage of Textiles and Clothing
Minnesota Historical Society: Salvage of Costumes and Accessories
National Park Service Conserv O gram: Salvage at a Glance - Textiles
The only way to limit mold growth is through stringent environmental control

- Relative Humidity
  - 45% and 55%
- Temperature
  - Below 68°F
Returning Collections

After severe outbreaks
Consider rate of use in determining housing and locations
Isolate collections and cool temperature storage
Prohibit use by public
Duplicate

Returning Collections

After minor outbreaks
Isolate collection materials in "tight" boxes or crates
Monitor and assess conditions regularly
Limit frequency and provide parameters of use

Returning Collections

Move collections through dirty room to cleaner rooms

Returning Collections

Policy, Procedure and Protocols
Stringent environmental control
Isolation from other collections
Limited use
Housekeeping

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Returning Collections
Regular monitoring and assessment
Immediate response in event of regrowth

Summary
Mold is everywhere
Mold is a major health hazard for people and collections
Mold will propagate in warm, humid, dark conditions
Mold is only managed through vigilance and climate control

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Thank You
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