Mold and Moisture: Double Trouble for Schools

- **Steven Caulfield, *Turner Building Science***
- **Chad Griffith, *Griffith Engineering***
- **Bill McKnight, *Forsyth County Schools***

Control of Moisture/Mold

- Conduct routine moisture inspections
- Establish mold prevention and remediation plan
- Maintain indoor humidity levels between 30% and 60%
- Address moisture problems promptly
- Dry wet areas within 24-48 hours

Moisture & Mold Basics

Steven M. Caulfield, P.E., CIH
Turner Building Science & Design, LLC
www.turnerbuildingscience.com

Mold (fungi) Amplification is Limited by Moisture

- **Liquid Moisture needed to Initiate growth, 55 - 85 deg. F preferred** (ACGIH)

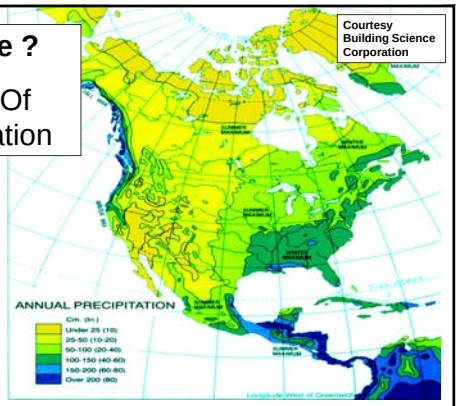
Presentation Outline

1. **Climate & Building Moisture Dynamics**
2. **Current Guidance Regarding Bioaerosols**
   Health: Finding, Fixing, & Preventing Mold
3. **Moisture Resistant Assemblies**

Moisture ?

Amount Of Precipitation

In a Wet or Dry Climate?



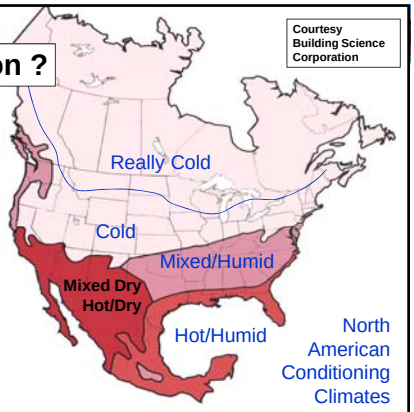
Condensation ?

Temperature of The Surface

&

Dew Point of Outdoor Air

Condensation on Surfaces at Dew Point



Buildings Get Wet From:

- Site Issues, Wicking Of Water
- Climate Moisture, or Re-evaporation
  - (oversized or poor part-load AC drying design)
- Wind Driven Rain & Plumbing Leaks
- Occasionally: Occupant Activities

How Fast Things Dry Out Depends Upon:

- The Type of Material
- The Relative Humidity of The Local Air
- Air Movement (Evaporation)
- Occupant Actions To Expose Surfaces

Evolution of Building Shell Construction (old)

Single Pane Glass

Steam Heat

Low "R" Value

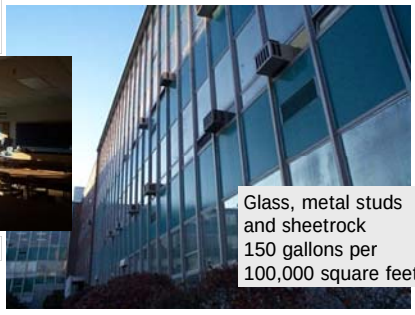
Often Low Air Leakage

Solid masonry 25,000 gallons per 100,000 square feet

" Huge Hygric Buffer Capacity"

Evolution of Building Shell Construction (newer)

Single? or Double Pane Glass



Glass, metal studs and sheetrock 150 gallons per 100,000 square feet

Hydronic or All Air

Often High Air Leakage & Low R Value

" Lower Hygric Buffer Capacity"

"Water Managed Assemblies"

- Keep Wind Driven Rain Out
- Manage Vapor Drive For The Climate
- Allow Moisture To Leave
- Use Durable Materials

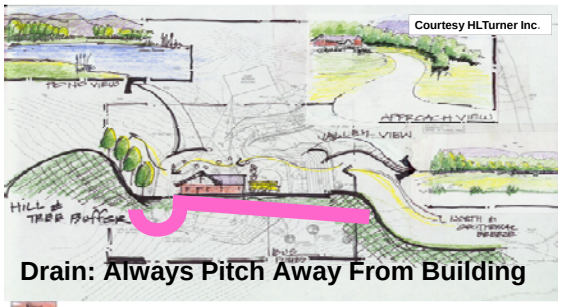
Water Runs Downhill – Except When It Does Not

- Gravity
- Vapor pressure differences
- Air / Water pressure differences
- Surface tension

Courtesy Camroden Associates

#1 Site Moisture

(½ foot drop per 10 feet run = 5% pitch)



Drain: Always Pitch Away From Building

When Renovating, Don't Put Textiles, Paper, or Wood on a Potentially Damp Surface

#2 Condensation Moisture

Fix:

1. Eliminate Moisture Source
2. Warm the Surface
3. or Dry The Air

Solution #1 Eliminate Moisture: Cover All Sumps & Earth Surfaces

Solution # 2

warm surfaces (insulation)

- **Warm walls and floors**
  - – **A) exterior insulation,** VB & insulation under the floors, and WP & insulation outside the walls
  - – or **B) interior insulation,** vapor barrier, damp-proofing / waterproofing & good site drainage

Courtesy Camroden Associates

Solution # 3

Dry Air

Air humidity control

1) monitor with hygrometers **(keep < 60% ? RH)**
2) ?? air basement only on days with **low outside** RH (maybe at best one day a week????)
3) use a **serious dehumidifier** set up to run without needing attendance, with a drain or pump.

Courtesy Camroden Associates

Serious De-humidifier

140 pints a day for same energy consumption as 40 pints a day, (may be ducted) Energy Star Rated? www.thermastor.com

Courtesy TBS

"Air Conditioning"

Can Wet or Dry A Building

#3 Flooding / Leaks

Fix: Find Water & Dry Fast

Permanently Fix Leak

Responding to Clean Water Flooding

Find Excess Dampness Fast

- Ventilate and Dry all Cavities & Monitor Drying dry in 24 - 48 hrs?

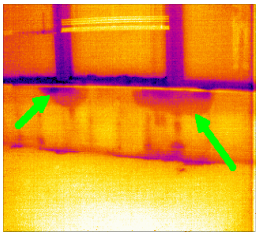
Courtesy TBS

Courtesy TBS

Find & Fix Moisture from Building Piping & Plumbing

- Plumbing Leaks
- Valve Drips
- Waste Lines
- Fire Protection Leaks

Find & Fix Window Leaks



Leaks may not always be visible

Fix HVAC Air Leakage into Attics: Keep Building Air from Entering the Attic

Seal Ducts & Ceilings

Or Move Thermal Envelope To Roof !!!

Finding & Fixing Mold Guidance

Repeated exposure to lots of Mold not healthy

- ACGIH Guidelines
  - Allergic /Asthma
  - Irritants / Toxins
  - Opportunistic Pathogens

ACGIH WORLDWIDE

Celebrating 60 years of outstanding service to occupational and environmental health and safety!

Some Mold Guidelines

- **ACGIH** Bioaerosols: Assessment and Control acgih.org/store/Products
- **NY City Guidelines** ci.nyc.ny.us/health
- **US EPA Guidelines** epa.gov./iaq/pubs/moldresource.html
- **AIHA** Recognition, Evaluation, and Control of Indoor Mold (microbial growth) www.aiha.org

Mold cleanup by qualified personnel / follow Guidelines

- **Contain the area and source, and minimize dispersion**
- **Protect the mitigator**
- **Protect the occupants**
- **Eliminate the <u>moisture</u> source!?**

Visual or Olfactory Signs of Suspect Mold/Microbial Activity?

- Looks Like Mold ?
- Smells Like Mold ?
- **Assume it is, and behave accordingly,** unless lab results from tape lift samples, or bulk samples prove otherwise.

Upper Building Envelope?

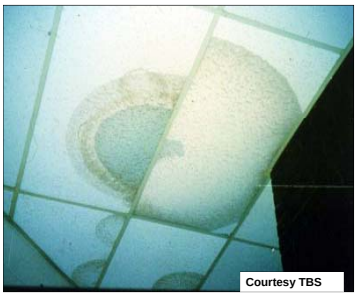
Roofing System Leaks ?

Roof Drain Leaks ?

Cold Pipes?

Above Ceilings

Plenums ?



Just Stains or Mold Growth?

Bulk sample?
Bio-film sample?
Air Testing?

Lower Building Envelope?

- **Utility Trenches - Behind Cove Base**

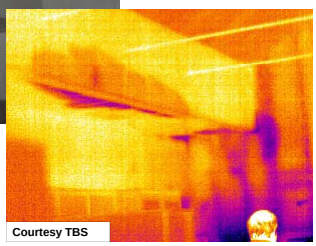
Lower Building Envelope?

- **Elevator Shafts**

Must Understand Testing Equipment

Visible

Infrared



Summary

- **Minimize opportunity for growth**
- When Mold does grow, **remove it without dispersing it into the breathing air.**
- Minimize the likelihood of the mold growth returning (**find the moisture & repair**).

Beware Possible? Snake Oil

- Enzyme Coatings
- Antimicrobial Coatings (poisons)
- Air Purifiers
- Radiation (UV)
- Ozone in Air

- Others?

Recent Moisture / Mold Resistant Products

- Paperless Gypsum Sheathing
- Paperless Gypsum Wall Board
- Wax/VOC Impregnated OSB
- Nylon Vapor Barrier

- Others?

Tried & True Moisture Resistant Products

- Plaster
- Gloss Paint
- Masonry
- Copper
- Plastics?

- Others?

Water Managed Assemblies

- Roofs, Attics, & Walls
- Basements, Crawlspaces, Slabs

1. Keep Wind Driven Rain Out
2. Manage Water Vapor
3. Allow Assembly to Dry if it Gets Wet
4. Use Durable Materials

Questions & Comments…..

Steven M. Caulfield, P.E., CIH

Turner Building Science &Design, LLC

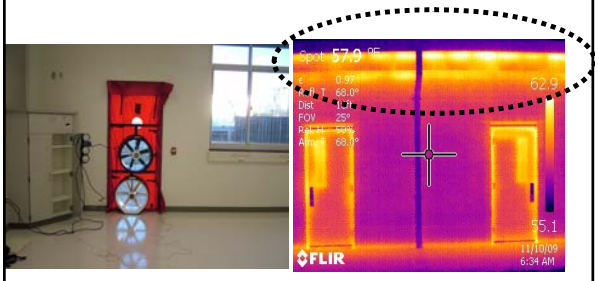
1-800-439-3446

http://www.turnerbuildingscience.com

Example: Building Problems Identified

Observations:
- **Exposed dirt** in crawlspace
- In door humidity at 70% RH or above
- **Extreme air infiltration at soffit & crawlspace**
- Site perimeter drainage issues
- HVAC control issues
- HVAC balancing issues

Problems Identified



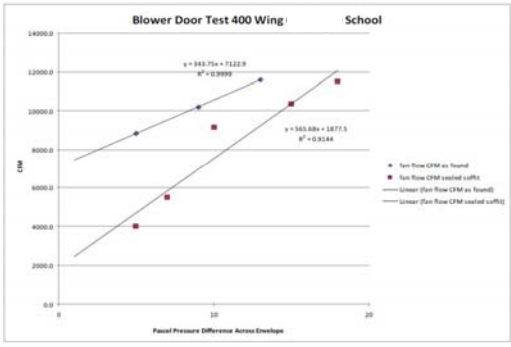
Solutions Identified

- Fix Crawlspace
- Fix Soffits
- Re-commission HVAC controls
- Balance HVAC
- Address Some Drainage

Fixed Crawlspace

Fix Soffits

Before and After Air Leakage Testing



Diagnostic Tools: Water & Moisture

Source of Water (above, below, in walls, dew point?)

1. **Visual Assessment (NIOSH Form)**
2. **Various Moisture Meters**
3. **Concrete Floor Testing**
4. **Wall/Window Infrared Themography**
5. **ASTM Type Window Leakage Testing**
6. **Past Reports**
7. **Construction Documents**
8. **Occupant Reported Information**

NIOSH Visual Assessment:

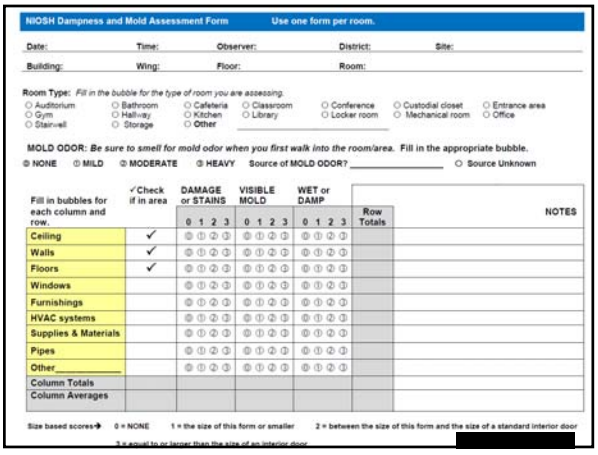
HE HealthHazard Evaluation Program

Email: moldsheet#1@cdc.gov
or mrmartin@cdc.gov

The Purpose of the NIOSH *Dampness and Mold Assessment Tool*:

- **Identify and record** areas of dampness or mold throughout your building.
- **Trigger early repair and remediation** to avoid potential health effects and more costly repair and remediation.
- **Create awareness** of potential problem areas.
- **Track (monitor)** past and present problem areas by repeating the use of this tool *at the frequency which your individual facility determines.*

Courtesy CDC, NIOSH



NIOSH Dampness and Mold Assessment Form — Use one form per room.

Date: Time: Observer: District: Site:

Building: Wing: Floor: Room:

Room Type: *Fill in the bubble for the type of room you are assessing.*

○ Auditorium ○ Bathroom ○ Cafeteria ○ Classroom ○ Conference ○ Custodial closet ○ Entrance area
○ Gym ○ Hallway ○ Kitchen ○ Library ○ Locker room ○ Mechanical room ○ Office
○ Stairwell ○ Storage ○ Other

MOLD ODOR: *Be sure to smell for mold odor when you first walk into the room/area.* Fill in the appropriate bubble.

⓪ NONE ① MILD ② MODERATE ③ HEAVY Source of MOLD ODOR? _____ ○ Source Unknown

Fill in bubbles for each column and row.	✓Check if in area	DAMAGE or STAINS 0 1 2 3	VISIBLE MOLD 0 1 2 3	WET or DAMP 0 1 2 3	Row Totals	NOTES
Ceiling	✓	⓪ ① ② ③	⓪ ① ② ③	⓪ ① ② ③		
Walls	✓	⓪ ① ② ③	⓪ ① ② ③	⓪ ① ② ③		
Floors	✓	⓪ ① ② ③	⓪ ① ② ③	⓪ ① ② ③		
Windows		⓪ ① ② ③	⓪ ① ② ③	⓪ ① ② ③		
Furnishings		⓪ ① ② ③	⓪ ① ② ③	⓪ ① ② ③		
HVAC systems		⓪ ① ② ③	⓪ ① ② ③	⓪ ① ② ③		
Supplies & Materials		⓪ ① ② ③	⓪ ① ② ③	⓪ ① ② ③		
Pipes		⓪ ① ② ③	⓪ ① ② ③	⓪ ① ② ③		
Other_____		⓪ ① ② ③	⓪ ① ② ③	⓪ ① ② ③		
Column Totals						
Column Averages						

Size based scores→ 0 = NONE 1 = the size of this form or smaller 2 = between the size of this form and the size of a standard interior door 3 = equal to or larger than the size of an interior door

Bill McKnight, Facilities Director
Forsyth County Schools

District Overview:

- Students - 38,000
- School Buildings: 38
- Square Footage: ~ 5,000,000
- Employees: 4,700
- Teachers: 3,300
- School Energy Costs: $1.03 / square foot

Forsyth County Schools

- Bill's Keys to Prevent Mold and Moisture:
  - Keep water from coming into buildings
  - Control humidity below 60%

2007 SPLOST Project Goals

- Provide Independent Outside Air Systems
- Improve Building Envelopes
- Upgrade outside air levels to 15 cfm/student
- Energy Efficient Approach

2007 SPLOST Project CASE STUDY

- 17 Schools
- Griffith Engineering, Inc. to provide design services
- Multiple mechanical contractors involved in implementation
- Air quality tests since project always better inside than outside

IAQ Challenges

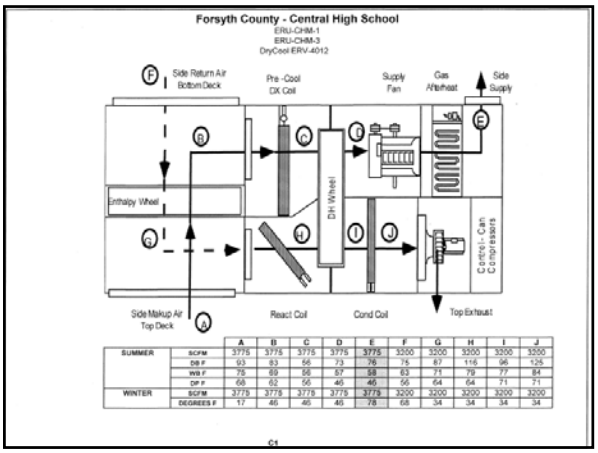
- Code changes - outside air requirements
  - Many existing schools designed for 7.5 cfm/student or less
  - Current IMC Table 403.3 requires 15 cfm/student
    - Increased outside air volume introduces moisture challenge
    - Increased dehumidification introduces energy efficiency challenge

Forsyth Case Study

- Address Envelope – Compromised Vapor Barrier

Forsyth Case Study

- Energy Recovery Units with Desiccant Wheel
- Toilet Exhaust Air Ducted to ERU
- OA and EA ducted to classrooms
- After hours recirculation



Benefits

- Ability to control the humidity
- Eliminated the mold and moisture issues
- Improved the classroom comfort and IAQ
- Ability to retrofit to multiple types of HVAC systems ie: wall mounted package, rooftop package etc.
- Meet the 15 cfm fresh air standard
- Allows for tight operation of the system to gain energy savings

Breakout Session Q&A

- Review your actions and strategies that you would like to apply to your own work.
- Please be ready to discuss these actions in your own words.