Indoor Environmental Quality
Schools, Businesses, Homes

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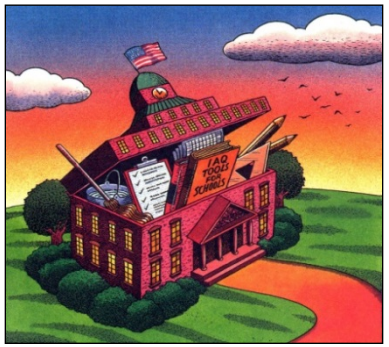
Tools for Schools



Introductions

What interest or responsibilities do you have in terms of Indoor Environmental Quality?

Do you have an *IEQ program* for your buildings?

What do you want to learn today?

Expectations for today?

Contribute to the "collective wisdom"

Today's IEQ Challenges

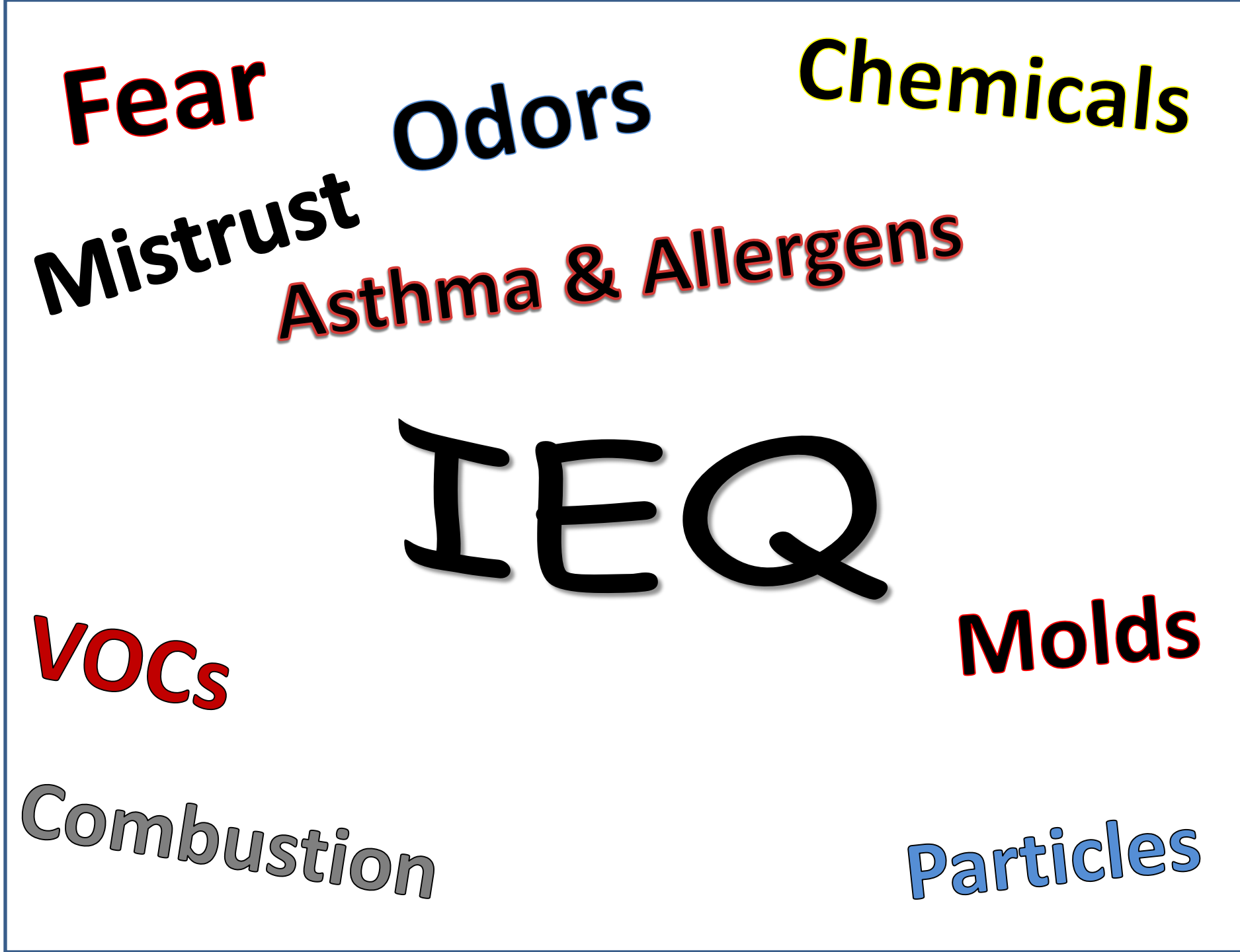
Heightened awareness of IAQ

Increased occupant asthma & sensitivities

Health care costs

Break-down maintenance and older equipment and structures

Shrinking dollars & rising costs for facilities


Fear
Odors
Chemicals
Mistrust
Asthma & Allergens
IEQ
VOCs
Molds
Combustion
Particles

Indoor Air / Environmental Quality

Every school day, one in five Americans occupies a school building. U.S. Department of Education, "about 40 percent of schools report at least one unsatisfactory environmental condition, such as poor ventilation."

schools are the most crowded buildings that are occupied for significant amounts of time.

Schools often contain pollutants that are not usually found in offices and other buildings: storage and custodial closets, art rooms, shop classes, biology and chemistry labs, locker rooms and the cafeteria.

Indoor air pollutants can cause a variety of health problems, as well as poor achievement and increased absenteeism.

Children Are More Susceptible to Poor IEQ

Children are even more susceptible to the effects of poor indoor air quality than adults.

Children are not simply small adults – they breathe in more air, eat more food, and drink more liquid in proportion to their body weight than adults.

Their immune systems are also not fully developed. Long-term exposures to environmental pollutants at a young age can have serious long-term consequences.

IEQ Programs

Effective planning and management of indoor air quality can lower pollutant levels and decrease exposure to respiratory triggers, improving occupant health.

Experts believe that improving IAQ and student health can also lead to tangible gains in student performance.

Source: U.S. Environmental Protection Agency

IEQ Problems Are Costly

IEQ problems can cause school closings or relocation of occupants; compromise community trust; and create friction among school administration, parents and staff.

Expensive testing and liability issues can easily outweigh the incremental costs of proactive operation and maintenance practices that focus on reducing exposures, pollutant control, adequate comfort and fresh air.

While some school buildings should be closed because of their indoor air hazards it's also true that occupant perception and mistrust can lead to dramatic measures such as school evacuation and closure when no serious conditions actually exist. Once a building gets a "sick building" reputation is nearly impossible to erase this stigma.

Indoor Air Quality Is Complex

Indoor air quality is a complex issue. Pollutant levels at a school are often much higher indoors than outdoors, due to the products, equipment and activities in schools.

Occupants can also be alarmed by media stories reporting IAQ problems, symptoms and illnesses of fellow occupants, observed or suspected deficiencies and rumors.

Providing good indoor air quality in schools should be a top priority

Good IAQ is critical to student learning, achievement, productivity, health, attendance and quality of life, as well as that of the staff.

Further, reducing exposure to indoor air pollutants reduces distraction, irritation, health symptoms and allergic reactions.

Good Operation and Maintenance Practices

It's essential that schools adopt good operation and maintenance practices, and communicate these efforts to parents and staff to establish credibility and trust.

Schools must also address IAQ *issues* before they escalate into *problems* that evoke emotional responses and concerns. IAQ preventive measures far outweigh the costs of assessment, testing and solving problems.

"My organization doesn't need IAQ Policies….
it will just raise the issue and cost us time and money"

What message does this send to occupants?

Concern

Respect

Compassion

Credibility

Break-down maintenance not appropriate for people

Benefits of an IEQ Program

Enables effective *communication*

Establishes *boundaries on expectations* for both facilities and occupants

Adds *credibility* and promotes *occupant confidence* in operations

Establishes accountability and defines standards of practice

"One Size Does Not Fit All"

Impossible to provide realistic, practical, and *specific* guidance for all schools

Too many different buildings, mechanical systems, climates, neighborhood, radon.

Realities of District politics, expectations, and resource$.

Create Your Own IEQ Program

Your **program will likely be**

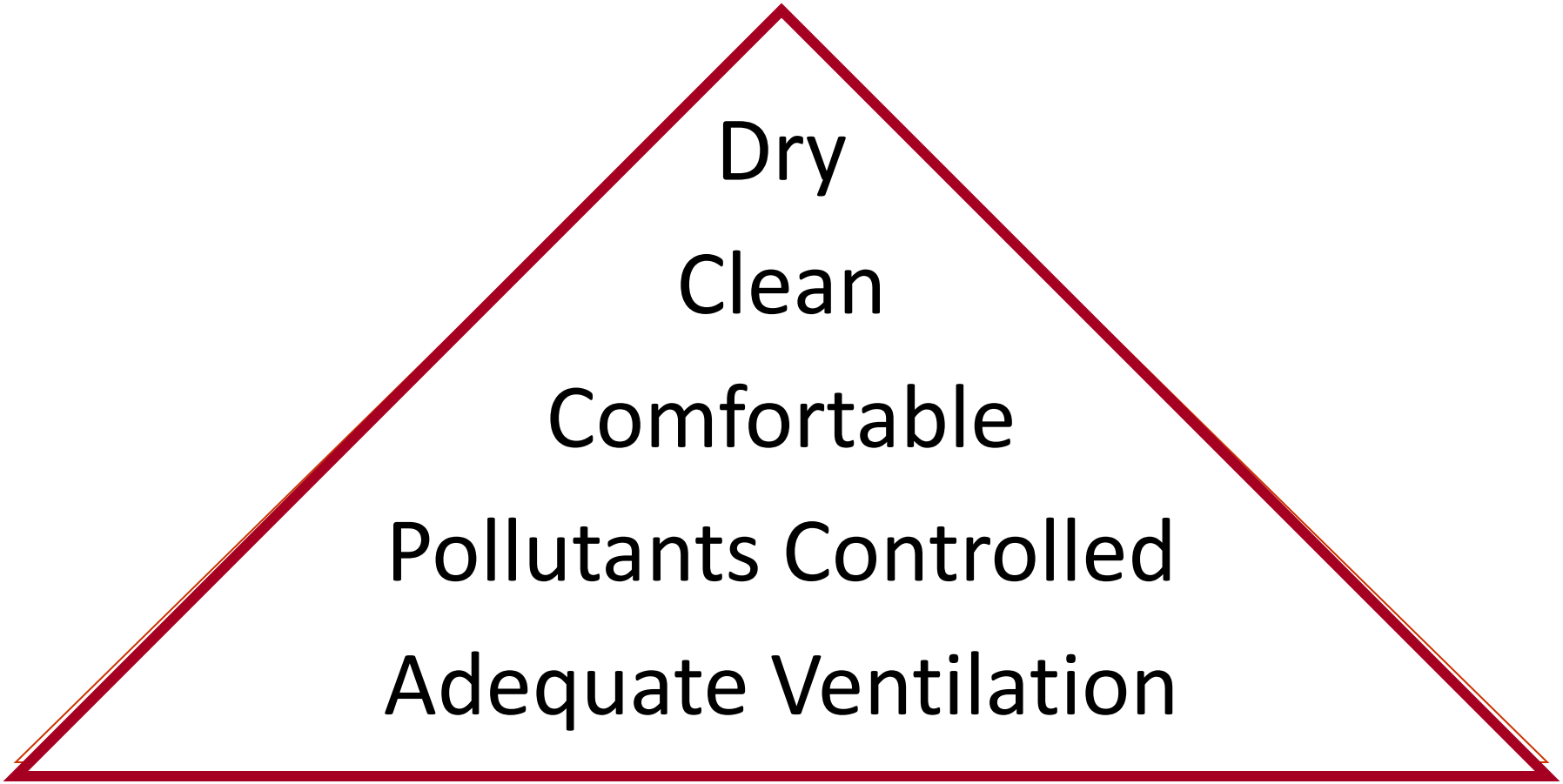
- **Easier**
- **More Effective**
- **Less Expensive**
- **Personally Rewarding**

Have it your way!

Essential ”Good Practices”

Observations & Measurements

Compare to common sense benchmarks:



Tools for School Action Kit

- ✓ best practices
- ✓ industry guidelines
- ✓ sample policies
- ✓ a sample IAQ management plan

IAQ Coordinator's Guide

Designed for the IAQ Coordinator at the school and district levels.

It offers guidance on preventing and solving most indoor air problems with minimal cost and coordinating IAQ projects with other members of an IAQ team.

The guide provides basic IAQ information, guidance for developing an IAQ management plan and suggestions for resolving IAQ problems

TFS Kit Checklists and Backgrounders:

Teachers

- Teacher's Classroom Checklist and Backgrounder

Administrative staff

- Administrative Staff Checklist and Backgrounder

Health officials/school nurses

- Health Officer/School Nurse Checklist

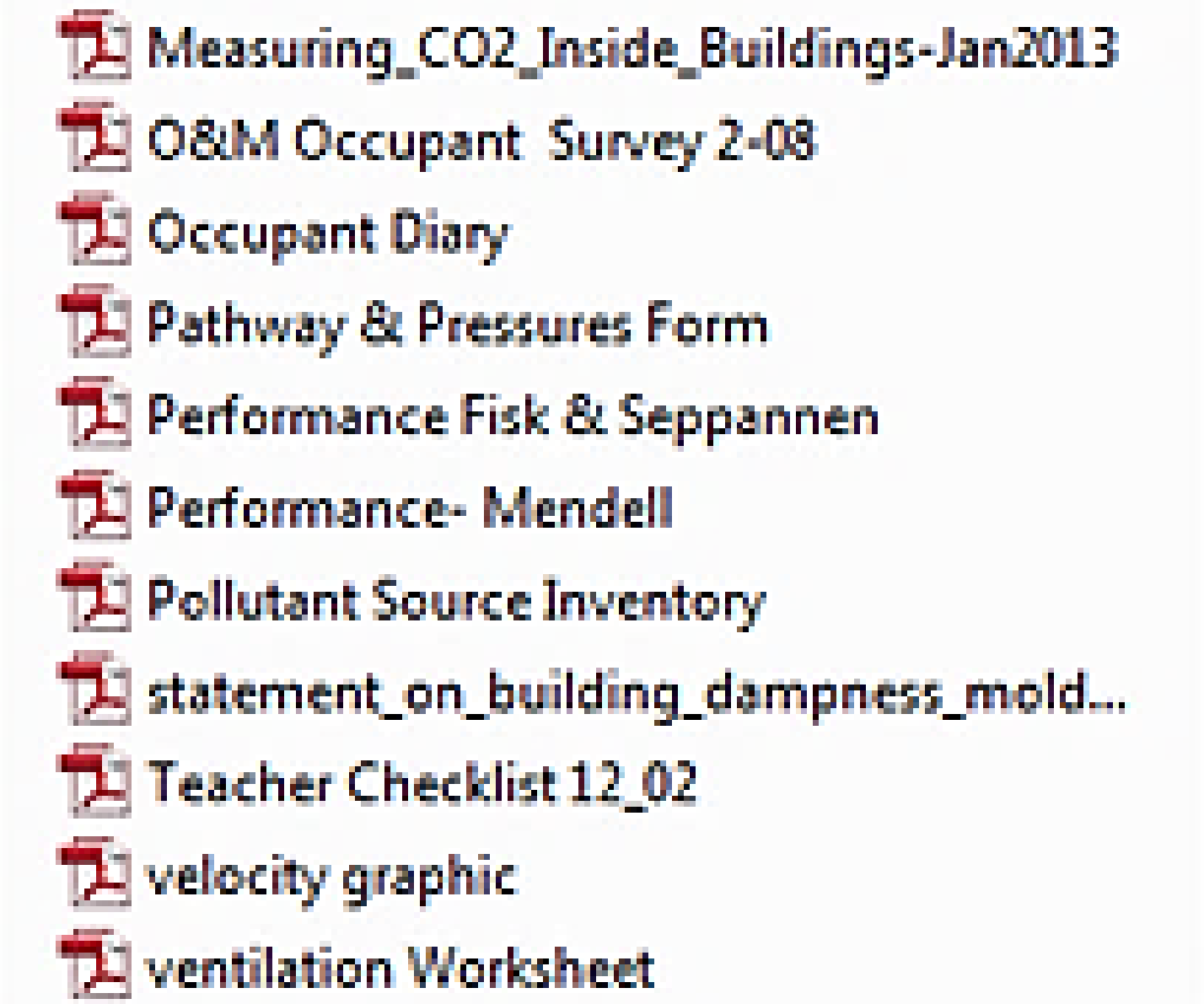
School officials

- School Official's Checklist and Backgrounder

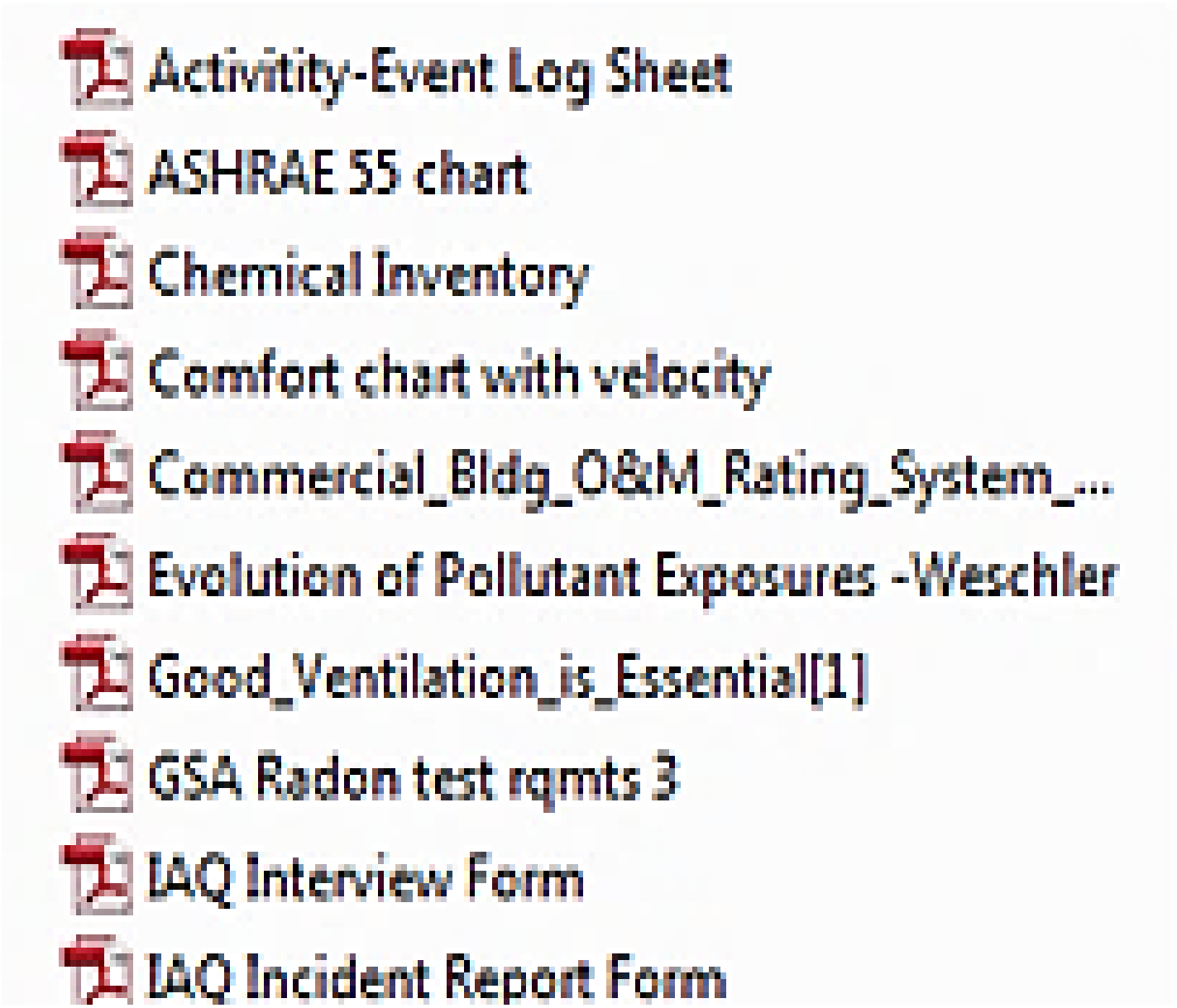
Specific school functions, including:

- **Building maintenance**
  - Building and Grounds Maintenance Checklist and Backgrounder
- Food service
  - Food Service Checklist and Backgrounder
- Waste management
  - Waste Management Checklist and Backgrounder
- Ventilation
  - Ventilation Checklist and Backgrounder
- Renovation and repairs
  - Renovation and Repairs Checklist and Backgrounder
- Walk-through inspections
  - Walk-through Inspection Checklist
- Pest management
  - Integrated Pest Management Checklist and Backgrounder

Rich's Resources CD



Rich's Resources CD



Rich's Resources CD


Building Performance Walk-Thru Assessment


Occupant Survey Score Card Blank for booklet 7-9


Particle Data W-OSA calcs


smoke handout


30 Schools Particle Data Summary & vacuums


California Radon Handout 1

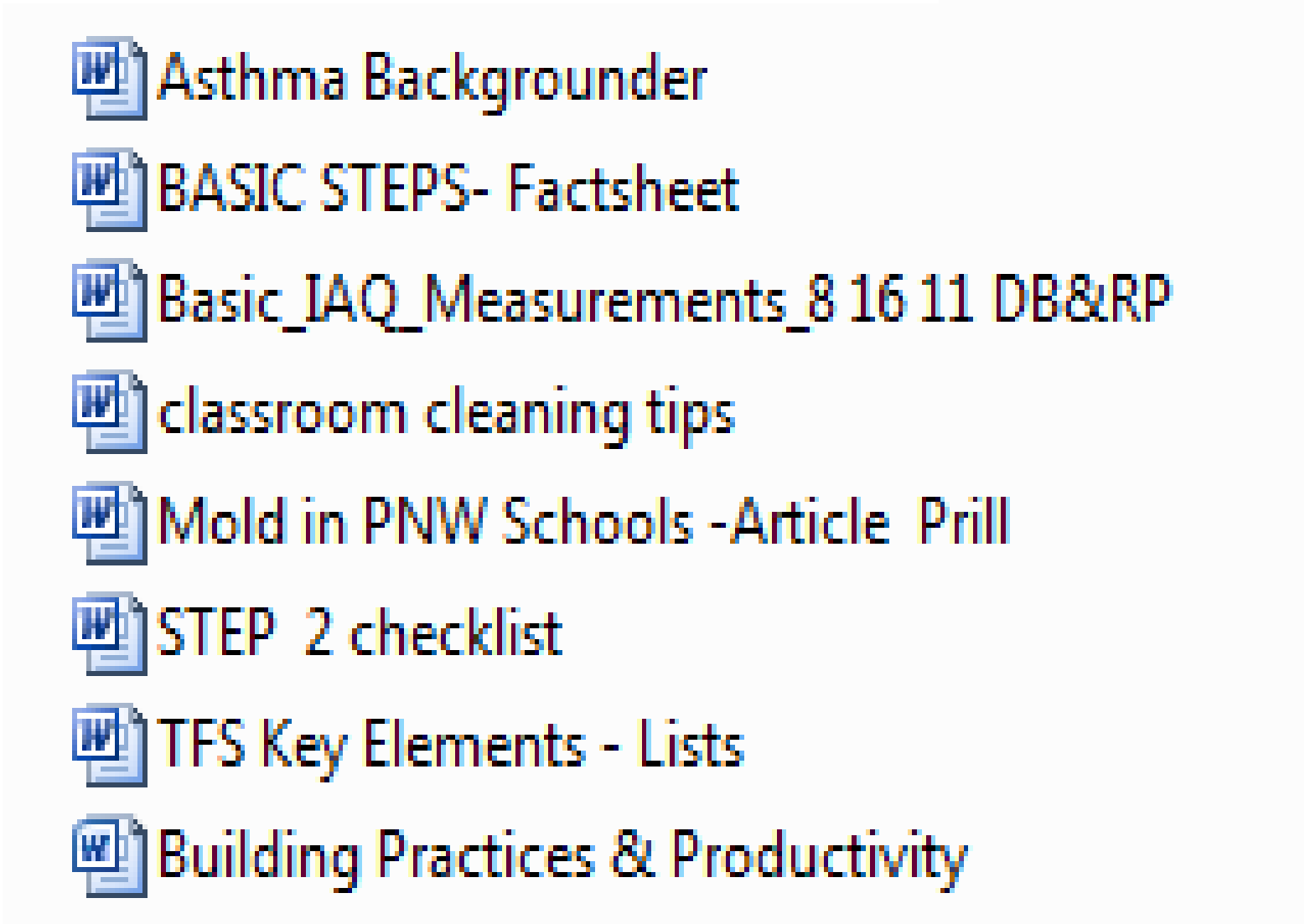

California Title 24 Ventilation


CO2 Estimate of Ventilation


CO2 - Ventilation


school particles1

Rich's Resources CD



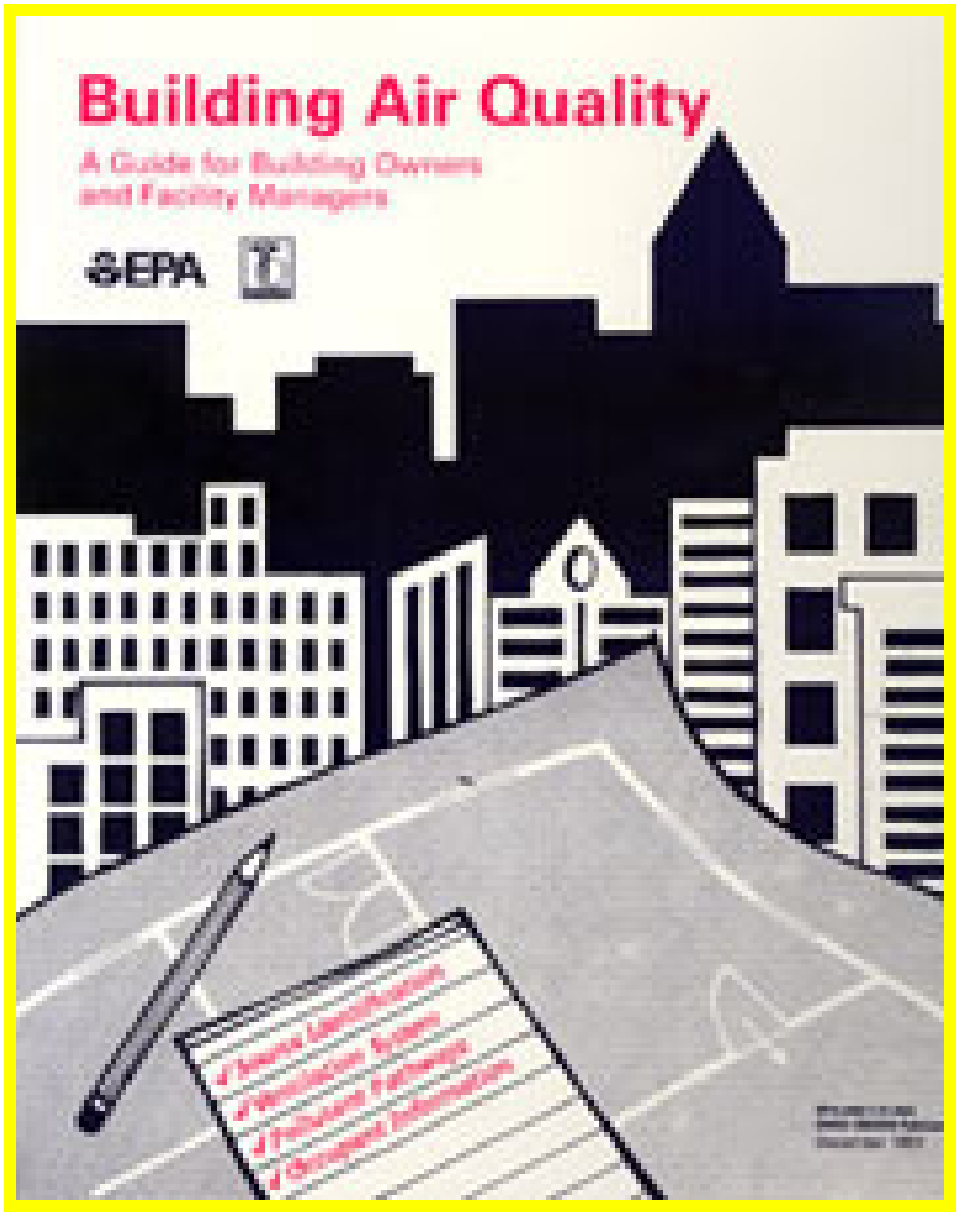
Rich's Resources CD

Sue Brown Cleaning Power Point

Steve Ashkin Cleaning Summary

Washington State Dept of Health
"Healthy School IAQ Tips"

Today's Condensed PowerPoint Presentation
(Please Do Not Publish or Distribute)



Excellent Guidance

Electronic Forms & Checklists

epa.gov

Adopt an IEQ Program

- ***Administration will understand benefits***
- ***A program inspires confidence among staff and parents while establishing clarity on expectations***
- ***Policy and Actions include Routine walk-through monitoring:***
  - **IEQ Walk-Throughs reduce exposures and improve IEQ through on-site *discussions, observations, and measurements*.**

IAQ *Pro-Tip*

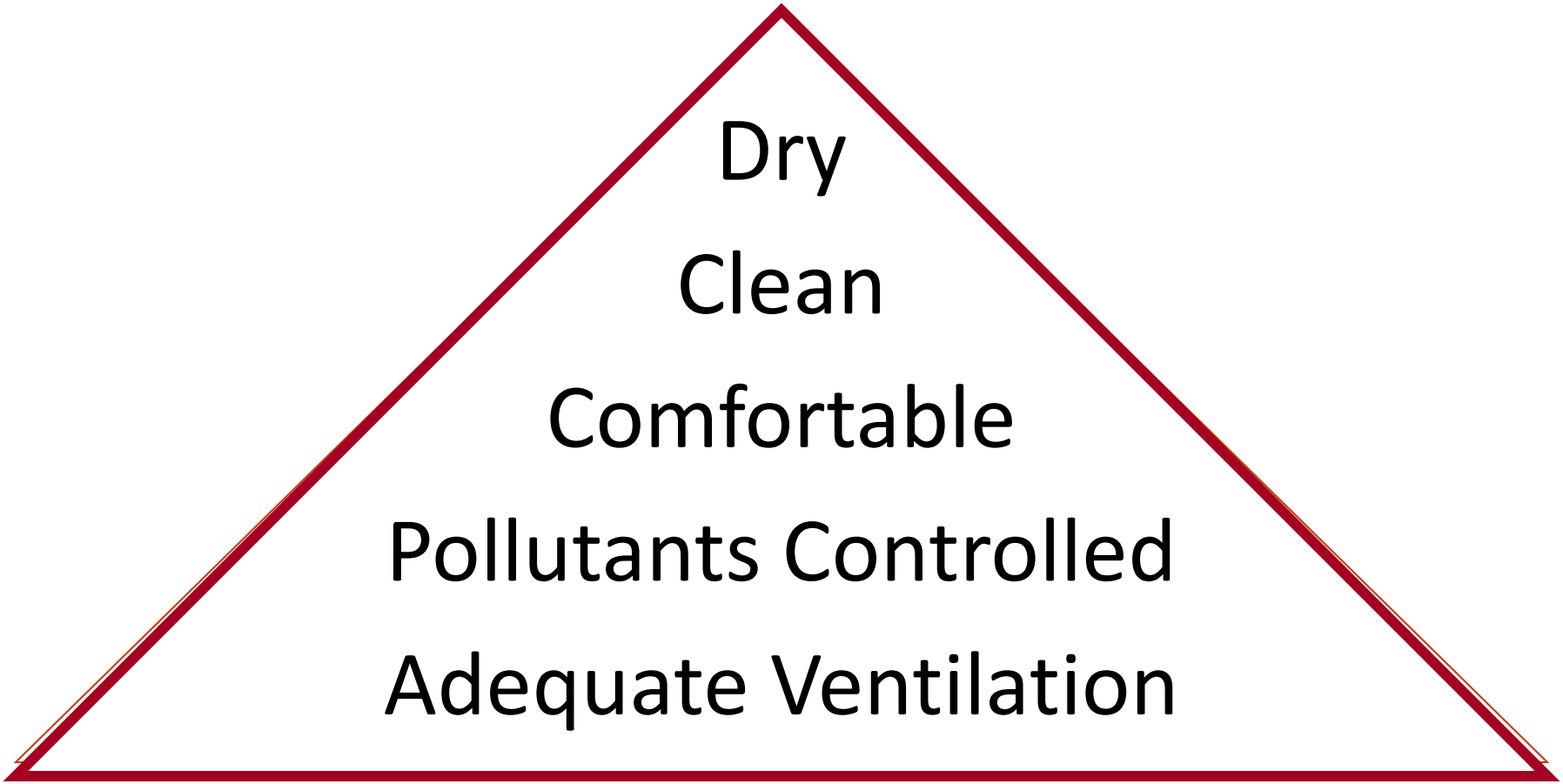
Schools are dynamic …

monitoring is your early warning system

Essential ”Good Practices”

Observations & Measurements

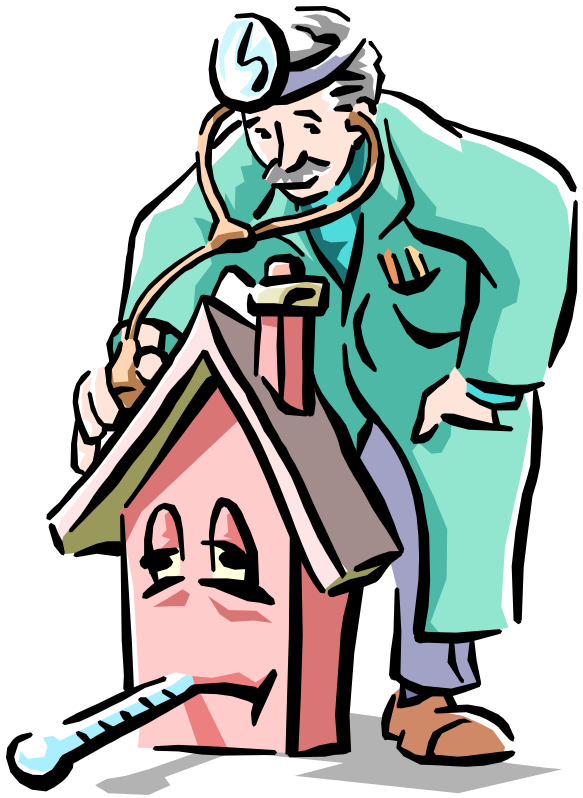
Compare to common sense benchmarks:



Routine Health Check-Up Analogy

Prevention makes the most sense

(find problems before they find you)



Routine Health Check-Up Analogy

"What gets measured
gets controlled or fixed"

Documentation establishes a
"baseline" for
goals and priorities

IEQ Walk Through Essentials

- Routine monitoring is critical
- Opportunity for communication
- Sends a positive message to occupants
- Non-threatening
  - Not intended to find fault with job performance
- Non-regulatory
- Practical learning opportunity
- Skills training

The Walk-Through

A typical walk through takes about 3 to 5 hours

Opportunity to establish team member *credibility* and demonstrates that you care and that you want to listen

Typical walk through team consists of

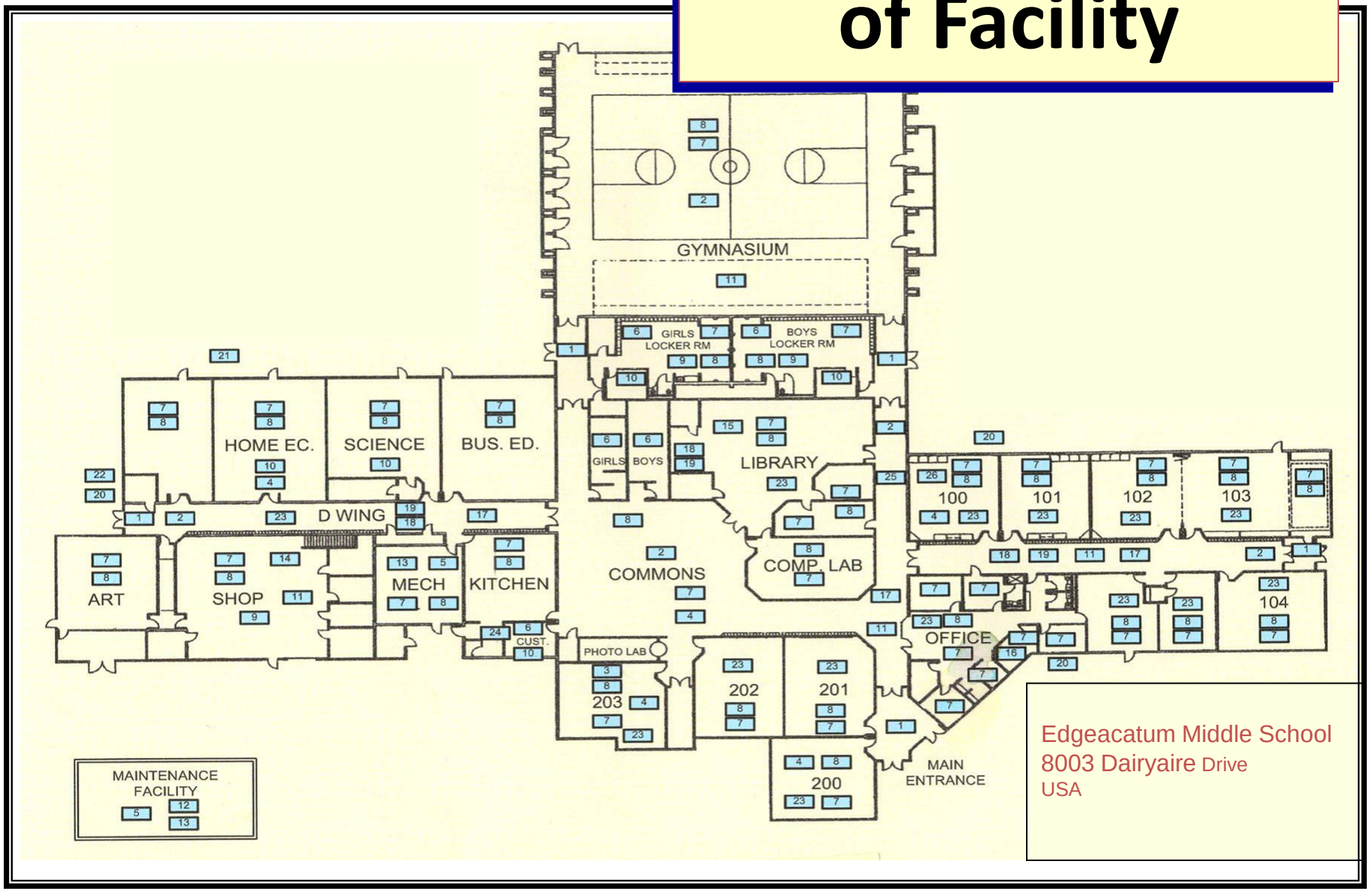
- **Facilities director**
- **Head custodian**
- **Principal**
- ***Other Stakeholders***

IEQ Walk Through

- **Advanced notice is essential to clarify purpose of walk through is “proactive”, not in response to a probem.**
- **Conduct during regular occupied hours**
  - **Provides insights into actual conditions and building operation**
- **Not a “science project”… intent is to look for good practices outside, inside, top to bottom**

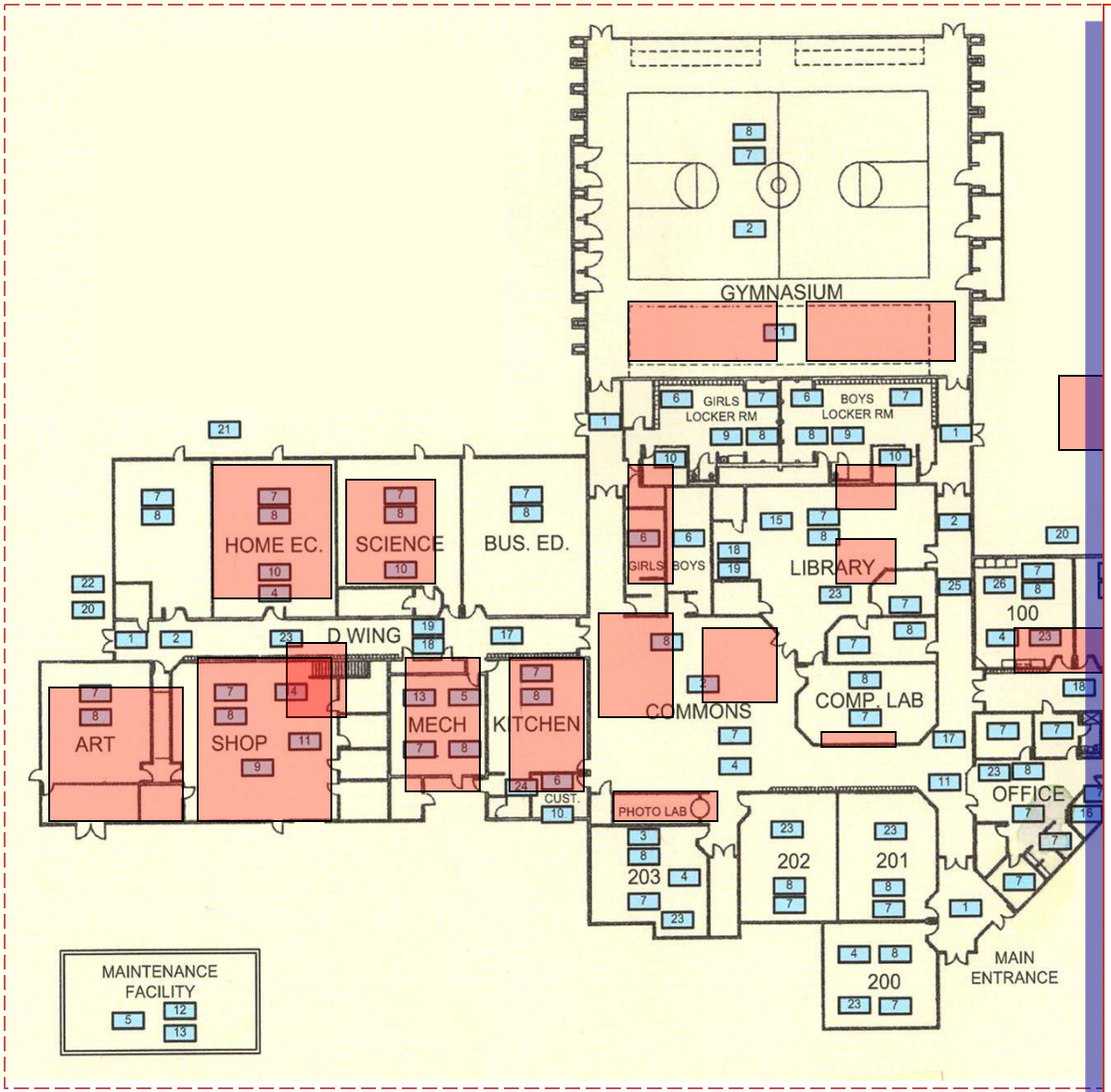
Fire Escape Plan

Basic Map of Facility



Edgeacatum Middle School
8003 Dairyaire Drive
USA

Pollutant Control: Source Inventory



- Chemistry
- Physics
- Biology
- Art
- Home Science
- Custodial
- Rest Rooms
- Workroom
- Locker Rooms
- Kitchen
- Boiler Room

IAQ Pro-Tip

Air should move from "clean" to "dirty" to outside

Carbon Dioxide (CO_2)

Easy method to check fresh air exchange

As CO_2 builds up indoors due to occupancy, so does "everything else"…

"Everything else" is too difficult to measure and interpret

Should be maintained below about 1,100 ppm

People and Pollutants

Exposure

Dose

Duration

Reaction

Perception

POLLUTANTS

Common IEQ Health Symptoms

- Eye irritation
- Headache
- Sinus congestion
- Nose irritation
- Skin irritation
- Fatigue
- Dry throat
- Cough
- Sneezing
- Shortness of breath
- Dizziness
- Nausea

These symptoms are largely “non-specific.”

Multiple Chemical Sensitivity (MCS)

Physical reaction to chemicals at very low exposures:

Headache
Rash
Asthma
Sore throat
Nasal congestion
Fatigue
Indigestion
Nausea
Depression
Watery eyes
Vision problems

Asthma

Asthma is one effect of poor air quality. It's a serious, sometimes life-threatening respiratory disease that affects 24.6 million Americans and one out of every ten school-age children. It's also a leading cause of school absenteeism: each year, 10.5 million school days are missed due to complications from it.

Although there's no cure, asthma can be controlled through medical treatment and the management of environmental triggers. Schools must recognize asthma triggers and control exposures, as well as educate staff and students in the proper response in case of an asthma attack.

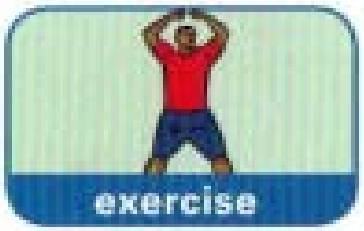
Asthma

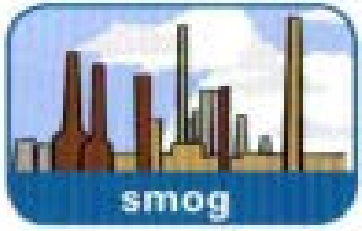
About 26 million people affected by chronic asthma, including 8 million children - CDC reported number of people diagnosed with asthma grew by 4.3 million from 2001 to 2009

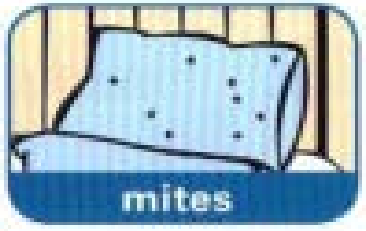
Health organizations have identified a number of chemicals know to cause the onset of asthma, known as *asthmagens - - m*any of these chemicals are ingredients in building and finish materials

Few strategies are in place to prevent exposure to chemicals that cause asthma

Asthma Triggers







HEALTHY BUILDING NETWORK

Full Disclosure Required:

A Strategy to Prevent Asthma Through Building Product Selection

A Healthy Building Network Report
by Sarah Lott and Jim Vallette
December 2013

"When people doubt that we can improve health outcomes, we're going to show them the drawers of unused asthma inhalers in green schools."

- Rick Fedrizzi, USGBC President and CEO, Plenary Address, Greenbuild 2012

Health problems should be treated by the medical community

- Avoids delays in treatment
- Helps identify causes and solutions
- Able to help focus on home environment diet, allergies, medications, and other exposures or behaviors

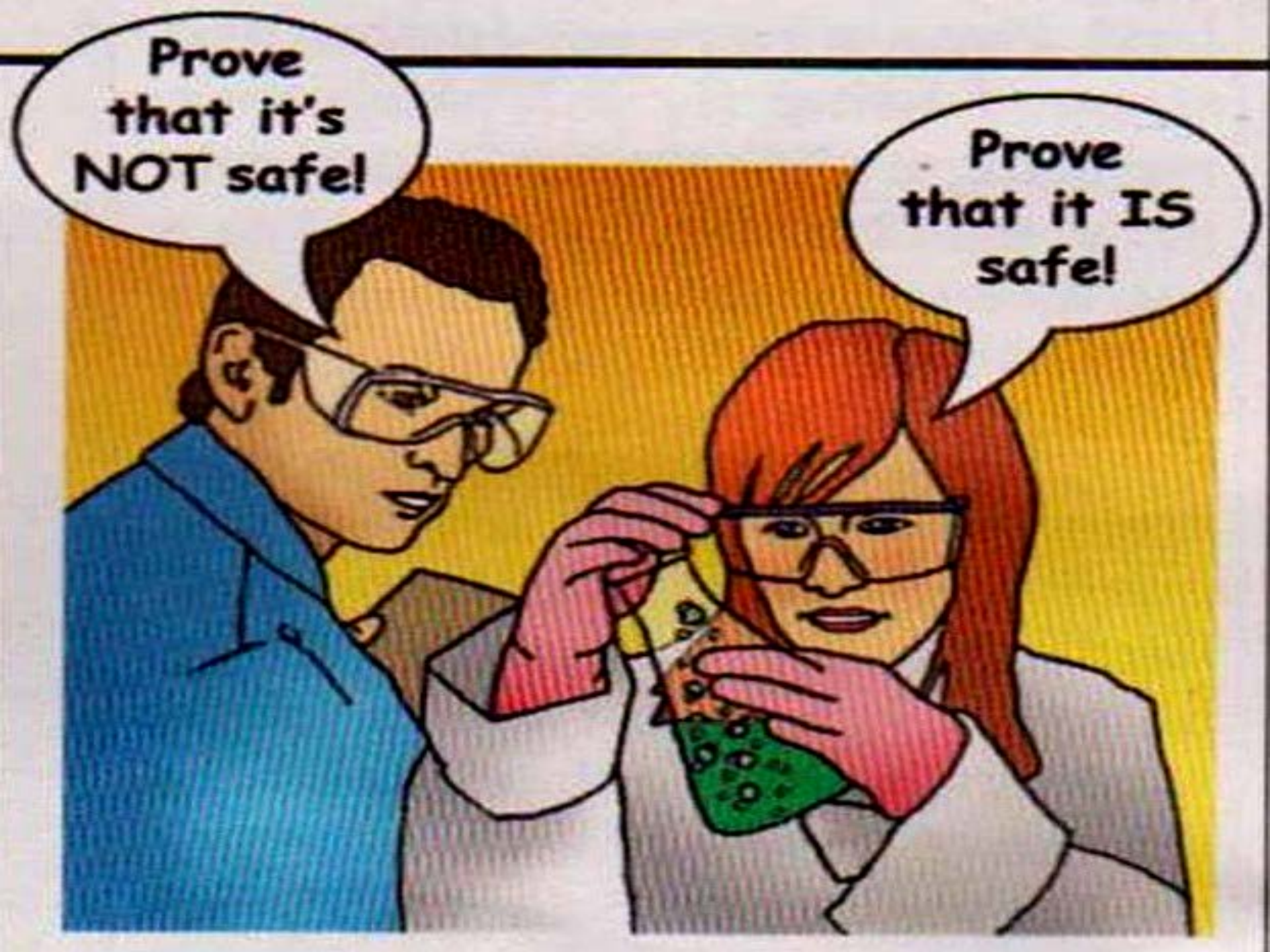
What are the Standards?

Availability of guidelines for indoor air is limited:

Industrial Standards apply to schools and offices.

These buildings rarely approach "industrial" exposures, even when problems exist!

Meeting OSHA Standards won't solve all IEQ issues.


Prove that it's NOT safe!
Prove that it IS safe!

Known Hazards in Many Schools

- Combustion By-products
- Chemicals
- Radon
- Asbestos, Lead
- Moisture and Molds
- Biologicals
- Particulates

Available Standards & Guidelines

- **Carbon Monoxide: 9 ppm, 35 ppm, 50 ppm**
  - **UL alarms**
  - **Low level alarms**
- **Radon: 4 pC/l annual exposure**
- **Formaldehyde: .05 ppm**
- **Carbon Dioxide: 800 to 1,000 ppm**
- **Comfort: ASHRAE Standard 55**

UL- 2034 Standard, Underwriters Laboratories specifies response times for CO alarms:

At 70 parts per million:

Unit must sound alarm within 60-240 minutes

At 150 parts per million:

Unit must sound alarm within 10-50 minutes

At 400 parts per million:

Unit must sound alarm within 4-15 minutes

Low-Level CO Alarms

For occupants “at risk” install CO detectors that respond quickly to low levels of CO

Visual CO Display starts at 7 PPM

User selected Audible Alarm level: 10 or 25 PPM

10 to 24 PPM … Series of four beeps ONCE every Minute

25 to 34 PPM … Series of four beeps ONCE every Minutes

35 to 50 PPM … Series of four beeps every 30 seconds

“HIGH” ….Series of four beeps every 20 Seconds

Odors

Another problem in schools is odors. Odors may not be serious, but they're distracting, disruptive, irritating and – sometimes – hazardous. Additionally, odors can cause fear and anxiety, and give the perception of a sick or failing building.

What is outside gets inside

What's inside builds up !

Pollutant levels inside can be
10, 100, 1,000 times higher than outside

Pollutant Sources

mostly unregulated

Exterior Sources

poor outdoor air quality

vehicle exhaust

re-entrainment

soil gas

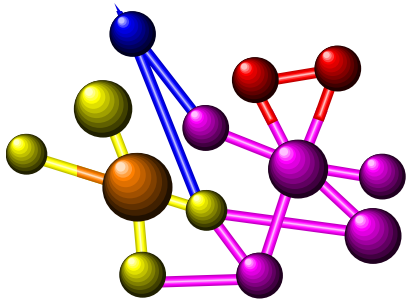
Interior sources

materials & furnishings

equipment & activities

Biologicals

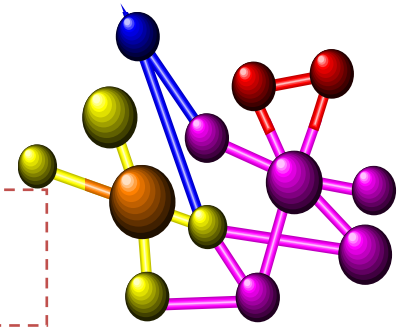
people



Results in infinite "Complex Mixtures"

Volatile Organic Compounds (VOCs)

- markers
- adhesives
- paints
- sealants
- roofing
- asphalt
- cleaning products
- material out-gassing
- deodorizers
- sewer gas
- personal care products
- mycotoxins



Combinations = "chemical soup"

Volatile organic compounds (VOCs) from “air fresheners”

Widespread commodity in private and business environments.

Their use leads to an *intentional contamination* of the room air with certain chemicals unsaturated hydrocarbons, specifically terpenes and terpenoids, which may react with ozone under indoor conditions to form a secondary organic aerosol (SOA).

(Nazaroff and Weschler 2004; Singer et al. 2006).

Pollutants from People

Heat

Moisture

Odors

CO_2

Particulates

Bacteria

Chemicals

Particles released during activities

Activity Level	Particles* Released/Minute
Motionless: sitting or standing	100,000
Moving head, arm, neck, and leg	1,000,000
Walking about 5 MPH	10,000,000

Clean room workers release millions of dead skin cells per minute

So do office workers and students!

* 0.3 micrometer and larger

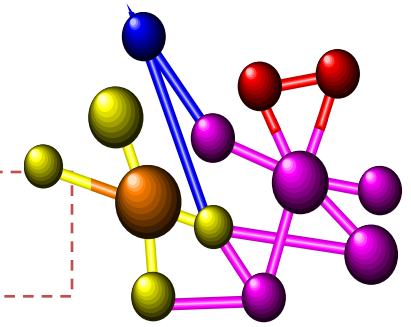
Source: Eudy, j. A2C2, April 2003

Which of these particles are potential IEQ pollutants ?

Pollens
paper & fabrics
building materials
carpet & cleaning
building renovation activities
fire retardants
floor wax
combustion
lead

Insulation
Insect parts
Chemicals
Ceiling tiles
Mercury
Tire wear
Duct liner
Saw dust
Chalk dust

asbestos
ScotchGard
Diesel
Frass
Effluvia
ANIMAL DANDER



consider impacts of combinations

Diesel Soot

Includes hundreds of chemical elements, including sulfates, ammonium, nitrates, elemental carbon, condensed organic compounds, and carcinogenic compounds and heavy metals such as arsenic, selenium, cadmium and zinc.

Particle diameters range in size from:

- **coarse particulates (< 10 microns)**
- **fine particulates (< 2.5 microns)**
- **ultrafine particulates (< 0.1 microns)**

Ultrafine particulates, small enough to penetrate the cells of the lungs, make up 80-95% of diesel soot pollution.

Perception of Risk

People tend to fear what they don't understand

A double standard often exists:

What they *choose to do* …

and what is *done to them*.

People want to be in control of their own risks…

What can occupants control in your building?

- Thermostat?
- Windows?
- Lighting
- _____
- _____

People want to be in control of their own risks…

What occupants *usually cannot control* in buildings ….

- Fresh air
- Filtration
- Noise
- Odors
- Cleaning & Chemicals, Pesticides
- Moisture/Molds/Bacteria
- Materials Out-Gassing
- Radon, Asbestos, Lead, Mercury, PCBs, etc.
- _____
- _____

“Stressors” Can Cause Complaints

Health symptoms can be caused or blamed on:

- thermal discomfort
- lighting and glare
- job-related problems
- ergonomic problems
- poor acoustics

Lighting Levels

Examples of maintained foot-candle guidelines:

OFFICES

work areas = 30-50
accounting = 50
computer use = 20-30
conference areas = 20-30

CLASSROOMS

desk work = 50
lecture rooms = 30
study halls = 50
white/chalk boards = 50-75

Based on guidelines from the Illuminating Engineering Society (IES)

Acoustics

Excessive noise can cause stress, fatigue, nausea, and other occupant impacts.

General recommended decibel range for office work is 55 to 65 decibels.

Sounds: Decibels

Sounds	dB SPL
Rocket Launching	180
Jet Engine	140
Thunderclap, Air Raid Siren 1 Meter	130
Jet takeoff (200 ft)	120
Rock Concert, Discotheque	110
Firecrackers, Subway Train	100
Heavy Truck (15 Meter), City Traffic	90
Alarm Clock (1 Meter), Hair Dryer	80
Noisy Restaurant, Business Office	70
Air Conditioning Unit, Conversational Speech	60
Light Traffic (50 Meter), Average Home	50
Living Room, Quiet Office	40
Library, Soft Whisper (5 Meter)	30
Broadcasting Studio, Rustling Leaves	20
Hearing Threshold	0

Occupant Concerns: An Early Warning Sign

It's important to understand that complaints about IAQ are often an early warning sign that something may be wrong. A prompt response in communication and investigation is important to prevent small issues from mushrooming into large and expensive problems.

Ignoring a problem only increases its size, duration and cost. Often, the longer a problem persists, the longer it takes to solve.

Responding to IAQ Issues

Communications are critical –
find "Issues" before they turn into "Problems"

According to studies, occupants *do not readily* express *dissatisfaction* with the indoor environment

Establish a non-threatening method for occupants to register concerns

Should be easy, non-threatening, policy-driven and effective

Issue or Concern Response

The clock is ticking

Occupants getting *emotional*

Rumor mill is working

Trust is compromised

Solutions become more *difficult & expensive*

An immediate response shows you are taking concerns seriously

Is the Problem Building-Related ?

Does the problem …

- ✓ occur at particular time?
- ✓ associated with particular zone or the entire building?
- ✓ symptoms improve when occupants leave building?
- ✓ relate to a particular event, activity, operating condition?
- ✓ other occupants affected?
- ✓ medical personnel suggest it is building-related?

Sample Forms

IEQ Report Form (*not* "complaint")

Occupant Diary

IEQ Incident Report Form

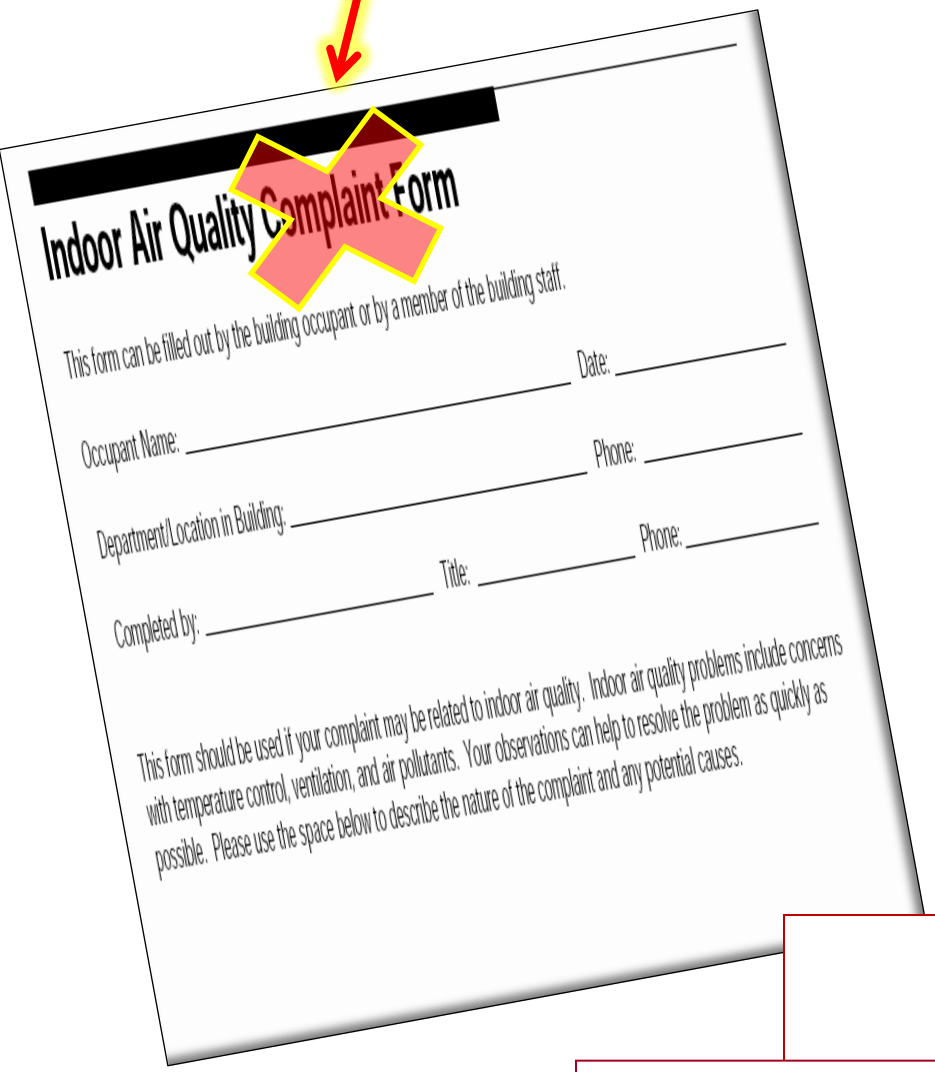
Pollutant Pathway Form

Pollutant & Source Inventory

Maintenance Calendar

HVAC Inspection & Checklist

"Issue" or "Concern"



Get the "facts"

Immediate Interview

Immediate Interview

Page 1 of 2

Occupant Interview

Building Name: _____ File Number: _____

Address: _____ Work Location: _____

Occupant Name: _____ Title: _____ Date: _____

Completed by: _____

Sections 4 discusses collecting and interpreting information from occupants.

SYMPTOM/PATTERNS

What kind of symptoms or discomfort are you experiencing?

Are you aware of other people with similar symptoms or concerns? Yes _____ No _____

If so, what are their names and locations? _____

Do you have any health conditions that may make you particularly susceptible to environmental problems?

- ❑ contact lenses
- ❑ allergies
- ❑ chronic cardiovascular disease
- ❑ chronic respiratory disease
- ❑ chronic neurological problems
- ❑ undergoing chemotherapy or radiation therapy
- ❑ immune system suppressed by disease or other causes

TIMING PATTERNS

When did your symptoms start?

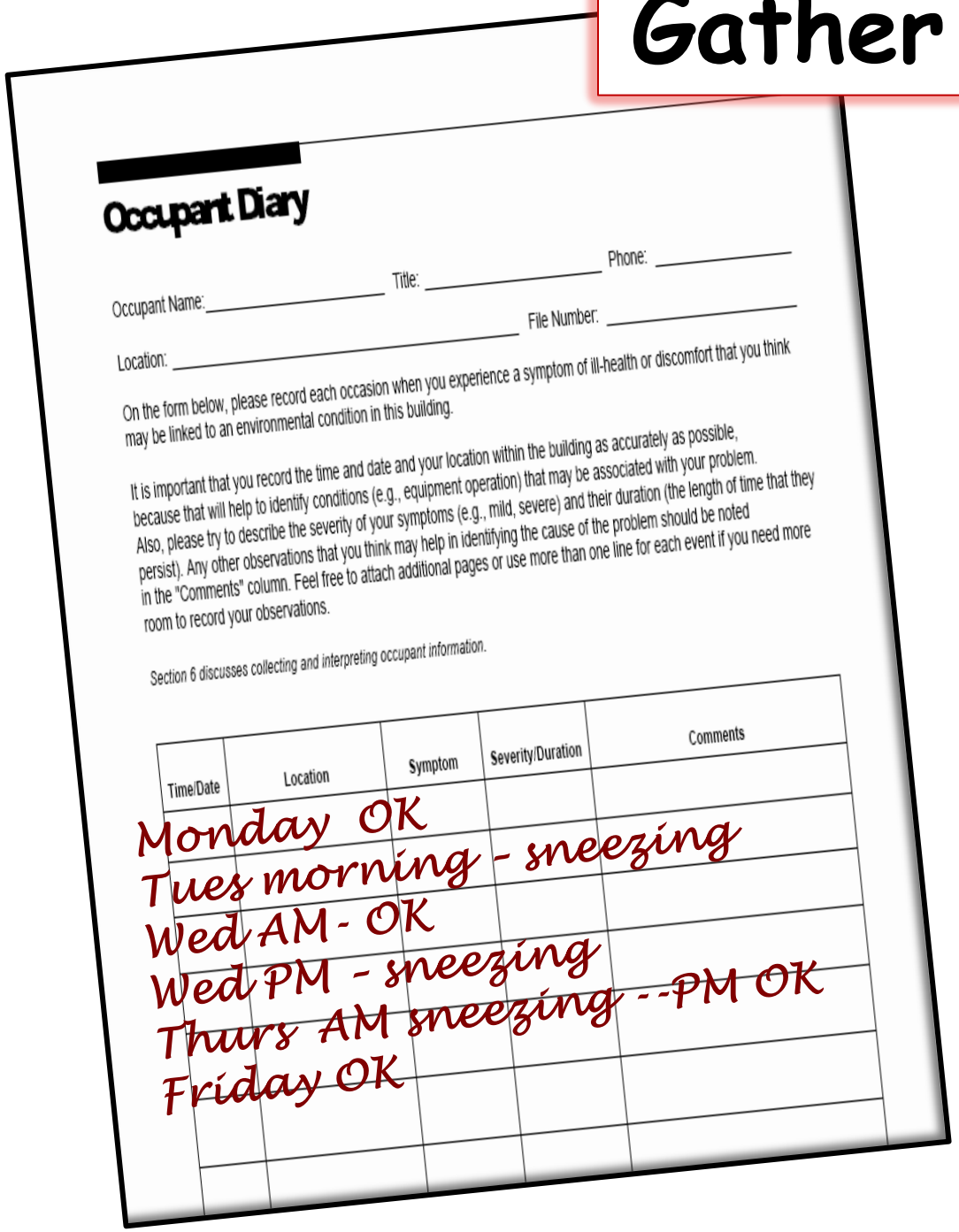
When are they generally worst?

- **WHO** is affected?
- **WHAT** is the nature of the issue?
- **WHERE** does the problem occur?
- **WHEN** does the problem occur?

Principal
Custodial
Facilities
IAQ Coordinator

Share interview and agree on next steps with the "team"

Gather more "facts"



Occupant Diary

Occupant Name:_____ Title: _____ Phone: _____

Location: _____ File Number: _____

On the form below, please record each occasion when you experience a symptom of ill-health or discomfort that you think may be linked to an environmental condition in this building.

It is important that you record the time and date and your location within the building as accurately as possible, because that will help to identify conditions (e.g., equipment operation) that may be associated with your problem. Also, please try to describe the severity of your symptoms (e.g., mild, severe) and their duration (the length of time that they persist). Any other observations that you think may help in identifying the cause of the problem should be noted in the "Comments" column. Feel free to attach additional pages or use more than one line for each event if you need more room to record your observations.

Section 6 discusses collecting and interpreting occupant information.

Time/Date	Location	Symptom	Severity/Duration	Comments

Monday OK
Tues morning - sneezing
Wed AM - OK
Wed PM - sneezing
Thurs AM sneezing --PM OK
Friday OK

Health issues must be addressed with medical professionals

Document:
- tests
- medications
- recommendations

Page 1 of 2

Occupant Interview

Building Name: _____ File Number: _____

Address: _____ Work Location: _____

Occupant Name: _____ Title: _____ Date: _____

Completed by: _____

Sections 4 discusses collecting and interpreting information from occupants.

SYMPTOM PATTERNS

What kind of symptoms or discomfort are you experiencing?

Are you aware of other people with similar symptoms or concerns? Yes _____ No _____

If so, what are their names and locations? _____

Do you have any health conditions that may make you particularly susceptible to environmental problems?

- ❑ contact lenses
- ❑ allergies
- ❑ chronic cardiovascular disease
- ❑ chronic respiratory disease
- ❑ chronic neurological problems
- ❑ undergoing chemotherapy or radiation therapy
- ❑ immune system suppressed by disease or other causes

TIMING PATTERNS

When did your symptoms start?

When are they generally worst?

Agree on Solutions

People are more likely to accept solutions they helped create!

"Team Up" with credible resources

Solutions must be collaborative

Try to agree on:

Investigation methods

Realistic timelines

Measurable outcomes

People are more likely to accept solutions they helped create!

Measurable outcomes are essential

Establish "expectations"

Use "Industry Standards"

Confirm or rule-out causes

Dial-in remediation

Verify solution effectiveness

Agree on *measureable* outcomes

- ✓ Comfort within guidelines
  - temperatures
  - relative humidity
  - air velocity
- ✓ Correct air flow direction
- ✓ Carbon dioxide (CO_2) $\leq$ 1,000 ppm
- ✓ Reduced noise
- ✓ Reduced airborne particles

Measurable Reductions

Health Effects

Absenteeism

Medication use

Doctor visits

Irritation

Distractions

Post-issue resolution:

Institutionalize prevention with policy, action, and accountability

Reinforce prevention with policy, action, and accountability

Air Flow Rules

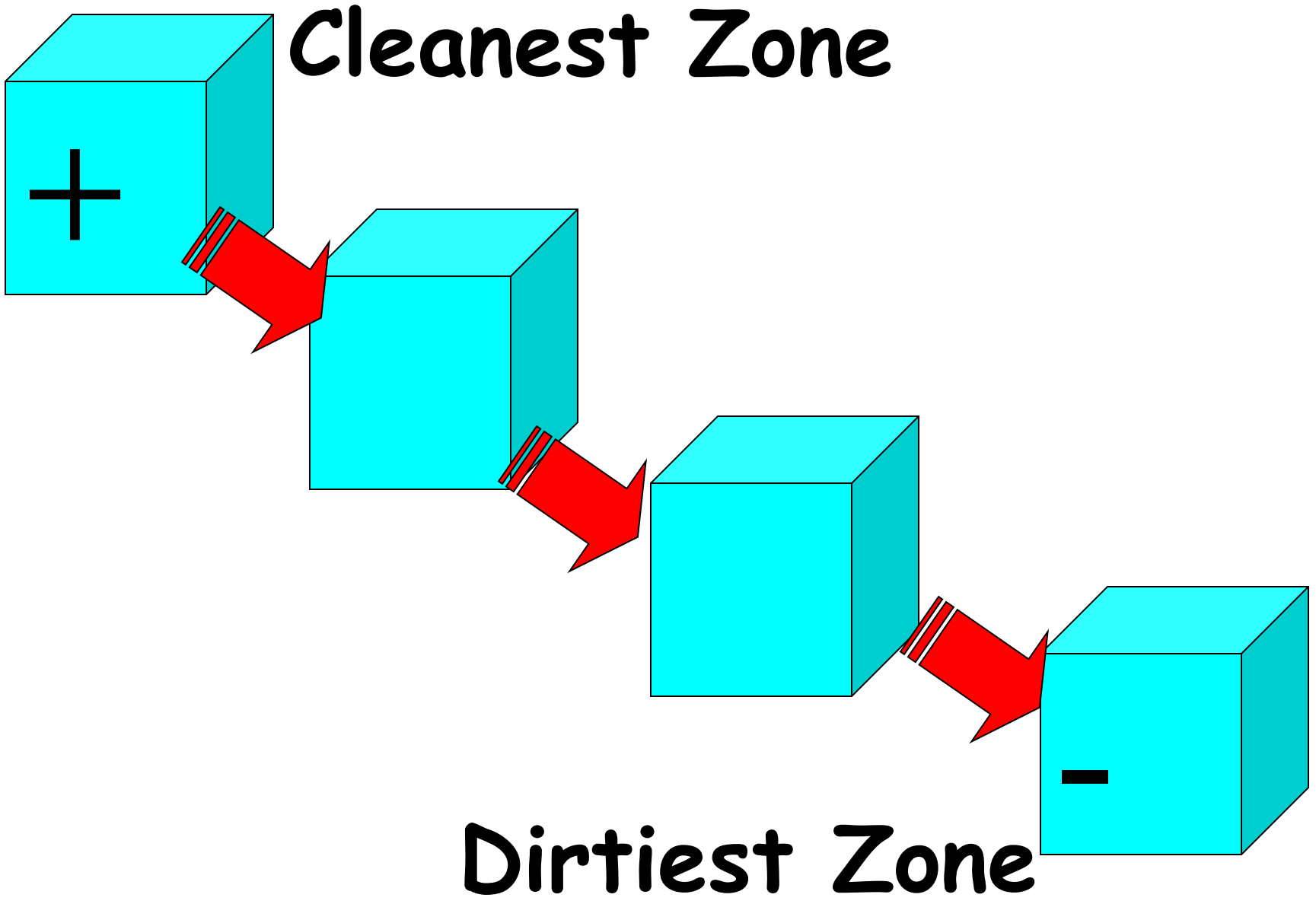
Air always goes where it is…

PUSHED or PULLED.

Air should move from…

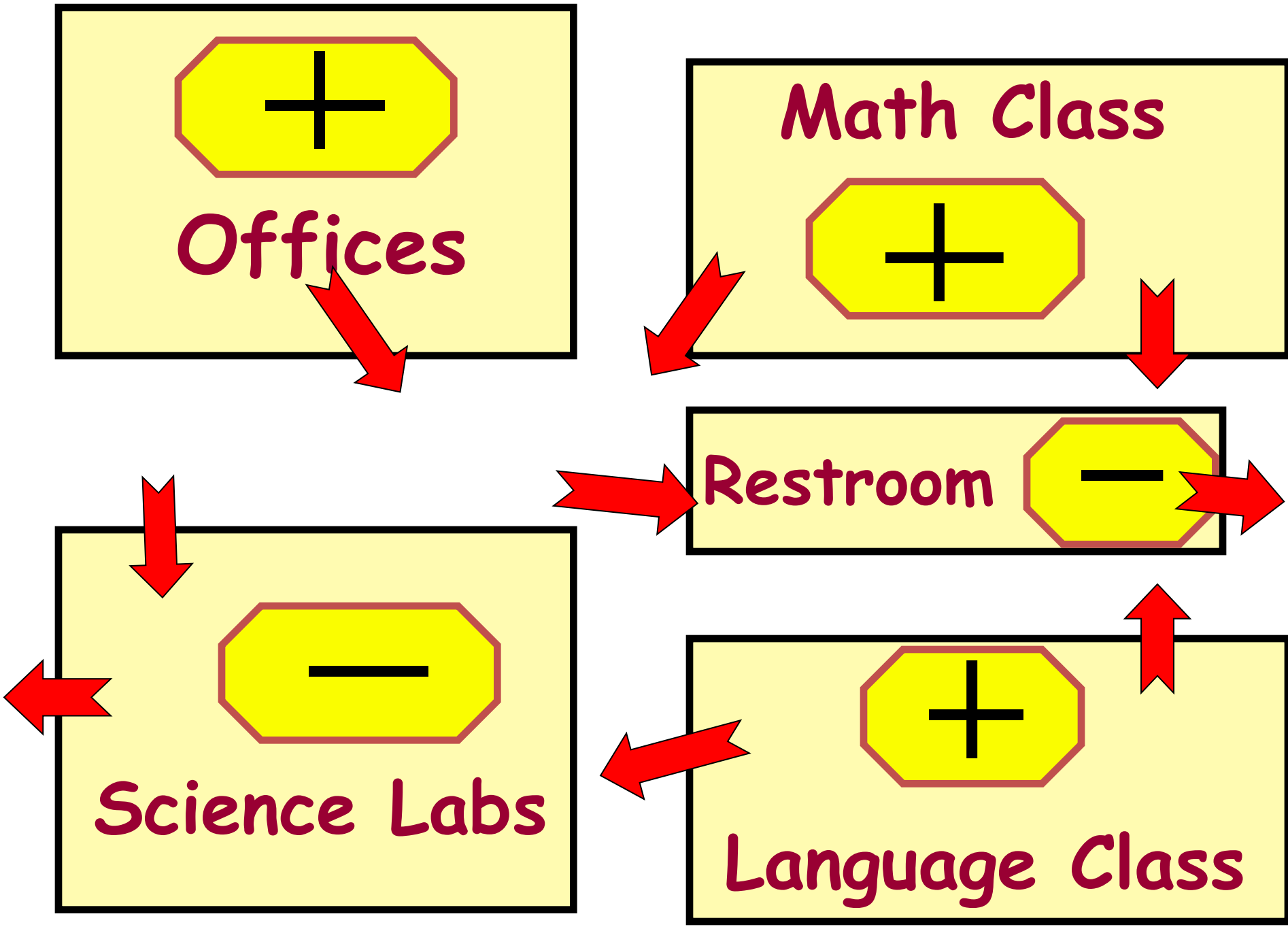
CLEAN to DIRTY.

Takes path of least resistance.

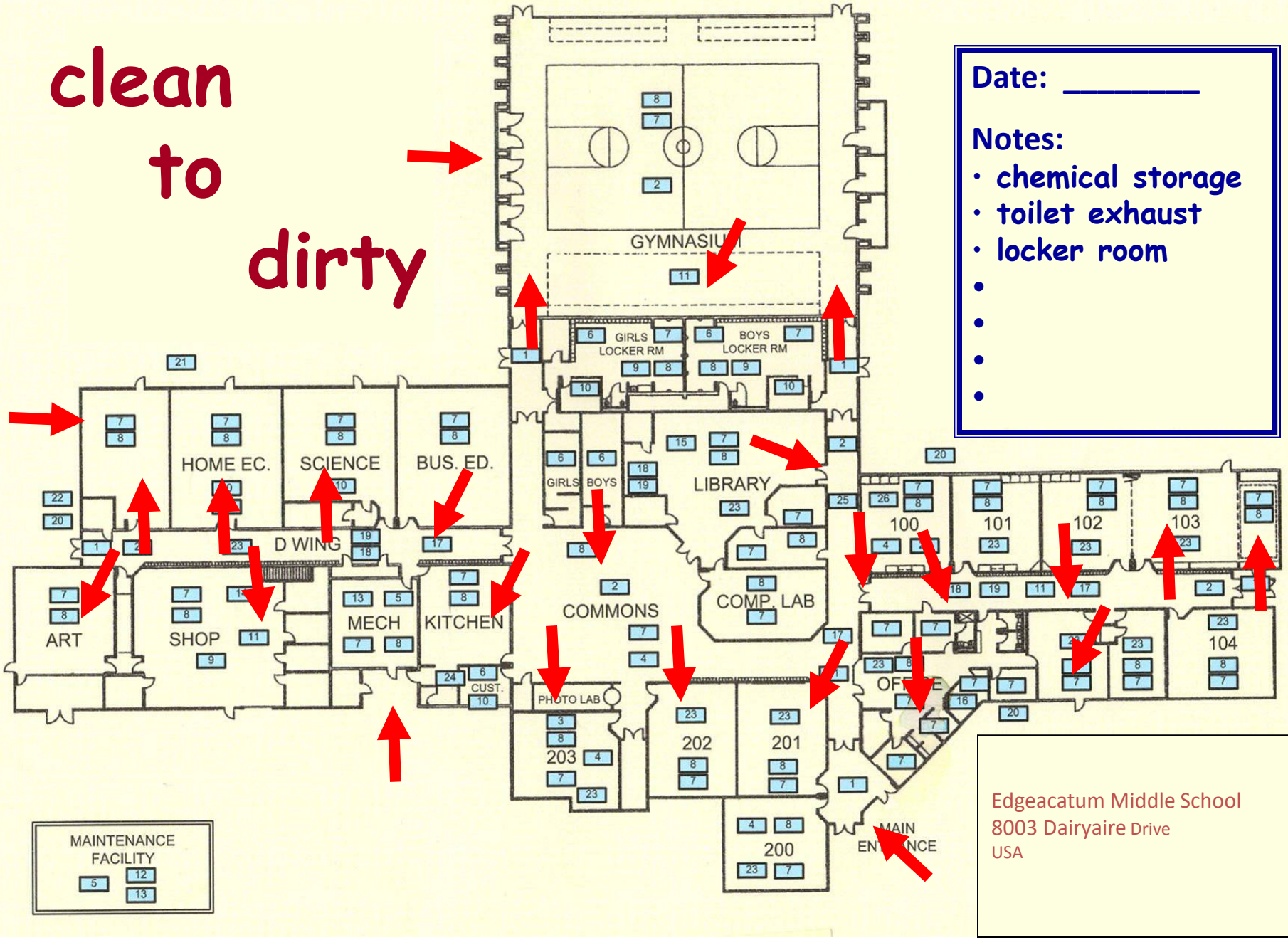

Cleanest Zone
+
-
Dirtiest Zone

What is a strong pressure?
~ 5 to 25 pascals of pressure provides robust containment of pollutants

25 pascals = 1/10th inch water column pressure


Offices
Math Class
Restroom
Science Labs
Language Class

clean to dirty



Date: _____

Notes:

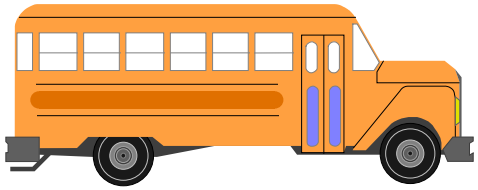
- chemical storage
- toilet exhaust
- locker room
-
-
-
-

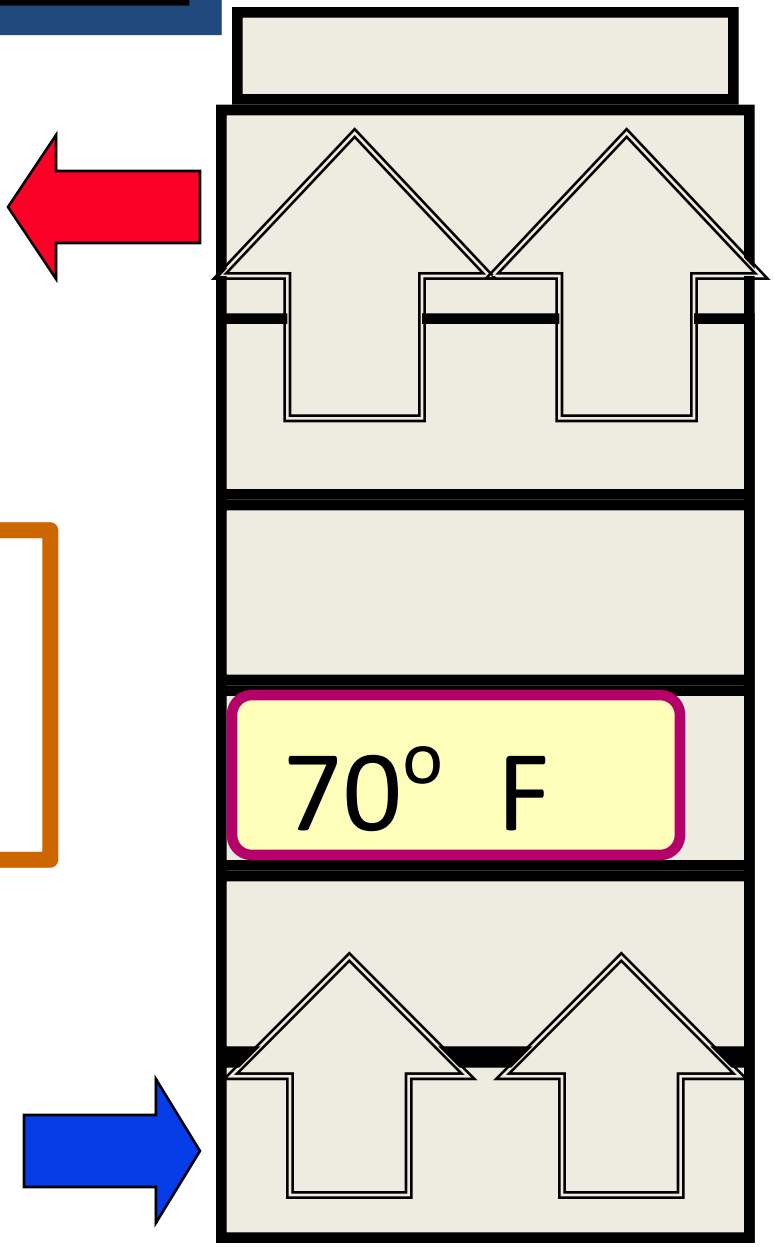
Edgeacatum Middle School
8003 Dairyaire Drive
USA

STACK EFFECT

40° F

Building Height
&
Temperature Differential





Limit Exposures

Exclude, Eliminate or Reduce

Remove pollutants to extent possible

Prevent entry of moisture, dirt, insects, rodents, outdoor air pollutants

Policies against occupants bringing in pollutants

Remove Asthma Triggers

No chemicals “from home

Find and correct exhaust ‘re-entrainment

LABS and Chemical Storage – note unsafe conditions

Remove non-district upholstered furniture, pillows, area rugs, stuffed toys, other fleecy materials

Note carpet due for extraction or replacement

Make sure rooms can be cleaned easily

Reduce Potential Sources

Reduce

- *Use less chemical,*
- *keep building clean,*
- *provide adequate filtration,*
- *reschedule activities.*

Reduce Strong Odors and Fragrances

Strong odors (cleaning products, art, air fresheners) can trigger allergic reactions and asthma.

- **Eliminate or use less of a product.**
- **Switch to a product that has less odor.**
- **Use products during unoccupied periods.**
- **Use exhaust fans or opening windows to reduce exposures.**
- **Do not use fragrances or air fresheners to cover up odors.**

Adopt “Green Cleaning”

“Green” Cleaning Products

Basic categories to look for from your custodial supplier:

Institutional Cleaning Products (GS-34, GS-37, GS-40)

GS-34 Cleaning and Degreasing Agents
GS-37 Cleaning Products *for Industrial and Institutional Use*
GS-40 Floor-Care Products *for Industrial and Institutional Use*

For example, major suppliers offers these 5

- ***Green Seal listed products:***
- ***General Purpose Cleaner***
- ***Glass Cleaner***
- ***Neutral GP Cleaner***
- ***HD Cleaner***
- ***Washroom Cleaner***

Isolate, Capture, Exhaust

- ***Keep areas with pollutant sources closed off from other spaces and check pressure differentials.***
- **Provide direct exhaust to capture and remove pollutant at the source.**
- **Ensure no infiltration or re-entrainment from exhausts.**

Lead

Lead has long been recognized as a harmful environmental pollutant.

In late 1991, the Secretary of the Department of Health and Human Services called lead *the "number one environmental threat to the health of children in the United States."*

Before it was known how harmful lead could be, it was used in paint, gasoline, water pipes, and many other products.

There are many ways in which humans are exposed to lead: through air, drinking water, food, contaminated soil, deteriorating paint, and dust.

Airborne lead enters the body when an individual breathes or swallows lead particles or dust once it has settled.

Old lead-based paint: The most significant source of lead exposure in the U.S. today

Harmful exposures to lead can be created when lead-based paint is improperly removed from surfaces by dry scraping, sanding, or open-flame burning.

High concentrations of airborne lead particles in homes can also result from lead dust from outdoor sources, including contaminated soil tracked inside, and use of lead in certain indoor activities such as soldering and stained-glass making.

Lead Health Effects

- **Lead affects practically all systems within the body.**
- **Lead at high levels (lead levels at or above 80 micrograms per deciliter of blood) can cause convulsions, coma, and even death.**
- **Lower levels of lead can cause adverse health effects on the central nervous system, kidney, and blood cells.**
- **Blood lead levels as low as 5 micrograms per deciliter can impair mental and physical development.**

Higher Levels of Lead

Lead affects practically all systems within the body.

Lead levels at or above 80 micrograms per deciliter of blood, can cause convulsions, coma, and even death.

Lead exposure is a potential concern for all humans
Young children (less than seven years old) are most at risk

Children typically have higher intake rates (per unit body weight) for environmental media (such as soil, dust, food, water, air, and paint) than adults, since they are more likely to play in dirt and put their hands and other objects in their mouths;

Children tend to absorb a higher fraction of ingested lead from the gastrointestinal tract than adults;

(Reagan and Silbergeld, 1989)

Lead Health Effects

- **The effects of lead exposure on fetuses and young children can be severe.**

- **They include delays in physical and mental development, lower IQ levels, shortened attention spans, and increased behavioral problems.**

Lead Health Effects

Fetuses, infants, and children are more vulnerable to lead exposure than adults since lead is more easily absorbed into growing bodies, and the tissues of small children are more sensitive to the damaging effects of lead.

Lead Health Effects

Children may have higher exposures since they are more likely to get lead dust on their hands and then put their fingers or other lead-contaminated objects into their mouths

Symptoms of Lead Exposure

Lead poisoning can be a serious public health threat with no unique signs or symptoms. Early symptoms of lead exposure may include:

- **persistent fatigue**
- **irritability**
- **loss of appetite**
- **stomach discomfort and/or constipation**
- **reduced attention span**
- **Insomnia**

Failure to treat lead poisoning in the early stages can cause long-term or permanent health damage, but because of the general nature of symptoms at early stages, lead poisoning is often not suspected.

In adults, lead poisoning can cause:

- poor muscle coordination
- nerve damage to the sense organs and nerves controlling the body
- increased blood pressure
- hearing and vision impairment
- reproductive problems (e.g., decreased sperm count)
- retarded fetal development even at relatively low exposure level

In children, lead poisoning can cause:

- damage to the brain and nervous system
- behavioral problems
- anemia
- liver and kidney damage
- hearing loss
- hyperactivity
- developmental delays
- in extreme cases, death

Lead exposure is a potential concern for all humans
Young children (less than seven years old) are most at risk

Children tend to be more susceptible than adults to the adverse neurological and developmental effects of lead;

Nutritional deficiencies of iron or calcium, which are common in children, may facilitate lead absorption and exacerbate the toxic effects of lead.

(Reagan and Silbergeld, 1989)

Due to efforts to reduce exposure to lead, the national average blood lead levels in children have dropped.

Banning lead paint and lead in gasoline were national efforts to stop childhood lead poisoning.

Contaminated sites require site-specific cleanups to reduce exposure to populations nearby.

Blood Lead Levels

The Centers for Disease Control (CDC) has identified that the current blood lead level of concern in children is 10 micrograms (µg) of lead per deciliter (dL) of blood (10 µg/dL).

However, adverse effects may occur at lower levels than previously thought.

In January of 2012, an advisory panel to the CDC recommended lowering the level that triggers intervention

Blood Tests for Lead

Doctors can conduct blood tests to determine lead concentrations in blood.

Blood tests are inexpensive and sometimes free; however, consult the insurance provider to determine coverage of tests.

Lead in bone and teeth can be measured using x-ray techniques, but this test is not used very often.

Blood Tests for Lead

In communities where houses are old and deteriorating, residents are encouraged to take advantage of available screening programs offered by local health departments and to have children living in the residence checked regularly for lead poisoning.

Because the early symptoms of lead poisoning are similar to those of other illnesses, it is difficult to diagnose lead poisoning without medical testing.

CPSC

To help protect small children who might swallow paint chips, the Consumer Product Safety Commission (CPSC), does not allow the amount of lead in most paints to exceed 0.06 percent.

The CDC suggests testing paint on the inside and outside of residential buildings for lead

1988 Lead Contamination Control Act

The CPSC, EPA, and states are required by the 1988 Lead Contamination Control Act to test drinking water in schools for lead, and to remove the lead if levels are too high.

Drinking water coolers must be free of lead contamination and any water coolers that are tainted with lead have to be removed.

EPA regulations limit lead in drinking water to 15 micrograms per liter (15 µg/L)

EPA has established standards designed to limit the amount of lead in ambient air. Over a three-month period, the average concentration of lead (as measured in total suspended particles) cannot be greater than 0.15 micrograms of lead per cubic meter of air (0.15 µg/m^3).

The National Institute for Occupational Safety and Health (NIOSH) recommends that workers not be exposed to lead levels of greater than 100 µg/m^3 for up to ten hours

EPA and the Centers for Disease Control and Prevention (CDC) have determined that childhood blood lead concentrations at or above 10 micrograms of lead per deciliter of blood (µg/dL) present risks to children's health.

EPA's risk reduction goal for contaminated sites is to limit the probability of a child's blood lead concentration exceeding 10 µg/dL (the P10) to 5 percent or less after cleanup.

How Are Adults Exposed to Lead?

Lead exposure occurs when lead dust or fumes are inhaled, or when lead is ingested via contaminated hands, food, water, cigarettes or clothing. Lead entering the respiratory and digestive systems is released to the blood and distributed throughout the body.

More than 90% of the total body burden of lead is accumulated in the bones, where it is stored. Lead in bones may be released into the blood, re-exposing organ systems long after the original exposure.

The toxic nature of lead is well documented. Lead affects all organs and functions of the body to varying degrees. many of the key lead-induced health effects.

Neurological Effects

- Fatigue / Irritability
- Impaired concentration
- Hearing loss
- Wrist / Foot drop
- Seizures
- Encephalopathy

Gastrointestinal Effects

- Nausea
- Dyspepsia
- Constipation
- Colic
- Lead line on gingival tissue

Reproductive Effects

- Miscarriages/Stillbirths
- Reduced sperm count & motility
- Abnormal sperm

Heme Synthesis

- Anemia
- Erythrocyte protoporphyrin elevation

Renal Effects

- Hypertension
- Chronic nephropathy with proximal tubular damage

Other

- Arthralgia
- Myalgia

Some Sources of Lead Exposure

Occupational

Construction workers

Steel welders

Bridge reconstruction workers

Firing range instructors

Painters

Remodelers and refinishers

Scrap metal recyclers

Auto repairers

Cable splicers

Hobbies

Casting bullets or fishing sinkers

Home remodeling

Target shooting at firing ranges

Lead soldering

Auto repair

Stained glass making

Glazed pottery making

Substance Use

Some folk remedies

Some "Health Foods"

Moonshine whiskey

Ceramicware

Steps to Reduce Exposure to Lead

Keep areas where children play as dust-free and clean as possible.

Leave lead-based paint undisturbed if it is in good condition; do not sand or burn off paint that may contain lead.

Do not remove lead paint yourself.

Do not bring lead dust into the home.

If your work or hobby involves lead, change clothes and use doormats before entering your home.

Eat a balanced diet, rich in calcium and iron.

Reduce the risk from lead-based paint.

Most homes built before 1960 contain heavily leaded paint. Some homes built as recently as 1978 may also contain lead paint.

This paint could be on window frames, walls, the outside of homes, or other surfaces. Do not burn painted wood since it may contain lead.

Reduce the risk from lead-based paint.

Leave lead-based paint undisturbed if it is in good condition, do not sand or burn off paint that may contain lead.

Lead paint in good condition is usually not a problem except in places where painted surfaces rub against each other and create dust (for example, opening a window)

Home test kits

Home test kits cannot detect small amounts of lead under some conditions.

Hire a person with special training for correcting lead paint problems to remove lead-based paint.

Occupants, especially children and pregnant women, should leave the building until all work is finished and clean-up is done.

LEAD PAINT:

BAD IN SCHOOLS, HOSPITALS, APARTMENTS OR ANYWHERE CHILDREN MAY BE PRESENT.

Many contractors and maintenance workers who have been on the job for years believe they know all about the dangers of and the precautions necessary for working with lead paint. Others think lead paint poisoning simply went away years ago. It didn't.

That's why you need to know the facts about lead paint and how disturbing it poses serious health risks to the people in your building, especially children.

If your pre-1978 hospital, child-care facility, school or extended-stay hotel suite is being renovated, repaired or painted, this pamphlet is for you. In it, you'll learn about the dangers of lead paint, how to hire a Lead-Safe Certified contractor, and how to make sure your own maintenance staff is doing the right thing.

THE TRUTH ABOUT LEAD PAINT POISONING.

Lead paint is an invisible danger. Here are some facts about lead paint poisoning that everyone should know:

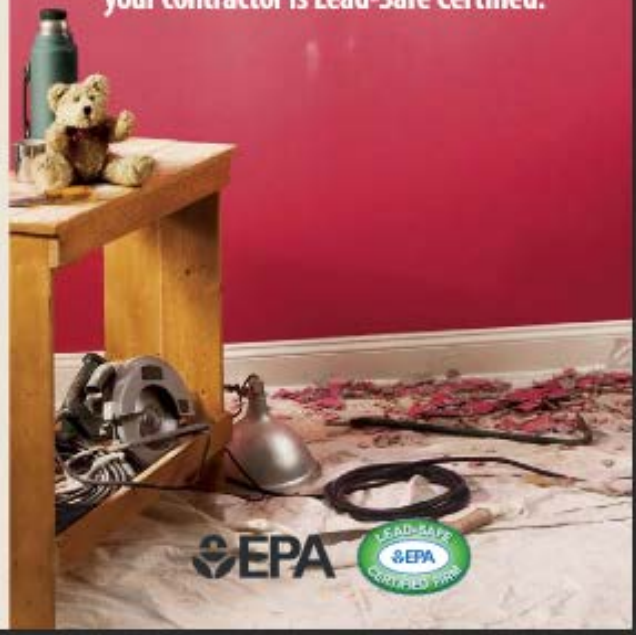
- A million kids are affected by lead paint poisoning with some level of irreversible damage, such as lower intelligence, learning disabilities and behavioral issues.
- New cases of childhood lead paint poisoning are diagnosed every year. Many more could go unreported.
- Recent research shows that new cases can be directly linked to renovations where the work environment was inadequately contained.
- Adults exposed to lead paint can suffer from high blood pressure, headaches, dizziness, diminished motor skills, fatigue and memory loss. Even small levels of exposure to lead paint can harm adults.
- It's not just lead paint chips that poison. Contamination can be caused by only a little bit of lead dust that is easily absorbed by anyone who inhales or ingests it.
- Once poisoned, it's for life and can never be reversed.

EPA United States Environmental Protection Agency

To learn more, visit epa.gov/getleadsafe or call 800-424-LEAD.

IF YOU'RE NOT LEAD-SAFE CERTIFIED, DISTURBING JUST SIX SQUARE FEET COULD COST YOU BIG TIME.

Building Managers: Make sure you or your contractor is Lead-Safe Certified.



WHERE DOES THE LEAD DANGER COME FROM TODAY?

In earlier decades, the fear of children eating lead paint chips was the main concern when it came to poisoning. But since then, research has shown that the most common way to get lead in the body is from inhaling or ingesting microscopic dust.

Renovation creates this dust. Common renovation activities, like sanding, cutting and demolition, can create hazardous lead dust and chips. Proper work practices can protect the people in your building, especially children, from this dust.

Even for small jobs, the key is to use lead-safe work practices such as containing dust inside the work area, using dust-minimizing work methods and conducting a careful cleanup. It also means keeping people out of the work area. Most important, it means making sure that anyone who does work in your building is Lead-Safe Certified.

HOW DO I CHOOSE THE RIGHT CONTRACTOR?

As a property manager or person in the position of authority to choose who renovates your hospital, child-care facility, school, or apartment, it is your responsibility to choose a contractor who is Lead-Safe Certified.

Here are a few helpful tips:

- Ask if the contractor is trained to perform lead-safe work practices and ask to see a copy of their EPA training certificate.
- Make sure your contractor can explain clearly the details of the job and how the firm will minimize lead hazards during the work process.
- Ask what lead-safe methods will be used to set up and perform the job in your hospital, child-care facility, school or apartment.
- Ask for references from at least three recent jobs involving buildings built before 1978, and speak to each personally.
- Always make sure the contract is clear about how the work will be set up, performed and cleaned.

You can verify that a contractor is certified by checking the EPA website at www.epa.gov/getleadsafe or by calling the National Lead Information Center at 1-800-424-LEAD (5323). You can also ask to see a copy of the contractor's firm certification.

DOES MY STAFF HAVE TO BE LEAD-SAFE CERTIFIED?

Federal law requires that if you or someone on your staff is performing the work your firm must be Lead-Safe Certified and your staff trained in lead-safe work practices. If not, you could face tens of thousands of dollars in fines. Plus, you put the health of yourself, your workers, and your customers at risk, which could result in lawsuits.
These work practices include:

- Containing the work area.
- Avoiding renovation methods that generate large amounts of lead-contaminated dust.
- Cleaning up thoroughly.

GETTING YOUR LEAD-SAFE CERTIFICATION.

- To become certified, individuals must attend a full-day Renovation, Repair and Painting Rule Course. The price for this course is set by private trainers accredited by the EPA. To find an accredited trainer near you, visit **www.epa.gov/getleadsafe or call 1-800-424-LEAD.**
- Your firm also needs to register with the EPA and pay $300 to receive official certification.
- To help you through this new regulation, there is a wealth of downloadable support information on our website, www.epa.gov/getleadsafe.

LEAD-SAFE EPA CERTIFIED FIRM

EPA regulations now mandate that any contractor or maintenance staff, from plumbers to electricians to painters, who disturbs more than six square feet of lead paint, replaces windows or does any demolition while working in a pre-1978 home, school or day-care center, must now be Lead-Safe Certified and trained in lead-safe work practices. If not, you could face tens of thousands of dollars in fines. These regulations are now the standard of care for the industry and complying with them will reduce your chance of being involved in potentially expensive lawsuits.

EPA: Renovation, Repair, and Painting Rule

The EPA has ruled that contractors who perform *renovation, repairs, and painting* must train and re-certify in lead-safe work practices before renovating certain projects.

***These new EPA rules took effect on April 22, 2010*.**

EPA: Renovation, Repair, and Painting Rule

There are 5 steps to be sure you are in compliance:

Get registered for an EPA-approved lead certification course

Submit an application to EPA on behalf of your company

Complete the training in a public or private workshop

Pass the short certification exam given in class

Receive approval from EPA and you're in the clear!

The EPA lead certification & licensing requirement went into effect on April 22, 2010 and you want to be sure that you're lead safety certified. Failure to comply with EPA certification requirements WILL result in ***fines of $37,500 per day*** that you are working in the field on a qualifying project.

Lead Testing

All three currently-recognized test kits meet this criterion. The recognition of such kits will last until EPA publicizes its recognition of the first test kit that meets both the negative response and positive response criteria outlined in the RRP rule.

EPA has recognized three lead test kits for use in complying with the RRP rule.

3M™ LeadCheck™

D-Lead®

State of Massachusetts test kit

New Test Kits . . .

Any newly recognized test kit must meet both the negative and positive response criteria:

No more than 5 percent false negatives and;

No more than 10 percent false positives;

Each with 95 percent confidence, as related to the regulated level of lead in paint of 1.0 (mg/cm^2) or 0.5 percent by weight.

As yet, no test kit has been developed to meet this criteria.

X-Ray Fluorescence (XRF) Analyzer

tells where the lead-in-paint is located,

how deeply buried it may be in the paint matrix,

how much lead is present.

X-Ray Fluorescence (XRF) Analyzer

Locate & quantify lead-in-soil & lead-in-building dust.

Perform soil screening for boundaries and scope of lead around homes and businesses, resulting from deteriorating building paint, industrial activity, illegal dumping, or agricultural use.

Many inspectors are prescreening wipes from post-lead abatement projects to expedite clearance process.

Elemental Mercury

- Heavy metal, *liquid* at room temperature
- Evaporates into a colorless odorless *vapor*
- *Toxic* to brain, kidneys, and other organs
- More toxic to *children* than adults

Mad hatter disease, or **mad hatter syndrome**,

Commonly used name for occupational chronic mercury poisoning *among hat makers whose felting work involved prolonged exposure to mercury vapours* (in the form of mercuric nitrate to treat the fur of small animals for the manufacture of felt hats).

The neurotoxic effects included tremor and the pathological shyness and irritability characteristic of erethism*

By the Victorian era the hatters' condition had become proverbial, as reflected in popular expressions like "mad as a hatter" and the hatters' shakes.

1898 a law was passed to protect hat makers from the risks of mercury exposure.

* a neurological disorder which affects the whole central nervous system, as well as a symptom complex derived from mercury poisoning

Mercury in our Buildings

homes, schools, commercial

Thermometers
Sphygmomanometers (blood pressure)
Thermostats
Barometers
Electrical switches
Flow meters
Mercury gauges
Batteries
Science labs
High pressure sodium lamps
Compact fluorescent light bulbs

Exposures to Mercury Exposure

- **Elemental (metallic) mercury primarily causes health effects when it is *breathed as a vapor* where it can be absorbed through the lungs.**

- ***These exposures can occur when elemental mercury is spilled or products that contain elemental mercury break and expose mercury to the air, particularly in warm or poorly-ventilated indoor spaces.***

Health Concerns of Mercury

- **Mercury Exposure is a Health Concern**
- **Exposure to elemental mercury can occur by breathing mercury vapors, eating or swallowing foods or water contaminated with mercury, or having skin contact with mercury droplets or beads.**
- **There is *little concern* about exposure to liquid mercury from eating or skin contact because the body absorbs little mercury through these routes. The route of exposure that poses the greatest health risk is inhalation of mercury vapor.**

Elemental Mercury Health Effects

- **Symptoms include these: tremors; emotional changes (e.g., mood swings, irritability, nervousness, excessive shyness); insomnia; neuromuscular changes (such as weakness, muscle atrophy, twitching); headaches; disturbances in sensations; changes in nerve responses; performance deficits on tests of cognitive function.**
- **At higher exposures there may be kidney effects, respiratory failure and death. People concerned about their exposure to elemental mercury should consult their physician**

Short-term exposure

- **Short-term exposure (up to a few weeks) to high levels of mercury can cause cough, shortness of breath, chest pain, nausea, vomiting, diarrhea, fever and hypertension.**
- **Breathing high levels of mercury in air can damage the nervous system and kidneys.**

Symptoms from Short-Term High Level Exposure

- ***Cough***
- ***Sore Throat***
- ***Shortness of breath***
- ***Nausea and vomiting***
- ***Diarrhea***
- ***Fast heart rate***
- ***Headache***
- ***Vision problems***
- ***Metallic taste in mouth***

Symptoms from Long-term Exposure

- ***Anxiety***
- ***Excessive shyness***
- ***Insomnia***
- ***Loss of appetite***
- ***Irritability***
- ***Fatigue***
- ***Forgetfulness***
- ***Tremors***
- ***Changes in vision and hearing***

Longer-term exposure

(more than a few weeks)

- **Exposure to mercury vapor is of particular concern for children and unborn babies because their nervous systems are still developing and may be more vulnerable.**
- **Other potentially vulnerable individuals include those with medical conditions of the nervous system, kidneys, or heart and vascular system. These conditions may be worsened by exposure to mercury. Biological sampling for mercury can serve as a valuable indicator of a person's exposure.**

Mercury Spills

- **At room temperature, mercury spills release *odorless and colorless mercury vapor* into the air where exposure by breathing can occur.**
- **Inhaled mercury vapor is readily absorbed from the lungs into the bloodstream, then transported to other parts of the body, including the brain and kidneys.**
- ***Very small amounts of mercury (for example, a few drops) can raise indoor air concentrations of mercury to levels that may be harmful to health*. Since mercury vapor is odorless and colorless, a person can breathe mercury vapor and not be aware that it is entering the body.**

Mercury Spills are a Problem

- ***Small spills*** **of mercury (for example, the amount in a fever thermometer) on a smooth, non-porous surface, can be cleaned up safely and easily with proper techniques.**
- **However, beads of mercury are heavy and readily *sink into cracked floors* or other open surfaces.**
- **Mercury can be *tracked* beyond the original spill area on footwear or on pets' feet.**
- **Mercury also clings to *porous materials* like fabric, carpet or wood, making it difficult to remove.**

School Mercury Spills

- Disruptive
- Exposure to mercury vapors
- Costly clean up
- Disposal of materials and equipment
- Contamination
  - school
  - school buses
  - houses

Case Study

September 2013, an elemental (metallic and liquid) mercury spill on a school bus.

An elementary student boarded the bus with approximately 1 pound (about 2 tablespoons) of elemental mercury contained in a film canister.

The student had taken this from an adult relative who had found it in a neighbor's shed.

Case Study

The canister was handled by several students before the contents spilled on the bus floor.

Ten passengers aboard the bus were exposed, including eight students and two staff members.

Although elemental mercury is not readily absorbed from skin contact or ingestion, it does vaporize at room temperatures and inhalation of the vapor can be harmful.

The bus driver promptly notified school officials.

Firefighters and a local hazardous materials team directed decontamination procedures (i.e., changing clothes and washing hands and shoes) for the 10 exposed passengers.

The bus was immediately taken out of service and sent for *disposal* because of its age and the cost of decontamination.

An Environmental Protection Agency (EPA) response team used a mercury vapor analyzer to determine mercury vapor levels at the residence from which the mercury was taken and at the three schools where the children were dropped off.

The residence had mercury levels of 673 μg/m3.

The Agency for Toxic Substances and Disease Registry's recommended levels:

Residential cleanup (1 μg/m3)

Evacuation (≥10 μg/m3).

Over a 10-day period, the EPA response team remediated the contaminated residence through ventilation, removal of free mercury and mercury-contaminated items (e.g., furniture, carpet, bedding, and clothing), cleaning of surfaces with a mercury binding solution, and heating of the residence.

EPA, XXX County Emergency Management, County Health Department, American Red Cross, and County Department of Social Services collaborated to assist the family with shelter, food, clothing, transportation, and medical needs during the response and recovery phases.

Testing with a mercury vapor analyzer at the three schools potentially affected did not indicate contamination, with the *exception of several pieces of carpet removed from one classroom*.

To quantify human exposure and assess symptoms, the XXX County Health Department administered a mercury exposure questionnaire to 23 persons, including the 10 exposed passengers aboard the school bus, seven family members who lived at the contaminated residence, two family members who had visited the residence 2 days before the exposure on the bus, and four firefighters.

The State Laboratory of Public Health performed blood mercury testing on 12 of the 23 persons.

Two students and three family members reported acute symptoms on the day of the exposure, including headache, cough, numbness or tingling in hands, and difficulty breathing.

The student who brought the mercury aboard the bus and five family members, including two adults, had elevated blood mercury levels, ranging from 134 μg/L to >200 μg/L.

A blood mercury concentration of ≥ 50 μg/L is considered the threshold for symptoms of toxicity after an acute high level exposure.

Two children who had symptoms and blood mercury levels >200 μg/L received a 19-day course of dimercaptosuccinic acid chelation therapy.

Two other children with elevated blood mercury levels but no symptoms were followed every 2 weeks with urine testing until levels normalized.

The two adults were referred to their physician for follow-up.

Results

Through this investigation, six persons with blood mercury levels exceeding human health risk thresholds were identified.

Two of these persons required chelation therapy.

School bus was totaled, a home was evacuated and mitigated, and school carpet was discarded

Results

To prevent mercury spills in schools and residences, continued efforts should be made to educate school children, school employees, and the public about the dangers of possessing and handling mercury.

Prompt actions by trained school personnel were critical in bringing this incident to the attention of authorities and avoiding further contamination.

Mercury Spill Response for Teachers

- **Isolate the area around the spill**
- **Do not let people walk through the spill area or touch the spilled mercury**
- **Communicate the spill with the principal, and designated personnel.**
- **Do not leave the students unsupervised**

Mercury Spill Response

- **Evacuate students/personnel from the room IF it can be done without walking through the mercury spill.**
- **Open windows if possible to prevent an accumulation of mercury fumes.**
- **Reduce vapor migration to other rooms or areas (shut down central air systems)**

Mercury Spill Response

- **Stabilize the perimeter with amalgam, sand, rags, or other absorbent material to prevent seepage into floor cracks, floor drains, or migrating to other areas.**

- **Determine who may have come in contact with the mercury and the quantity involved.**

Mercury Spill Response

- **Any time one pound or more of mercury is released to the environment it is mandatory to call the National Response Center (NRC). The NRC hotline operates 24 hours a day, 7 days a week.**
- **Call (800) 424-8802.**
- **Note that because mercury is heavy, only two tablespoons of mercury weigh about one pound.**

Dealing With Spills

- ***Stabilize the spill***
- ***Contain the spill***
- ***Isolate the area***
- ***Contain exposed individuals***
- ***Only trained persons attempt clean-up***
- ***Use an Amalgam clean-up kit***
- ***Do not turn up the heat***

Elemental Mercury Spill Kit

Less than $100

Mercury spill cleanup

- **Mercury spill cleanup must be thorough and complete.**
- **Inadequate mercury cleaning may lead to long-term exposure from residual droplets or beads. Inadequate cleaning can also increase contamination and cleanup costs.**
- **Mercury spills that happen indoors where people typically spend long periods of time (such as homes or schools) can be very disruptive and present relocation issues.**
- **Increased costs can result from replacement of contaminated materials (computers!) and expenses incurred while the contaminated space is unavailable.**

Be Prepared

- **Have a plan**
- **Provide training**
- **Clean-up kit**
- **Know who to call**

Mercury Analyzer

Acceptable Vapor Concentration Levels
1 mg/m³ to 3 mg/m³

Emergency response to mercury spills
Verification of spill clean up
Workplace monitoring at sites where mercury is handled
Fluorescent lamp disposal and recycling
Waste screening
Listed on US EPA Emergency Response Equipment List
Range: 0.10 µg/m³ to 200 µg/m³

Differential Zeeman Atomic Absorption spectrometry using high frequency modulation of light polarization.

Principal/Administration Spill Response

Document what is being done and by whom.

Contact appropriate district personnel to coordinate clean-up with properly trained personnel or contact local HAZ MAT team (fire department).

- **What material is involved**
- **Provide MSDS if possible**
- **Where was the spill**
- **What was the quantity**
- **Provide a floor plan (fire exit map)**
- **Ventilation system in the area (dedicated exhaust?)**

Contact district communications person.

Information will need to be relayed to parents and media.

Prevention

- **Educate: how to recognize mercury and report immediately.**
- **Prepare for spill even if school is “mercury free”**
- **Annual reminders: immediate response, what to do, whom to contact,**
- **Refresh training: how to respond to a spill – stabilization and cleaning**
- **Consider purchasing mercury spill response equipment**

Decontamination

Heat to vaporize: *Do this outdoors!*

Proper disposal of contaminated materials

http://www.atsdr.cdc.gov/dontmesswithmercury/

don't mess with MERCURY

En Español

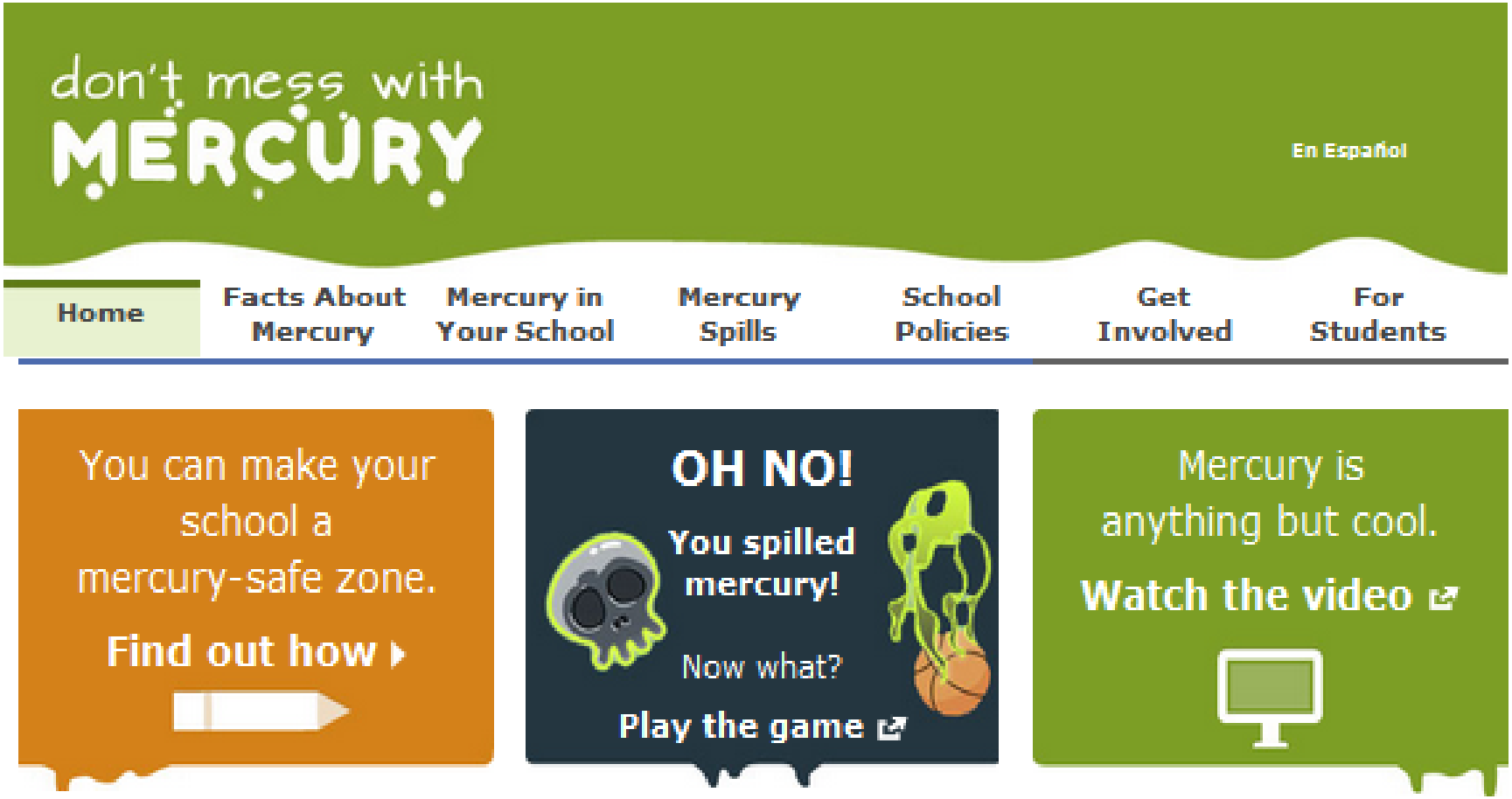
Home | Facts About Mercury | Mercury in Your School | Mercury Spills | School Policies | Get Involved | For Students

Learn what you can do to make your school safer.

Is your school prepared for a mercury spill?

Learn how to make a mercury policy for your school.

See how mercury can **affect your body.**



http://www.atsdr.cdc.gov/dontmesswithmercury/

Wildfire Health Effects and Response

Smoke is a Complex mixture*

- Carbon dioxide
- Water vapor
- Carbon monoxide
- Particulate matter ($PM_{2.5}$)
- Hydrocarbons
- Organic chemicals
- Nitrogen oxides
- Trace minerals

*Compounds can number in the thousands

Health Effects

Minor health concerns (PM_{10})

- Irritation of eyes, nose and throat

More serious health concerns

- Reduced lung function, pulmonary inflammation, bronchitis, exacerbation of asthma, premature death

Sensitive Populations

Children

Pregnant women

Elderly

Smokers

Those with respiratory disease

Those with cardiovascular disease

Sensitive Populations

Children

- Even children without pre-existing conditions are considered a sensitive population.
  - Spend more time outside
  - Engage in vigorous activities
  - Inhale more air per pound of body weight

Elderly

- Many have pre-existing lung and/or heart disease
- The immune system defenses decline with age
  - This may lead to more susceptibility to bacterial and viral infections.

Sensitive Populations

Those with respiratory disease

- Asthma, airway hyperresponsiveness, chronic obstructive pulmonary disease (COPD)

Those with cardiovascular disease

- Coronary artery disease, congestive heart failure, atherosclerosis, high blood pressure
  - Particle induced inflammatory response may increase risk for stroke, blood clot formation, angina and heart attacks.

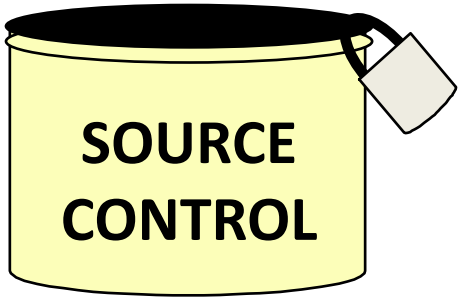
What you can do to reduce exposure

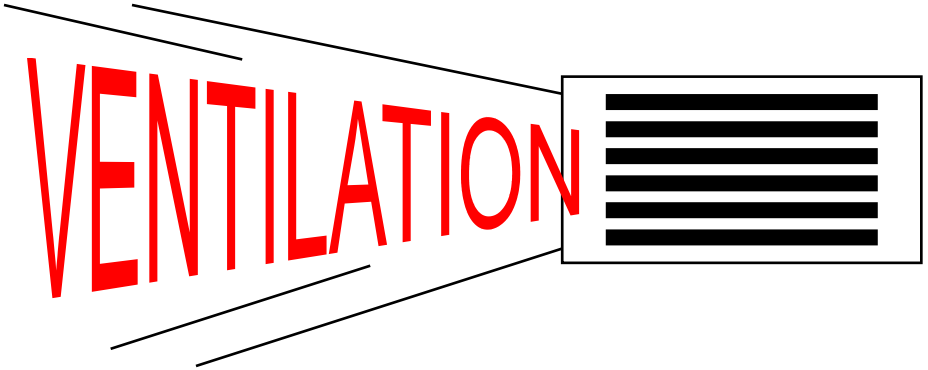
- Stay indoors
- Reduce outside air entry
- Reduce other sources of indoor air pollution
- Reduce activity

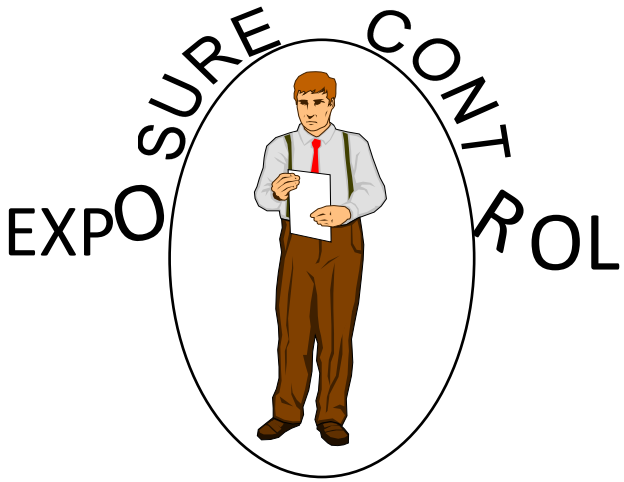
- Use air conditioners and filters

- Check the air quality in your area
  and use the guidance provided

Four Control Strategies







Understanding indoor Radon

Health effects

Radon entry

Radon measurements

Radon mitigation systems

Radon: Radioactive gas

2nd leading cause lung cancer

more annual US deaths than car wrecks

Naturally occurring from the soil (or well water)

What you may NOT KNOW about radon

Something other than smoking causes lung cancer

Radioactive gas is radon

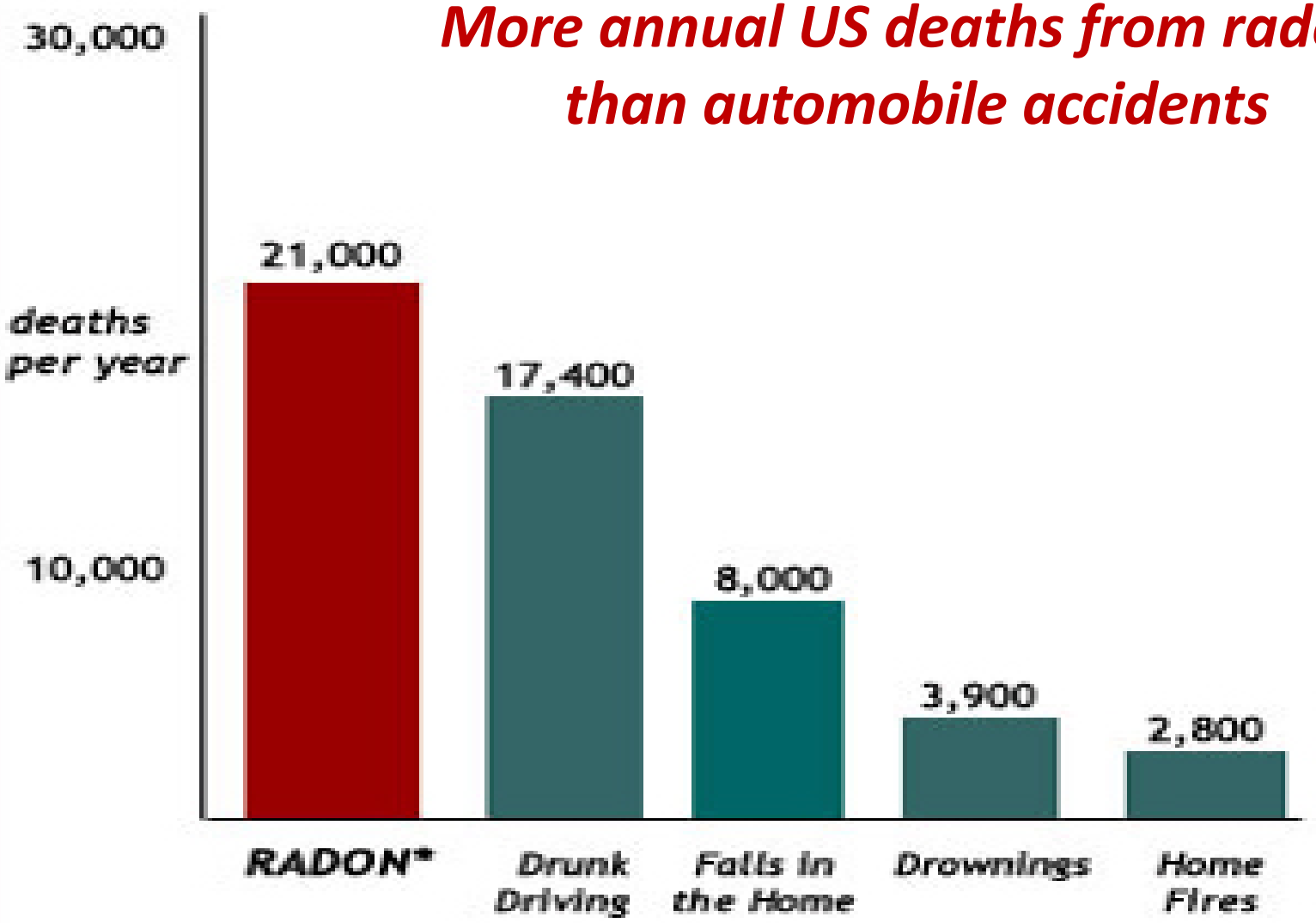
Radon is the NUMBER 1 cause of lung cancer in non-smokers

Radon is responsible for more than 21,000 deaths / year in the United States

EPA Estimates for Deaths due to Radon

(from "*A Citizen's Guide to Radon*")

More annual US deaths from radon than automobile accidents



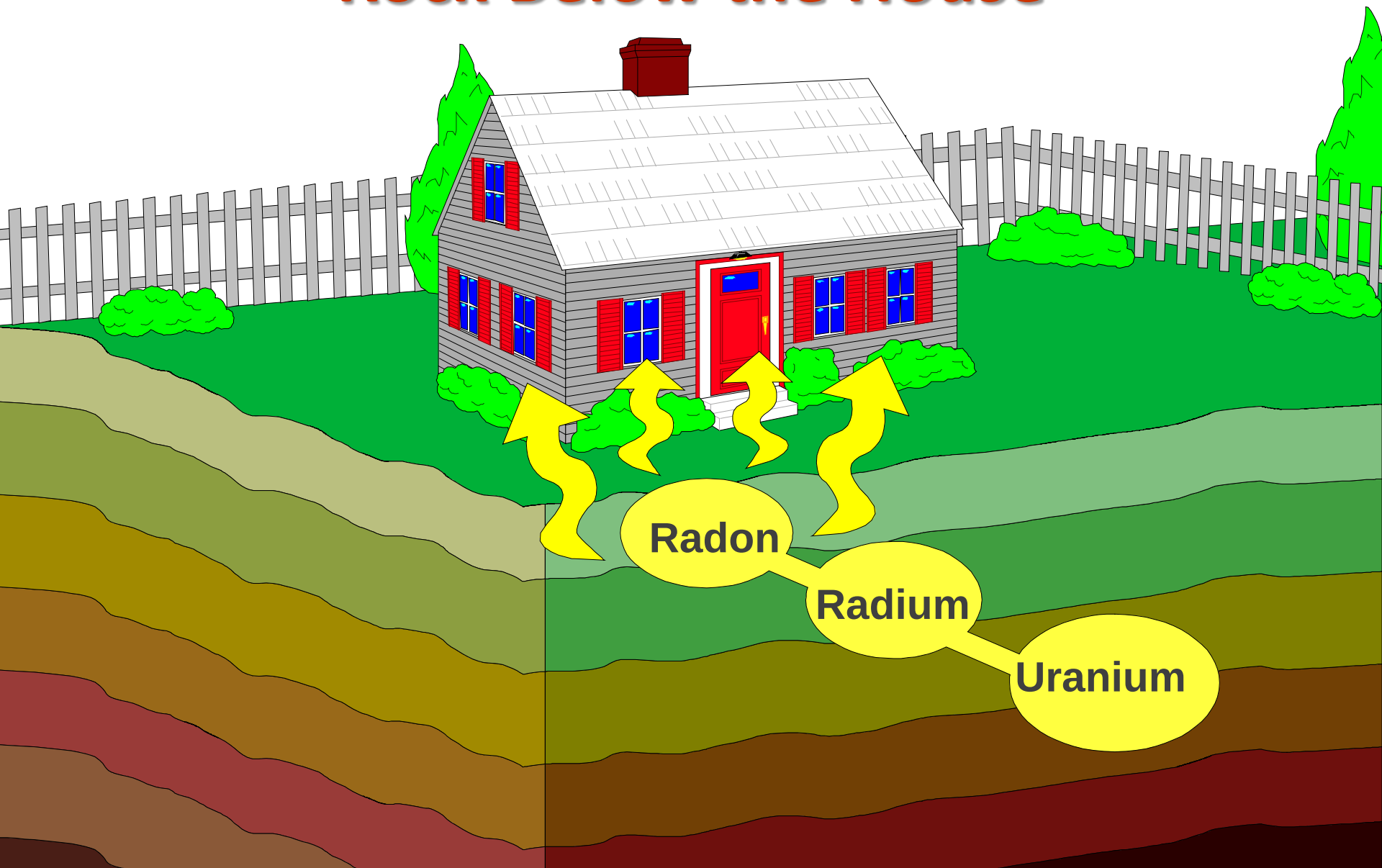
Radon Risks – "never smoked"

Radon Level	If 1,000 people who never smoked were exposed to this level over a lifetime…	The risk of cancer from radon exposure compares to…	WHAT TO DO:
20 pCi/L	About 36 people could get lung cancer	35 times the risk of drowning	Fix your home
10 pCi/L	About 18 people could get lung cancer	20 times the risk of dying in a home fire	Fix your home
8 pCi/L	About 15 people could get lung cancer	4 times the risk of dying in a fall	Fix your home
4 pCi/L	About 7 people could get lung cancer	The risk of dying in a car crash	Fix your home
2 pCi/L	About 4 people could get lung cancer	The risk of dying from poison	Consider fixing between 2 and 4 pCi/L
1.3 pCi/L	Less then 2 people could get lung cancer	(Average indoor radon level)	(Reducing radon levels below 2 pCi/L is difficult)
0.4 pCi/L		(Average outdoor radon level)	(Reducing radon levels below 2 pCi/L is difficult)
Note: If you are a former smoker, your risk may be higher.			

Radon Risks "smokers"

Radon Level	If 1,000 people who smoked were exposed to this level over a lifetime...	The risk of cancer from radon exposure compares to...	WHAT TO DO: Stop smoking and...
20 pCi/L	About 260 people could get lung cancer	250 times the risk of drowning	Fix your home
10 pCi/L	About 150 people could get lung cancer	200 times the risk of dying in a home fire	Fix your home
8 pCi/L	About 120 people could get lung cancer	30 times the risk of dying in a fall	Fix your home
4 pCi/L	About 62 people could get lung cancer	5 times the risk of dying in a car crash	Fix your home
2 pCi/L	About 32 people could get lung cancer	6 times the risk of dying from poison	Consider fixing between 2 and 4 pCi/L
1.3 pCi/L	About 20 people could get lung cancer	(Average indoor radon level)	(Reducing radon levels below 2 pCi/L is difficult)
0.4 pCi/L		(Average outdoor radon level)	(Reducing radon levels below 2 pCi/L is difficult)
Note: If you are a former smoker, your risk may be lower.			

Radon Gas from Uranium in Soil and Rock Below the House



Radon Characteristics

- Noble gas (does not chemically react)
- Colorless
- Odorless
- Tasteless
- Naturally occurring
- Radioactive

 # 86 Periodic Table of Elements

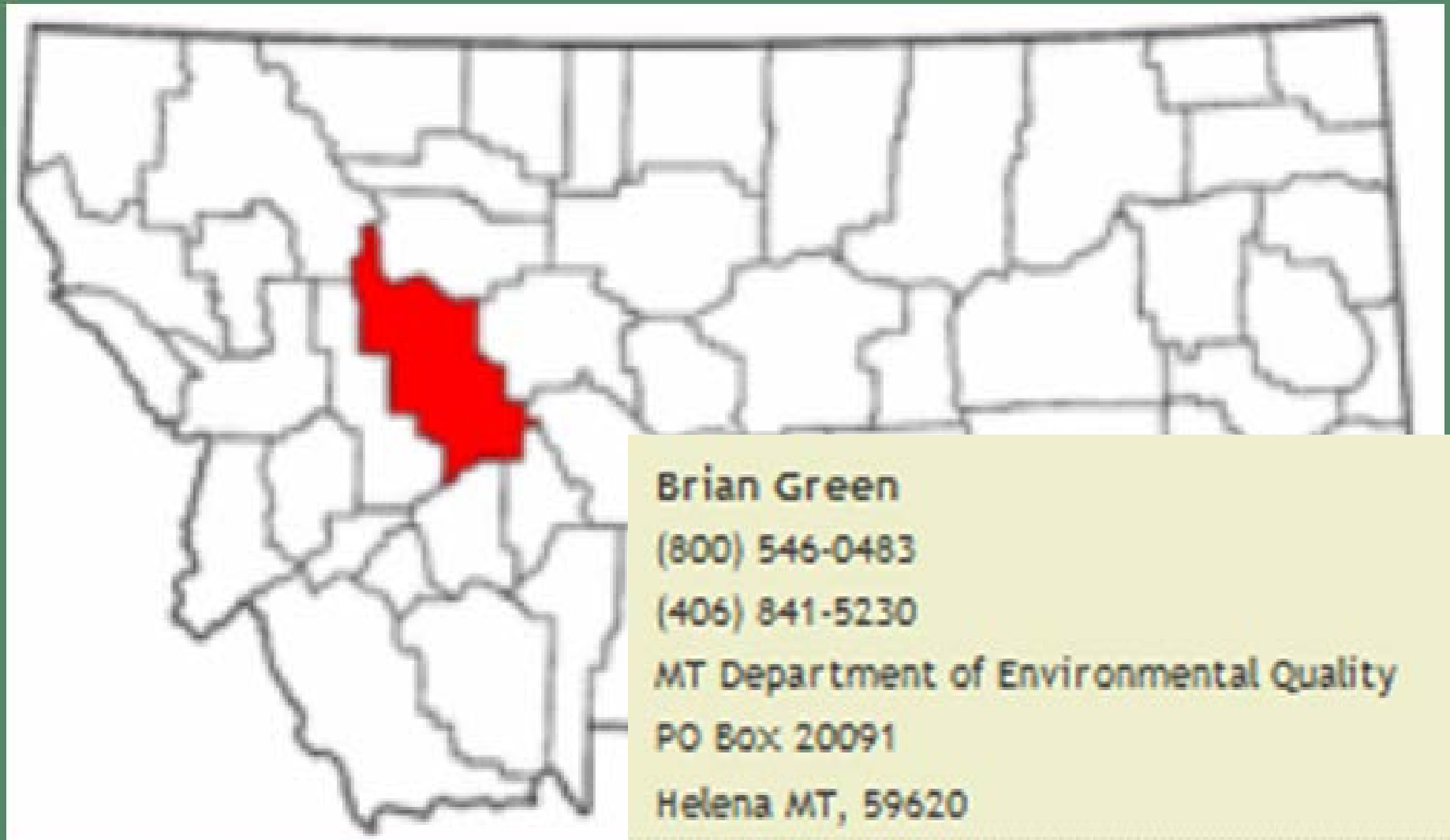
Radon is a long-term problem

About 99.284% of natural Uranium is **Uranium-238** has a half-life of 4.468 billion *years* *(alpha particle)*

Decays to **Radium 226** which has half-life of 1,601 *years* *(alpha particle)*

Decays to **Radon 222** (gas) which has a half-life of 3.8 *days* *(alpha particle)*

Lewis and Clark County



Brian Green

(800) 546-0483

(406) 841-5230

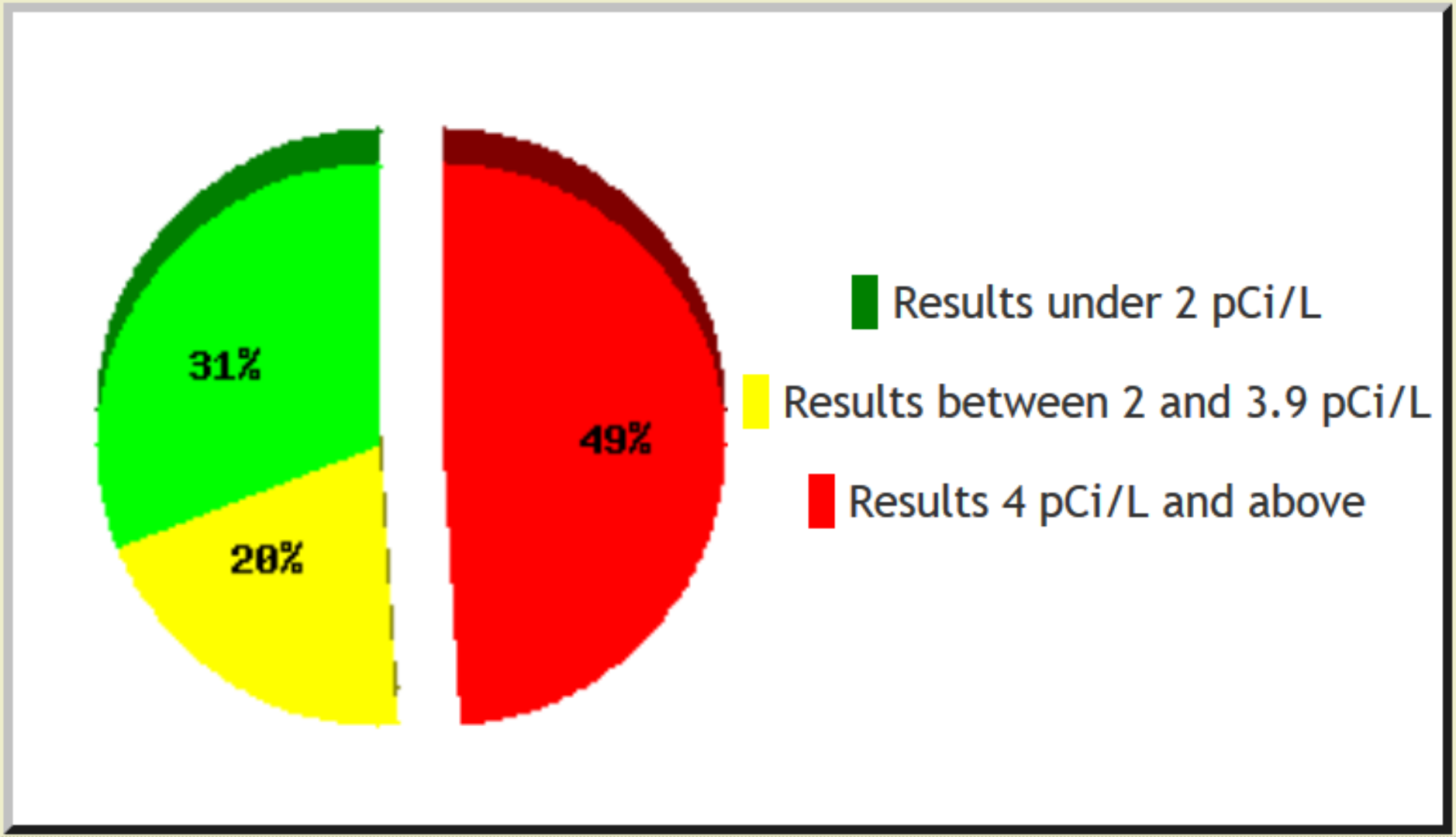
MT Department of Environmental Quality

PO Box 20091

Helena MT, 59620

The average national indoor radon level is 1.3 pCi/L. (What is a picocurie?)

The average indoor radon levels of Lewis and Clark County, as determined by radon test results from Air Chek, Inc, is 7.6 pCi/L



Is Radon Serious?

SURGEON GENERAL'S WARNING:

RADON CAUSES LUNG CANCER

Testing is easy, simple, and the only way to know

Inexpensive, and the right thing to do for school occupants.

Encourages families to test their homes

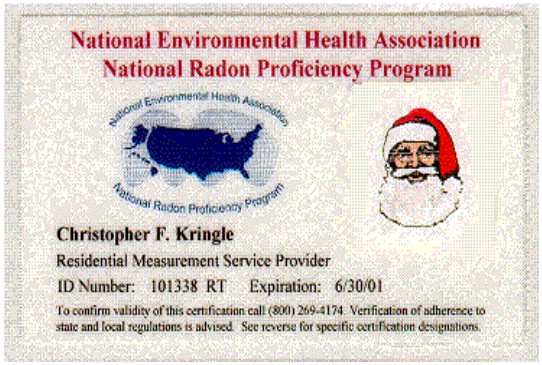
Short-Term Radon Test Kits
about $ 10

Long-Term Radon Test Kits
about $ 30

Real-time electronic radon meters
start at about $ 130

NATIONAL RADON PROFICIENCY PROGRAM

Radon Measurement & Mitigation contractors certified by NEHA have been trained and carry ID cards



Lists of certified individuals and labs can be found and other helpful information at: http://www.radongas.org and www.nrsb.org or call 1-800-445-8647

What it is & testing

United States Environmental Protection Agency | U.S. Department Of Health and Human Services | U.S. Public Health Service

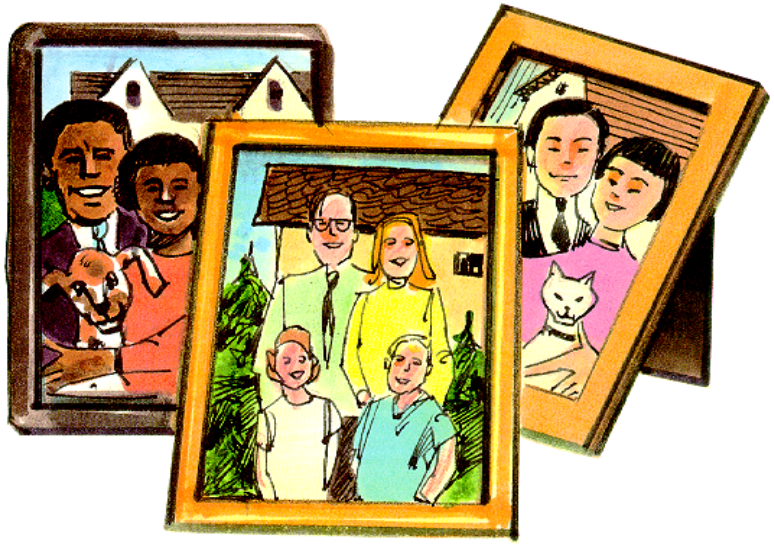
Air And Radiation (ANR-464) | 402-K92-001 | May 1992

EPA

CDC

A Citizen's Guide To Radon (Second Edition)

The Guide To Protecting Yourself And Your Family From Radon



Printed on Recycled Paper

How to fix radon

United States Environmental Protection Agency | 402-K92-003 August 1992

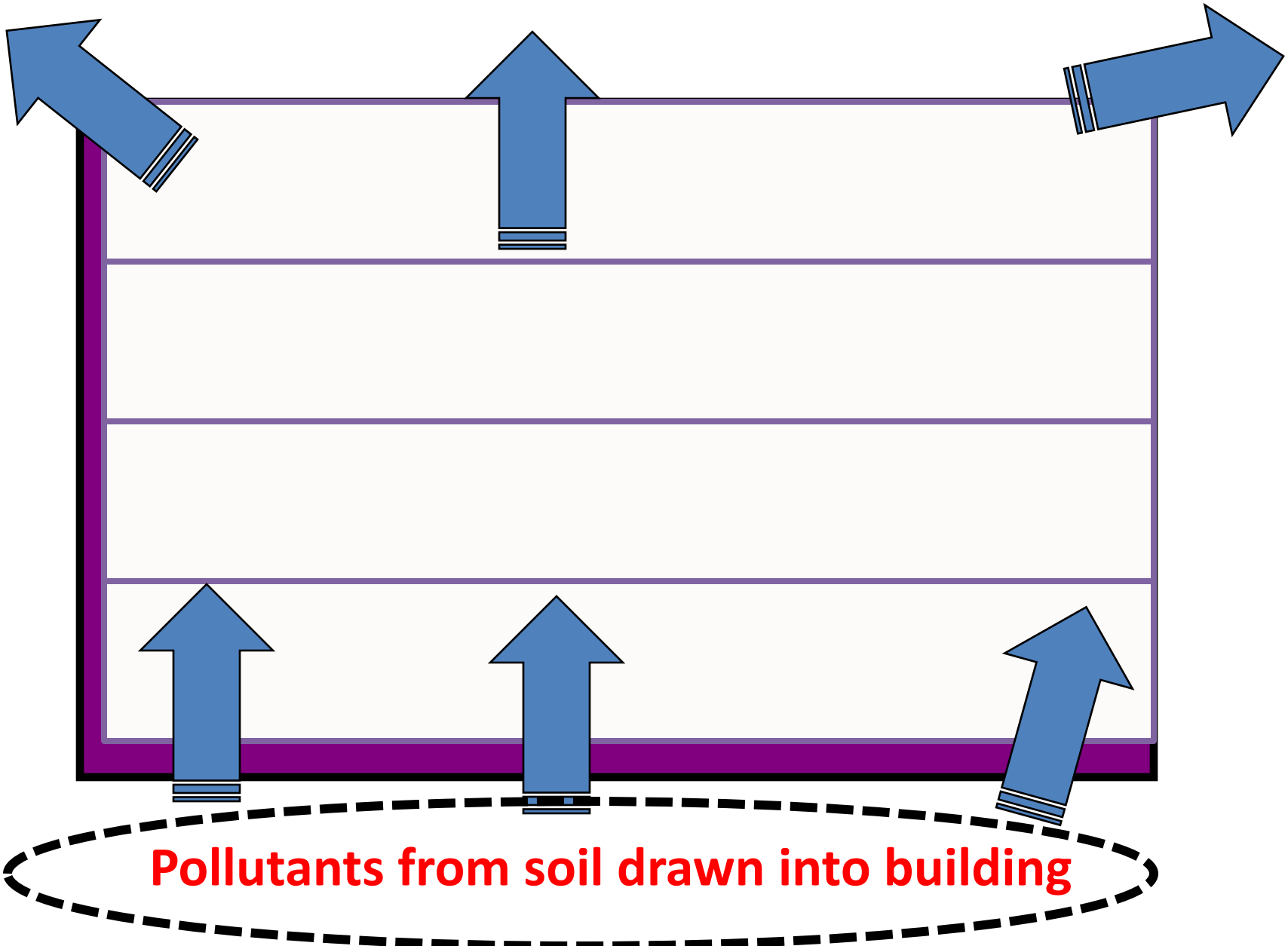
Air and Radiation 6604J

EPA

Consumer's Guide To Radon Reduction

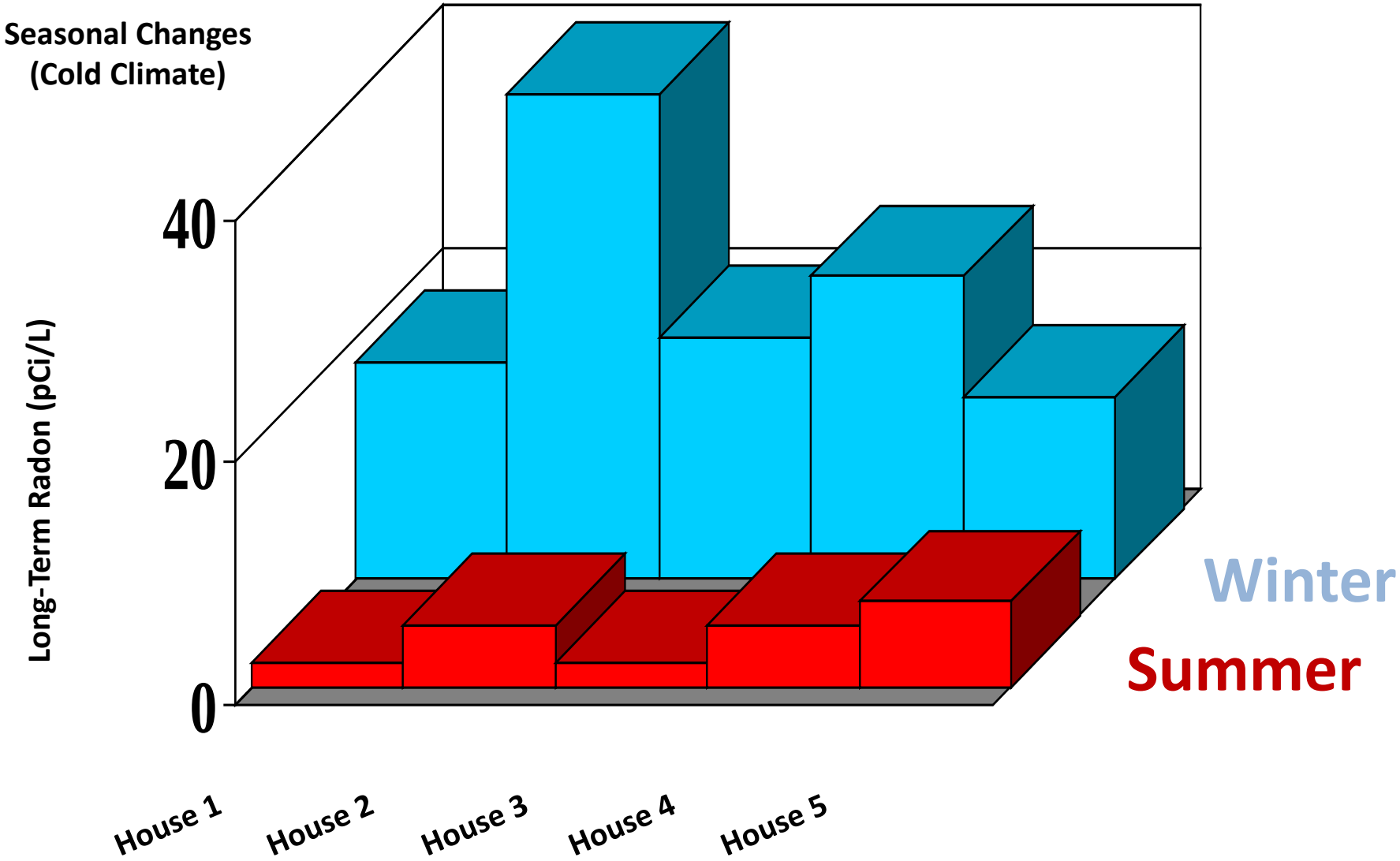
How to reduce radon levels in your home...

Soil Air Entry Into Buildings



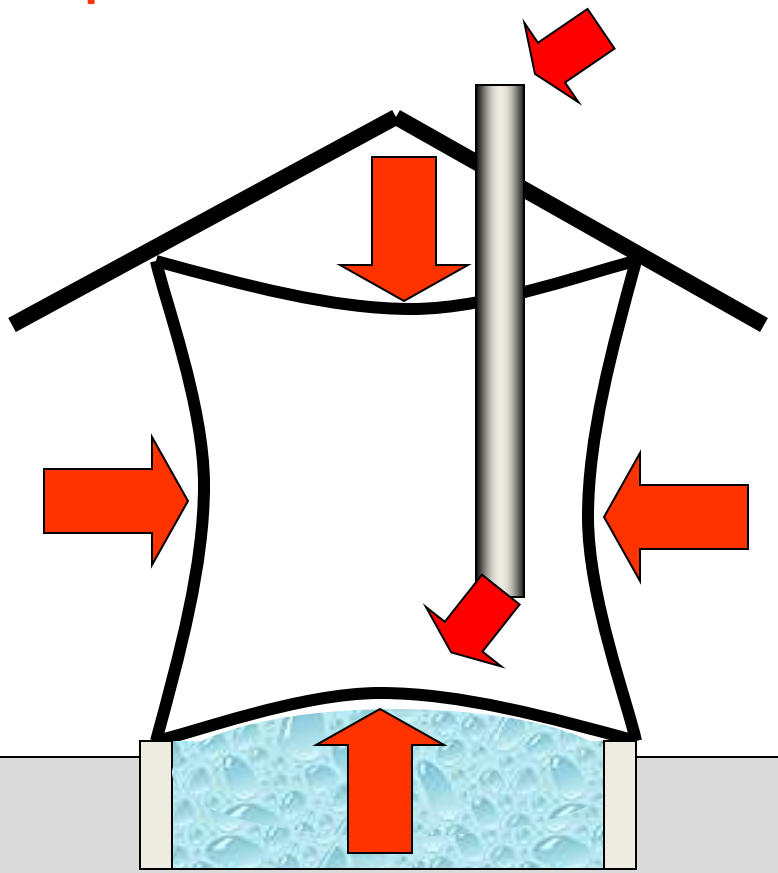
Radon Levels can be Seasonal

Usually Higher in Winter (in Cold Climates)



Duct Leaks

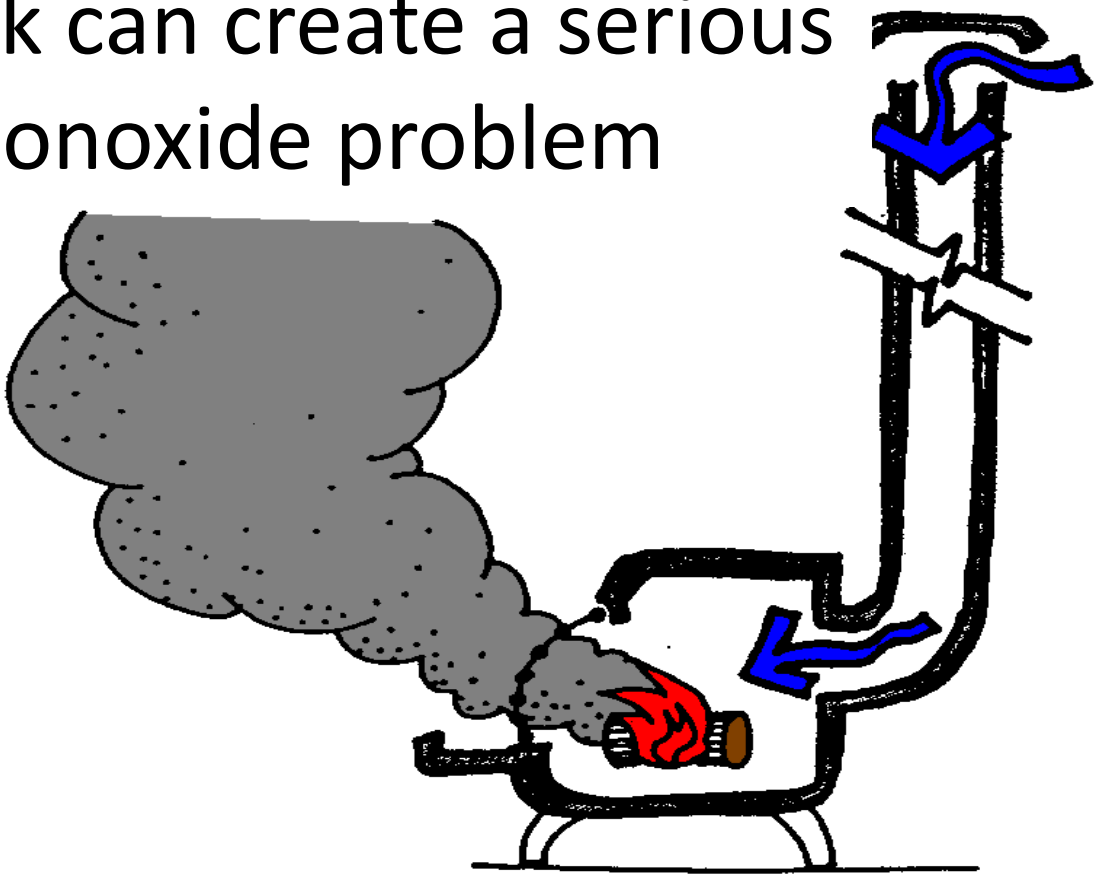
- Supply Air duct leaks to the outside create a negative pressure in the building



“ The air forced out must be replaced ”

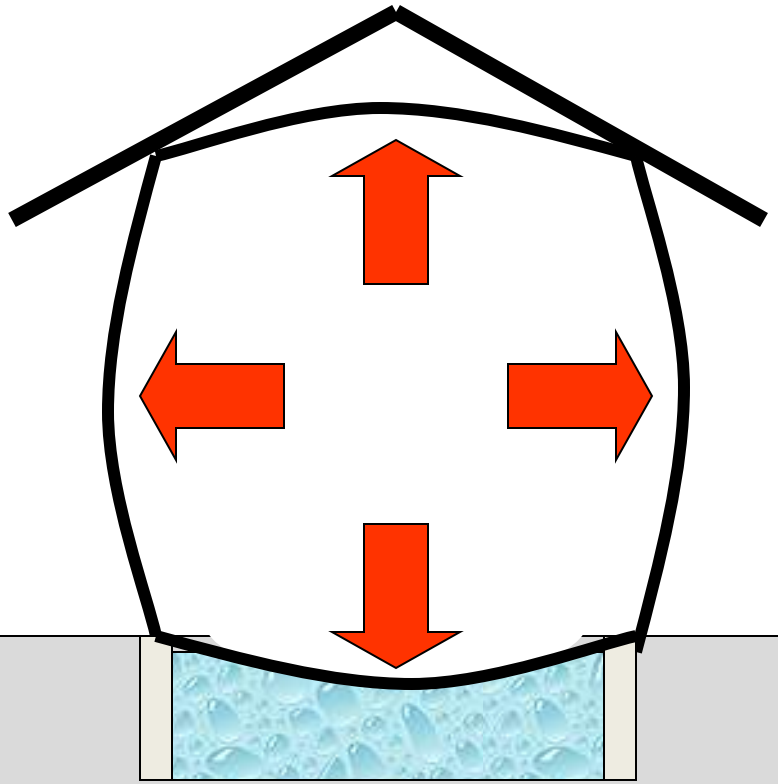
Spillage / Back-drafting

A duct leak can create a serious carbon monoxide problem



Duct Leaks

- Return Air duct leaks to the outside create a positive pressure in the building

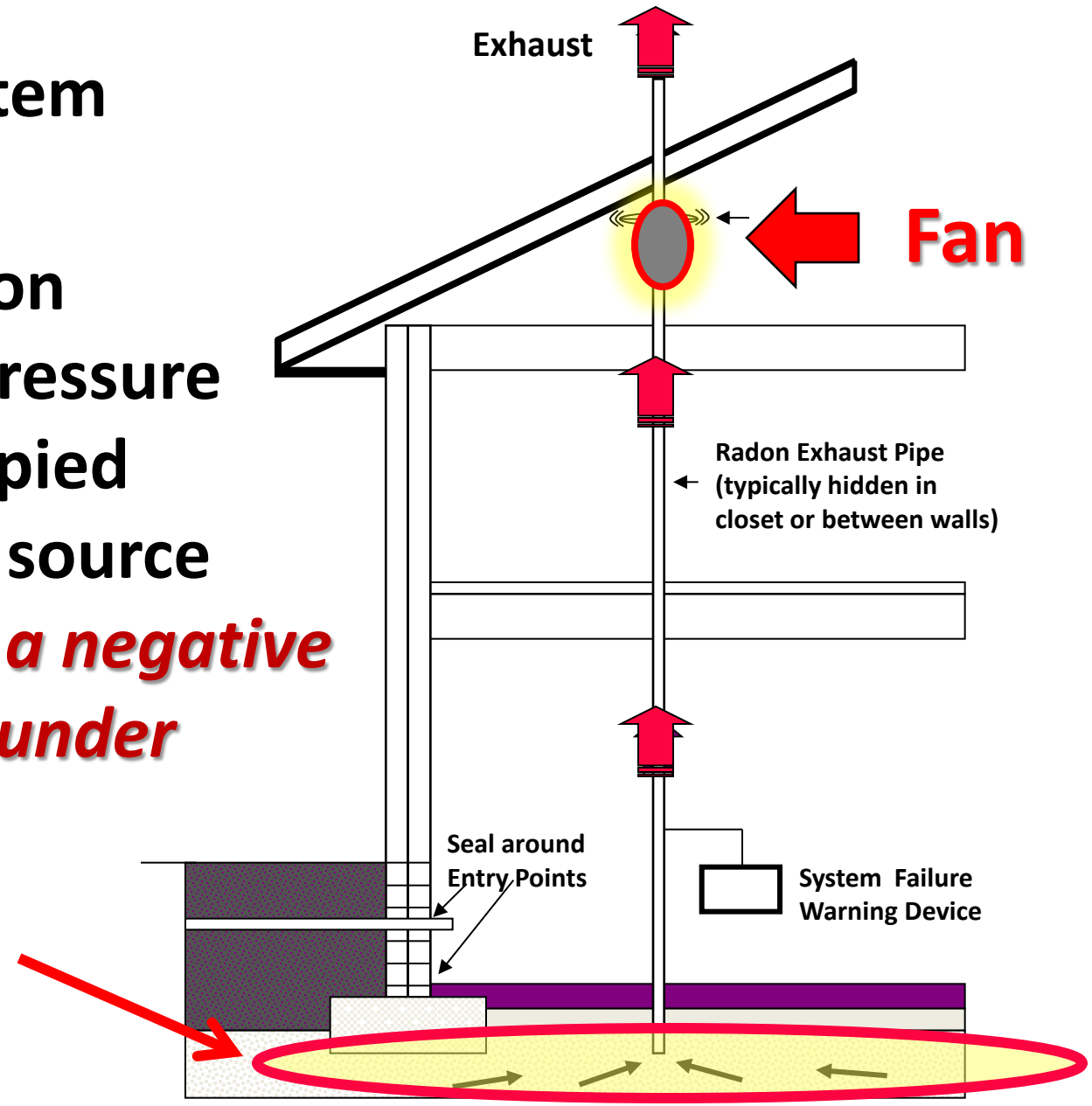


“ The air sucked in must be exhausted ”

Typical *Radon* Mitigation System

Sub-slab suction reverses the pressure between occupied space and the source by *creation of a negative pressure field under the slab*

Pressure Field



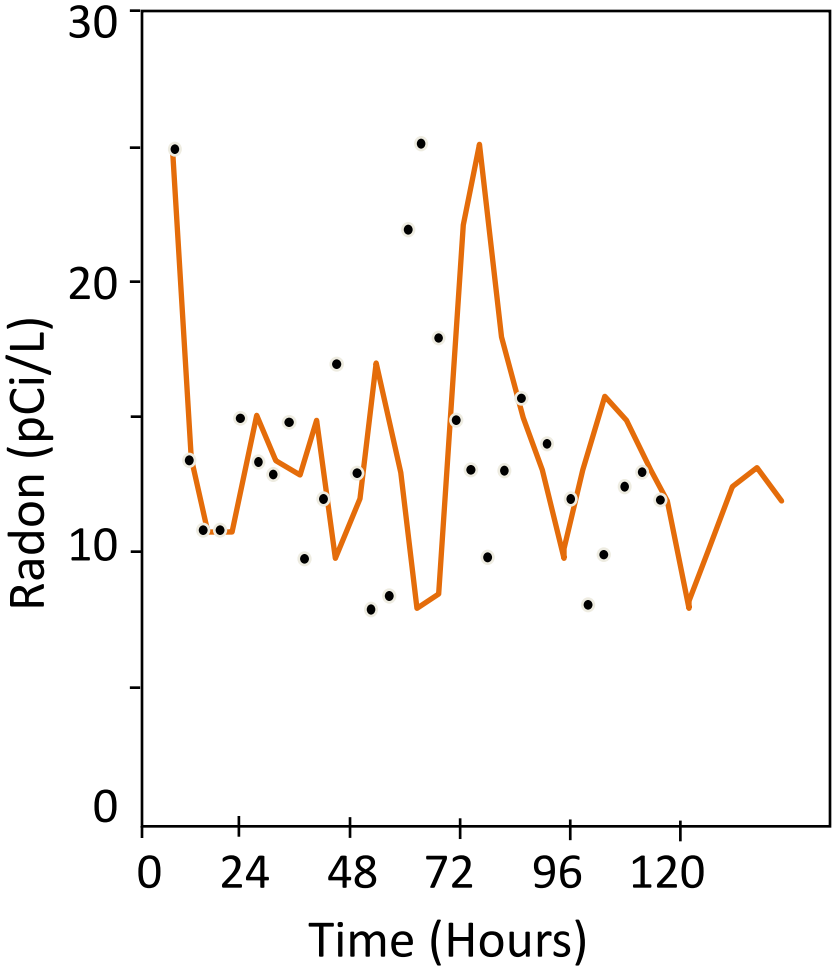
Radon Measurement & Testing

Radon levels:

- **Vary over time (hours, days, months)**
- **Are affected by many environmental and human factors**
  - **Wind, rain, barometric pressure, door & window openings, etc.**
- **Differ from one floor to another in a building**
- **Vary from one locale to another**

Radon Levels Are Variable

Driving Forces & Other Factors Are Variable



- **Pressure differentials can change rapidly**
  - **Temperature changes**
  - **Weather changes**
  - **Mechanical equipment operation**

Short vs. Long-Term Testing

- **Short-term tests are from 2 – 90 days**
  - **Adequate to indicate need for mitigation**
  - **2-day test following EPA guidance for real estate transactions (HB&SG): correctly indicates need for mitigation 94% of the time**
- **Long-term tests more than 90 days**
  - ***Better represents annual average radon level***

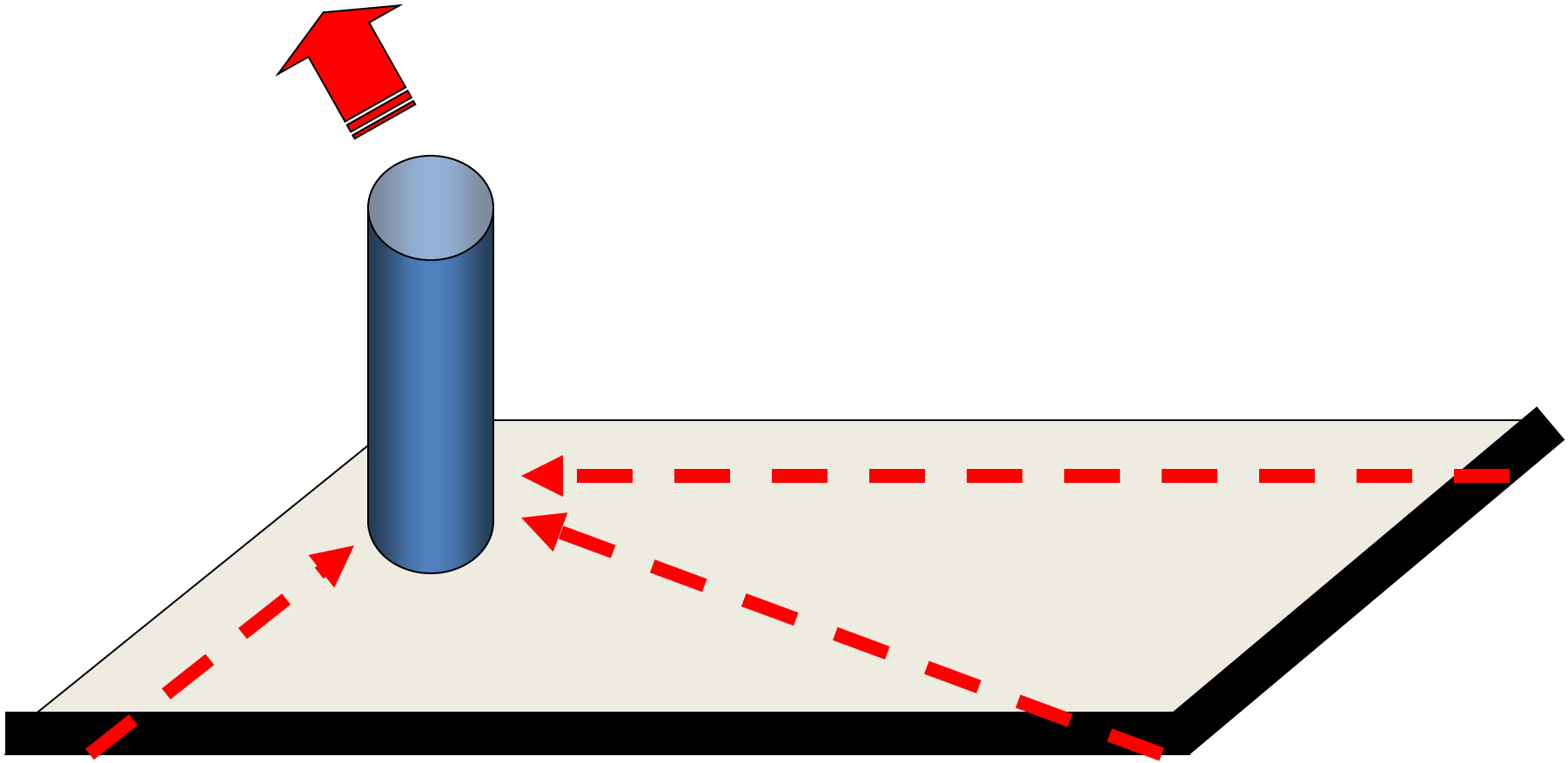
Typical Sub-Slab Ventilation Rn Mitigation System

1) Choose the “best” pipe location
2) Create a pit under slab
3) Route the Pipe *
4) Install Air-Tight, In-Line Fan **
5) Terminate above roof line
6) Seal & support the pipe
7) Label the System
8) Pressure Gauge to monitor performance

* don’t build in “traps”

** best in attic due to freeze potential

Pressure Field Extension



Mitigating Radon in a Crawlspace

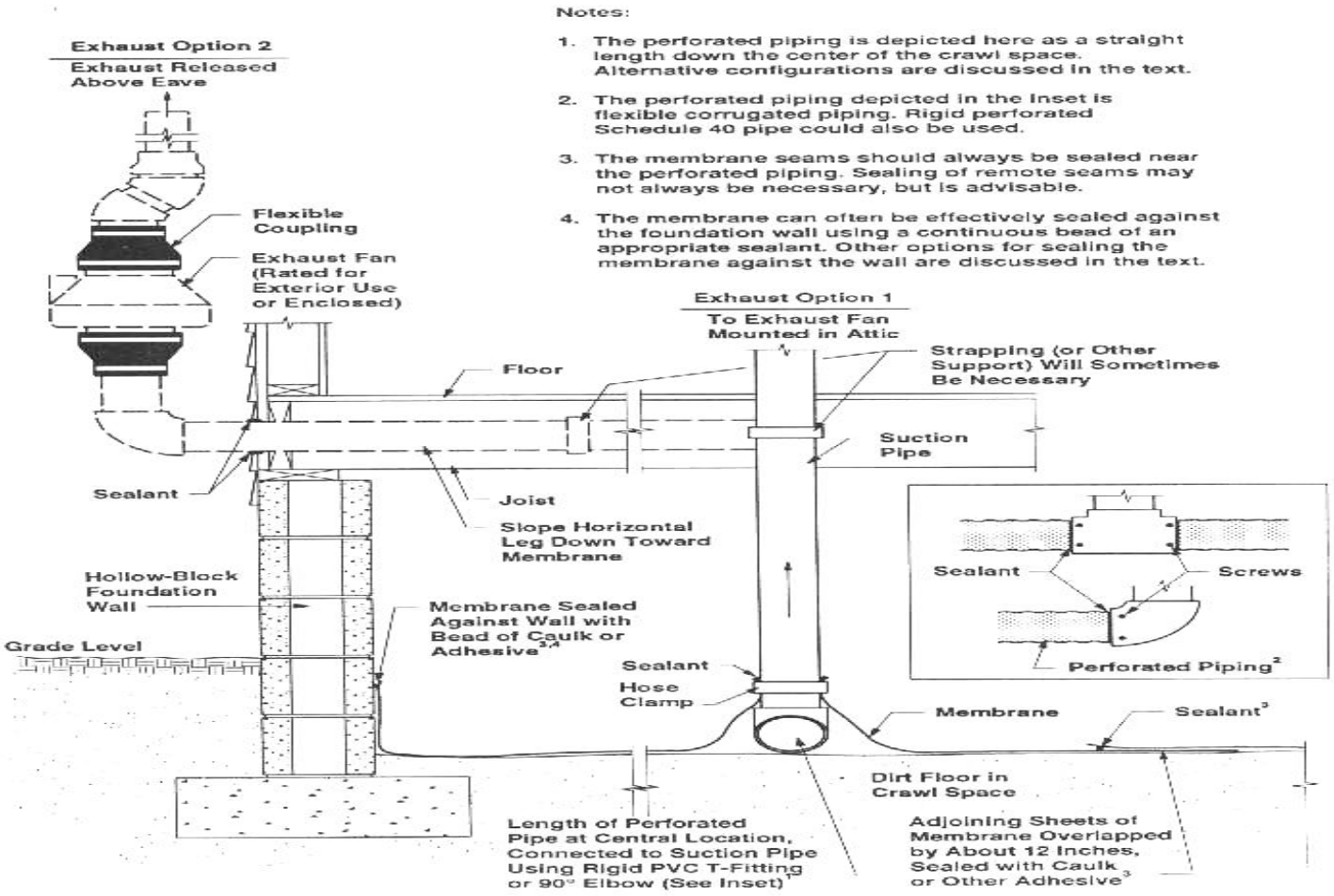


Figure 7. Sub-membrane depressurization (SMD) for the case where suction is drawn on perforated piping beneath the membrane (DTD analogue).

3 Key Factors for Moisture Control

1. **Keep the moisture out**
   - **Building Sheds Water**
   - **Adequate Site Drainage**
   - **Stop Water & Air Leaks**

2. **Use exhaust fans = capture and exhaust moist air**

3. **Ventilation = exchange damp indoor air with dryer outside air**

Dehumidification may be necessary

Indoor Dampness, Molds, and Health

Surveys find dampness and molds are common in schools and office buildings

Causes:

- **water leakage through roofs and walls**
- **plumbing system leaks**
- **groundwater floods**
- **damp construction materials**
- **high indoor rates of moisture generation**
- **entry of humid outdoor air**
- **water vapor condensation on cold surfaces of windows and walls**

Based on the available surveys, **approximately half of U.S. homes** have visible evidence of a dampness problem or mold contamination

Molds & Bacteria

- **Can lead to microscopic airborne particles, containing allergens or chemicals with *potential to induce inflammation in the respiratory system***
- **Dampness also increases emission rates of gaseous non-microbial chemicals such as formaldehyde**
- **High indoor relative humidity can increase house dust mites - - a very important source of indoor allergens**

National Academy of Science Institute of Medicine (2004)

Extensive study concluded that building dampness and mold represented a public health problem

" Building dampness and mold were associated with *30% to 50% increases* in a variety of *respiratory and asthma-related health outcomes* "

Molds & Dampness

Of the 21.8 million people reported to have asthma in the U.S., approximately 4.6 million cases (~20%) were estimated to be attributable to dampness and mold exposure in the home

The associated annual cost of current asthma attributable to dampness and mold in the U.S was *estimated to be $3.5 billion*

Mold Basics

- **Four requirements for mold growth**
  - **Mold spores**
  - **Temperature** (40°F to 100°F)
  - **Nutrient (mold food)**
  - **Moisture**

- **Which factor(s) are *practical* to control to prevent mold growth?**

Moisture Rules

- **Moisture flow is from warm to cold.**
- **Moisture moves from more to less.**
- **Air carries moisture from high pressure areas to low pressure areas.**
- **Gravity pulls water down.**
- **Water wicks up.**
- **Drainage is critical.**

Moisture = Mold Potential

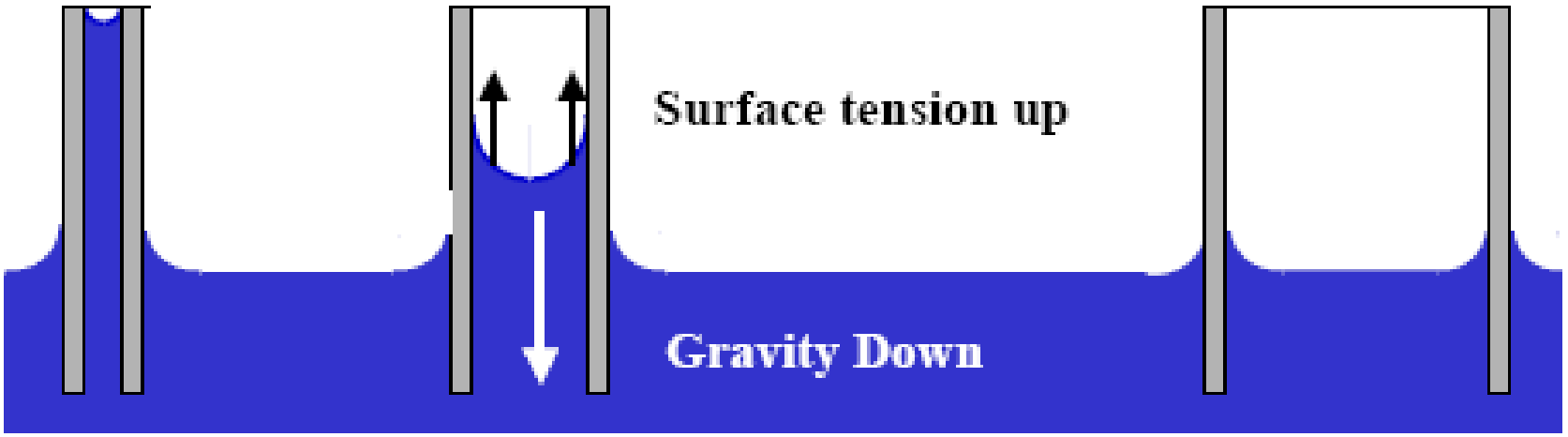
Mold is often a result of negligence

Remove the mold food until moisture problem is solved

Recommended to dry "mold food" materials within 48 hours.

Capillary Pressures

- Result of surface tension = attraction to surfaces
  - pressure varies with pore size
  - e.g., height rise in a glass tube



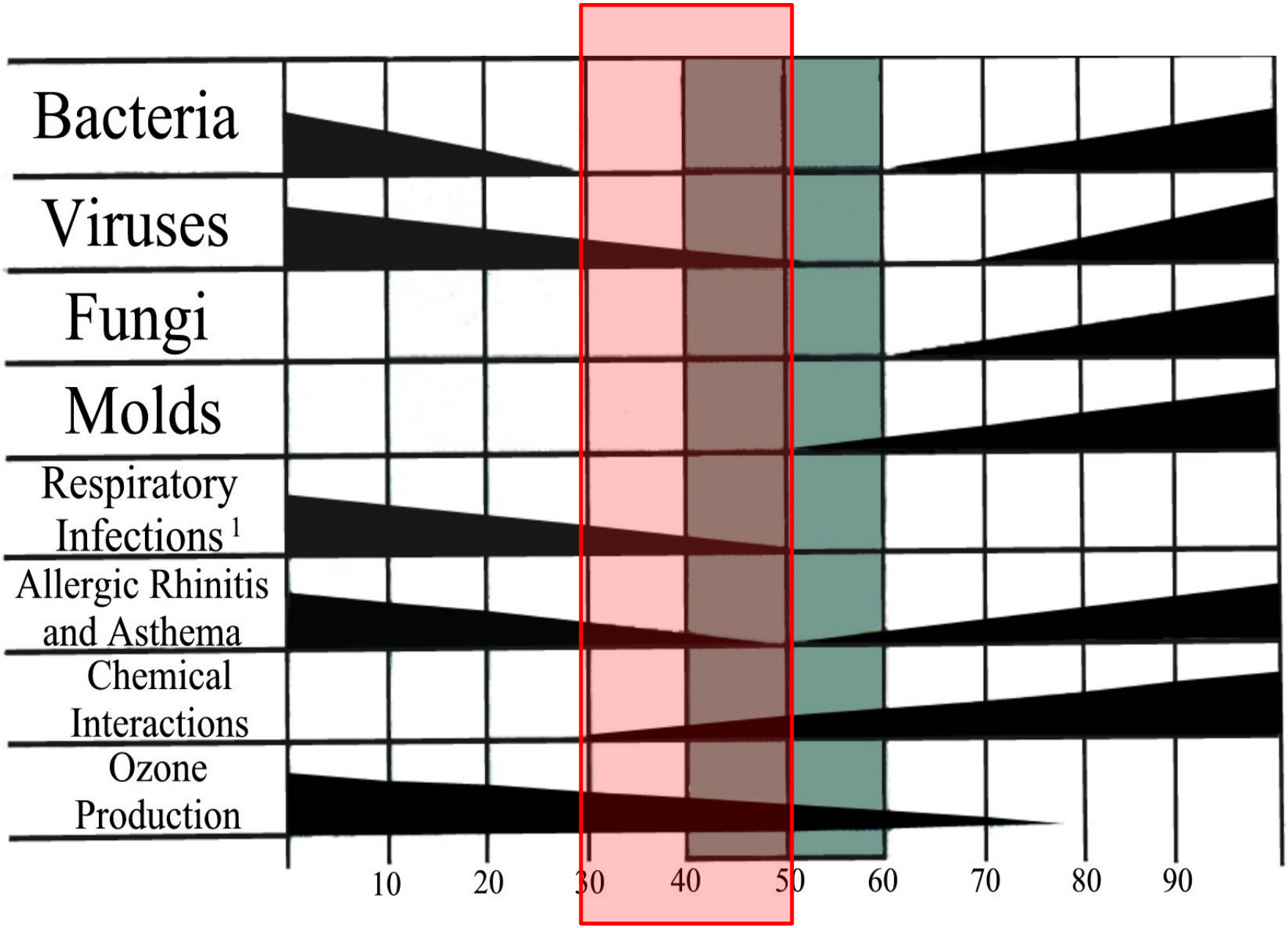
Evidence of moisture/molds may not be obvious

Visual inspections are first priority

Air testing has limited utility

“If it smells moldy, it is moldy”

Decreased bar thickness indicates ***Decreased effect***



Moisture Dynamics

Relative Humidity

Saturation of the air at a given temperature

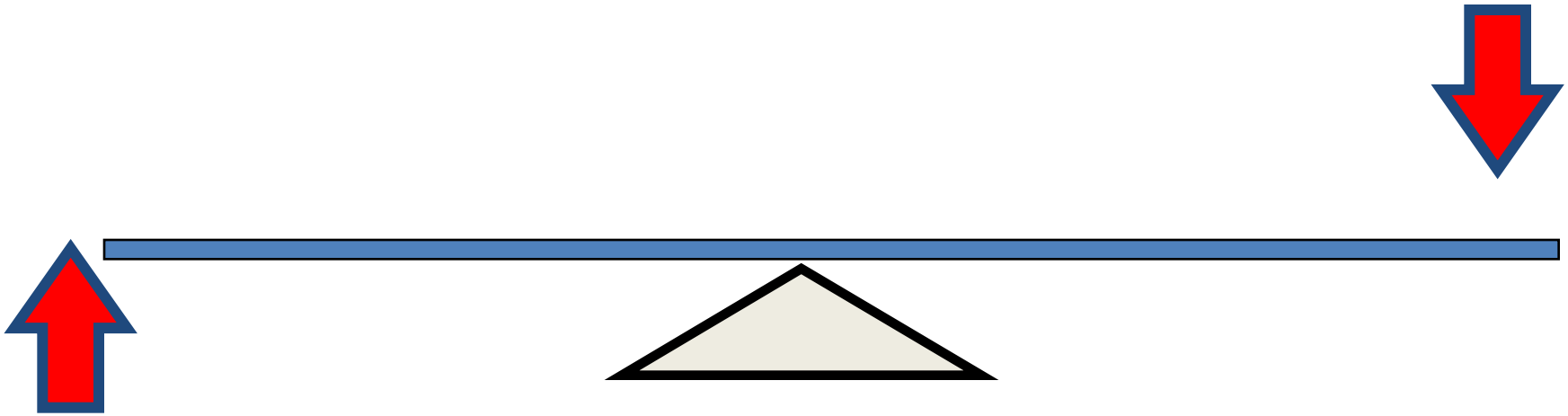
The *% of water holding capacity of the air*

50% RH means the air is 1/2 full

90% RH means the air can only hold 10% more water vapor

Relative Humidity

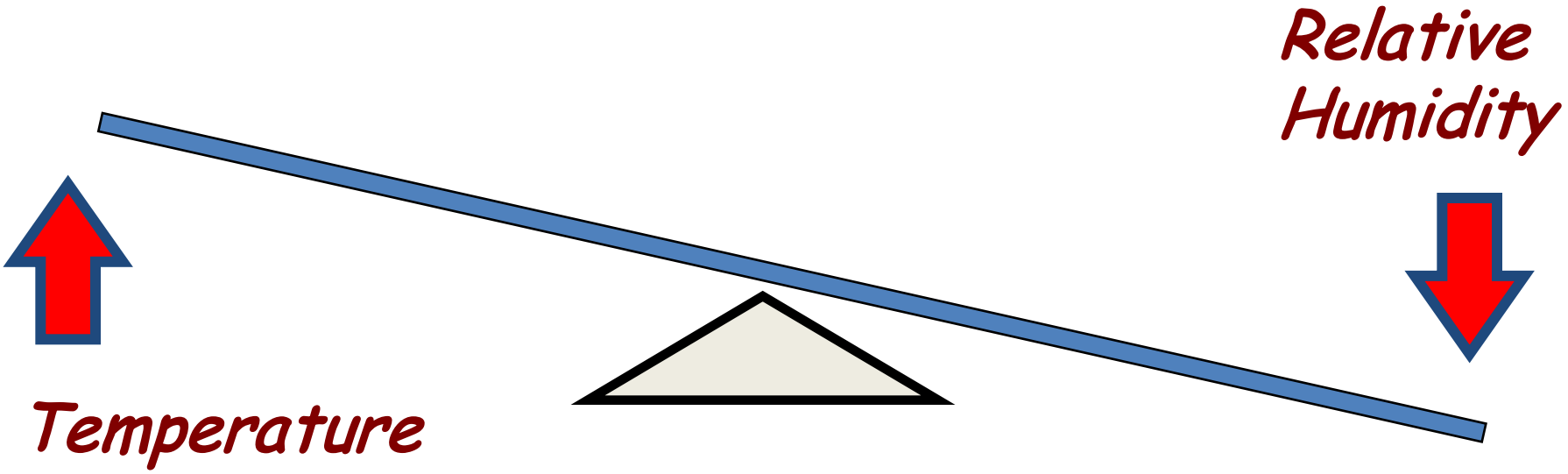
FACT: **Warm air can hold more moisture than cold air**



Relative Humidity

Raise the temperature . . .

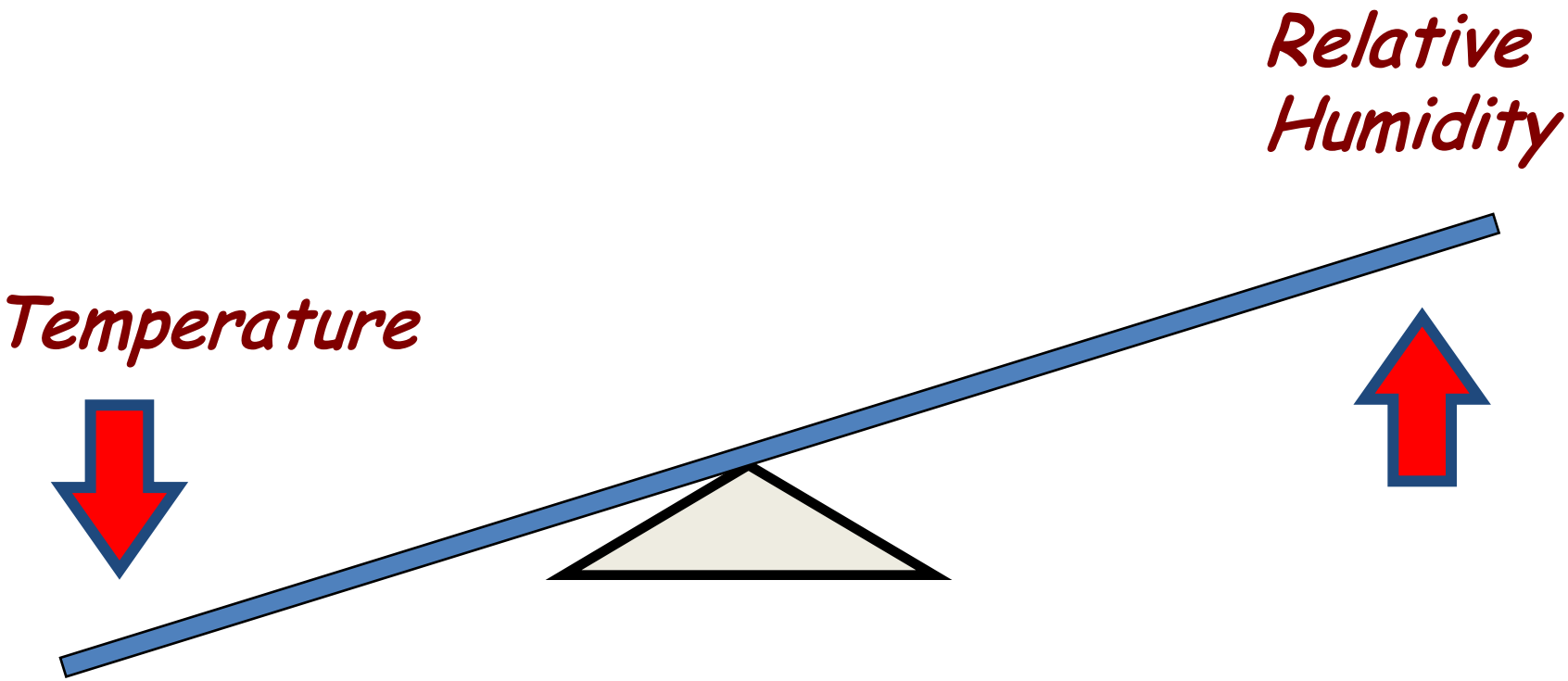
Relative Humidity *decreases*



Relative Humidity

Lower the temperature . . .

Relative Humidity increases



Mold and Moisture

Dew Point:

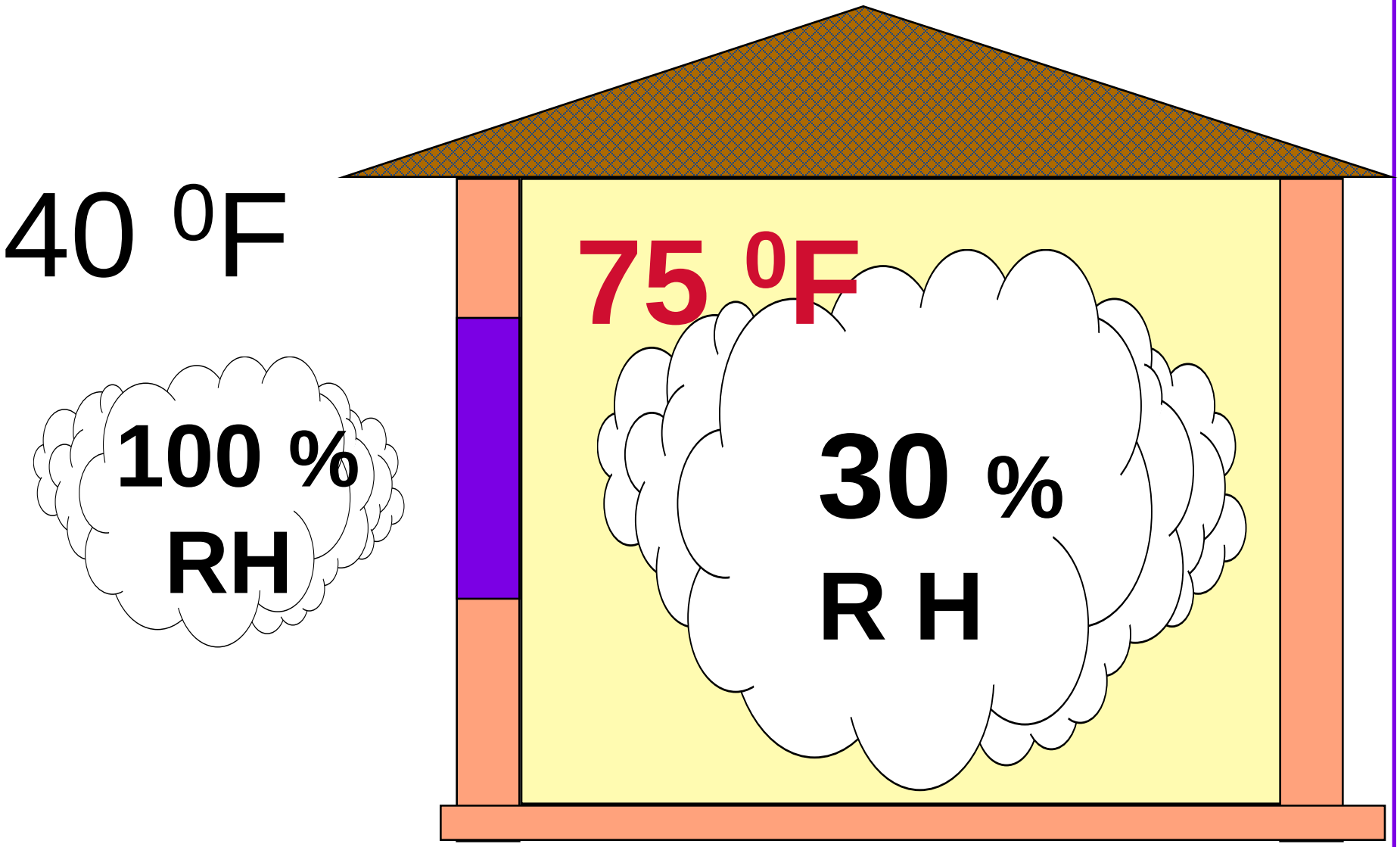
Temperature at which air becomes completely saturated (100% RH)

Materials only need to be at 85% to 90% relative humidity to support mold growth

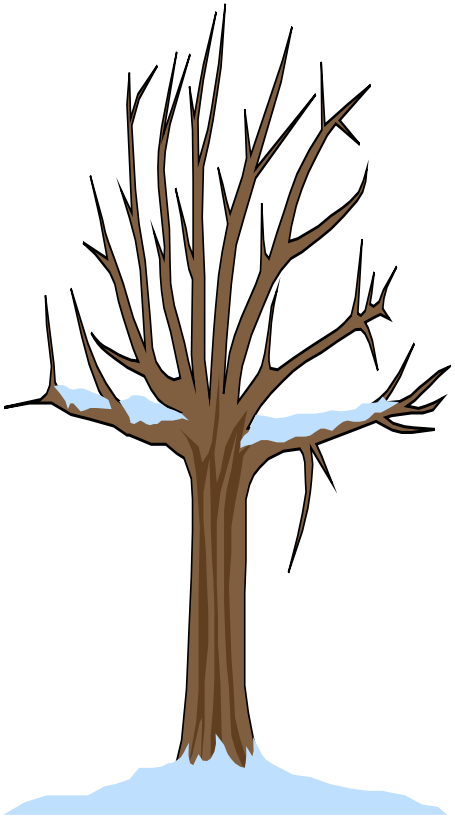
Dew Point Calculator

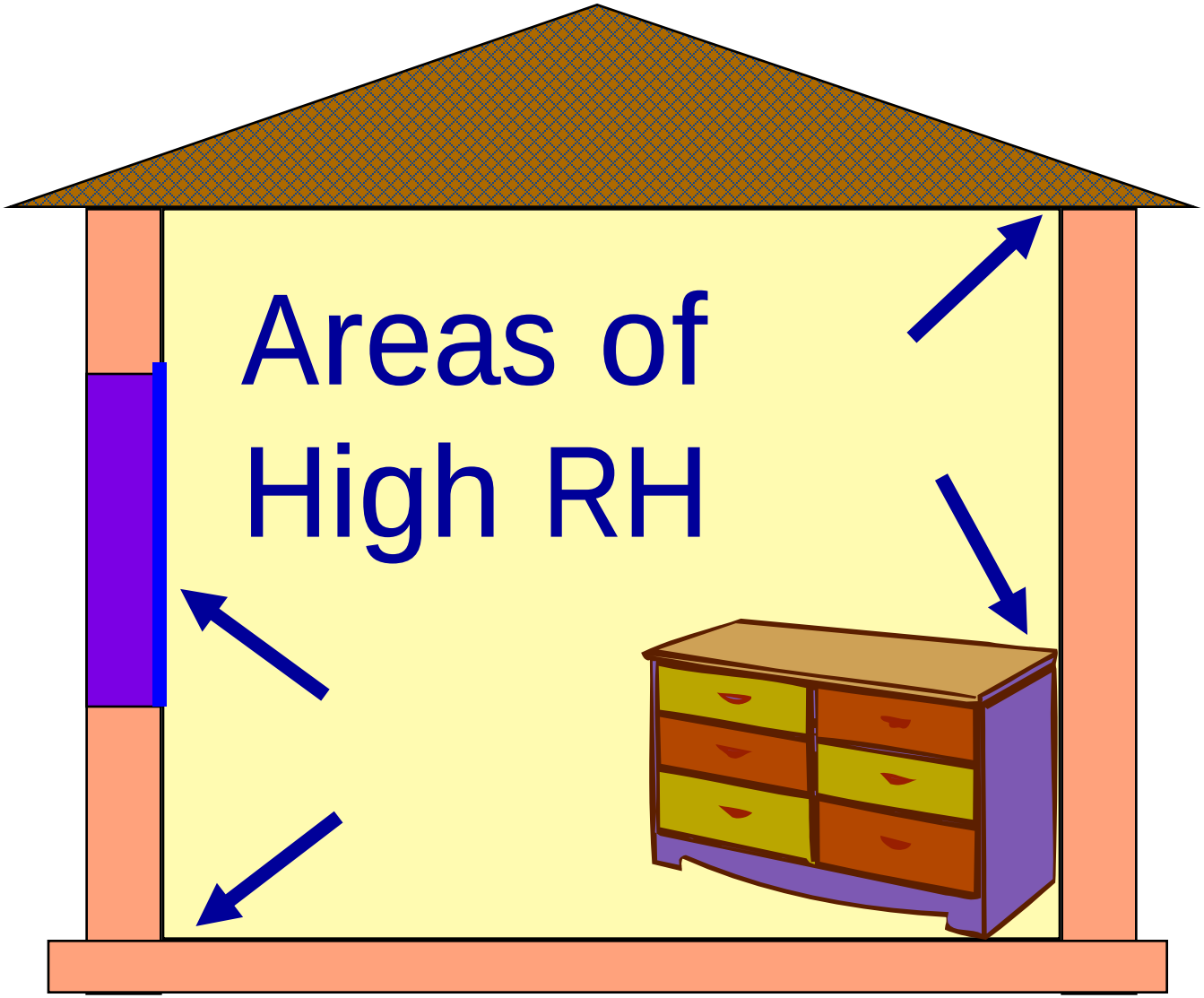
dpcalc.org

http://www.dpcalc.org/


40 ⁰F
100 %
RH
75 ⁰F
30 %
R H

COLD OUTSIDE





Buildings have micro-climates

Moisture and Air Exchange

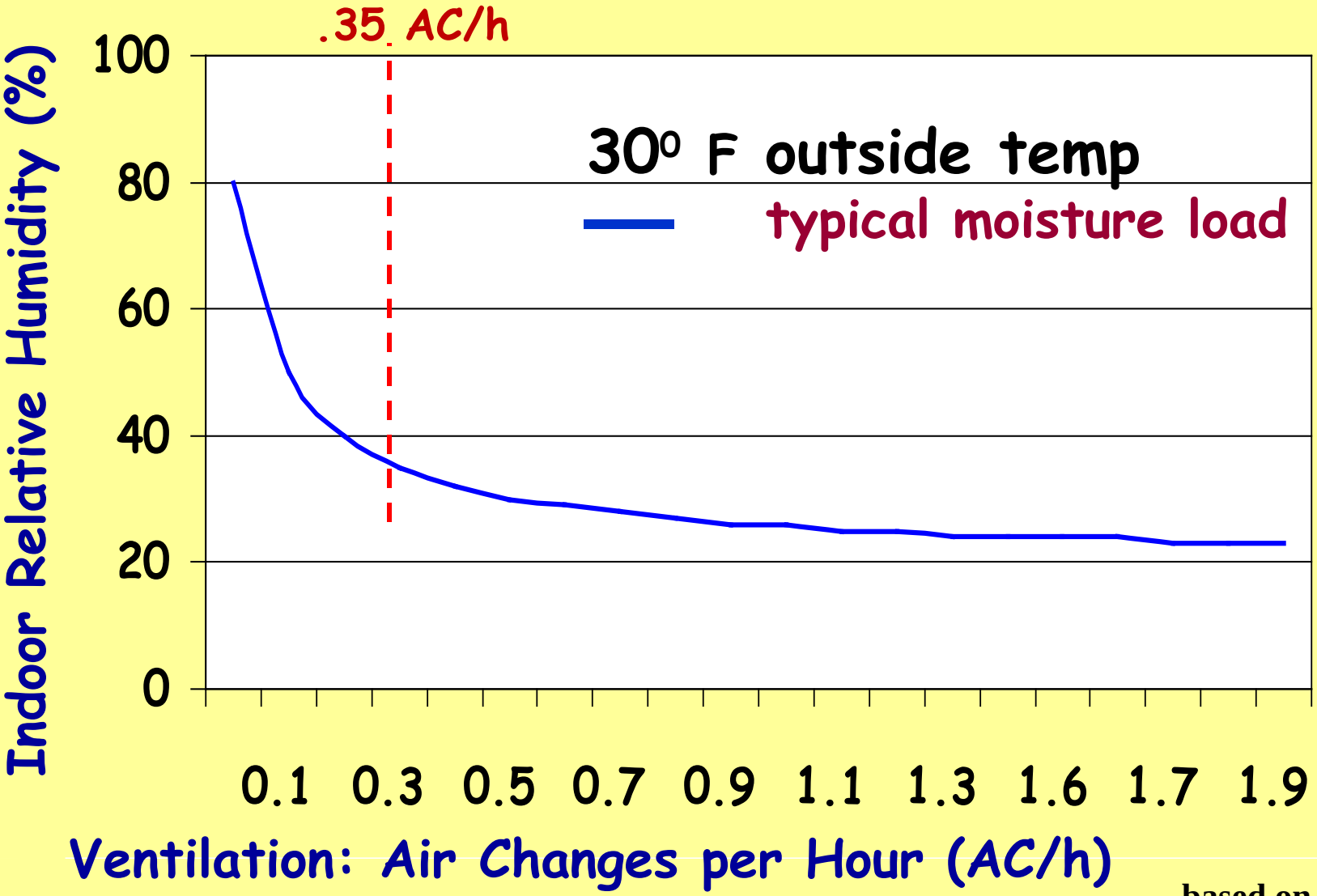
Ventilation is fundamental for control of "typical" moisture loads

Control of moisture *at the Source* is essential

Excessive ventilation not recommended

1,500 ft sq house
70⁰ F indoor temp
85 % outdoor RH

Ventilation (AC/h) vs Indoor Relative Humidity (%)



based on G. Tsongas

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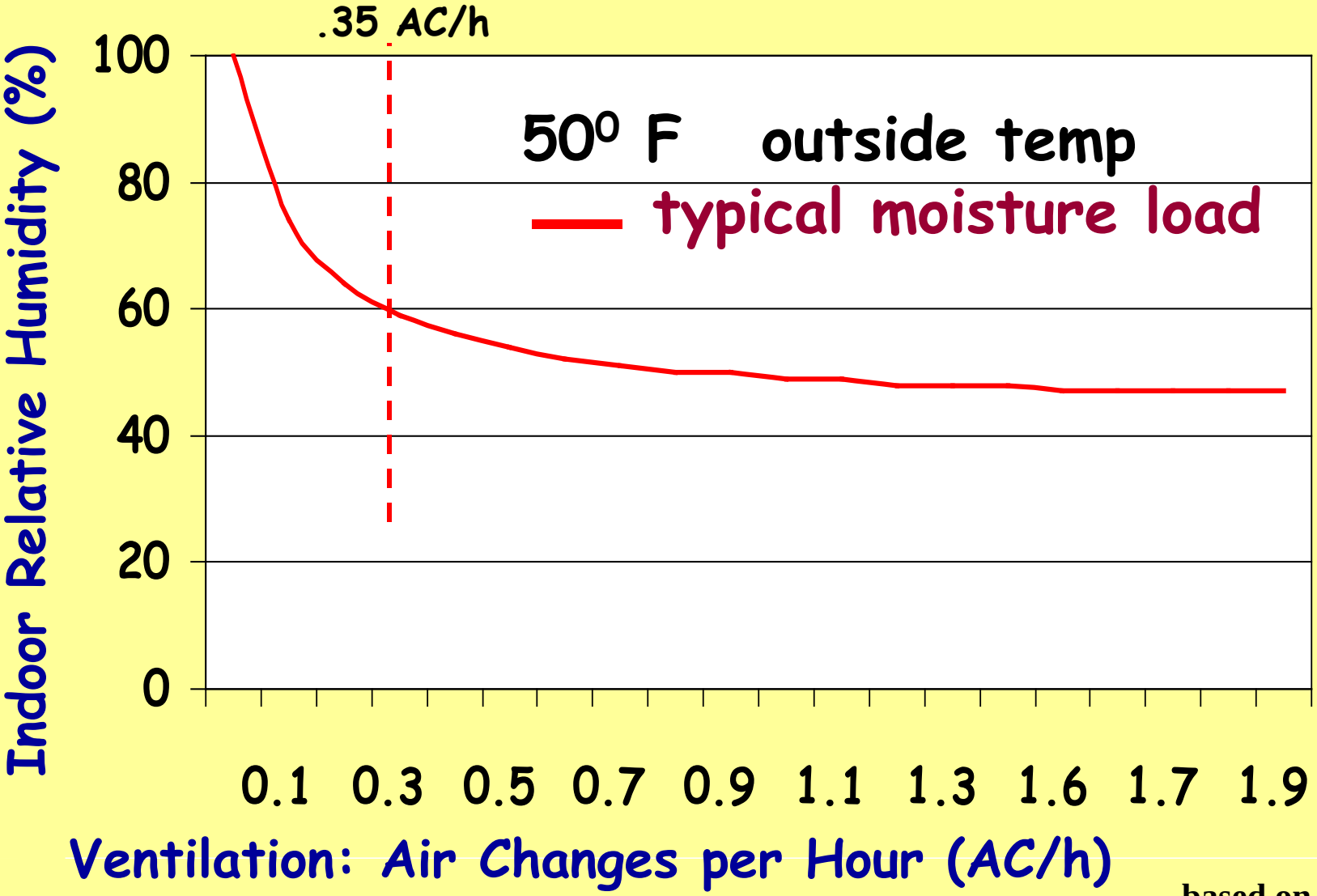

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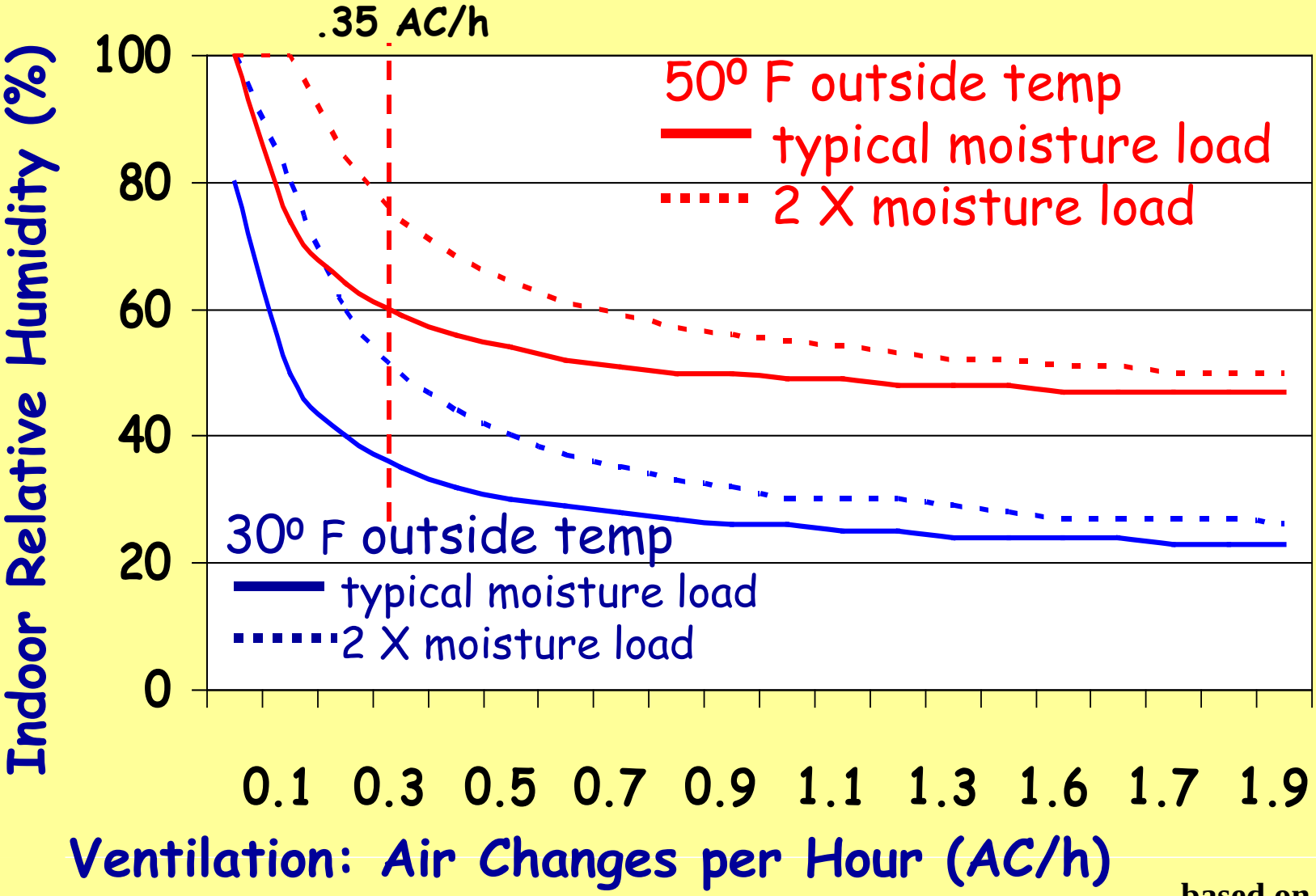


based on G. Tsongas

The Good News

Need *less outdoor air* for moisture control with cold outside air

Need *more outdoor air* when mild outside, but less energy penalty

Bleach

Bleach can kill - *does not* clean

- **No need to kill mold,**

  But *must remove mold*

- **Soapy water is less dangerous**

- **If necessary, treat cleaned surfaces with dilute bleach**

Airborne Mold Sampling

EPA, ACGIH* and other peer reviewed guidelines **do not** recommend airborne mold sampling as part of an investigation or remediation…

*American Congress of Governmental Industrial Hygienists

Airborne Mold Sampling

It is *very unlikely* that airborne mold samples will provide evidence

that cannot be more easily and reliably obtained by a *thorough* inspection

Airborne Sampling can produce
False Negatives . .
but not False Positives

"Absence of Evidence is NOT Evidence of Absence"

Consensus is that traditional methods used to identify increased mold exposure *do not reliably predict* increased health risks.

California Department of Public Health
Statement on Building Dampness, Mold, and Health, September 2011

Current practices for collection, analysis, and interpretation of environmental samples for mold…

cannot be used to quantify health risks posed by dampness and mold in buildings or to guide health-based actions.

California Department of Public Health
Statement on Building Dampness, Mold, and Health, September 2011

Current consensus does not justify the differentiation of some molds (such as *Stachybotrys* species) as "toxic molds"

California Department of Public Health
Statement on Building Dampness, Mold, and Health, September 2011

The only types of evidence that have been related consistently to adverse health effects are:

current or past water damage,
damp materials,
visible mold,
mold odor.

But *not* the number or type of mold spores nor the presence of other markers of mold in indoor air or dust.

California Department of Public Health
Statement on Building Dampness, Mold, and Health, September 2011

The *most effective tool* for locating mold growth and building dampness:

- ✓ **a detailed site inspection,**
- ✓ **understanding moisture dynamics,**
- ✓ **building science fundamentals.**

(Light, 2009)

12 cases where opposing experts evaluated the same water damaged site:

One set of investigations based on detailed *building inspection*,

Parallel investigations based on *mold testing.*

***Results indicated that extensive collection of air and surface samples failed to identify mold growth in addition to that observed using visual indicators*.**

Moreover, the inspector using visual cues located hidden mold growth undetected by sampling in half of the cases (6 of 12).

(Light, 2009)

CONCLUSIONS

The range of airborne mold concentrations in water damaged buildings and buildings with poor mechanical hygiene was *similar to that in . . . dry, well maintained buildings*.

The *range and outdoor/indoor ratios for airborne mold* were *similar* in water damaged buildings and buildings with poor mechanical hygiene . . . *compared to dry, well maintained buildings.*

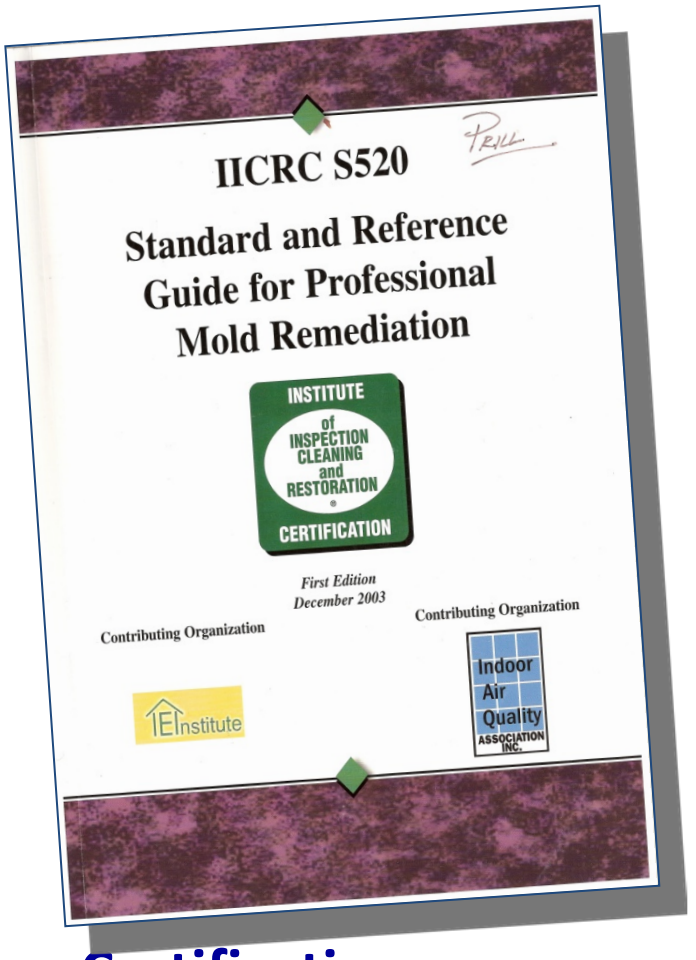
A detailed site evaluation based on an understanding of moisture dynamics is the most effective tool for locating mold growth and building dampness. (Light, 2009)

Remediation / Restoration

IICRC Standard S-520

Guidance for
water damage restoration

www.IICRC.org



Institute of Inspection, Cleaning, Restoration Certification

Building Operator Certification

Idaho, Montana, Utah:

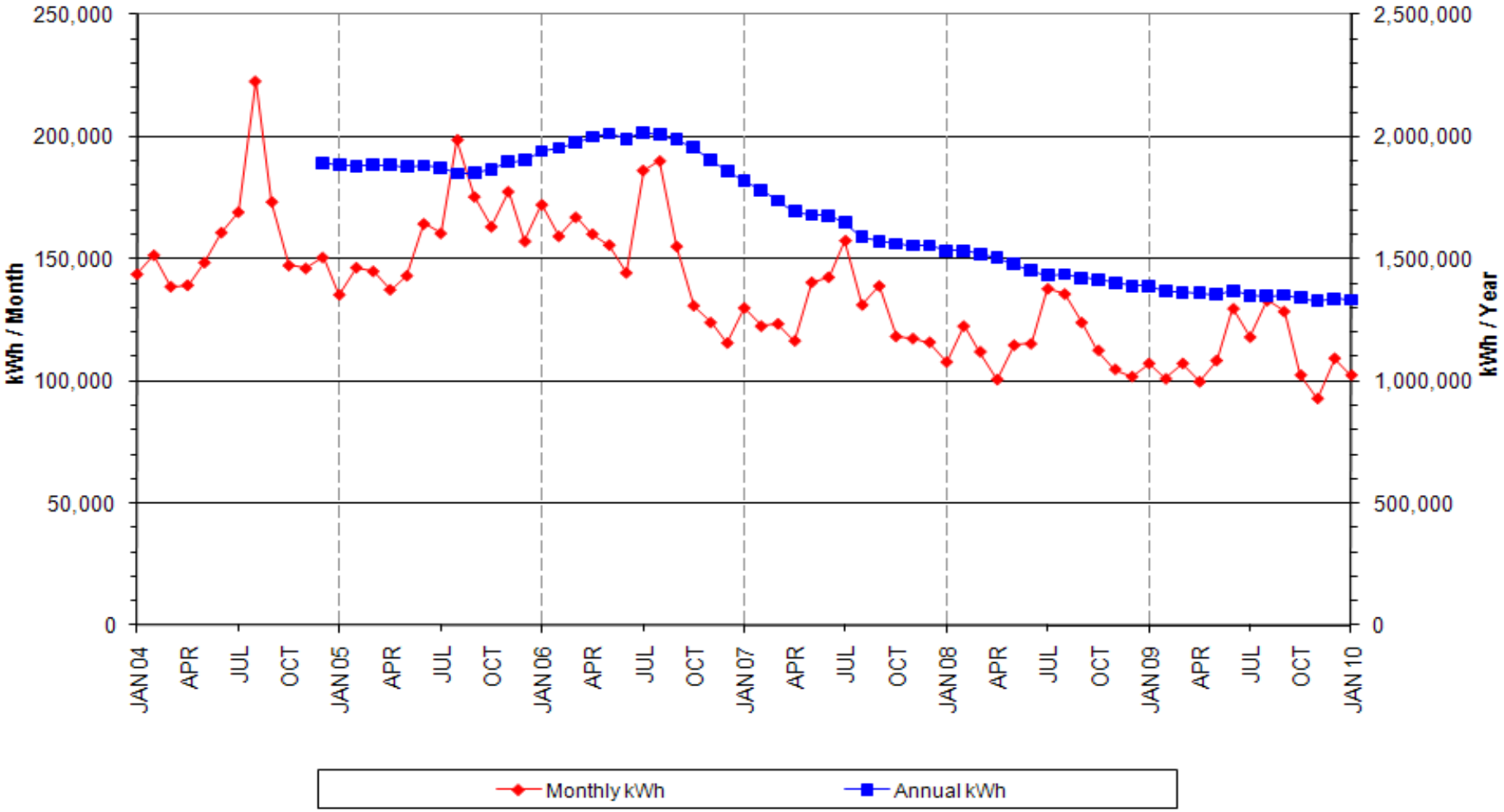
Intermountain Building Operator Association

Clarence Wieting, iboa@intboa.org

208-258-300

How many of your organizations *thoroughly* track resource usage?

Electricity Consumption 2004 through 2010



School business offices u*sually just pay invoices if these look "OK*

Resource Conservation Management …

is a coordinated effort to manage the resources and services used, and waste generated, by public facilities to reduce operating costs, increase efficiency and promote environmentally friendly operations.

This involves carefully tracking resources and improving operational efficiency while enhancing occupant comfort and overall cost-effectiveness

WSU RCM Website:
http://www.energy.wsu.edu/PublicFacilitiesSupport/ResourceConservation.aspx

Puget Sound Energy RCM Website:
https://pse.com/savingsandenergycenter/ForBusinesses/energy-management-programs/Pages/Resource-Conservation-Manager.aspx

Resource Conservation Managers Document Savings

Example:

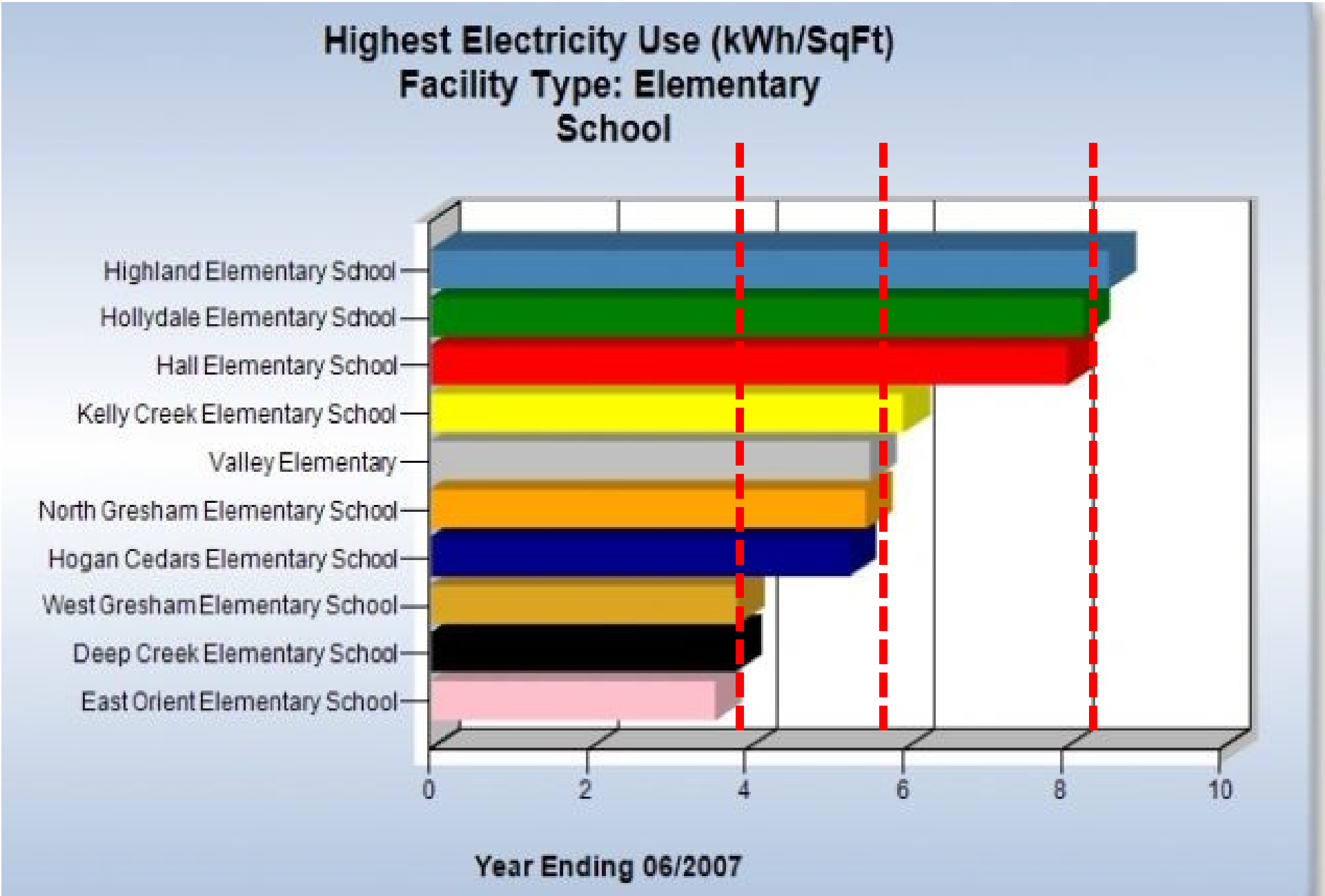
Olympia School District's RCM
Brittin Witzenburg

Actual Cost Savings

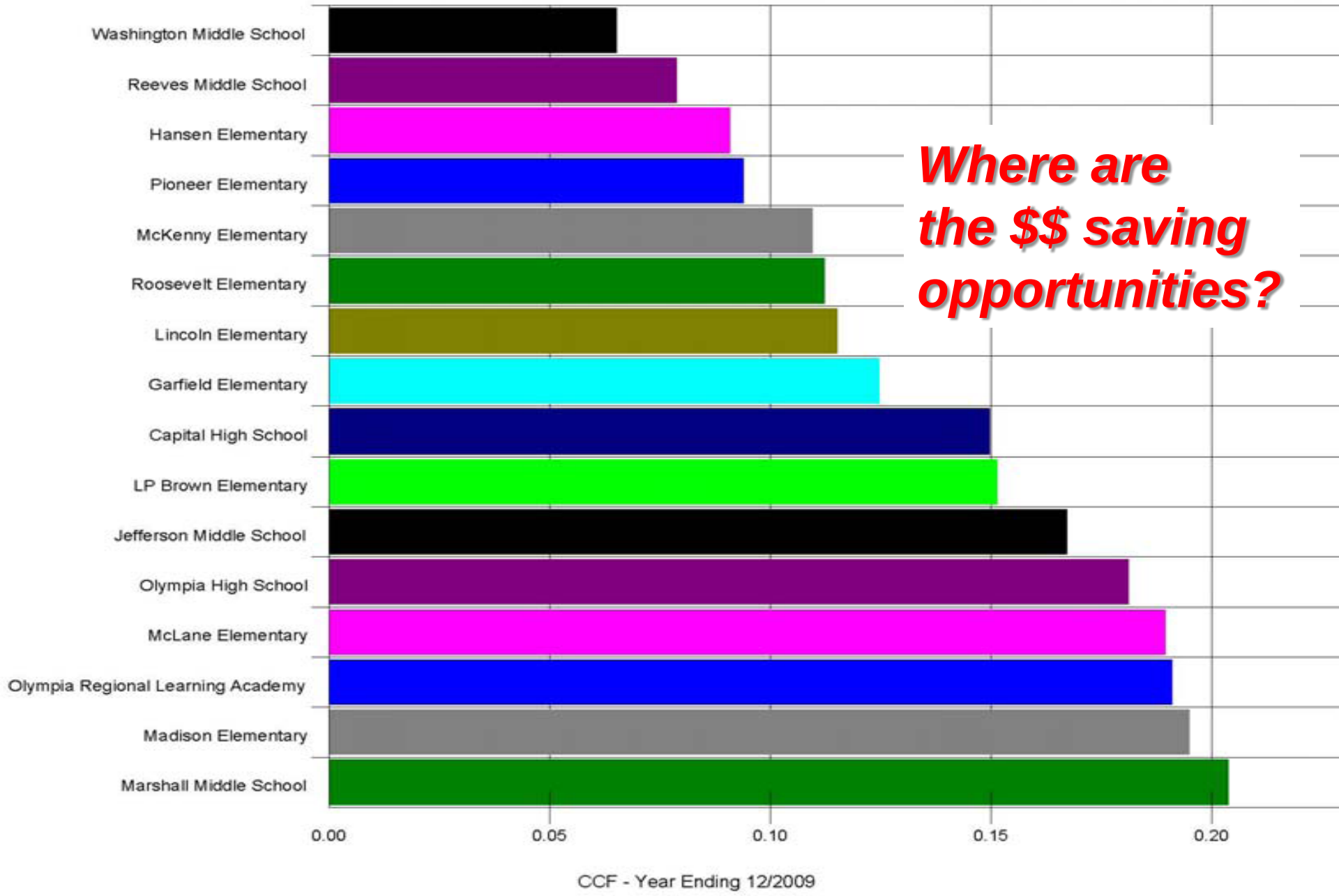
Year 1 $ 196,793
Year 2 $ 247,268

See WSU Profile of Brittin
www.energy.wsu.edu

Compare Similar Buildings



Consumption Comparison: *Water Usage per Student*



Where are the $$ saving opportunities?

Resource Conservation Manager

Karen Messmer *360-956-2090* www.energy.wsu.edu

Employee or local contract

Assume 1 person @ $80 K salary & benefits

RCM is in-house resource:

Dollar & utility savings
Total efficiency
Comfort & productivity
Problem solving
Training & education
Vested interest
$ stay in the community

Expected annual savings with annual utility cost examples

$ 1.5 million @ 5% = $ 75 K
$ 1.5 million @ 10 % = $ 150 K
$ 2 million @ 5% = $ 100 K
$ 2 million @ 10% = $ 200 K

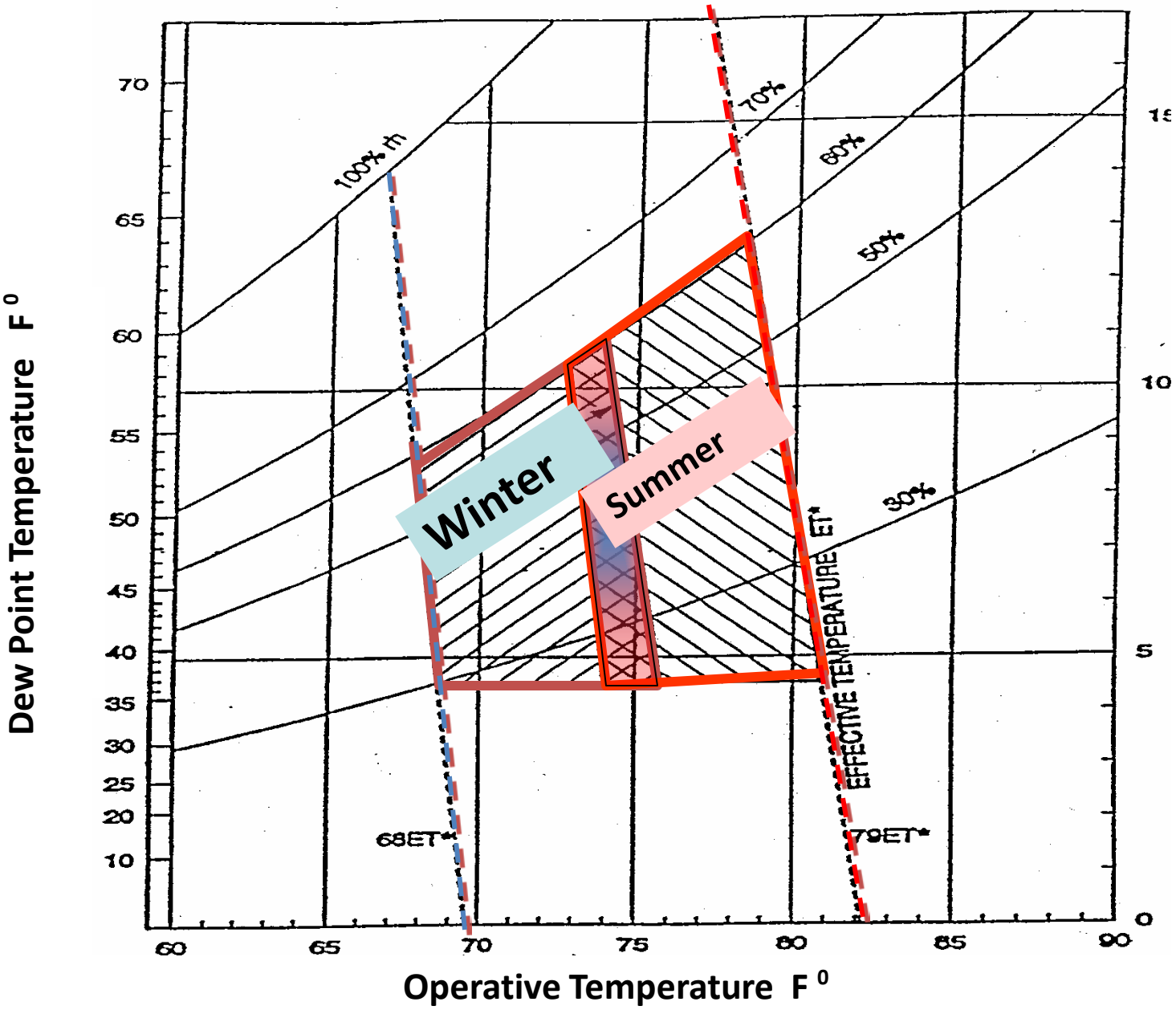
Comfort Basics

Air temperature
Surface temperature

} **Total = ~ 140 ^{0}F**

- Fresh Air
- Relative Humidity
- Air Velocity
- Clothing
- Odors

Humidity Ratio lb water vapor per 1000 lb dry air

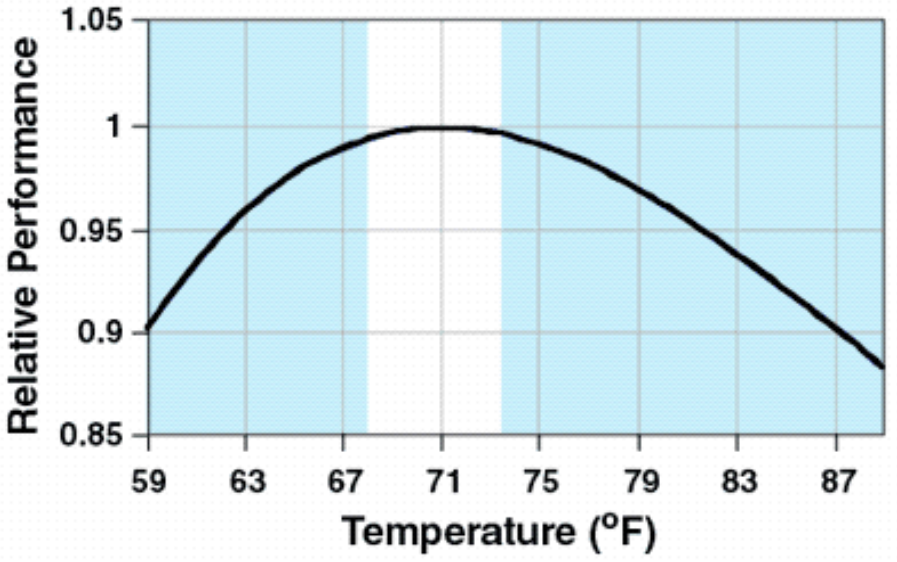


Office Performance and Temperature

The performance (speed and accuracy) of office work tasks is *maximized with air temperature of approximately 71 °F.*

Performance *decreases*, on average, by 0.43% per each 1 °F increase in temperature between 71 °F and 80 °F

Performance decreases, on average, by 0.37% per each 1 °F drop in temperature between 71 °F and 65 °F



Temperatures in Schools

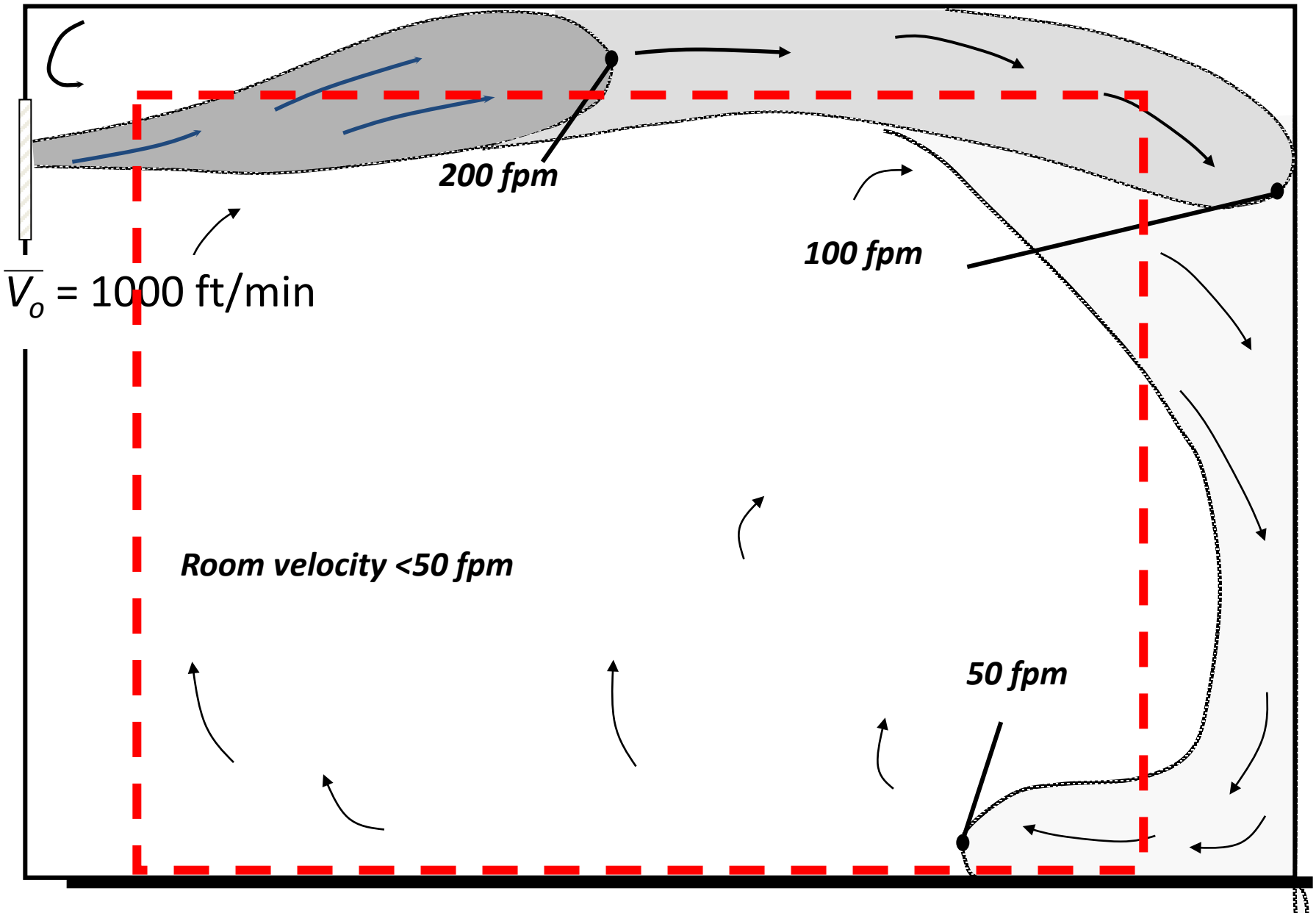
Average speed of completing academic work

decreased **by approximately 1.1%** ***for each***

1 °F temperature increase from 68 °F to 77 °F

(based on monitoring of performance of eight simulated school work tasks)

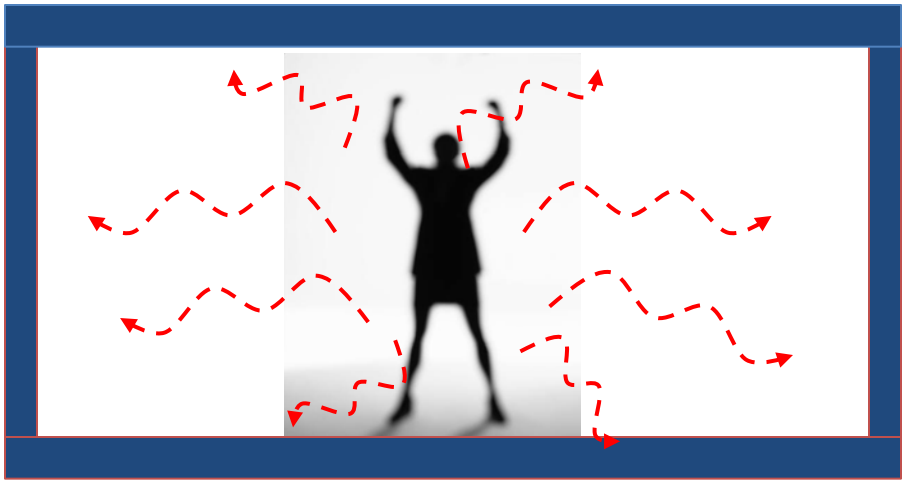
Room Air Velocity



Mean Radian Temperature (MRT)

Surface temperatures are critical for human comfort

Occupants *lose heat* to surfaces



Occupants *gain heat* from surfaces

Effective comfort temperature of 70°F

For every one degree Fahrenheit the ***average surface temperature*** is ***below*** **70°**,

need to ***raise*** ***the air temperature 1.4°F***

to compensate for the radiant cooling effects of the cooler surfaces

Equivalent MRT and Air Temperature for a feeling of 70°F

MRT	50	55	60	65	68	69	70	71	72	70	75	80
Air Temp	98	91	84	77	72.8	71.4	70	70	68.6	67.2	63	56

Tom Wilson, Thermal Solutions, 2007

Effective comfort temperature of 70°F

Similarly, for ***every degree above 70° in MRT*** would allow us to **reduce the air temperature by 1.4°** and still maintain the same level of comfort.

Equivalent MRT and Air Temperature for a feeling of 70°F

MRT	50	55	60	65	68	69	70	71	72	70	75	80
Air Temp	98	91	84	77	72.8	71.4	70	70	68.6	67.2	63	56

Tom Wilson, Thermal Solutions, 2007

In this corner . . .

The former champ

“ Space Heater with Fan ”

The Numbers:

- 1,500Watts
- Safety issues
- Creates breeze
- Noisy

And, in this corner . . .

The Challenger:

Radiant Heat Panel

Heats objects, not air

The Numbers

- **Thin panel**
- **No Drafts**
- **Silent**
- **Safe**

Radiant Panel: only 175 Watts

OPERATION & MAINTENANCE
SERVICE RATING PROGRAM

OCCUPANT RATING OF BUILDING PERFORMANCE

BUILDING NAME: _____ Date: _____

Please provide your rating of this building's performance by circling the number that best fits your experiences. Your feedback will help improve the Operation & Maintenance of the building and building systems.

Please rate the following:

COMFORT

In terms of the overall comfort of my work area, I am:

5	4	3	2	1
Very Satisfied	*Satisfied*	*Somewhat Satisfied*	*Unsatisfied*	*Very Unsatisfied*

In terms of the temperature in my work area, I am:

5	4	3	2	1
Very Satisfied	*Satisfied*	*Somewhat Satisfied*	*Unsatisfied*	*Very Unsatisfied*

If unsatisfied with the temperature in my work area, I am able to:

5	4	3	2	1
Adjust thermostat	*Adjust doors*	*Add /remove clothing*	*open /close windows*	*Block /unblock a register*

In terms of the movement of air in my work area, I am:

5	4	3	2	1
Very Satisfied	*Satisfied*	*Somewhat Satisfied*	*Unsatisfied*	*Very Unsatisfied*

In terms of the humidity in my work area I am:

5	4	3	2	1
Very Satisfied	*Satisfied*	*Somewhat Satisfied*	*Unsatisfied*	*Very Unsatisfied*

I would be more satisfied with the comfort in my work area if I were able to:

5	4	3	2	1
Adjust thermostat	*Adjust air currents*	*Open window*	*Use a personal fan*	*Use a space heater*

ODORS:

In terms of odors in my work area , I am:

5	4	3	2	1
Very Satisfied	*Satisfied*	*Somewhat Satisfied*	*Unsatisfied*	*Very Unsatisfied*

NOISE:

In terms of the overall level of noise in my work area, I am:

5	4	3	2	1
Very Satisfied	*Satisfied*	*Somewhat Satisfied*	*Unsatisfied*	*Very Unsatisfied*

In general, I am most satisfied when the noise level in my work area is:

5	4	3	2	1
Very quiet	*Somewhat quiet*	*Neither quiet nor loud*	*Somewhat loud*	*Very loud*

When the noise level is not acceptable, the noise that adversely affects me is:

5	4	3	2	1
Co-workers talking	*Printer/copier*	*Outdoor noise*	*Lights*	*Air System*

When unsatisfied with the noise level, I am:

5	4	3	2	1
Not distracted at all	*Mildly distracted*	*Somewhat distracted*	*Mostly distracted*	*Very distracted*

LIGHTING:

In terms of the lighting in my work area, I am:

5	4	3	2	1
Very Satisfied	*Satisfied*	*Somewhat Satisfied*	*Unsatisfied*	*Very Unsatisfied*

I believe the biggest problem with lighting in my work area is:

5	4	3	2	1
Too dim	*Too bright*	*Glare*	*Lighting "Quality"*	*Inadequate control/switches*

When unsatisfied with the lighting, I am:

5	4	3	2	1
Not distracted at all	*Mildly distracted*	*Somewhat distracted*	*Mostly distracted*	*Very distracted*

GENERAL COMMENTS:

How does the performance of the building in your area impact your job productivity:

5	4	3	2	1
Enhances productivity	*Promotes productivity*	*Somewhat promotes productivity*	*Somewhat hinders productivity*	*Hinders productivity*

Briefly describe your overall perception of how the performance of the building meets your needs:

_____

In what part of the building do you work, or spend most of your time: _____

_____

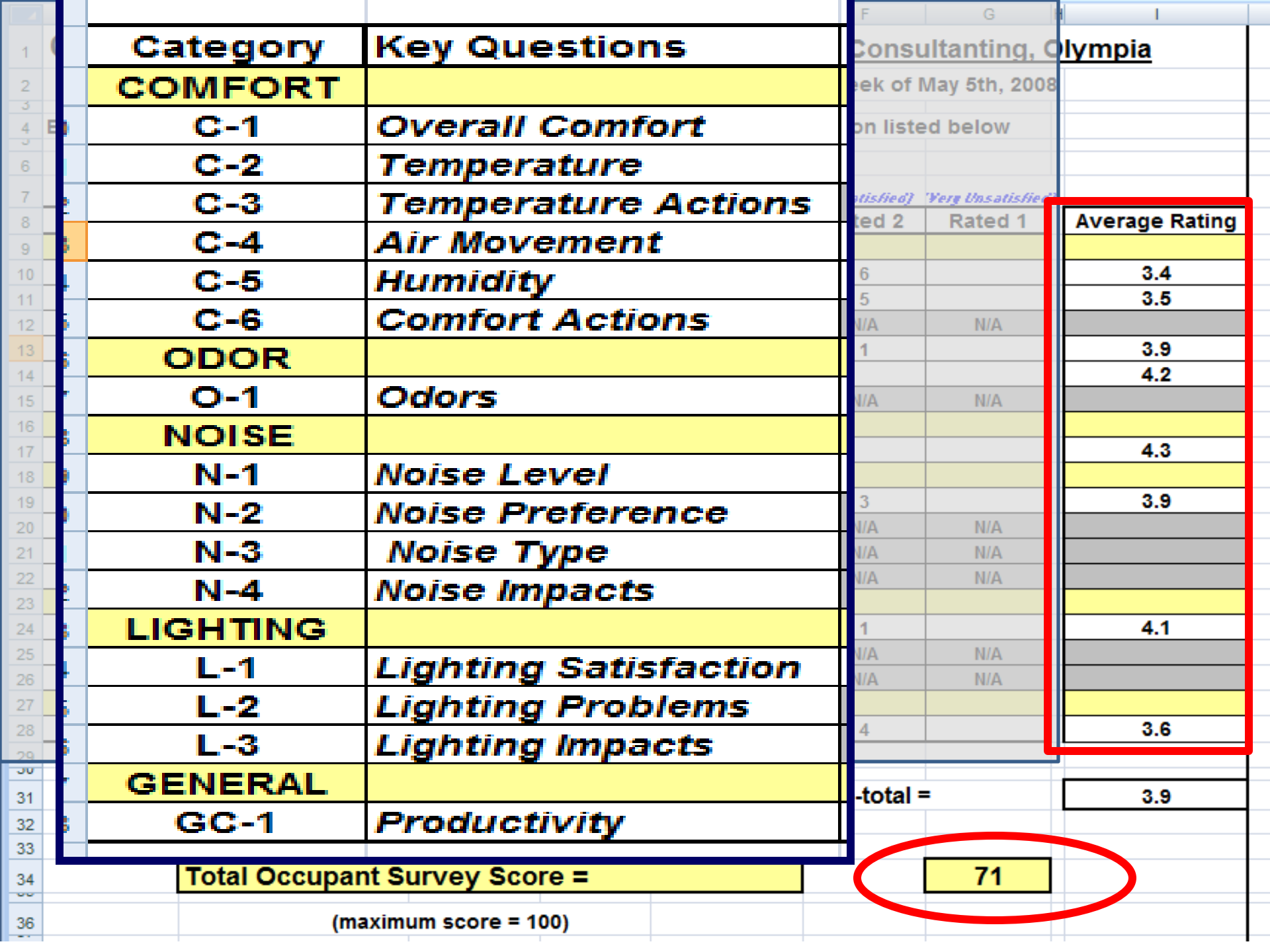
Briefly describe how the staff responsible for the Operations & Maintenance of the building respond to your comfort or other issues: _____

_____

Other comments regarding how the building impacts your ability to do your work _____

_____

_____


Category
Key Questions
COMFORT
C-1
Overall Comfort
C-2
Temperature
C-3
Temperature Actions
C-4
Air Movement
C-5
Humidity
C-6
Comfort Actions
ODOR
O-1
Odors
NOISE
N-1
Noise Level
N-2
Noise Preference
N-3
Noise Type
N-4
Noise Impacts
LIGHTING
L-1
Lighting Satisfaction
L-2
Lighting Problems
L-3
Lighting Impacts
GENERAL
GC-1
Productivity
Consultanting, Olympia
ek of May 5th, 2008
on listed below
Rated 2
Rated 1
Average Rating
3.4
3.5
3.9
4.2
4.3
3.9
4.1
3.6
-total =
3.9
Total Occupant Survey Score =
71
(maximum score = 100)

Cleaning for Health

Custodial practices in schools should focus on cleaning for health, not just appearance, which can be challenging at times.

The national average workload for a school custodian is about 25,000 square feet. This figure doesn't account for issues found in specific schools. Some schools are much easier to keep clean than others.

An Appearance of Cleanliness

Certain factors can make it impossible for custodial staff to do more than achieve a mere appearance of cleanliness. These include:

- **complicated building designs**
- **the amount and age of carpeting**
- **insufficient extraction of contaminants from carpeting**
- **the type of custodial equipment provided (and)**
- **climate and site-specific challenges – such as tracked-in moisture and dirt, for instance**

Significant advances in cleaning techniques, equipment and chemicals have been made in recent years, but many schools are slow to adopt new practices and switch to more advanced products and equipment.

Carpet in Schools

Most schools contain carpeting, which has advantages and disadvantages.

Carpet not only looks nice, but provides benefits in terms of noise control and reducing slip and fall hazards.

Disadvantages of Carpet

Carpet care often doesn't meet the manufacturer's recommendations. Many custodians are given too little time to maintain carpet on a daily basis, vacuuming a carpeted classroom for only 5 – 8 minutes.

Some schools don't follow current recommendations for carpet care, which calls for regular extraction of dirt with high-quality equipment and use of hot water only.

Carpet sometimes remains in schools well beyond its useful life and/or despite its degree of contamination.

Disadvantages of Carpet (cont.)

Unfortunately, carpet can hide a multitude of problems. Some of the disadvantages of carpet include the following:

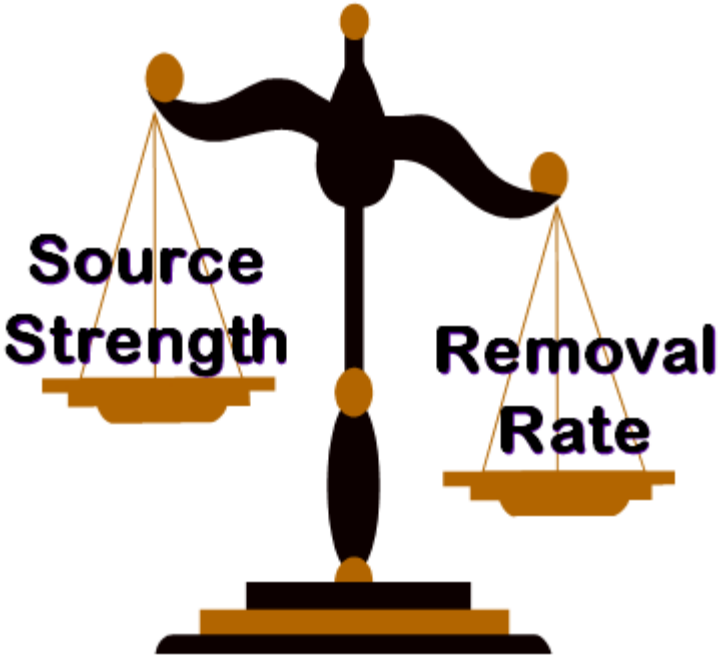
Use of carpet cleaning chemicals often results in residues that create an exposure to occupants. Aged carpet often contains a variety of different chemical residues.

Sometimes old, worn and contaminated carpet remains in a building because it's been glued to asbestos tiles. In that case, carpet replacement includes an expensive and disruptive asbestos abatement process.

“GREEN” Cleaning Methods

- **Damp wiping rather than spraying, which greatly reduces the release of airborne contaminants. Spray on clothes, no on surfaces**
- **Cleaning smarter, not harder. Micro-fiber cloths hold more particles and are recommended.**
- **Reviewing the ingredients of each cleaning product used for toxins, irritants, allergens and asthma triggers, and opt for low toxicity and irritancy products when available.**
- **Using modern, appropriate cleaning products and methods, and always using as little product as possible.**

Ventilation



“I am certain that no air is so unwholesome as air in a closed room that has been often breathed . . .

and not changed.”

Ben Franklin

Ventilation Guidelines

- **ASHRAE Standard 62**
  - **62.1 commercial buildings**
  - **62.2 residential buildings**
    - **ventilation guidelines**
    - **pollutant guidelines**
    - **operation guidelines**

Individual states may have their own ventilation requirements

CO_2 and Ventilation Rate *Per Person*

CO_2 (ppm)	Outside Air (ventilation rate)	
2,400	5 cfm/p	Unacceptable
1,400	10 cfm/p	Poor
1,000	15 cfm/p	Classrooms
800	20 cfm/p	Offices
600	25 cfm/p	
~ 380	<------>	Outdoors

Carbon Dioxide (CO_2)

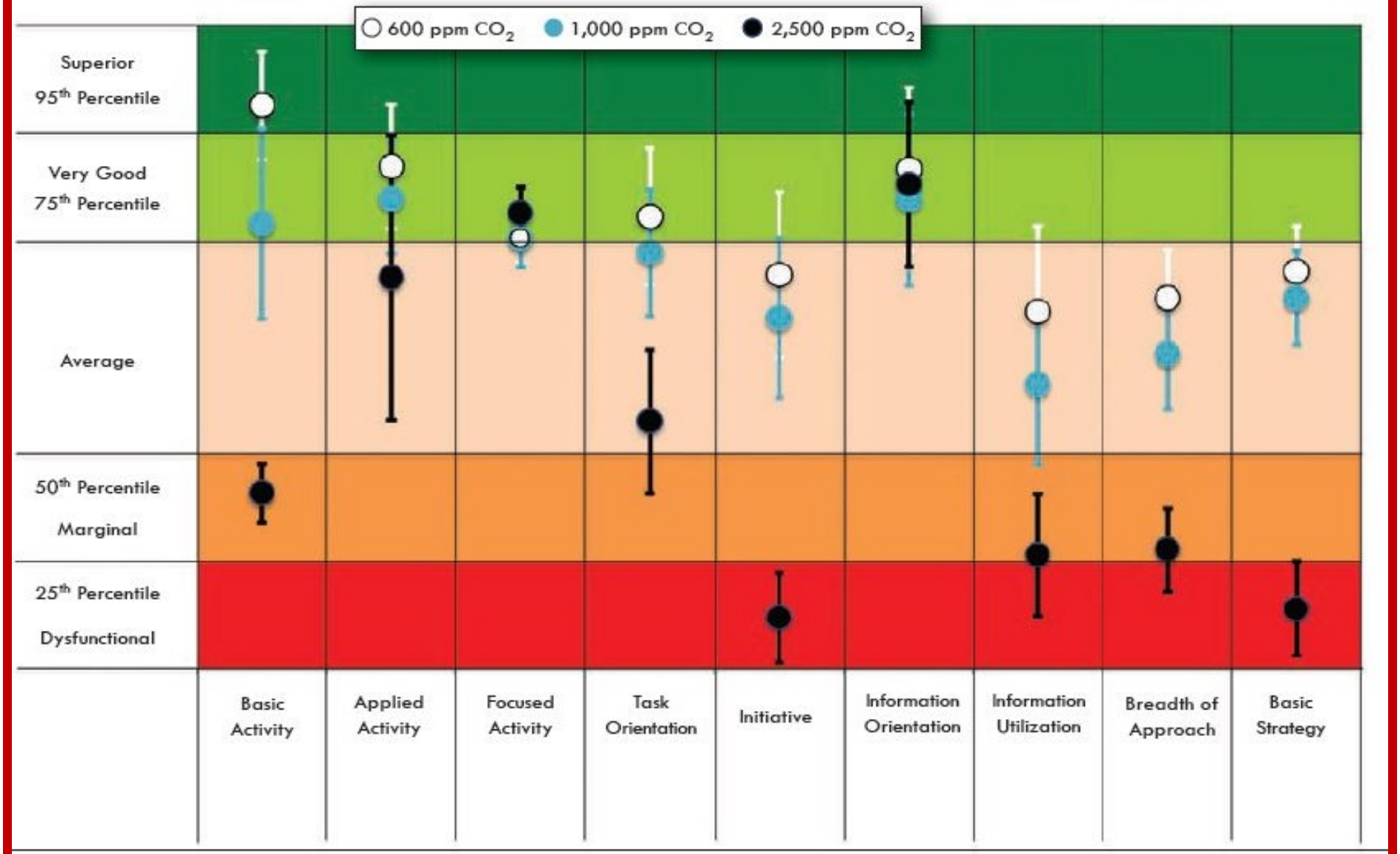
Easy method to check fresh air exchange

Lowest Outdoor CO_2 on the planet is now about 400 ppm

Should be maintained below about 1,100 ppm

As CO_2 builds up,
so does "everything else"…

"Everything else" is
too difficult to measure
and interpret



Impact of CO_2 on human decision-making performance. Error bars indicate one standard deviation.

Fisk, W.J. ASHRAE Journal March 2013

Associations between classroom CO2 concentrations and student attendance in Washington and Idaho.

Absenteeism and carbon dioxide data were collected in 409 traditional and 25 portable classrooms .

22 schools located in six school districts in Washington and Idaho.

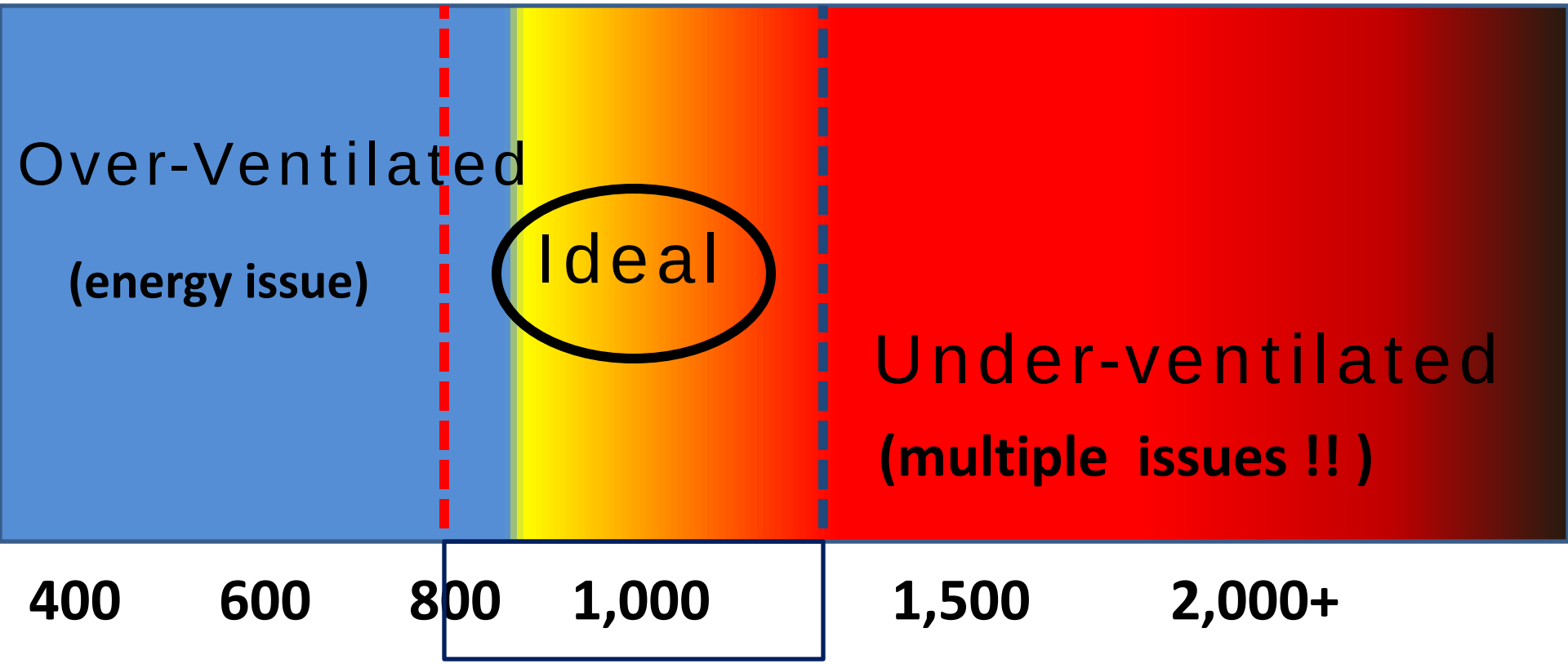
Study classrooms had individual heating, ventilation, and air conditioning (HVAC) systems, except two classrooms without mechanical ventilation.

Classroom attributes, student attendance and school-level ethnicity, gender, and socioeconomic status (SES) were included in multivariate modeling

Results: For every additional 1,000 ppm CO_2 there was a 20% increase in absenteeism

Report published in Journal of Indoor Air. 2004 Oct;14(5):333-41.
Shendell DG, Prill R, Fisk WJ, Apte MG, Blake D, Faulkner D

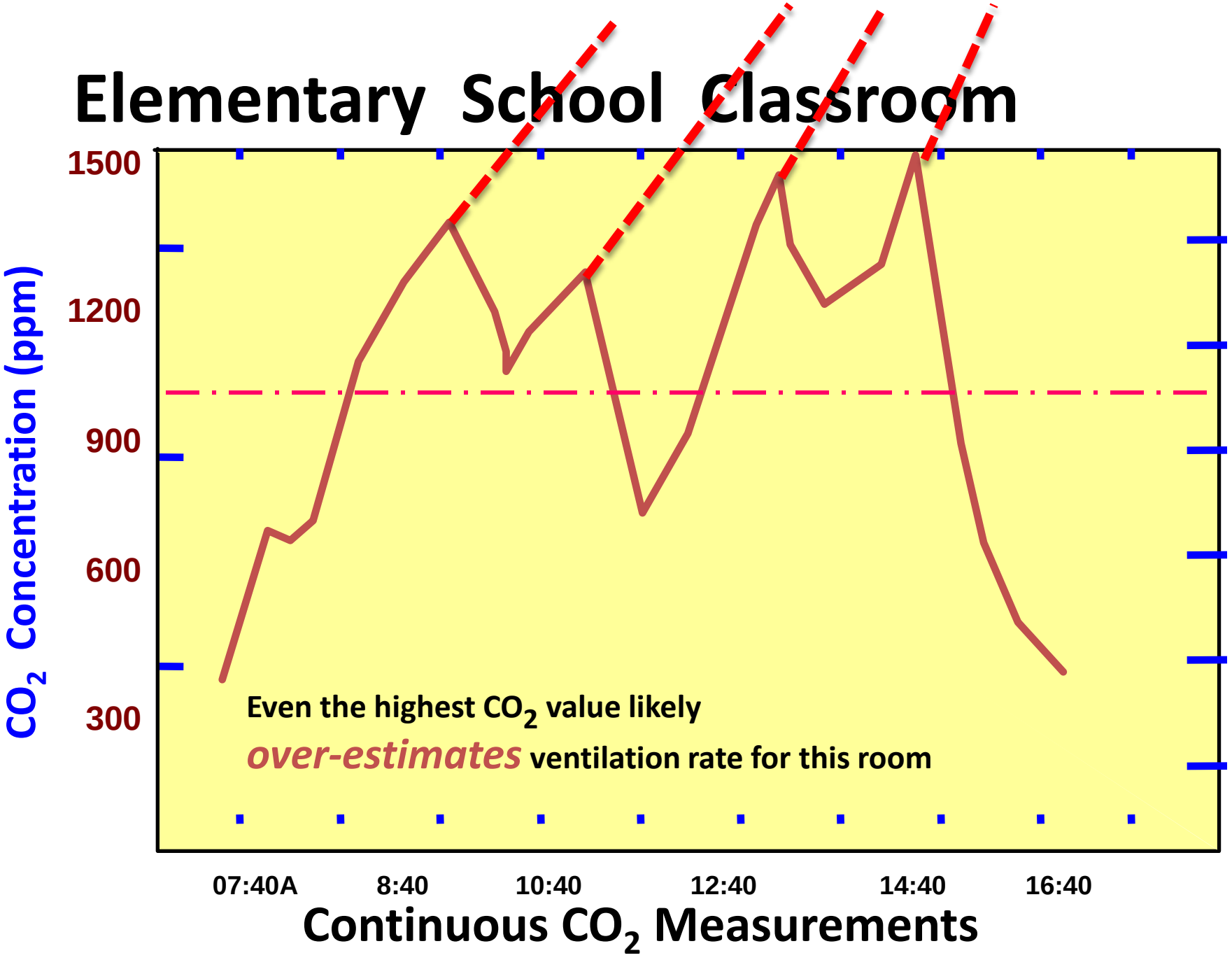
CO_2 Estimate of Ventilation



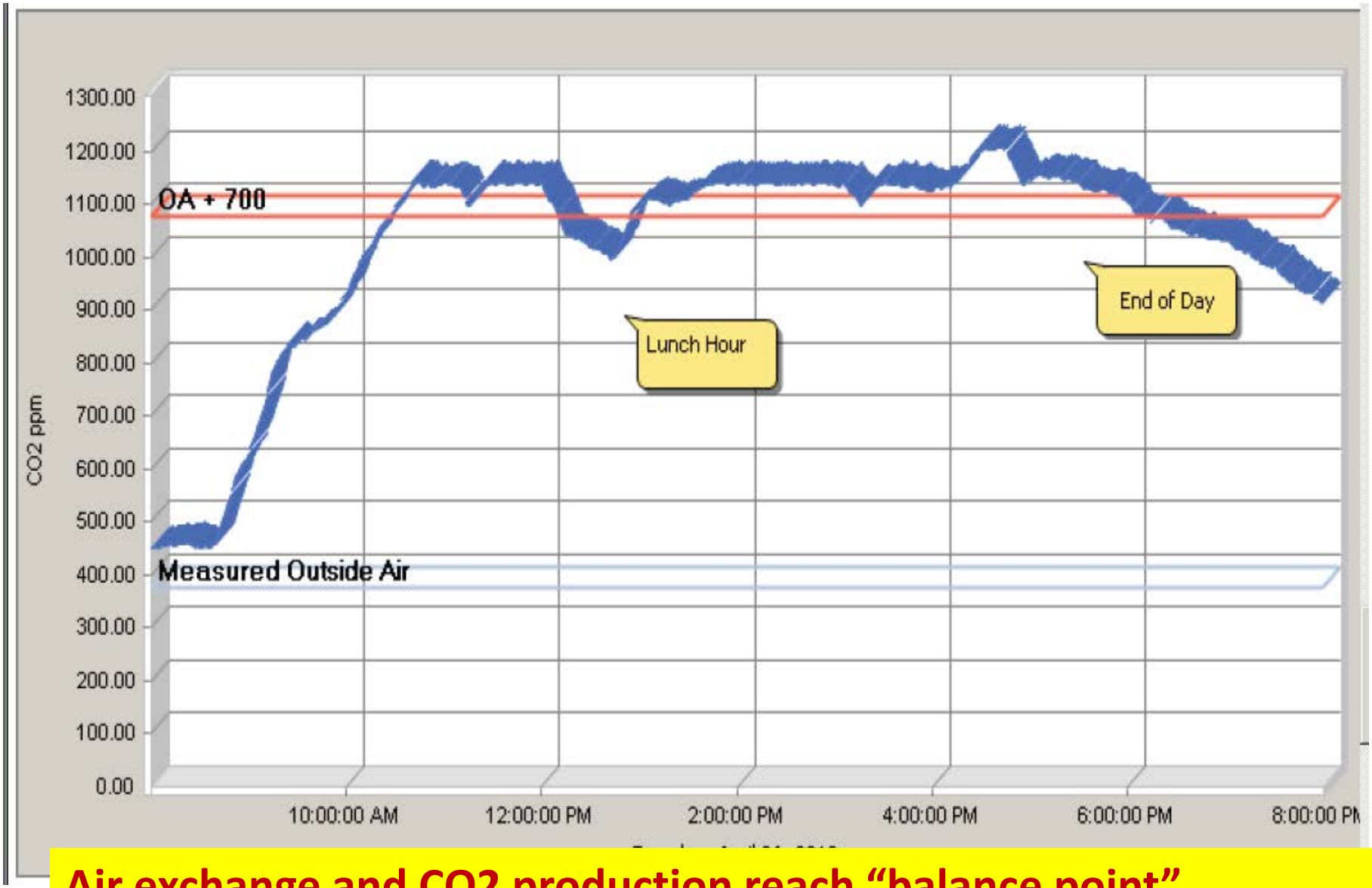
Carbon Dioxide vs. Ventilation Rate

Carbon Dioxide (ppm)	Outside Air	
2,400	----- 5 cfm/p	Unacceptable
1,400	----- 10 cfm/p	Poor
1,000	----- 15 cfm/p	
800	----- 20 cfm/p	ASHRAE Standard 62
600	----- 25 cfm/p	
380 (and above)		Outdoor

Elementary School Classroom



Measure CO_2 at Steady State Conditions



Air exchange and CO2 production reach "balance point"

What are my CO2 measurement options?

Many affordable choices **Prices from about $200 +**

What features do you need?

- accuracy
- response time
- ease of use
- portability
- DYI calibration
- data logging
- multi-function
  - CO2
  - temperature
  - relative humidity
  - carbon monoxide

What is a Data Logger?

- **Small electronic instrument that records measurements over time (temperature, relative humidity, light intensity, etc.).**
- **Many varieties of loggers.**
- **Most use proprietary software to create graphs/charts of data (ie. “data visualization”).**

Source: Onset Computer Corp.

Mini Loggers

Easily measure energy usage

Document operation costs

Monitor time-of-use

Educate occupants

1. Temperature: air, surface, liquid
2. Moisture: relative & absolute humidity, dew point, materials
3. Carbon Dioxide
4. Carbon Monoxide
5. Pressure
6. Flow: air, liquid
7. Amps, Volts, Watts, Power Quality, Peak
8. Run Time
9. Lighting
10. Occupancy
11. State: open/closed, on/off, “yes/no”

File Device Edit View Tools Window Help

Skirball_BOC.hobo

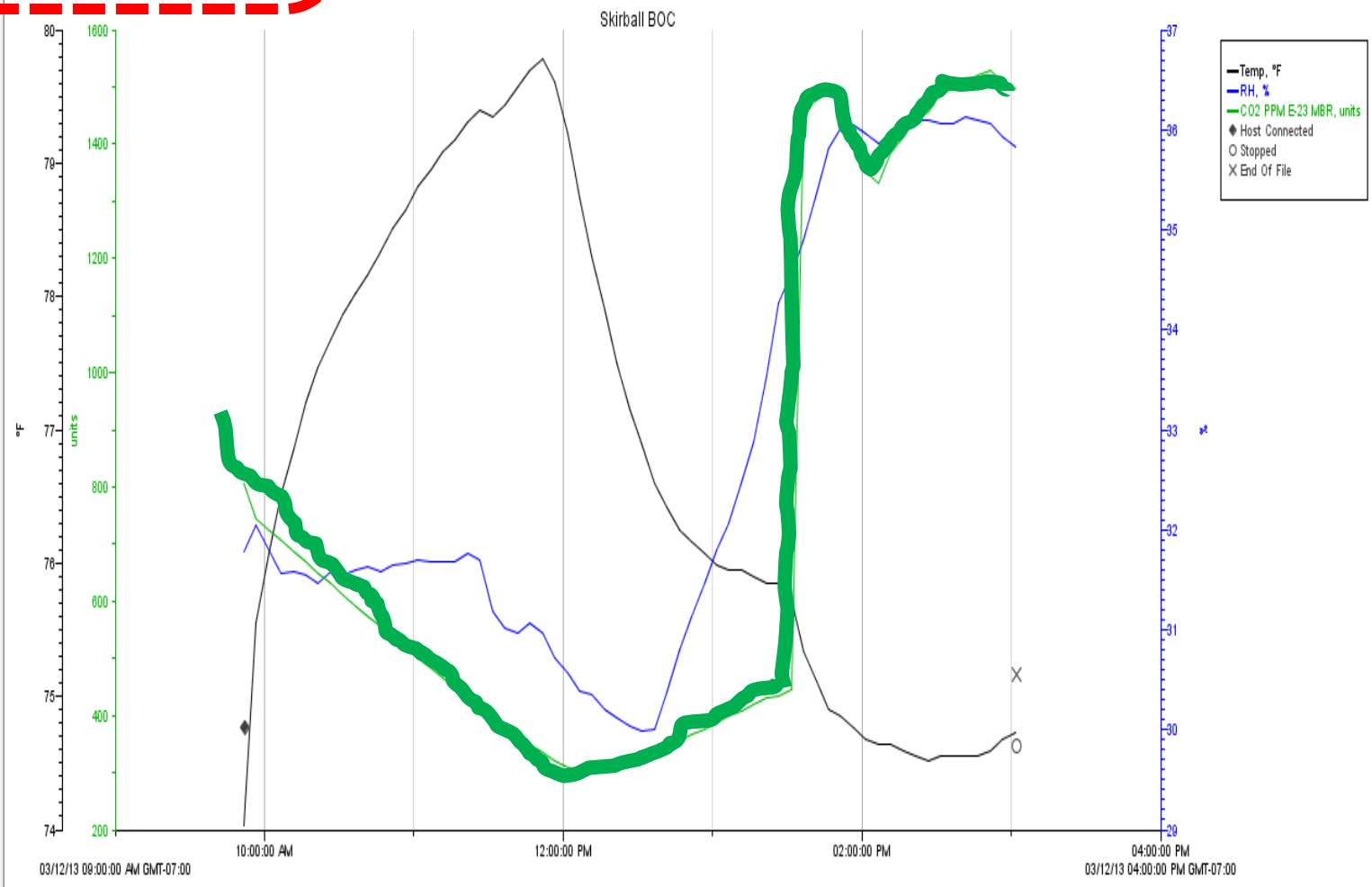
#	Time, GMT-07:00	Temp, °F	RH, %	CO2 PPM E-23 MBR, units	Host Connected	Stopped	End Of File
1	03/12/13 09:51:38 AM	74.034	31.773	806.00			
2	03/12/13 09:52:21 AM				Logged		
3	03/12/13 09:56:38 AM	75.551	32.048	744.00			
4	03/12/13 10:01:38 AM	76.071	31.804	724.00			
5	03/12/13 10:06:38 AM	76.507	31.557	707.00			
6	03/12/13 10:11:38 AM	76.854	31.573	687.00			
7	03/12/13 10:16:38 AM	77.203	31.556	668.00			

5 Minute Data Files

Show All | Hide All

Details

- Series: Temp, °F
- Series: RH, %
- Series: CO2 PPM E-23 MBR, units
- Event Type: Host Connected
- Event Type: Stopped
- Event Type: End Of File



Sampling Air for Contaminants & Indicators

- **Do not begin with complex air sampling.**
- **Sampling for thermal and ventilation problems is routine.**
- **Pollutant sampling**:
  - **can be expensive.**
  - **is often inconclusive**.

Measure only what can be reasonably interpreted and leads to a solution.

BASIC IEQ Measurements

Pressures & air flow direction

Temperatures (air and surfaces)

Air velocity

Relative humidity & materials moisture

CO_2 concentrations

Carbon Monoxide

Also: Carbon Monoxide, Radon, Particulates, Lead, Asbestos

Air Sampling Checklist

How will the results be used?

What substances should be measured?

Where and when should samples be taken?

What type of testing devices?

Calibration and quality control?

What method should be used?

Who should make the measurements?

- ✓ Create and adopt an IEQ Program
- ✓ Common Indoor Environmental Pollutants
  - Moisture & Molds, Radon, CO, Biologicals, Chemicals, Lead, Mercury, Asbestos ….
- ✓ Walk Through and Investigations
- ✓ Control Strategies
- ✓ Cleaning
- ✓ Dealing with People
- ✓ Comfort
- ✓ Ventilation
- ✓ Resource Efficiency
- ✓ Measurements and Equipment
- ✓ Resources

Thank You For Participating

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