

# Remediation Overview: Regulations, Guidelines Approaches.... Where to begin?

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# National Expenditures for IAQ Problem Prevention or Mitigation

(LBNL – 58694, June 2005)

- \$15.9 billion annual business (range \$12-20 billion)
  - Air clng and improved filtration.....\$1.5 billion
  - **IAQ Consultant services.....\$2.1 billion**
  - **Building Remediation.....\$3.4 billion**
  - Duct Cleaning.....\$ 4 billion
  - Asbestos/lead abatement.....\$ 4 billion
  - IAQ litigation/insurance.....\$500 million
  - Radon Mitigation.....\$200 million
  - Certification/labeling.....\$100 million
  - Laboratory Services.....\$100 million

# Goal of Mold Remediation

- **To remove or clean mold-damaged materials using work practices that protect occupants by controlling the dispersion of mold from the work area and protect remediation workers from exposures to mold.**

# Remediation guidance

- Progression or evolution encompasses some of the following factors:
  - Amount of mold
  - Specific types of organisms present
  - Location or distribution of mold
  - Types of materials affected
  - Extent of degradation
  - PPE consideration
  - Training/competency
  - Type of buildings and occupants

# New York City Department of Health (1993)

- *Guidelines for Assessment and Remediation of Stachybotrys atra*

- Four levels of contamination:

- **Level I: areas less than 2 ft<sup>2</sup>**

- **Level II: 2-30 ft<sup>2</sup>**

- **Level III: areas exceeding 30 ft<sup>2</sup>**

- **Level IV: for remediation of HVAC equipment**

(Level III & IV: Require full containment with negative air pressure, isolation of heating, ventilation, air condition HVAC, and dermal & respiratory protection for workers)

# International Society of Indoor Air Quality and Climate (1996)



- *Guideline TFI-1996 – Control of Moisture Problems Affecting Biological Indoor Air Quality*
- Three levels of remediation:
  - **Level I:** less than 2.15 ft<sup>2</sup> (0.2 m<sup>2</sup>)
    - No specific recommendations
  - **Level II:** 2.1-32.3 ft<sup>2</sup> (0.2-3.0 m<sup>2</sup>)
    - **Local containment** w/ HEPA filtered exhaust air, bagging of refuse, and proper respiratory protection
  - **Level III:** greater than 32.3 ft<sup>2</sup> (3.0 m<sup>2</sup>)
    - Full containment w/ critical barriers, air locks, HVAC protection, full-face HEPA respirator, coveralls & eye protection

# American Conference of Governmental Industrial Hygienists (1999)

- Recommended removal & containment precautions specified for toxigenic fungi be used as general rule  
“Virtually all fungi can cause allergy (in sensitized individuals) and many fungi produce toxins.”
- Three levels of visible fungal growth:
  - **Minimal growth:** requires source containment with N-95 respirators & gloves
  - **Moderate growth:** requires local containment with N-95 respirator, enclosures, negative air, full-body covering
  - **Extensive contamination:** full containment with critical barriers, negative air & trained personnel
  - Dimensions not specified – professional judgment.

# NYCDOH (2000)

- NYCDOH updated its '93 Guidelines by expanding the scope to include the growth of all indoor molds
- Criteria for extent of contamination revised:
  - **Level I:** areas smaller than 10 ft<sup>2</sup>
    - Areas vacated, dust suppression methods used, N-95 respirator
  - **Level II:** 10-30 ft<sup>2</sup>
    - Area covered with polyethylene, HEPA vacuumed, N-95 respirator
  - **Level III:** 30-100 ft<sup>2</sup>
    - Sealing HVAC system, negative pressure enclosure w/ HEPA filtered exhaust air, N-95 respirator recommended
  - **Level IV:** greater than 100 ft<sup>2</sup>
    - Oversight by H&S professional, full containment with critical barriers, full-face HEPA-filtered respirators



# U.S. EPA (2001)



- *Mold Remediation in Schools and Commercial Buildings*
- Addresses “Hidden Mold” – concealed from view
- Three levels of containment:
  - **Level I:** less than 10 ft<sup>2</sup>
    - No containment required; requires N-95 respirator
  - **Level II:** 10-100 ft<sup>2</sup>
    - Poly sheeting around area, HEPA filtered exhaust air, blocked HVAC openings, N-95 respirator, coveralls, eye protection
  - **Level III:** greater than 100 ft<sup>2</sup>
    - Full containment w/ critical barriers & airlocks, full-face HEPA filtered respirator, coveralls & eye protection

# Canadian Construction Association (2004)

- Guidelines based on universal precautions & controlled conditions (professional judgment)
- **Level I:** areas less than 1 m<sup>2</sup> (10 ft<sup>2</sup>)
  - N-95 respirator, disposable coveralls, gloves & boots
- **Level II:** 1-10 m<sup>2</sup> (10-100 ft<sup>2</sup>)
  - Negative pressure isolation & H&S professional
- **Level III:** greater than 10 m<sup>2</sup> (100 ft<sup>2</sup>)
  - Full-face air purifying respirator (APR) with P100 filters, decontamination area for negative pressure enclosure

# Institute of Inspection, Cleaning and Restoration, IICRC (2003)

- *Standard and Reference Guide S520 for Professional Mold Remediation*
- General guidance defines mold contamination ranging from normal fungal ecology to active growth (no action levels or procedures based on area)
- Professional judgment required based primarily on:
  - Extent and ecology of mold growth
  - Location of mold growth
  - Sensitivity of the occupant population

# NYC DOH Guidelines 2008

- For bldg owners/mgrs, env contractors/consultants; includes summary fact sheet for quick reference
- Includes hidden mold (crawlspaces, attics, behind wallboard)
- **Level I:** areas less than 1 m<sup>2</sup> (10 ft<sup>2</sup>); (trained bldg staff)
  - N-95 respirator, gloves, eye protection
- **Level II:** 1-10 m<sup>2</sup> (10-100 ft<sup>2</sup>); (trained bldg staff)
  - Seal ductwork; cover floor and pathways w/ plastic sheeting
- **Level III:** greater than 10 m<sup>2</sup> (100 ft<sup>2</sup>); (Trained professionals)
  - Min'm of 1/2 faced respirators w/ P-100 filters; full body cover, gloves, eyes; , negative pressure enclosure and isolation suggested

# Hidden Mold

- Active, dormant, or nonviable colonization concealed from view during normal walk-through inspection
- Settled spores & hyphal fragments (although not visible) should not be considered “hidden”; Cleaning should address
- When **hidden mold is identified, the amount of growth should be factored into plans** for removal, proper containment, and cleaning

# Transporting Mold (and other contaminants) in Buildings

- A building is composed of a network of chambers, interconnected by air leaks
- Air (and associated mold) can move between:
  - indoor and outdoors
  - all zones and cavities of buildings
- Movement is highly variable and affected by many factors

# Environmental Protection Agency, 2011

- revise your remediation plan to account for the total affected area (w/ hidden mold)
- investigation involves disturbing potential sites of mold growth—Use PPE and minimize disturbance.
  - ❖ e.g. removal of wall covering can lead to a massive release of spores

# Degrees of Visual Inspection

1. **Visual, nondestructive:** visible growth, stains, etc? Check seams crevices baseboards, under carpets, base of windows, etc.
2. **Slightly destructive:** use of borescope
3. **Complete/systematic:** open wall cavities to determine full extent, location, and nature



# In-Wall Sampling

- Controversial
  - What does data mean
  - False positives and negatives
  - Still must open wall
- Interpretation difficult and uncertain
- Reference locations may be considered (suspect area compared with control)

# Hidden Mold; need to remediate?

- Emerging consensus is hidden mold should be effectively cleaned or removed
- AIHA, Health Canada, NYCDOH, CMHC, US EPA, FEMA have all referenced growth in wall cavities as potential health problem and recommend inclusion in remediation plans
- Final decision to remediate hidden mold may be based on proximity to occupied areas and occupancies of high risk (viability and taxa not pivotal to decision)



- *Damp Indoor Spaces and Health (2004)*
- Compared 7 published guidelines for mold remediation
- “Guidance for containment and worker protection **lack clarity** within and between documents”; often **subjective**
- Because of **lack of dose-response relationship**, approach depends more on the “magnitude” of contamination”

# Shifting Focus



- Health Canada's *Fungal Contamination in Public Buildings: Health Effects and Investigation Methods* (2004) expanded the definition of “remediation” to include [the elimination of the building defect \(moisture problem\)](#) that allowed mold growth to occur.

# AIHA 2008: Recognition, Evaluation, and Control of Indoor Mold



- *Comprehensive guidelines written by practitioners, govt personnel, and scientists*
- Attention paid to moisture and mold damaged areas on remediation efforts
- General mold remediation guidelines follow Canadian Construction guidance
- Attention to type of buildings and occupancy
- Professional judgment emphasized



***The definition of moisture damage used here follows that presented by the ISIAQ Task Force IX, 2002:***



***Damage caused by unwanted moisture (air humidity / dampness / liquid water / ice) in building structures or on the surfaces of building materials***

# WHO guidelines for indoor air quality : dampness and mould (2009)

- Dampness/microbial growth may result in greater numbers of spores, cell fragments, allergens, mycotoxins, endotoxins,  $\beta$ -glucans and volatile organic compounds in indoor air.
- Persistent dampness and microbial growth on interior surfaces and in building structures should be avoided or minimized, as they may lead to adverse health effects.

[http://www.euro.who.int/\\_\\_data/assets/pdf\\_file/0017/43325/E92645.pdf](http://www.euro.who.int/__data/assets/pdf_file/0017/43325/E92645.pdf)



# Cleanup Based on MOISTURE Damage

AIHA Green Book, 2008

**Table 16.1** Cleanup Matrix Based on Severity of Moisture Damage/Dampness in Room or Zone

	<i>Severity of Moisture Damage/Dampness<sup>A</sup></i>	
	<i>Low</i>	<i>High<sup>B</sup></i>
Response Actions	<p>Fix moisture problem and dry building immediately. Problem typically can be resolved by building operator (including homeowner) or building maintenance personnel.</p> <p>Visible signs of moisture damage on non-biodegradable materials should be removed/cleaned using mild detergent solution.</p> <p>Damaged biodegradable materials, especially those left wet for a prolonged period (&gt; 48–72 hr) should be professionally cleaned or discarded.</p>	<p>Fix moisture problem and dry building immediately. These problems may be more complex in nature (e.g., accumulation of moisture in envelope wall; inadequate damp-proofed basement wall; ceiling concrete slab with leaks/condensation issues resulting from penetrations in the slab and/or temperature gradients leading to condensation). In these cases an indoor environmental professional, engineer, or architect with building science expertise may be needed to resolve the problem.</p> <p>Visible signs of moisture damage on non-biodegradable materials should be removed/cleaned using mild detergent solution.</p> <p>Damaged biodegradable materials, especially those left wet for a prolonged period (&gt; 48–72 hr), should be professionally cleaned or discarded.</p> <p>HEPA<sup>C</sup> vacuuming of surfaces may be considered as a final step.</p>



## Examples of Low/High Severity Designation

# LOW

- Minor slow water intrusion or spillage of water (e.g., small leaks in water lines, water seeping through building envelope, periodic moisture accumulation from convection/diffusion)
- No hidden damage suspected;
- Damage on resistant building material
- No odors
- Localized damage



■Photo courtesy of R Shaughnessy , Univ of Tulsa

## Examples of Low/High Severity Designation

# HIGH

- Massive powerful water leakage
- Possibility of hidden damage (e.g., closed cavity space with possible air leakage to indoor spaces)
- Damage on **susceptible building material**
- Odorous materials (MVOCs)
- Building-wide problem

If Mold Contamination is Present.....

**Table 16.3 Mold Cleanup Matrix Based on Severity of Mold Colonization in Room or Zone\***

Low	<i>Severity of Mold Colonization<sup>A</sup></i>	
	<i>Medium</i>	<i>High</i>
Response Actions		
<p><b>Actions can be carried out by appropriately trained building personnel.</b></p>	<p><b>Industrial hygienist (IH) or indoor environmental professional (IEP) experienced in mold remediation should be consulted to provide oversight during remediation activities.</b></p>	<p><b>IH or IEP experienced in mold remediation must be consulted to provide oversight and inspection prior to and during remediation activities. The IH or IEP must determine the exact containment methodology based on the following recommendations.</b></p>
<p>N95 minimum respirator</p>	<p>Competent supervisor to be present during all work; should be capable of inspecting work area for defective containments.</p>	<p>Workers use full face-piece air purifying respirators with P100 filters, or a positive pressure full face-piece powered APR with HEPA filters.</p>
<p>Eye protection</p>	<p>Full-body dust impervious overalls; eye protection; N95 respirator minimum, with full face HEPA air-purifying respirator (APR) recommended.</p>	<p>Workers shall wear impermeable gloves and full-body dust-impervious coveralls, with attached hoods, tightly secured with tape at the ankles and wrists; boot covers that can be cleaned with a HEPA vac; isolate work area using temporary containment measures (taping/polyethylene sheeting; cover all walls with one layer of polyethylene sheeting, taped in place).</p>
<p>Glove protection (suitable to work being performed); disposable overalls/boots may be considered based on situation Turn off HVAC<sup>B</sup> system (place plastic sheeting on diffusers &amp; return air openings)</p>	<p>Isolate the work area w/polyethylene sheeting, taped and supported as needed; provide for containment roof as needed; use polyethylene sheeting for floor covering.</p>	<p>Provide negative pressure within enclosure with HEPA negative air machines; minimum negative pressure of 5 pascal (0.02 inches of water column); design of minimum of 4 air changes per hour within the enclosure area (as described in Reference 4, p. 26, item 6).</p>
<p>HEPA<sup>C</sup> vac nonporous items, followed with cleaning detergent/disinfectant solution. If further remediation is needed, remove cleaned items from the space; for fixed items, seal w/ polyethylene sheeting to protect during subsequent work.</p>	<p>Induce a minimum negative pressure within the enclosure of 5 pascal (0.02 inches water column) by drawing air from enclosure using (a) exhaust fan directing air from within enclosure to outdoors (away from people) or (b) HEPA air filtration device (negative air machine), exhausting air to outside of enclosure preferably to outdoors if possible.</p>	<p>Provide a three-chamber decontamination unit to include clean change room and dirty change room; workers to don all clothing/PPE in clean change room; when exiting, workers must exit thru dirt change room and remove all coveralls, etc., prior to leaving contained area.</p>
<p>Remove porous visually moldy materials (e.g., ceiling tile); remove gypsum wallboard a minimum of 30 cm beyond demarcation line of visible growth.</p>	<p>Consider use of a single chamber airlock at entry to containment area; ensure airlock is under negative pressure with respect to occupied areas of building, and under positive pressure with respect to containment work area.</p>	<p>Double bag and seal wastes generated during mold remediation and remove those wastes through the decontamination unit (for more detail refer to Reference 4, p. 26, item 10).</p>
<p>For moldy items being removed, consider placing drop cloth under the material; dust suppression methods should be considered.</p>		
<p>Bag all waste into 6 mil minimum disposable bags for removal; wet wipe/HEPA vac the plastic bag and then double bag for final removal.</p>		
<p>After bulk removal of material, damp wipe exposed surfaces in the room; consider HEPA vacuuming of surfaces when necessary.</p>		
<p>Leave all the remediated areas visibly free of contamination and/or debris.</p>		

Refer to Canadian Construction Guidelines, 2004



# *Criteria to Assess Severity of Mold Contamination Based on Location, Extent & Material*



<b>LOW SEVERITY</b>	<b>MEDIUM SEVERITY</b>	<b>HIGH SEVERITY</b>
Moderately close, less extensive, resistant	Close, moderately extensive, resistant	Close, extensive, susceptible
Distant, moderately extensive, resistant	Close, less extensive, susceptible	Close, extensive, resistant
Distant, less extensive, susceptible	Moderately close, moderately extensive, susceptible	Close, moderately extensive, susceptible
Distant, less extensive, resistant	Moderately close, moderately extensive, resistant	Moderately close, extensive, susceptible
Close, less extensive, resistant	Moderately close, less extensive, susceptible	Distant, extensive, susceptible
	Distant, extensive, resistant	Moderately close, extensive, resistant
	Distant, moderately extensive, susceptible	

# LOCATION

3 **Categories** for mold damage observations are formed primarily based on **proximity to occupants**:

- **Distant locations** (hallways, closets, storage rooms, garages, basements, crawlspaces).
- **Moderately close** to occupants (bathrooms and kitchens) where people normally spend less than an hour/day.
- **Close proximity** to occupants (classrooms, offices, bedrooms) where people spend the most time.

# EXTENT

3 **Categories** are formed based on estimated size of damage (in  $m^2$ ); size designations are not meant to be exact determinants, but rather **approximations** based on professional judgment:

- Less extensive ( $<3 m^2$ ).
- Moderately extensive (3-10  $m^2$ ).
- Extensive ( $>10 m^2$ ).



# MATERIAL Type

## 2 Categories of Materials

- **Susceptible** (poor at resisting moisture and provides nutrients for microbes; subject to structural damage or failure)
  - Wood
  - Gypsum board
  - Amorphous cellulose products
  - Fiberboard
- **Resistant** (low in nutrients/inert)
  - Concrete
  - Brick
  - Metal surfaces
  - Terracotta and ceramic tiles



Photo courtesy of Richard Shaughnessy, University of Tulsa



# Roles & Communication

- Address Outrage  
Not Just Risk
- Empathetic
- Listen
- Err on Side of  
Caution
- Adjust for building  
type

## Professional Judgment to be Exercised:

-Making “informed” decision based on all information-