James Bukowski, MS, CIH
Director, Occupational and Environmental Safety
HSE (Health, Safety, and Environment)
DEFINING TERMS

Exposure Monitoring

v

Indoor Air Quality
Known contaminants

Established occupational exposure limits (OELs), usually

Hierarchy of Controllable

Limited, clearly defined number of people affected
EXPOSURE MONITORING
Unknown contaminants (if any)

Established occupational exposure limits (OELs), infrequently

Hierarchy of Control (not really applicable)

Number of people affected can vary greatly
DEFINING TERMS

INDOOR AIR QUALITY IS NOT THE PREFERRED NOMENCLATURE

THE PROPER TERM IS INDOOR ENVIRONMENTAL QUALITY.
DEFINING TERMS

Indoor Environmental Quality (IEQ)
Takes into account IAQ plus:

- Lighting
- Noise/Acoustics
- Occupant control over temperature and lighting
- Office layout
- General cleanliness
- Psychosocial factors
DEFINING TERMS

Sick Building Syndrome (SBS)

v

Building-Related Illness (BRI)
DEFINING TERMS

SBS

Cause of symptoms is not known but attributed to work environment

Symptoms include headache, eye, nose, throat irritation, dry cough, dry/itchy skin, dizziness nausea, fatigue, sensitivity to odors

Symptoms resolve soon after leaving the building.
DEFINING TERMS

BRI

Symptoms include cough, chest tightness, fever, chills, and muscle aches

Symptoms can be clinically defined and have clearly identifiable causes

Symptoms do not resolve soon after leaving the building.
BUILDING-RELATED ILLNESS

Legionnaires’ Disease/Pontiac Fever

Hypersensitivity Pneumonitis

Occupational Asthma
INDOOR AIR QUALITY

Comfort factors
  Temperature
  Humidity
  Carbon Dioxide (CO2)

Chemical Contaminants (Odors)

Biological Contaminants (Odors/Mold)

Non-biological particulates (Dust)
COMFORT FACTORS

Temperature (°F)
OSHA: 68 - 76
ANSI/ASHRAE: 68.5 – 75 (winter)*
    75 – 80.5 (summer)*

* Based on slow air movement and 50% RH

Activity (metabolic rate) will also influence optimal temperature
TEMPERATURE

Having control of temperature for your area is an important satisfier
Consider clothing and PPE
Reduced perception of poor air quality at lower temperature, but.....
Odors are more easily detected at lower temps
*Ceteris paribus*, err on the side of cool
Comfort Factors

Humidity (%R.H.)
OSHA: 20 – 60
TJC: 30 – 60
ASHRAE: <65

>60: concerns about mold growth
<20: drying of mucous membranes, static electricity concerns
Carbon Dioxide (CO2)

CO2 is used as a surrogate to determine if an area is getting adequate ventilation.

- < 1000 ppm acceptable
- < 800 ppm optimal

OSHA PEL: 10,000 ppm

More outside air/person => lower CO2

ASHRAE default value for office space: 17 cfm/person
CHEMICAL CONTAMINANTS

Indoor Sources
Off-gassing from carpeting, furniture, paint, etc.
Cleaning and other building maintenance products
Migration from other areas within building
Pesticide application
Dry traps
Humans
CHEMICAL CONTAMINANTS

Outdoor Sources

Vehicle Exhaust
Generator Exhaust
Roofing/Painting/Maintenance near air intake
Hazardous exhaust/plumbing vents near intake
Fires
OUTDOOR SOURCES
OUTDOOR SOURCES
OUTDOOR SOURCES
Levels of chemical contaminants will be well below OELs, usually orders of magnitude.

Typically will list concentration of chemicals found and compare to lowest published OEL.

Can also list total VOC concentration and compare to LEED standard for new buildings.
<table>
<thead>
<tr>
<th>Chemical</th>
<th>Concentration</th>
<th>Strictest Regulatory Occupational Exposure Limits</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ug/m$^3$</td>
<td>ug/m$^3$</td>
</tr>
<tr>
<td>Acetone</td>
<td>13.3</td>
<td>590,000 (NIOSH)</td>
</tr>
<tr>
<td>Benzene</td>
<td>0.26</td>
<td>319 (NIOSH)</td>
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<tr>
<td>Carbon tetrachloride</td>
<td>0.38</td>
<td>12,600 (NIOSH)</td>
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<td>Chloroform</td>
<td>0.24</td>
<td>49,000 (ACGIH)</td>
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<td>Chloromethane</td>
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<td>103,000 (ACGIH)</td>
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<td>Dichlorodifluoromethane</td>
<td>1.63</td>
<td>4,950,000 (OSHA)</td>
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<tr>
<td>Freon 113</td>
<td>0.38</td>
<td>7,600,000 (NIOSH)</td>
</tr>
<tr>
<td>n-Heptane</td>
<td>0.66</td>
<td>350,000 (NIOSH)</td>
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<tr>
<td>Methylene chloride</td>
<td>18.4</td>
<td>86,750 (OSHA)</td>
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<tr>
<td>Methyl ethyl ketone</td>
<td>0.74</td>
<td>590,000 (OSHA)</td>
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<tr>
<td>Styrene</td>
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<td>215,000 (NIOSH)</td>
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<td>Toluene</td>
<td>2.26</td>
<td>75,000 (ACGIH)</td>
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<tr>
<td>Trichloroethene</td>
<td>2.15</td>
<td>54,000 (ACGIH)</td>
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<tr>
<td>Trichlorofluoromethane (Freon 11)</td>
<td>0.96</td>
<td>5,600,000 (OSHA)</td>
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<tr>
<td>2,2,4-Trimethylpentane</td>
<td>0.37</td>
<td>1,402,000 (ACGIH)</td>
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<tr>
<td>1,1-Difluoroethane</td>
<td>11.9</td>
<td>2,201,000 (AIHA)</td>
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<tr>
<td>Ethanol</td>
<td>32.9</td>
<td>1,900,000 (OSHA)</td>
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<tr>
<td>Hexamethylcyclotrisiloxane</td>
<td>20.6</td>
<td>N/A</td>
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<tr>
<td>Isopropyl Alcohol</td>
<td>242</td>
<td>491,000 (ACGIH)</td>
</tr>
<tr>
<td>Octamethylcyclotetrasiloxane</td>
<td>15.0</td>
<td>N/A</td>
</tr>
<tr>
<td>Total VOCs</td>
<td>365.55</td>
<td>500 (LEED Guidance Documents)</td>
</tr>
</tbody>
</table>
BIOLOGICAL CONTAMINANTS

Animal-related allergens
  Research Animals
  Pests (rodent, cockroach, dust mites)
  Pets
Pollen

MOLD
Mold is ubiquitous

Your nose and your eyes are good investigative tools

Associated with water damage or water infiltration that is not addressed quickly

Unless you are immuno-compromised or have severe allergies/asthma, mold does not present a health hazard

No OELs for mold. Sampling typically compares indoor levels to outdoor levels to see if there is amplification inside.
A WORD ABOUT... TOXIC BLACK MOLD

8 SIGNS OF BLACK MOLD TOXICITY & HOW TO DETOX FAST!

TOXIC BLACK MOLD IS CAUSED BY ALIENS
**A WORD ABOUT...TOXIC BLACK MOLD**

*Stachybotris chartarum or atra*

Produces a mycotoxin (like thousands of other molds)

Mycotoxins are large molecules, not easily airborne => inhalation potential extremely low

Originally tied to infant Acute Idiopathic Pulmonary Hemorrhage (AIPH) in Cleveland (c.1995), later retracted by CDC

Bottom line: don’t ingest or rub Stachybotris or other toxigenic molds on open wounds.
PARTICULATES

Sources

Outdoor air

Degradation of HVAC components

Construction/renovation inside building

Re-suspension of settled material inside building
PARTICULATES

Regulatory Limits

OSHA PNOR (Total): <15000 ug/m3
   (PM5): <5000 ug/m3

ACGIH PNOR (PM10): <10000 ug/m3
   (PM5): <3000 ug/m3

US EPA PNOR (PM10): <150 ug/m3 (24 HR)

JHH PNOR Patient Areas (Total): <100 ug/m3

JHH PNOR Office Areas (Total): <1000 ug/m3
PARTICULATES

EPA survey of 100 randomly selected office buildings
PM10:  GM 11.4 ug/m3 (3.0 – 35.4)
PM 2.5: GM 7.2 ug/m3 (1.3 – 24.8)

Recent sampling in office complaint area in JHH
PM10: 0.65 – 230 ug/m3
PM2.5: 0.30 – 6.12 ug/m3

Highly unlikely to see regulatory limits exceeded.
Complaints regarding particulates typically related to:

Interior construction/renovation: Failure to maintain dust barriers and/or differential pressure.

HVAC system maintenance/outages: dust in ducts gets “burped” out when system comes back on.

Poor housekeeping: re-aerosolization of stuff already in the room.
INVESTIGATIONS

Basics
Review complaint
Visit area
Speak with area occupants
Speak with facilities staff: information about HVAC system
INVESTIGATIONS

First Impressions
TOOLS

Comfort
TOOLS

Chemical

25 common indoor air contaminants
TOOLS

Chemical

EPA TO-15: 62 VOCs + TICs (tentatively identified compounds)
TOOLS

Biological

For airborne allergens, sampling pump with filter.

Can also sample for allergens in carpeting.
Tools

Mold

Viable (plates) v Non-viable (cassette)
Plate sampling used for:
Compare levels (CFU/volume air) inside to outside
OR
Send to mycology lab for speciation

Cassette sampling used for:
Identify to genus level for known allergies
<table>
<thead>
<tr>
<th>Particle Identification</th>
<th>Raw Count</th>
<th>Count/sq cm</th>
<th>% of Total</th>
<th>Interpretation Guidelines</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alternaria</td>
<td>8</td>
<td>300</td>
<td>31.6</td>
<td>Acceptable</td>
</tr>
<tr>
<td>Ascosporae</td>
<td>9</td>
<td>400</td>
<td>42.1</td>
<td>Acceptable</td>
</tr>
<tr>
<td>Aspergillus/Penicillium</td>
<td>1*</td>
<td>10*</td>
<td>1.1</td>
<td>Slightly Elevated</td>
</tr>
<tr>
<td>Basidiocarpites</td>
<td>4</td>
<td>200</td>
<td>21.1</td>
<td>Acceptable</td>
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<tr>
<td>Bipolaris</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>Acceptable</td>
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<tr>
<td>Chalara</td>
<td>-</td>
<td>-</td>
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</tr>
<tr>
<td>Cladosporium</td>
<td>-</td>
<td>-</td>
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</tr>
<tr>
<td>Curvularia</td>
<td>-</td>
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<td>Epicoccum</td>
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<tr>
<td>Fusarium</td>
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<td>Ganoderma</td>
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<td>Myxomycetes</td>
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<td>Pithomyces</td>
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</tr>
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<td>Rust</td>
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<td>Scopularia</td>
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<tr>
<td>Stachybotrys</td>
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<td>Torula</td>
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<tr>
<td>Ustulidium</td>
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<tr>
<td>Unidentified Spores</td>
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<td>Zygomycetes</td>
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<td>Acceptable</td>
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<td>Fuscidiadelma</td>
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</tr>
<tr>
<td>Oidium</td>
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</tr>
<tr>
<td>Total Fungi</td>
<td>23</td>
<td>950</td>
<td>100</td>
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<tr>
<td>Hyphal Fragment</td>
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<tr>
<td>Insect Fragment</td>
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<tr>
<td>Pollen</td>
<td>2*</td>
<td>30*</td>
<td>-</td>
<td>Acceptable</td>
</tr>
</tbody>
</table>

Analytical Sensitivity: 0032:00 46 counts/sq cm; 0033:13 counts/sq cm.

- **Acceptable**: Concentration at or below background.
- **Slightly Elevated**: Concentration below background.
- **Elevated**: Concentration 10% or more above background.
- **Not Commonly Found indoors, Spores likely come from outside.**
- **Spores reported to be alleve cause allergies in individuals.**
- **Potential for maximum production exists with inoculation.**
- **These fungi are considered water damage indicators.**

High levels of background particulate can obscure spores and other particulates leading to underestimation. Background levels of 0 indicate an underestimation of background particulates, resulting in inaccurate detection and quantification. Present = Spores detected on overloaded samples. Results are not blank corrected unless otherwise noted. The detection limit is equal to one fungus spore, structure, pollen, free particles or insect fragment. "*" denotes parasites found at 20x, **" denotes parasites found at 40x. "*" Denotes not detected. Due to methodological rules, raw counts in excess of 100 are extrapolated based on the percentage analysis. EMSL maintains liability limited to cost of analysis. This report relates only to the samples reported above and may not be reproduced, except in full, without written approval by EMSL. EMSL bears no responsibility for sample collection activities or analytical method limitations. Interpretation and use of test results are the responsibility of the client. Samples received in good condition unless otherwise noted.

Samples analyzed by EMSL Analytical, Inc., Seattle, WA 98108-2312, EMLAP-Accredited #LOM1CL.


For information on the fungi listed in this report please visit the Resources section at www.emsl.com
TOOLS

Particulate

Direct reading instruments
PARTICULATE CASSETTE SAMPLING

If there is concern about the composition of the dust, can also send for qualitative analysis.
Many IAQ complaints are comfort-related; addressing those parameters – temperature, humidity, ventilation – goes a long way to resolving complaints. Apart from susceptible individuals, poor IAQ is not a health hazard.

Take into account psychosocial factors: attitude, transparency, and risk communication skills are important.

Good IAQ => higher productivity.
CONTACT INFO

2024 E. Monument St.
Ste. B-200
410-955-5918
HSEinfo@jhmi.edu

Home
Safety
Everyday