Indoor Environmental Quality (IEQ)

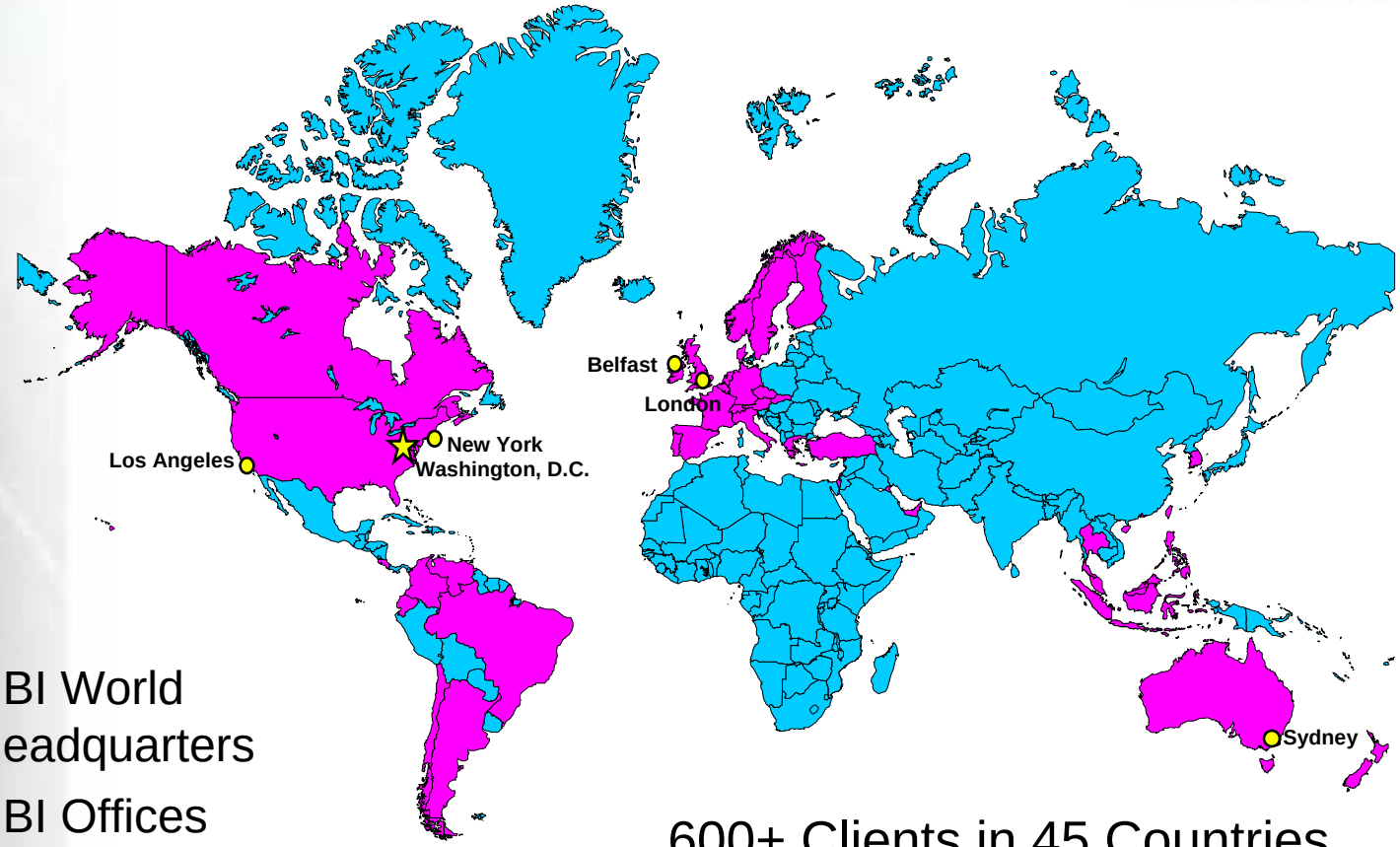
Healthy Buildings International, Inc.

Simon Turner, President

GovEnergy
www.govenergy.gov

Healthy Buildings International, Inc.
Who We Are

GSA Schedule
Contract GS-10F-0125K



- ★ HBI World Headquarters
- ● HBI Offices
- ■ Client Countries

600+ Clients in 45 Countries
4,500+ Buildings
450+ Million Square Feet

HBI Healthy Buildings International

HBI Indoor Environmental Activities

- **IAQ Reactive Inspections**
- **IAQ Proactive Monitoring Programs**
- Drinking Water, Asbestos, Lead, Mold, etc.
- Construction Monitoring
- Architectural Design and Renovation Reviews
- Ventilation System Design and Analysis
- Expert Witness Testimony on IAQ Issues
- LEED Consulting

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“Sick Building Syndrome”

Symptoms

Eye Irritation

Dry Throat

Rhinitis, Runny Nose

Headache

Fatigue

Sinus Congestion

Skin Irritation

Shortness of Breath

Cough

Dizziness

Nausea

Mental Confusion

Mildest

Severest

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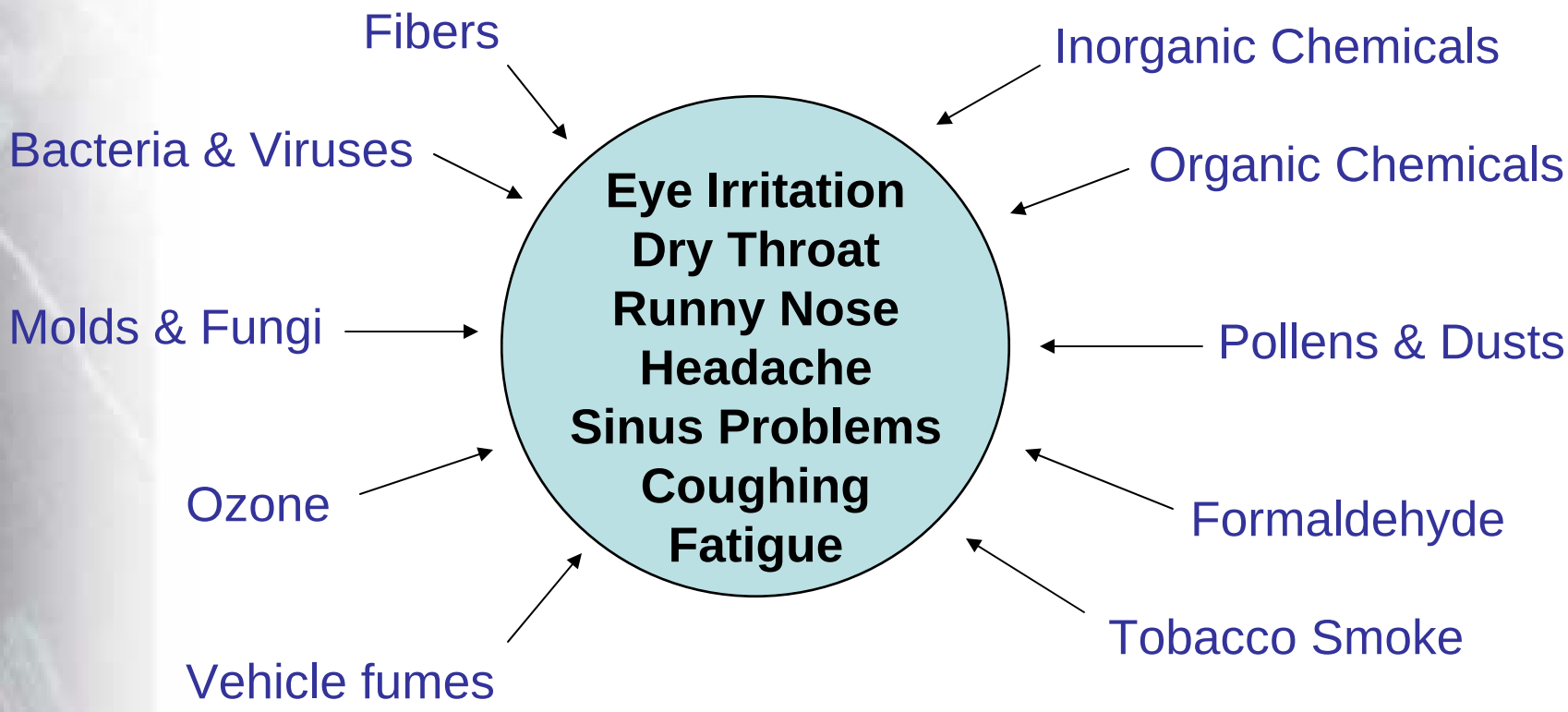
Sick Building Syndrome Overlapping Symptomatology



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Cover Story -- June 2000

Healthy Buildings International

The Washington Post

HEALTH

Tuesday, September 17, 2002

ATTACK OF THE KILLER MOLD

Some people are allergic to molds and suffer **mild respiratory symptoms**. In others, mold can trigger **asthma attacks**. Those with weakened immune systems may contract mold-related **infections**. But more exotic symptoms—including bleeding lungs, confusion and other mental problems — have not been firmly linked to mold.

Mold forms in areas that are damp and where there is little air circulation, like **under sinks** and **inside walls** where a pipe is leaking. Remove the source of moisture and you kill the mold. Most mold-related lawsuits charge builders or contractors with flaws that create persistently wet conditions where mold thrives.

Stachybotrys (above), the infamous black mold, produces mycotoxins. But it's not clear whether or how they expose people to additional health risks.

September 2002

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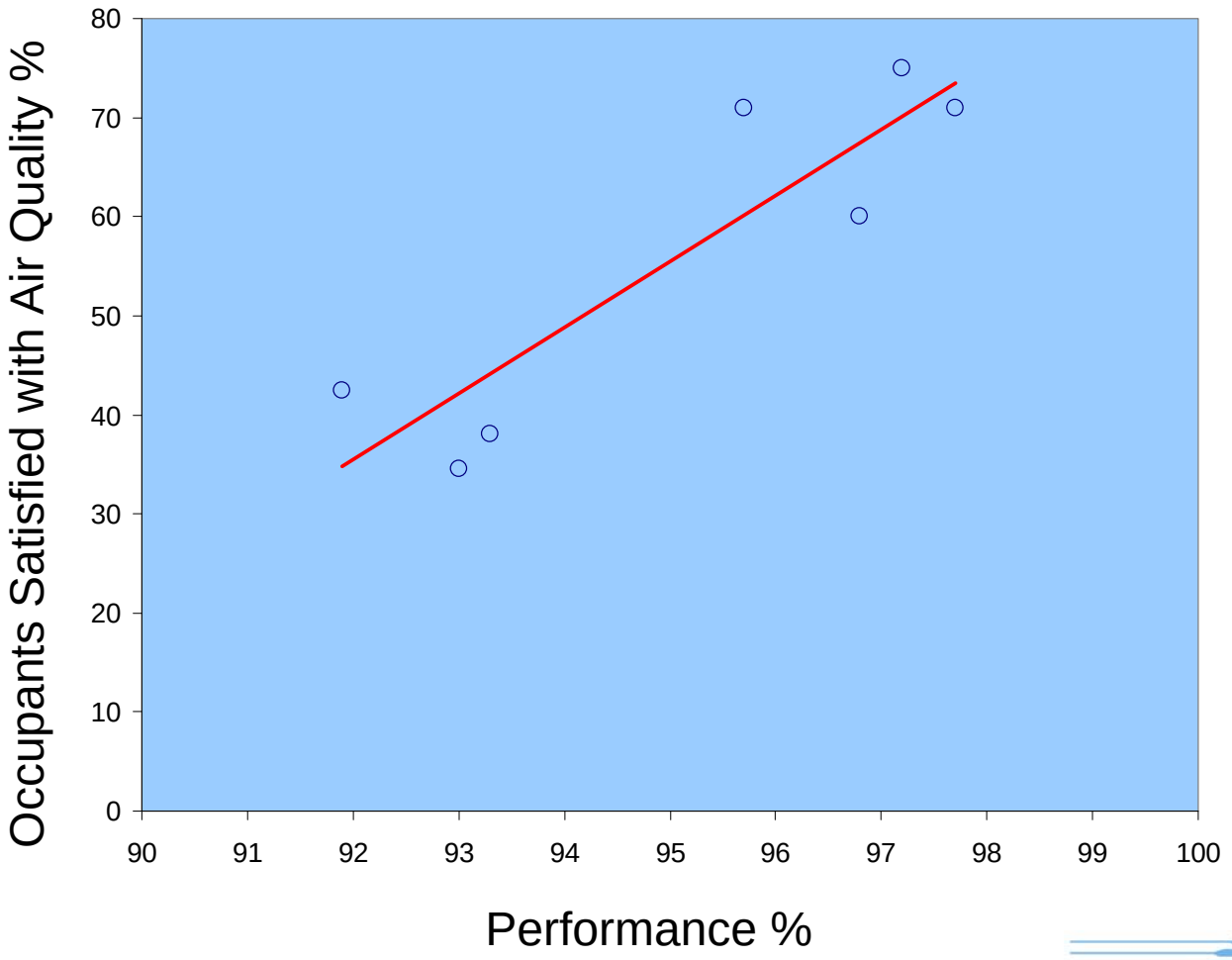
The Relationship Between Occupant Perceptions of IAQ And Productivity



Adapted from Wargocki, P., et al. 1999, Wargocki, P., et al. 2000, Wargocki, P., D. Wyon and P.O. Fanger. 2000, Wargocki, P., et al. 2002.

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The Media Has Negatively (& Unfairly?) Affected Occupants' Perceptions of IAQ

- Occupants Fear the Unknown
- They React to Horror Stories in the Press
- Most IAQ Complaints are Comfort Issues
- Serious IAQ Problems are Rare
- Pollutant Levels Rarely Even <u>Approach</u> Permissible Exposure Limits (PELs)

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The Pandora's Box…

Some Facility Managers are Afraid

To Open "Pandora's Box"

Historically Concerned with Documenting

Presence of Specific Airborne Pollutants

However

The Truth is

Actual Documentation has Great Value

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HBI's Philosophy on IAQ Management

Indoor Pollutants Rarely Reach

Permissible Exposure Levels (PEL)

Typically Levels are 100 –1,000 Fold Lower

Confirming Such Low Values – Reassures Occupants

Documenting Results - Exhibits Due Diligence

Protects Managers Against Liability

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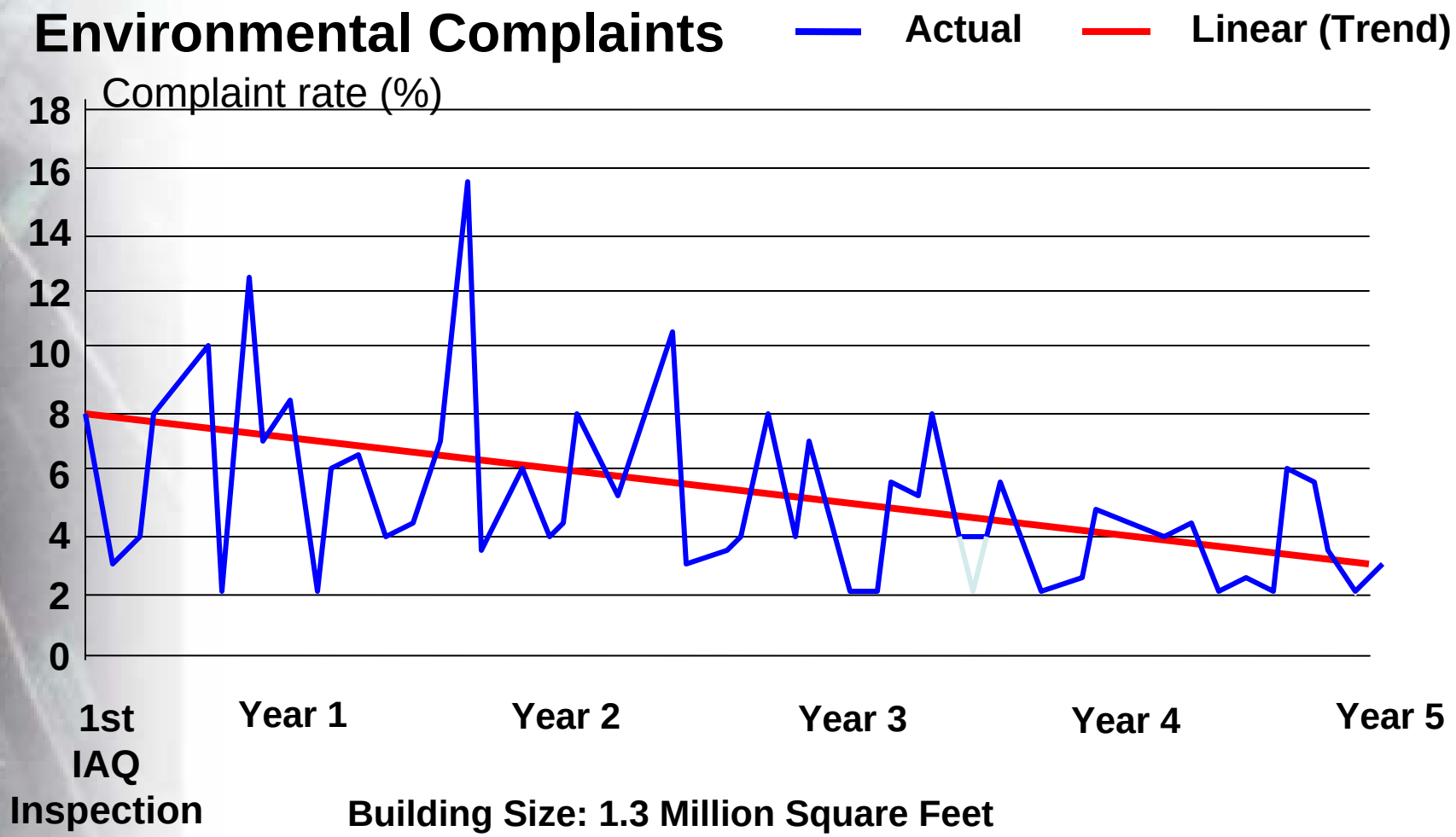
Results of Proactive Monitoring

A Major Corporation's 5 Year Experience



Building Size: 1.3 Million Square Feet

Source F. Gallo, Union Carbide Corporation

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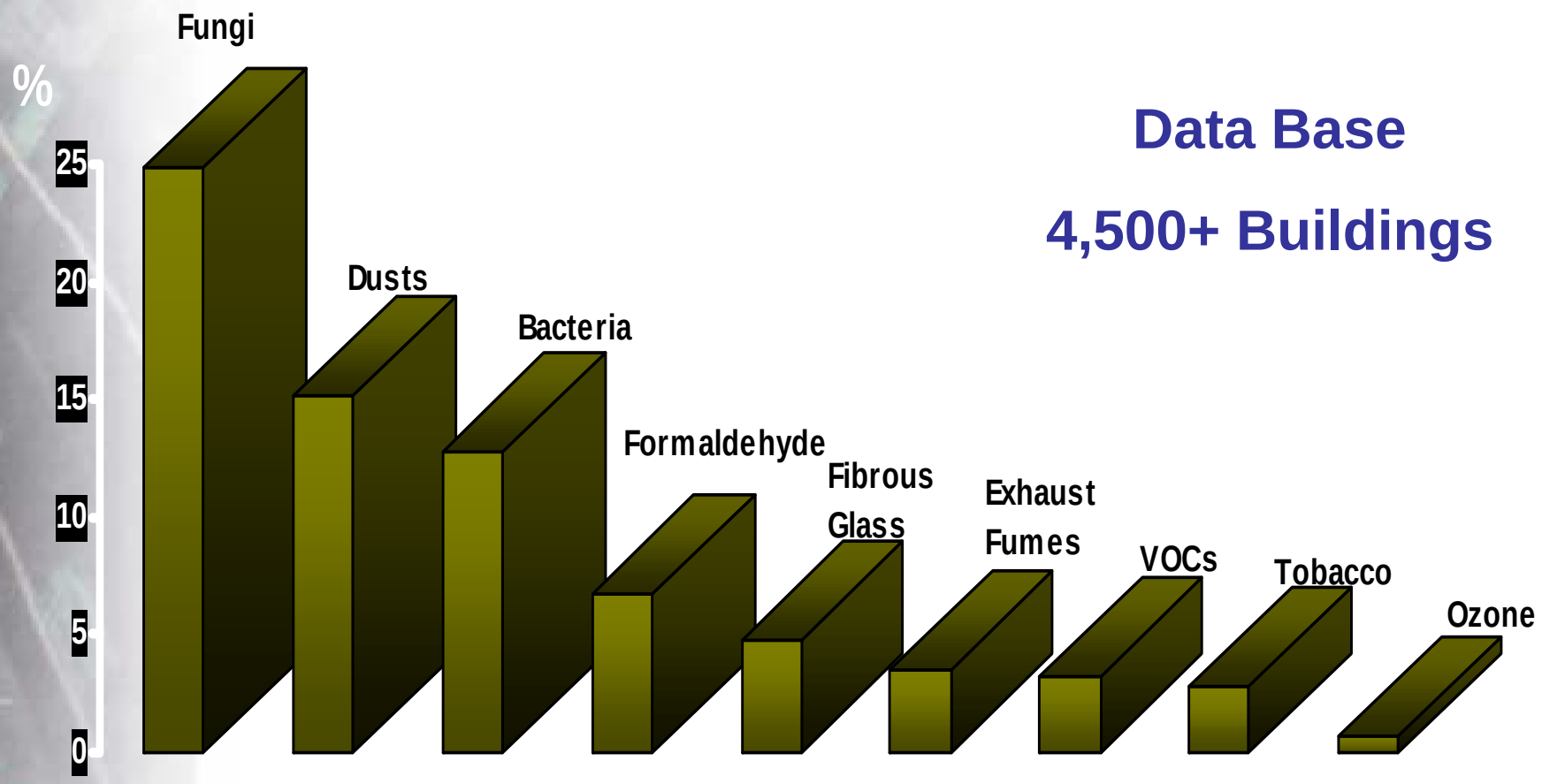
HVAC System Faults Contributed to Airborne Pollutants - Major Culprits



Data Base

4,500+ Buildings

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HBI'S 25 YEARS OF EXPERIENCE

Most IAQ Problems are Caused by

HVAC Systems 3 Common Denominators:

- **Inadequate Ventilation**
- **Inefficient Filtration**
- **Poor Hygiene**

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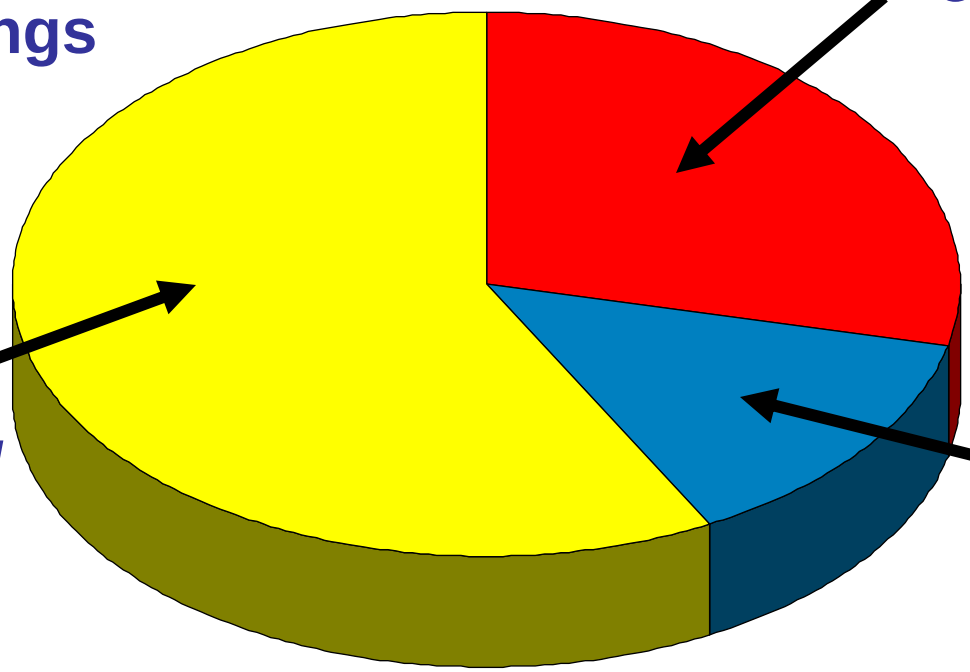
Causes – IAQ Problems (1 of 3)
Inadequate Ventilation

HBI Database

4,500+ Buildings



Adequate Ventilation:
Carbon Dioxide Less Than 800 ppm

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Ventilation is Essential But How Do We Define Minimum Ventilation Rates ?

What is “a Sufficient Volume” of Ventilation Air?

How have Minimum Ventilation Rates Evolved?

The Following Graphs Help Answer These Questions and Help Support ASHRAE 62-2007

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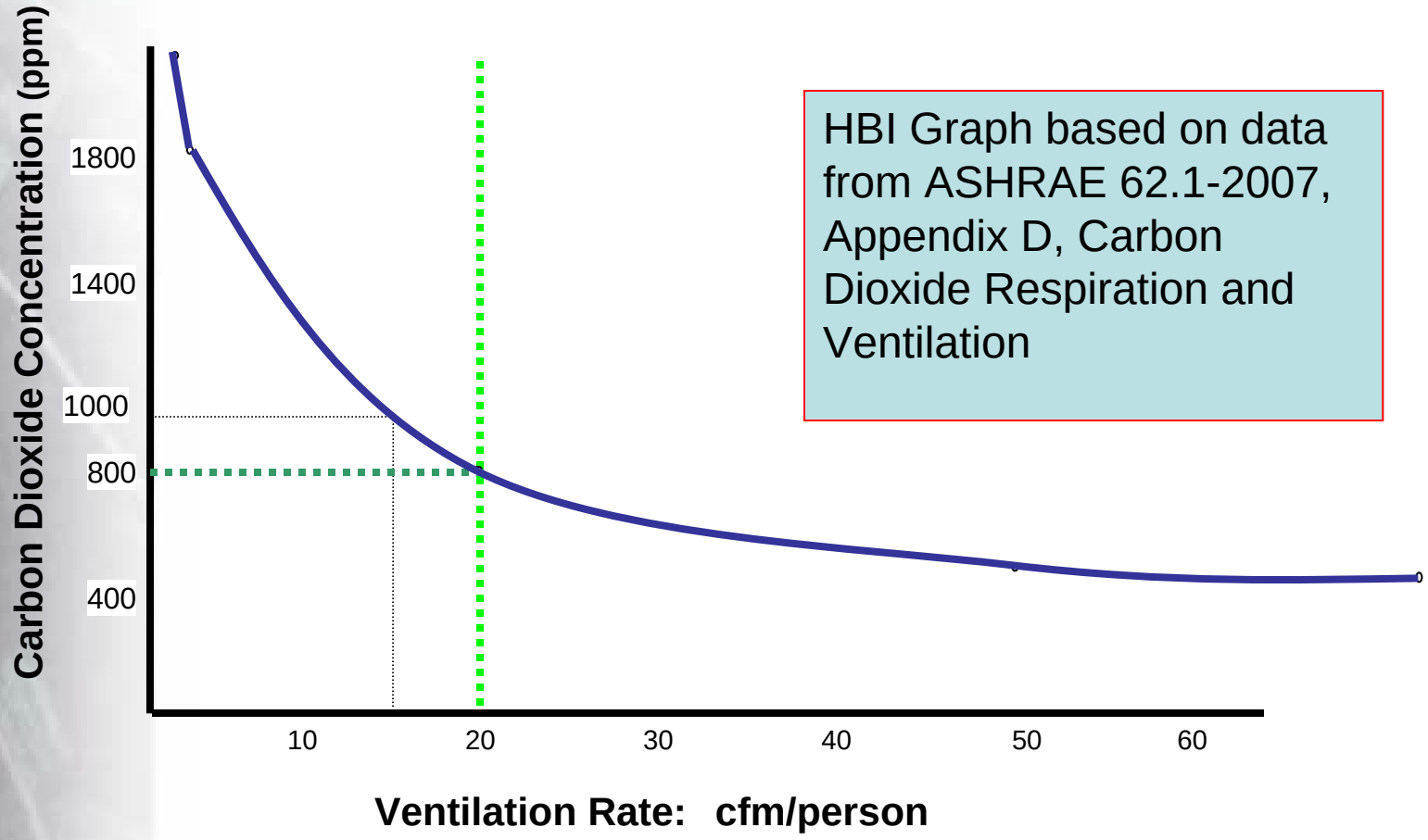
CARBON DIOXIDE vs. VENTILATION



HBI Graph based on data from ASHRAE 62.1-2007, Appendix D, Carbon Dioxide Respiration and Ventilation

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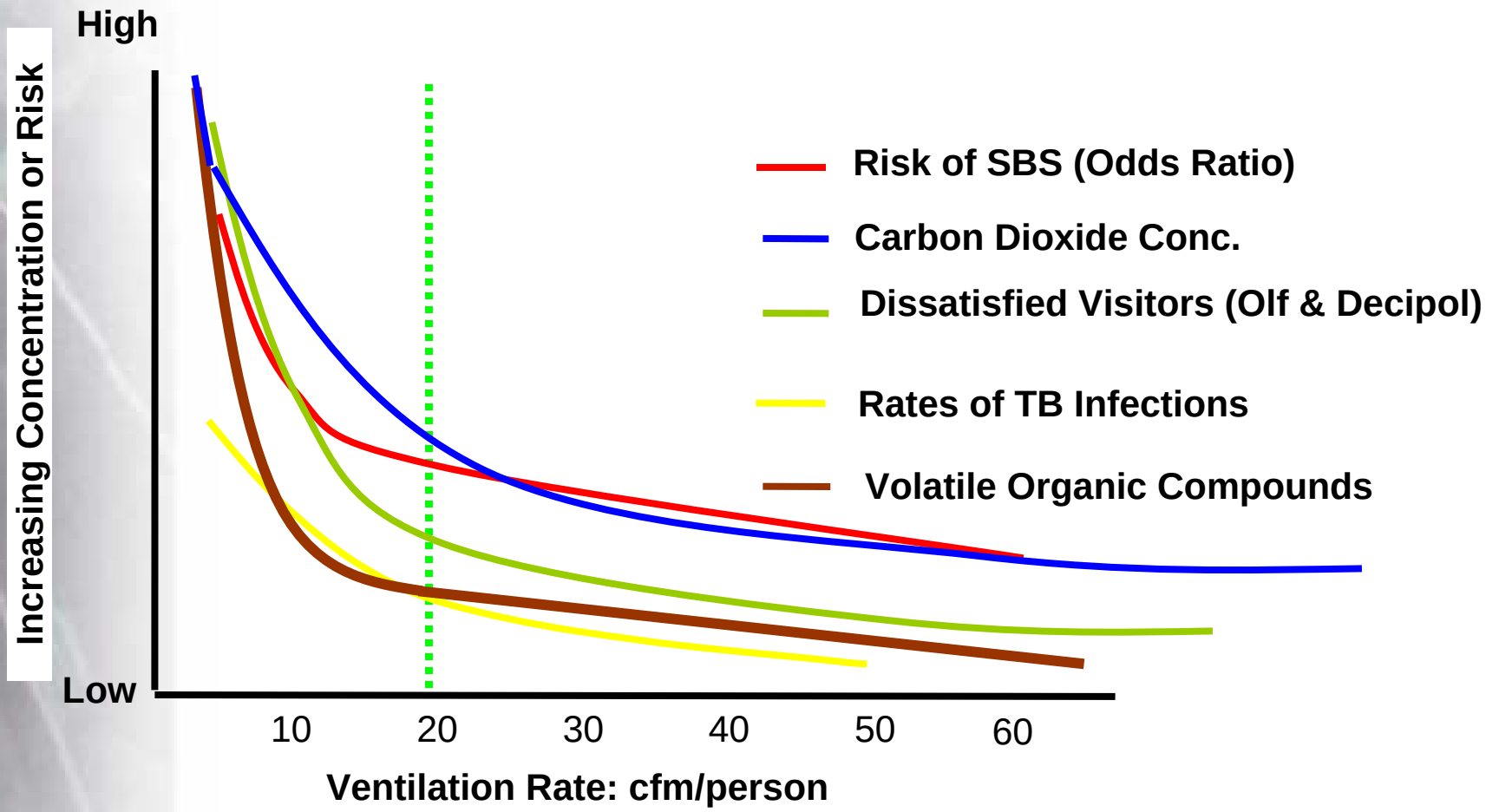
VENTILATION vs. POLLUTANT OR RISK



20 cfm/p: ASHRAE 62-01 and OSHA Proposed Rules

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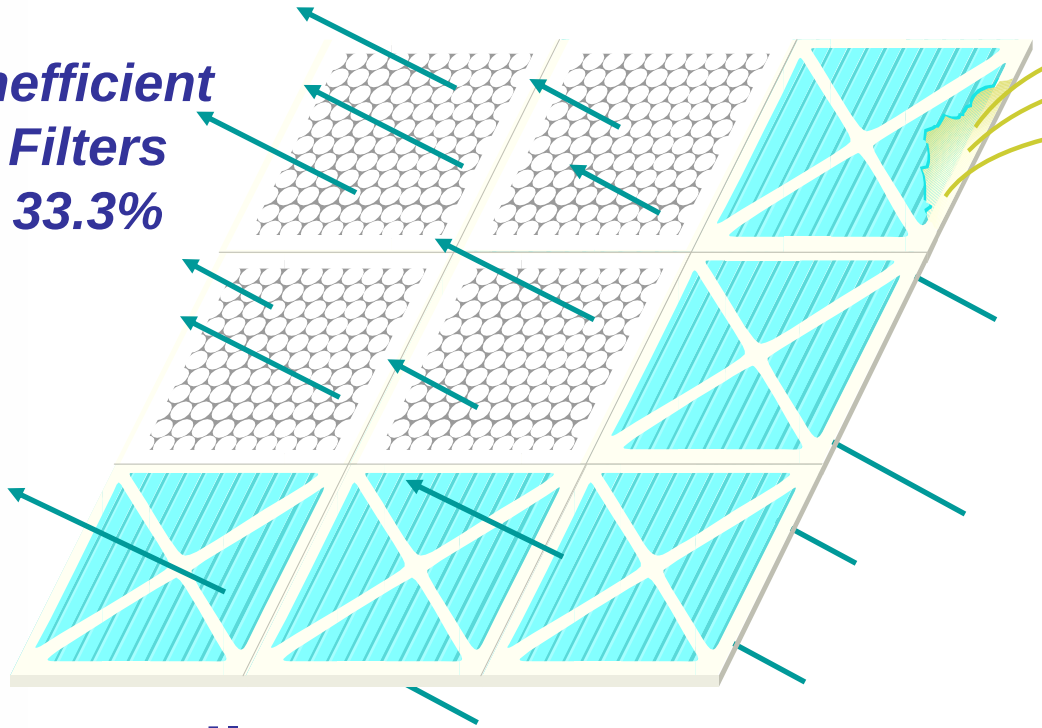
Causes – IAQ Problems (2 of 3)
Inefficient Filtration



HBI Database

4,500 Buildings

Satisfactory Filters: MERV > 7, LEED Requirement 13
ASHRAE 52.9-1999

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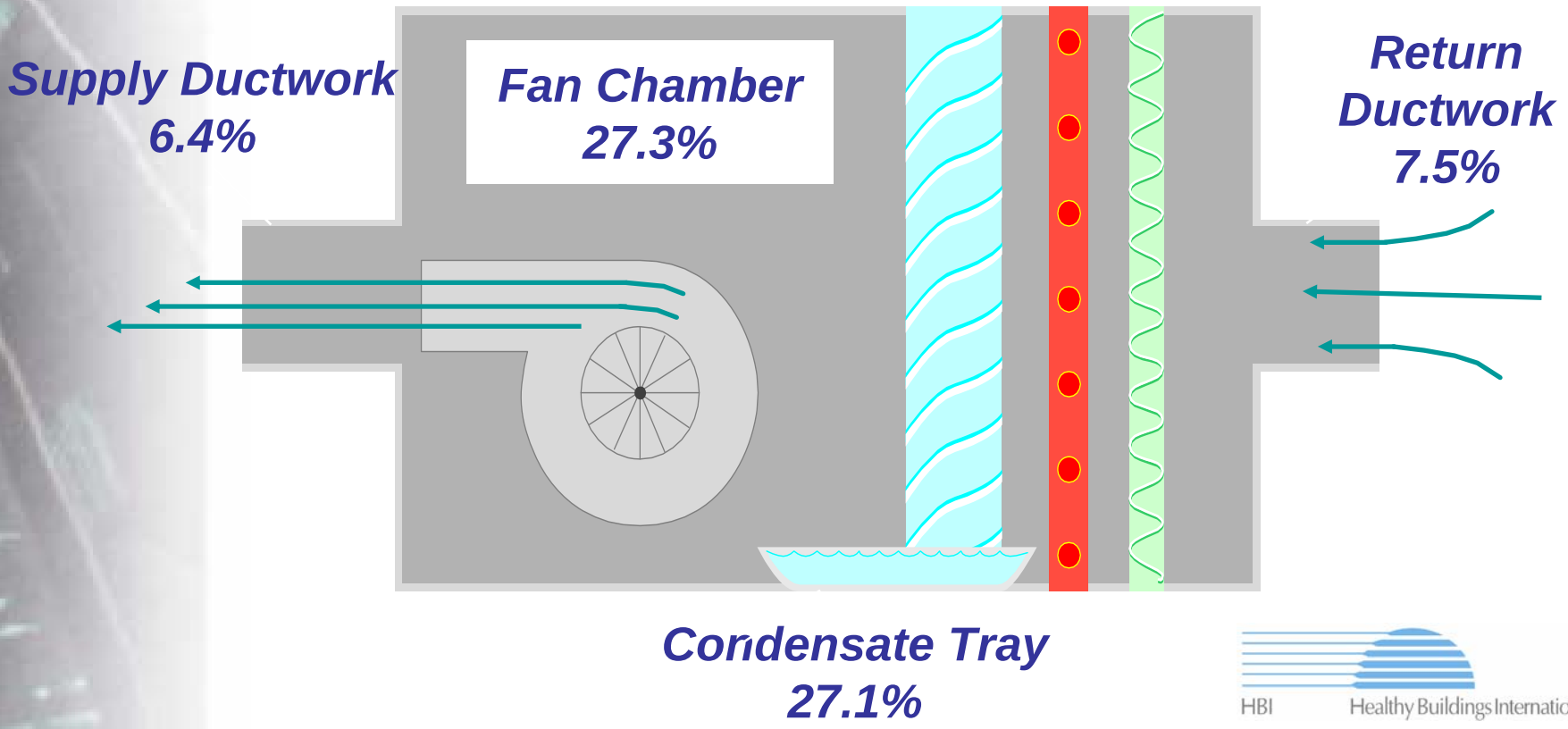
Causes – IAQ Problems (3 of 3) Poor HVAC Hygiene

HBI Database – 4,500 Buildings



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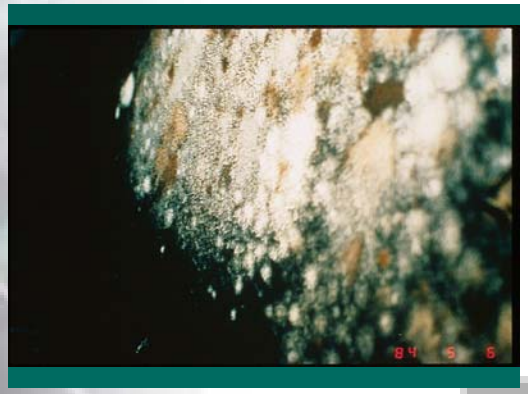
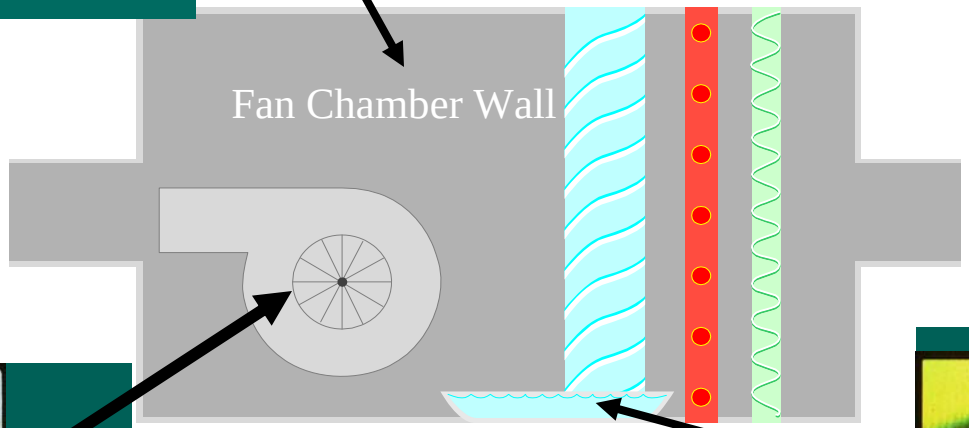
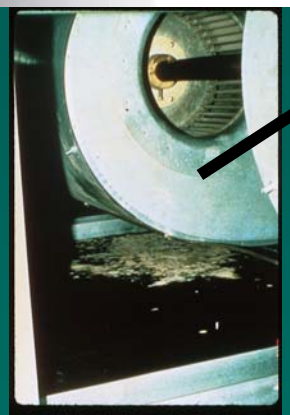
Potential Problems Caused by Poor Hygiene

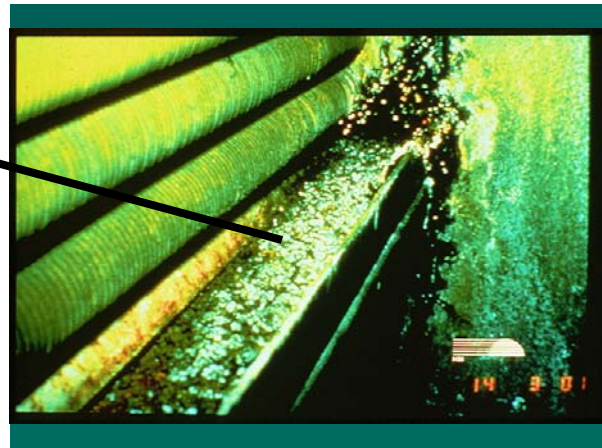


Inside Air Handling Unit

Favorite Sites for Fungal Infestation



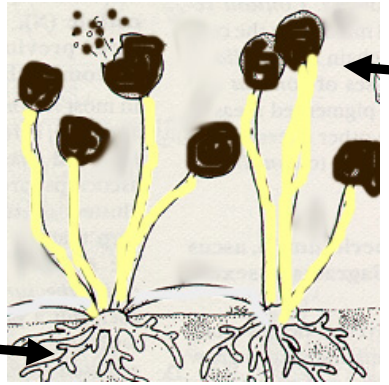




Types of Microorganisms
Fungi (Size 0.5 –30 microns)

- **Cell membrane separates nuclear material from cell protoplasm**
- **They include molds, yeasts, mildews as well as large mushrooms and puff balls**
- **Molds and mildews are a subset of fungi that are of most concern since they frequently inhabit buildings**
- **Need organic material and water to grow**
- **Within 48 – 72 hours wetted surfaces can harbor millions of mold spores**

A typical mold: Mucor (Black mold on bread)



Spore heads, releasing spores "seeds"

Hypha – penetrate substrate like roots

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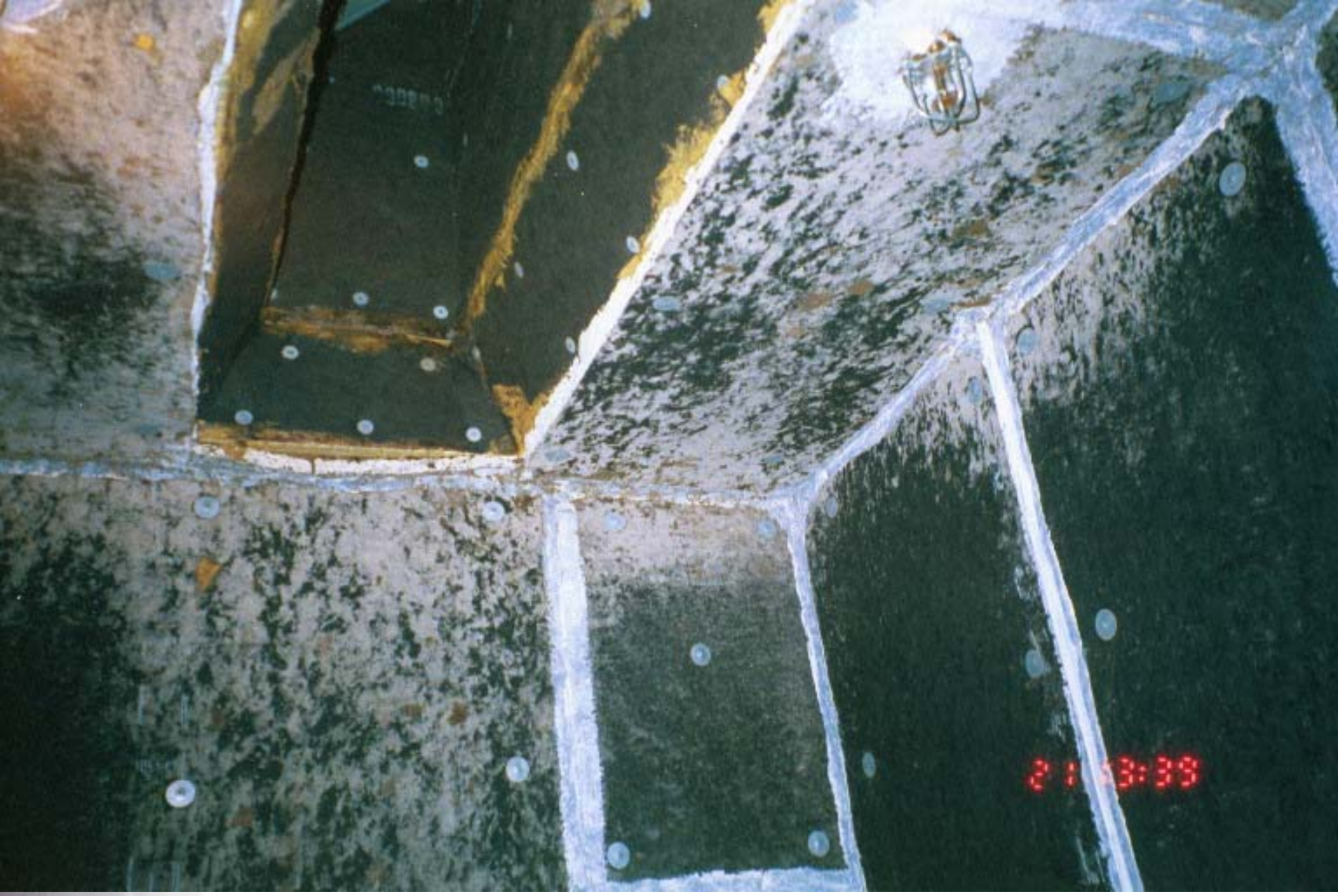

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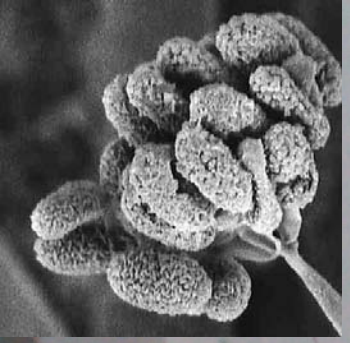

27. 8. 2001

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Outside Air Intakes and Filters

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Hospital Kitchen

Moisture condensation on cellulose ceiling materials. No mold could wish for more

Hospital in Central America

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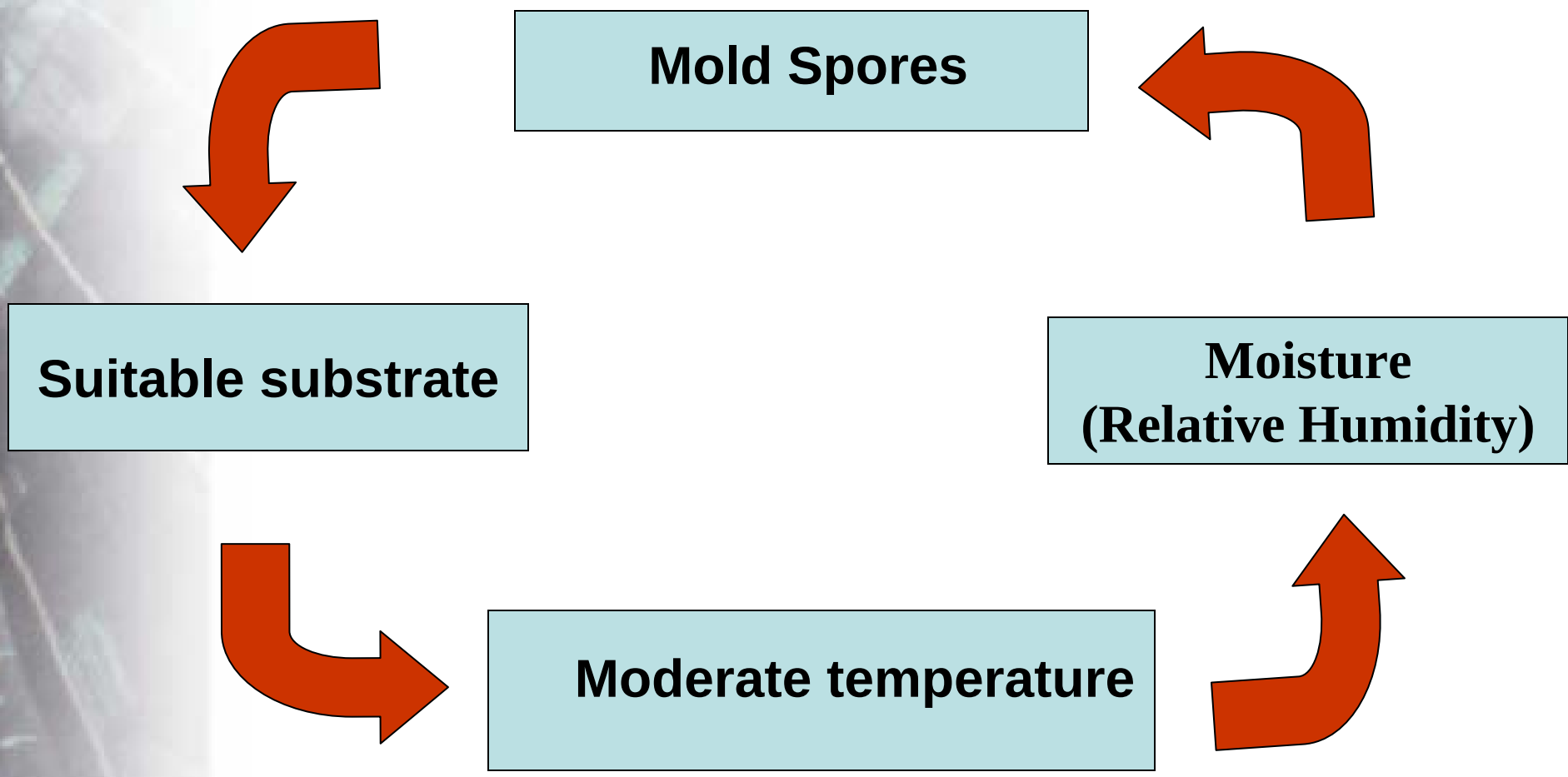
Prevention of Mold

We need to break this cycle:



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Mold Control – Breaking the Cycle
Moisture – Mold's Achilles heel!

Moisture control is the key to success

With no liquid water and with surface relative humidities below 65% few fungi proliferate

Fact: by controlling moisture we control molds!

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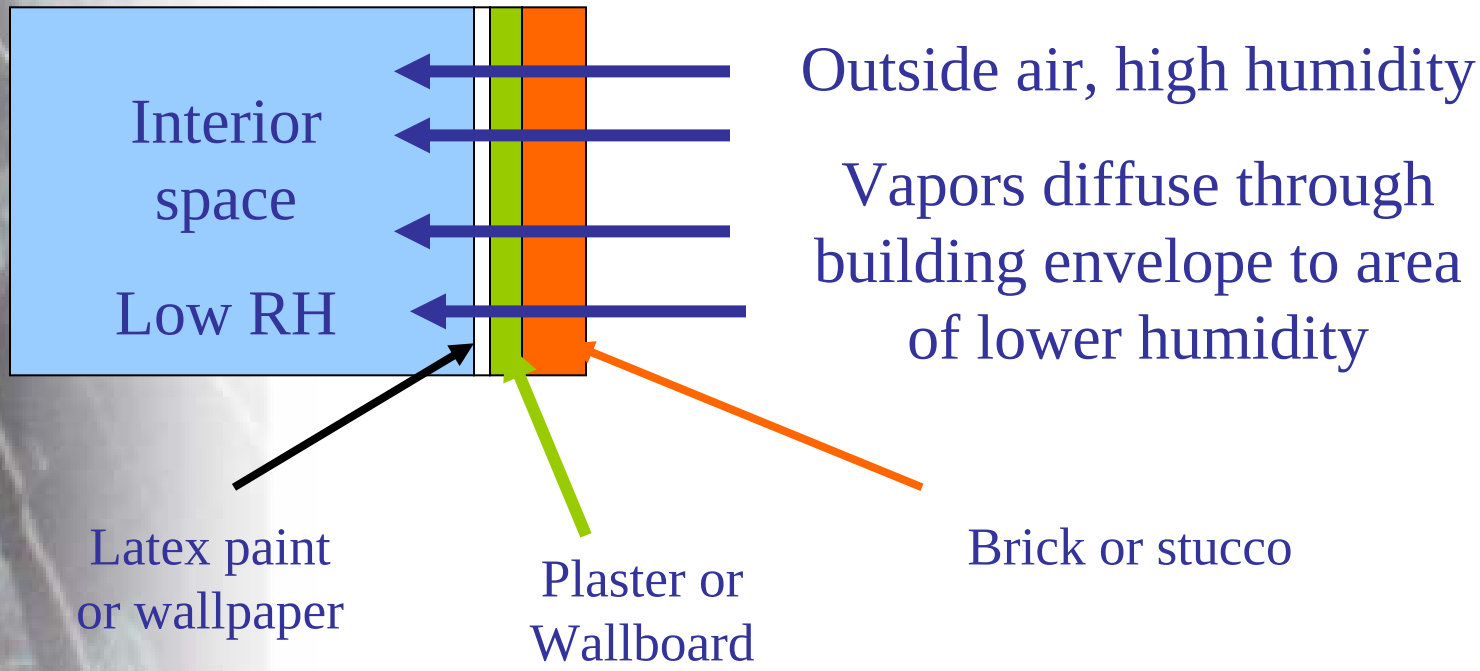
Assume Humid Climate

Building with lower humidity than outdoors



Latex paint, paper, plaster, wallboard, brick and stucco all somewhat permeable to water vapor

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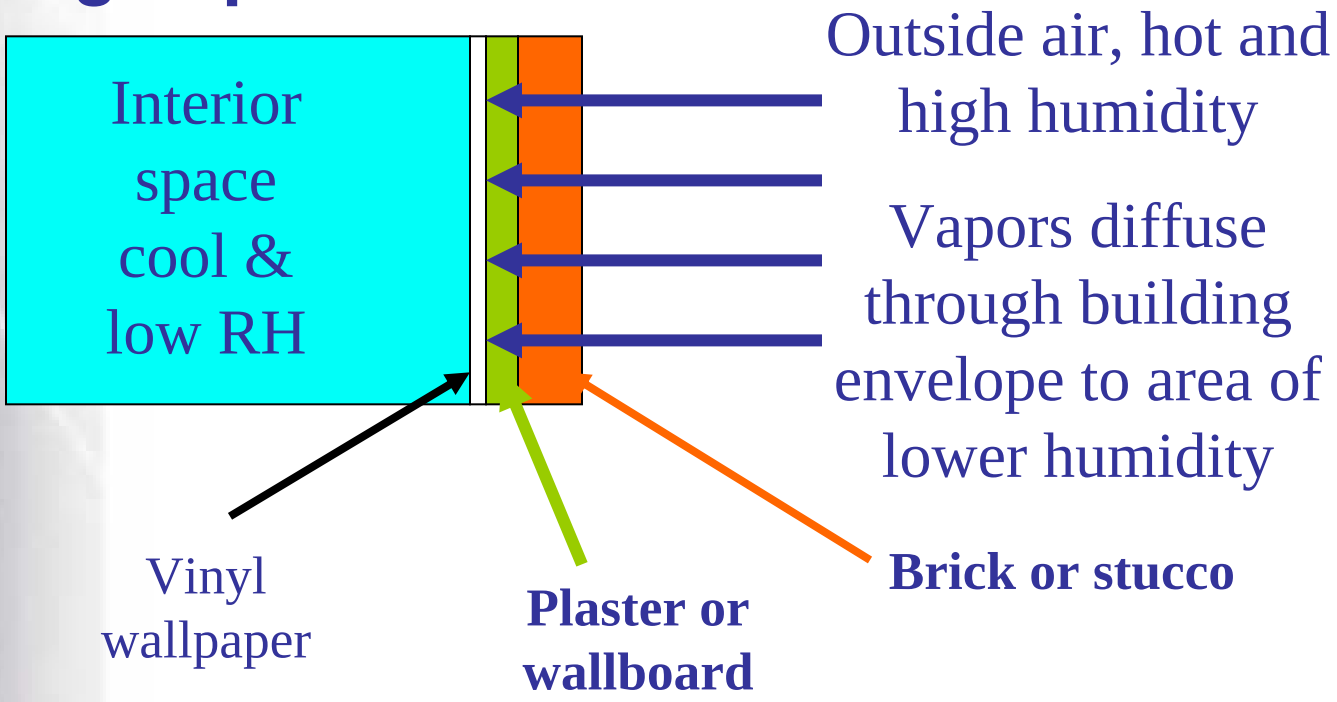
Assume Humid Climate

Building with lower humidity than outdoors

Wrong vapor barrier!



Vinyl wallpaper on interior of outside wall is impermeable. Water vapor trapped, inner wall is coldest surface, so vapors condense.

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Molds on Interior Vapor Barriers

As the water vapor condenses we now have moisture and adhesives (containing starch - ideal food for molds) in a dark warm place under the wallpaper.

Usual scenario - musty odors reported, lighter colored patches appear on wallpaper

Very common in hotels where bathroom exhausts help maintain high negative pressure inside building

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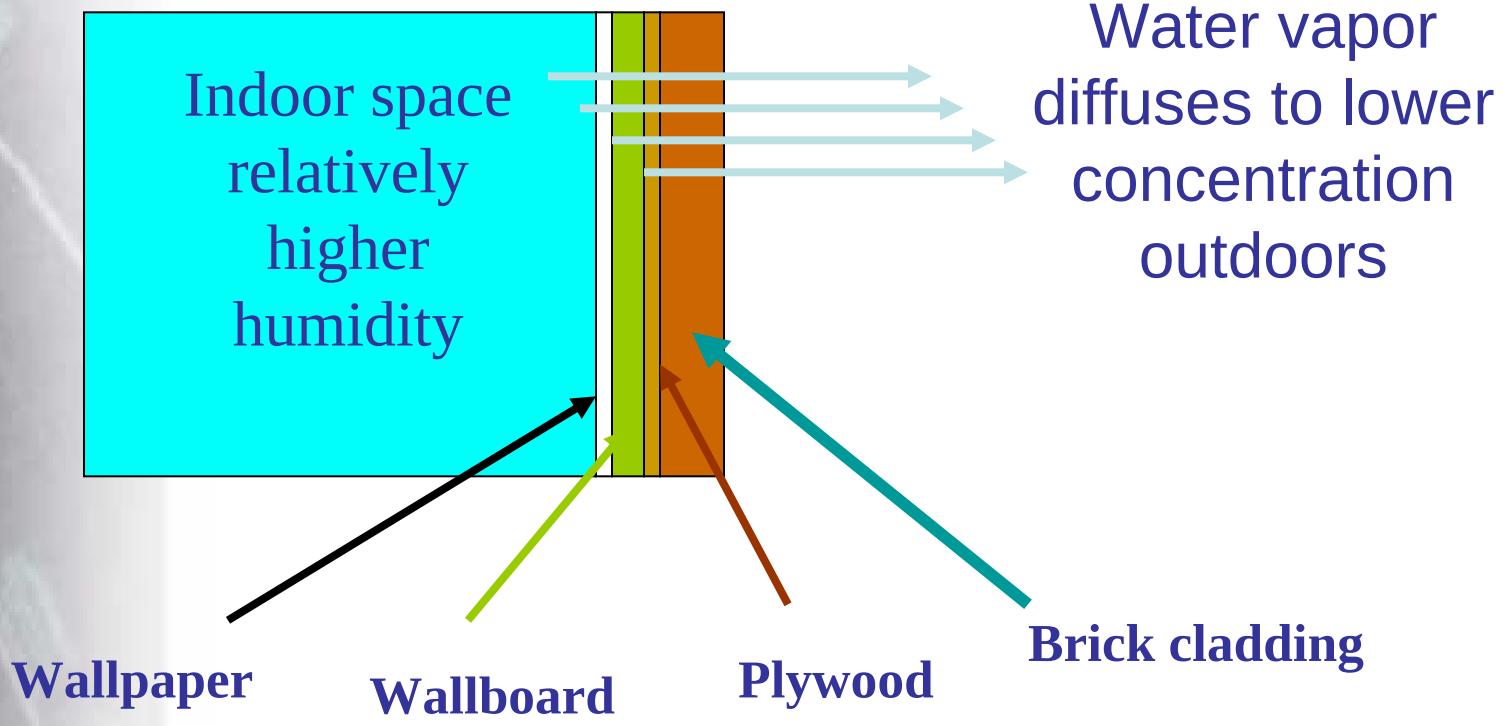
Now Consider a Cold Climate

Inside building more humid than outdoors



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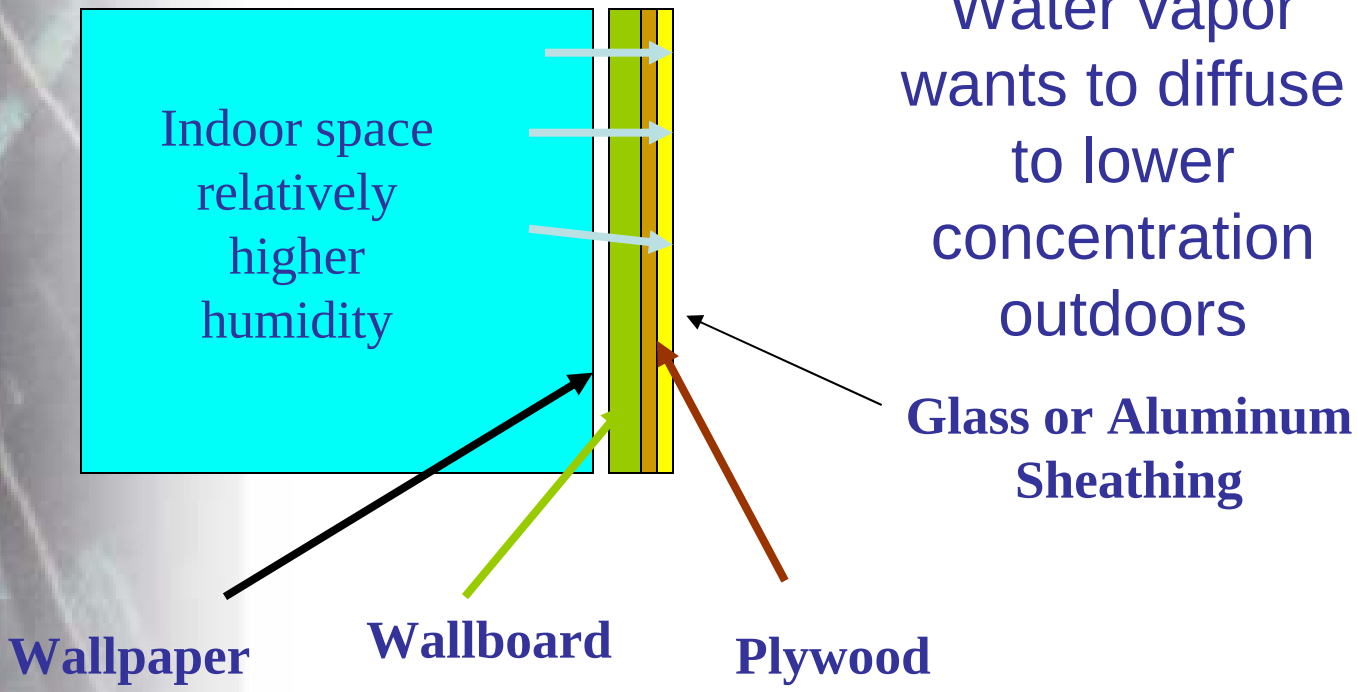
In Such a Cold Climate

Inside building more humid than outdoors

Wrong vapor barrier!



Glass or aluminum is impermeable to water vapor, thus vapors condense on underlying plywood and molds develop

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Heating Season - Mold on Vapor Barrier

See dampness under window joints, plywood and insulation contaminated with mold

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Summary of Moisture Sources in Buildings

Liquid water – rain, snow, floods & pipe leaks

Liquids and vapor from sub-soils

Moisture built in during construction

- **Water vapor from:**
  - Humid outside air
  - Infiltration through building envelope when building is under a negative air pressure **(high volume and fast)**
  - Infiltration through building envelope via vapor pressure differences **(slow but cumulative)**
  - People (perspiration) and indoor activities, cooking, washing etc

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Remediation of Mold: Whom to Involve

If there are no symptoms reported and the area of mold damage is small (<10 ft^2) – consider this a housekeeping function and delegate clean-up to maintenance staff.

But call in professional help if:

- **Occupants are experiencing symptoms of suspected mold exposure**
- **The affected area is substantially greater than 10 square feet,**
- **There are widespread musty odors**
- **The risk of exposure to remediator is great**
- **Potential for litigation is present**

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The Key Variables to Consider When Faced With a Mold Remediation

- Total surface area affected
- Materials/Furnishings affected
- Cleanup methods
- Personal protective equipment
- Containment

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U.S. EPA Mold Remediation Definitions
Total Surface Area Affected

- Small = less than 10 ft^2 affected
- Medium = between 10 and 100 ft^2 affected
- Large = greater than 100 ft^2 affected

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U.S. EPA Mold Remediation Definitions

Cleanup Methods

Carpets/some upholstered furniture

Wet vacuum, or steam cleaning

Hard Surfaces

Damp-wipe with water or water/bleach solution. Scrub as necessary.

Drywall

Cut out and discard in sealed bags. Dispose as normal waste. Then HEPA vacuum area.

HEPA vacuum after material is dry. Dispose of vacuum contents in sealed bags.

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U.S. EPA Mold Remediation Definitions
Personal Protective Equipment (PPE)

- Minimum: Gloves, N-95 respirator, goggles/eye protection.
- Limited: Gloves, N-95 respirator or half-face respirator with HEPA filter, disposable overalls, goggles/eye protection.
- Full: Gloves, disposable full body clothing, head gear, foot coverings, full-face respirator with HEPA filter.

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U.S. EPA Mold Remediation Definitions

Containment

- Limited: Polyethylene sheeting ceiling to floor around affected area with slit entry & covering flap; maintain area under negative pressure with HEPA fan unit; block supply/return air grilles.
- Full: 2 layers of fire-retardant polyethylene sheeting w/ airlock chamber. Maintain area under negative pressure with HEPA fan unit exhausted to outside; block supply/return air grilles.

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What Precipitated the Current Concern Over Toxic Molds?

In 1994-6, a cluster of 10 infants from Cleveland, Ohio were identified with pulmonary hemorrhage (bleeding in the lungs)

One infant died

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Medical Investigation

Preliminary results indicated that hemorrhaging was associated with major water damage (flooding) in the homes and increased mold counts, including the mold:

Stachybotrys chartarum.

The toxic effects of *Stachybotrys* were first reported in the 1920's in Russia, where researchers reported bleeding lungs and high mortality in cattle & horses that had ingested moldy hay

Remember – The horses ATE the moldy hay!

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Medical Report Published

The fact that the CDC helped support the study by local doctors who blamed the common black mold, added credibility

The Media had a field day

-- Death of Infants

-- Life Threatening Black Mold

Stachybotrys “Toxic Mold”

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A Media Feeding Frenzy Followed

Time Magazine - July 2, 2002

‘Beware: Toxic Mold”

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Molds and Sick Buildings

How can the general public not feel concerned with this sort of publicity?

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Effects of Media Attention

- **Public buildings have been closed**
- **Mold inspectors and remediation "experts" have materialized "like mushrooms after a heavy rain"**
- **Cleanup costs have soared**
- **Litigation has flourished**
- **The insurance industry has been plundered**

Some plaintiff attorneys appear to rank Stachybotrys as more dangerous than Plutonium!

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Toxic Findings Retracted
March 10, 2000

The CDC now concludes that the available evidence does not substantiate the reported epidemiological associations, stating:

- The available evidence does not substantiate the association between water damage and the infant symptoms
- There were serious shortcomings in the collection, analysis and reporting of the data
- The methods used did not distinguish between contamination and exposure
- No isolates or serological evidence of exposure to fungi were obtained

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Mold in Commercial Buildings

Legislative Activity

In California: Toxic Mold Protection Act of 2001 Signed into Law by Governor

- ✓Any person who sells, transfers or rents property must disclose suspect mold contamination to buyers or tenants
- ✓Task force to determine Permissible Exposure Limits on molds in indoor environments.
- ✓Other States expected to follow lead, esp. NY, TX and TN

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Conclusions (1 of 2)

Mold Contamination is:

- **Common in Humid Climates**
- **Widespread After Flooding**
- **Disruptive and Expensive**
- **Attracting Media Attention**
- **Creating a new "Ambulance Chasing" Group of Plaintiff Attorneys**

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Conclusions (2 of 2)

Mold Contamination:

- **Prevention is Better than Cure**
- **Moisture Control is the Key**
- **Prompt Response Minimizes Extent of Damage**
- **Corrective Technologies Exist**
- **Proper Protocols Minimize the Risk of Litigation**

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Floods

- **Clean Water -** Waters that do not contain contaminants and includes broken water lines, malfunctioning appliances, toilets holding tanks, snow melt and rainwater. Most substrates, if not moldy, can be simply dried out.
- Over time, say within 48 hours, should be considered Gray Water

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Floods

- **Gray Water -** waters include discharges from dishwashers, washing machines, sinks, showers, aquariums and waterbeds.
- Over time, say within 48 hours, Gray Water should be considered Black Water

Black Water…

Ugh!!…

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Floods

- **Black Water -** This is a positive health risk. These waters are presumed to contain multiple and potentially harmful contaminants. It includes floodwaters containing soil and any sewage waters.
- Most porous substrates, if touched by black water, should be removed from the building

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Legionella

Preferred Growth Temperatures

68°F 95°F 115°F 122°F

← Optimum Range →

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Legionella

- **First Isolated After the American Legion Convention at the Bellevue Stratford Hotel in Philadelphia in July 1976**
  - 221 Cases of Pneumonia
  - 34 Deaths
- **Currently, About 8,000-18,000 Cases/ Year Reported to the CDC - But Many More Go Unreported**
- **Low Attack Rate (5%)**
- **High Fatality Rate (10-15%) and up to 80% in Elderly/Immunosupressed if Left Untreated**

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Legionella

Found in:

- Cooling Towers
- Evaporative Condensers
- Domestic Hot Water Systems
- Spas
- Whirlpools
- Humidifiers
- Decorative Fountains
- Showerheads
- Vegetable Misters

Look for Dead Legs, Stagnant Water, Unused Piping, Scale, Biofilm

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Legionella

Control Strategies

- Thermal Pasteurization (Superheating)
- Periodic Chlorination
- Metal Ions
- UV Light
- Ozone or Chlorine Dioxide Injection

Note: Cleaning is Important!

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The Green Building Revolution

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LEED EB and IAQ

Fulfill Credit Requirements

EQ Credit 1.1 – IAQ Management

Document Building Practices

EQ Prerequisite 2 – ETS Control (No Smoking)

EQ Credit 1.4 – Reduce Particulates in Air Distribution

EQ Credit 2.2 – Occupant Controlled Lighting

Additional Credit Opportunities

ID Credits 1.1 & 1.2 – Innovations in Operations – Water Quality

ID Credit 2 – LEED™ AP – Add a LEED™ AP to your project team

Other IAQ Related Credits

EQ Prerequisite 1 / Credit 1.3 – Outdoor Air Introduction

EQ Credit 1.5 – Management for Facility Alterations

EQ Credit 2.3 – Thermal Comfort Monitoring

Partially Fulfill Requirements

EA Prerequisite 1 – Systems Documentation

EA Credit 2.1 – Commissioning – Investigation & Analysis

EA Credit 2.3 Ongoing Commissioning

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The Green Building Revolution, Continued

LEED Existing Buildings (EB) Program
Indoor Environmental Quality 2008

Prerequisite 1 – Comply with ASHRAE Standard 62.1-2007

Prerequisite 2 – Environmental Tobacco Smoke Control

Prerequisite 3 - Green Cleaning Policy

Failure to comply with Asbestos Management, PCBs, Water Discharge and Other Federal, State and Local Regulations Now Grounds for Revocation of LEED EB Rating

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LEED EB Credits (cont.)

EQ Credit 1.1 – IAQ Management Program

- "Operate a program to enhance IAQ by optimizing practices to prevent the development of IAQ problems in buildings and maintain the well being of occupants. Survey and evaluate building systems to identify potential IAQ problems and implement an ongoing program to prevent these problems from occurring and to maintain a high level of IAQ.
- Include in the program a plan for preventing moisture accumulation and mold in the building."

LEED EB Credits

EQ Credit 1.2 - Install Permanent CO_2 Sensors

EQ Credit 1.3 – Increased Ventilation

Verify that ventilation rates are at least 30% above the ASHRAE standard (62.1-2007)

EQ Credit 1.4 – Use MERV 13 Filters

EQ Credit 1.5 - Management for Facility Alterations and Additions

Develop an IAQ Management Plan to be implemented during construction

Conduct Flush-out after Completion of Tenant Improvements

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Step 1 – IAQ Management Plan Contractor Guidelines (EQ 3.1)

- HVAC Protection
- Pollutant Source Control
- Control of Pollutant Pathways
- Housekeeping Measures
- Environmental Benchmarks

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Indoor Environmental Quality

Construction Management Plans (EQ 3.1)

Uninstalled Insulation correctly wrapped

Air handler wrapped

Clean Conditions

Capped air return duct

Poly screen across access door

Insulation on pallets

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EQ credit 1.5: IAQ Sampling vs. Flush-out

IAQ Sampling

- Energy consumption – NONE
- Cost – relatively low
- Results – within days
- Allowed in LEED NC and CI

Flush-out

- Energy consumption – HIGH
- Cost – HIGH
- Results – depends on climate

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LEEB EB Credits

EQ Credit 2.1 - Occupant Survey

Assess building occupant comfort as it relates to temperature, acoustics, IAQ, lighting levels, building cleanliness and comfort

EQ Credit 2.2 – Occupant Controlled Lighting

50% of occupants shall have individually controlled lighting

EQ Credit 2.3 – Thermal Comfort Monitoring

Verify that the thermal comfort conditions stated in the ASHRAE standard (55-2004) are being maintained

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Air Distribution Configuration	E_z
Ceiling supply of cool air	1.0
Ceiling supply of warm air and floor return	1.0
Ceiling supply of warm air 15°F (8°C) or more above space temperature and ceiling return.	0.8
Ceiling supply of warm air less than 15°F (8°C) above space temperature and ceiling return provided that the 150 fpm (0.8 m/s) supply air jet reaches to within 4.5 ft (1.4 m) of floor level. **Note**: For lower velocity supply air, $E_z = 0.8$.	1.0
Floor supply of cool air and ceiling return provided that the 150 fpm (0.8 m/s) supply jet reaches 4.5 ft (1.4 m) or more above the floor. **Note**: Most underfloor air distribution systems comply with this proviso.	1.0
Floor supply of cool air and ceiling return, provided low-velocity displacement ventilation achieves unidirectional flow and thermal stratification	1.2
Floor supply of warm air and floor return	1.0
Floor supply of warm air and ceiling return	0.7
Makeup supply drawn in on the opposite side of the room from the exhaust and/or return	0.8
Makeup supply drawn in near to the exhaust and/or return location	0.5

1. "Cool air" is air cooler than space temperature.
2. "Warm air" is air warmer than space temperature.
3. "Ceiling" includes any point above the *breathing zone*.
4. "Floor" includes any point below the *breathing zone*.
5. As an alternative to using the above values, E_z may be regarded as equal to air change effectiveness determined in accordance with ASHRAE Standard 129[16] for all air distribution configurations except unidirectional flow.

ASHRAE Standard 62.1-2004

Displacement Ventilation Provides Highest Ventilation Efficiency

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In Summary...

Steps in the Development of a Cohesive and Logical Indoor Air Quality Policy...

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Developing an IAQ Policy

Priority One - Minimum Ventilation Rates

Ventilation Rates - Outside Air Rates per Person

Offices:	Minimum of 17 cfm
Conference Rooms:	Minimum of 6 cfm

ASHRAE 62.1-2007: Still the Definitive Standard for the USA

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Developing an IAQ Policy

Priority Two* - Filtration Standards

- Filters Need to Meet ASHRAE "Atmospheric Dust-Spot' Standards of at Least 30% Efficiency* (MERV 7-8, Preferably Higher)
- Filters Must be Installed and Maintained Properly *
- Independent Third Party Assessment of Filters is Recommended

Source: ASHRAE 62-2007 and Past OSHA Positions

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Developing an IAQ Policy

Priority Three - Hygiene Standards

- Mechanical Equipment Rooms Must be Regularly Examined - Log Results
- HVAC Units - Filter Chambers, Coils, Condensate Trays, and Fan Chambers - Must Be Inspected and Documentation Retained
- Moisture Must be Carefully Controlled
- Supply and Return Ducts Must be Routinely Examined and Their Status Documented

Source: ASHRAE 62-2007 and Past OSHA Positions

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Developing an IAQ Policy

Priority Four - Document Results

- **Records Prove Due Diligence**
- **Negative Results are Invaluable**: Records Show Irrefutable Proof of Absence of Specific Contaminants
- **Communicate Results** - Deliver Executive Summaries to Building Occupants

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Questions?

Would you like to know more about this session?

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Don't forget to fill out and drop off your session evaluations!

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