

# Diagnosing Ventilation and IAQ Problems in Commercial Buildings

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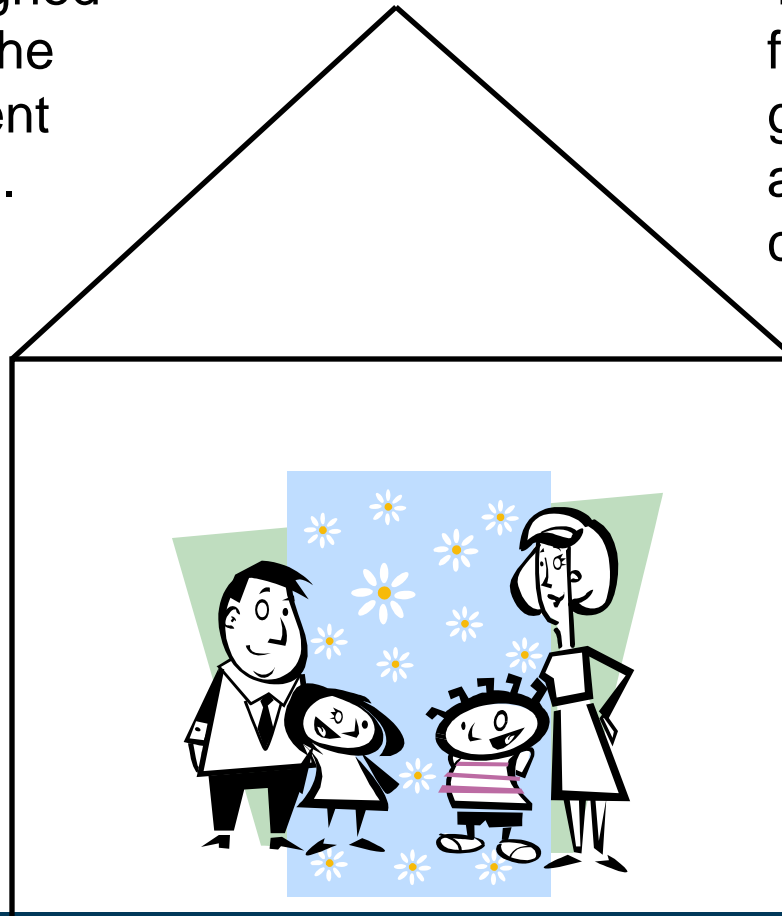
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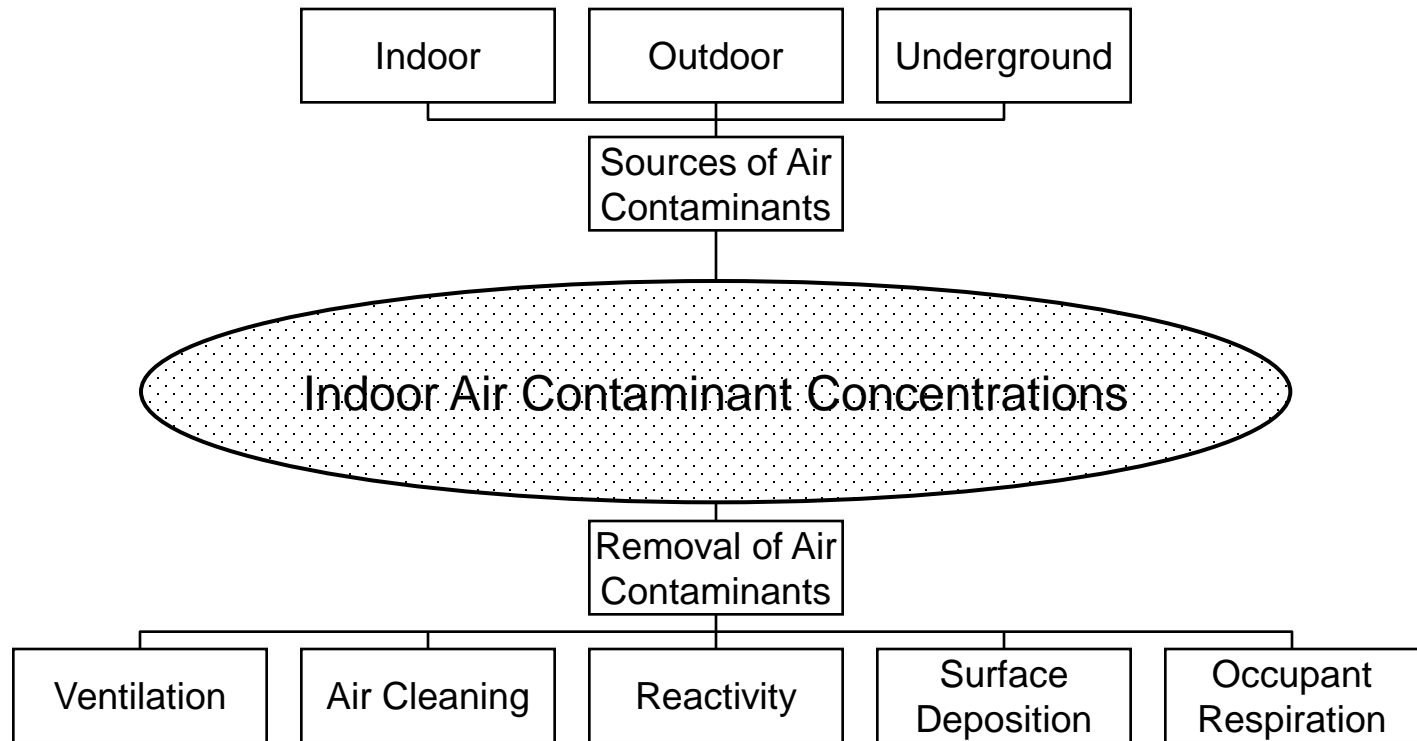
# The Problem - Tight Envelopes and Indoor Pollutant Sources

Buildings are designed to isolate us from the outdoor environment (i.e. rain, hot, cold).

This isolation allows for air contaminants generated indoors to accumulate to high concentrations.



# Understanding IAQ



# Understanding IAQ

## Indoor Contaminant Sources

Building Occupants	Building Materials	Home Furnishings	Home Activities	Cleaning Items	Ventilation Systems
<ul style="list-style-type: none"><li>•Biological emissions</li><li>•Infectious disease</li><li>•Tobacco smoking</li><li>•Personal hygiene products</li><li>• Pets</li></ul>	<ul style="list-style-type: none"><li>•Adhesives</li><li>•Caulking</li><li>•Composite wood products</li><li>•Vinyl wall coverings</li><li>•Thermal insulation</li><li>•Paint/Finishes</li></ul>	<ul style="list-style-type: none"><li>•Composite-wood</li><li>-Furniture</li><li>-Cabinetry</li><li>-Flooring</li><li>-Door/window trims</li></ul>	<ul style="list-style-type: none"><li>•Cooking</li><li>•Hobbies</li><li>•Vacuuming</li></ul>	<ul style="list-style-type: none"><li>•Cleaners</li><li>•Deodorizers</li><li>•Pesticides</li></ul>	<ul style="list-style-type: none"><li>•Condensate pans, coils</li><li>•Leaky ducts</li><li>•Humidifiers</li><li>•Untrapped condensate drains</li><li>•Contaminated air filters</li><li>•Induced unplanned airflows</li></ul>

# Understanding IAQ

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## Outdoor and Underground Sources

Outdoor Air

- Ozone
- Vehicle Traffic
- Wood Smoke

Exhaust  
Stacks and  
Vents

- Furnace
- Hot Water Heaters
- Kitchen
- Toilette
- Sewer

Soil Gas

- Radon
- Methane
- Other Soil  
Contaminants

# Healthy Building - IAQ Top 10

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- 1.) Air temperature (70° F to 74° )
- 2.) Air pressure (3 to 7 pascals positive with respect to outdoor air and special use areas)
- 3.) Outdoor air ventilation (on prior to and continuous during occupancy, and at least the minimum flow rates as specified by ASHRAE 62.1, or preferably, 15 cfm/occupant and 1.0 ach, whichever is greater)

# Healthy Building - IAQ Top 10

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4.) Outdoor air inlet (locate away from sources of air contaminants or odors)

5.) Indoor sources (use low-emitting materials, isolate tenant improvement/construction areas, flush out areas)

6.) Moisture (don't let materials get and stay wet for more than two days)

# Healthy Building - IAQ Top 10

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7.) Soiling around supply air diffusers (clean soiling around diffusers and improve air filtration)

8.) Particle emissions from ventilation systems (fix sound liner erosion and clean ducts)



# Healthy Building - IAQ Top 10

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9.) Air filtration (minimum of MERV 8 and preferably MERV 11 or 13, no ozone, electrostatics, or UV)

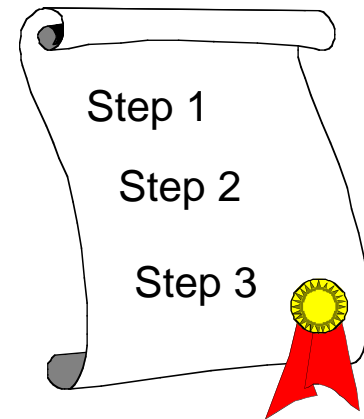
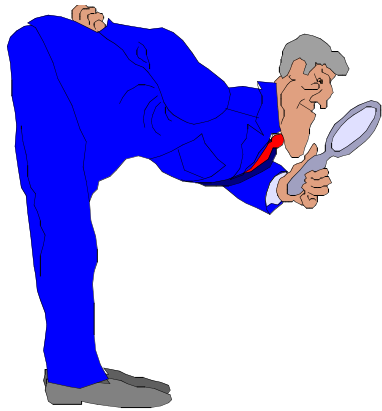
10.) Occupant complaint/response system (implement one)

# IAQ Diagnostics

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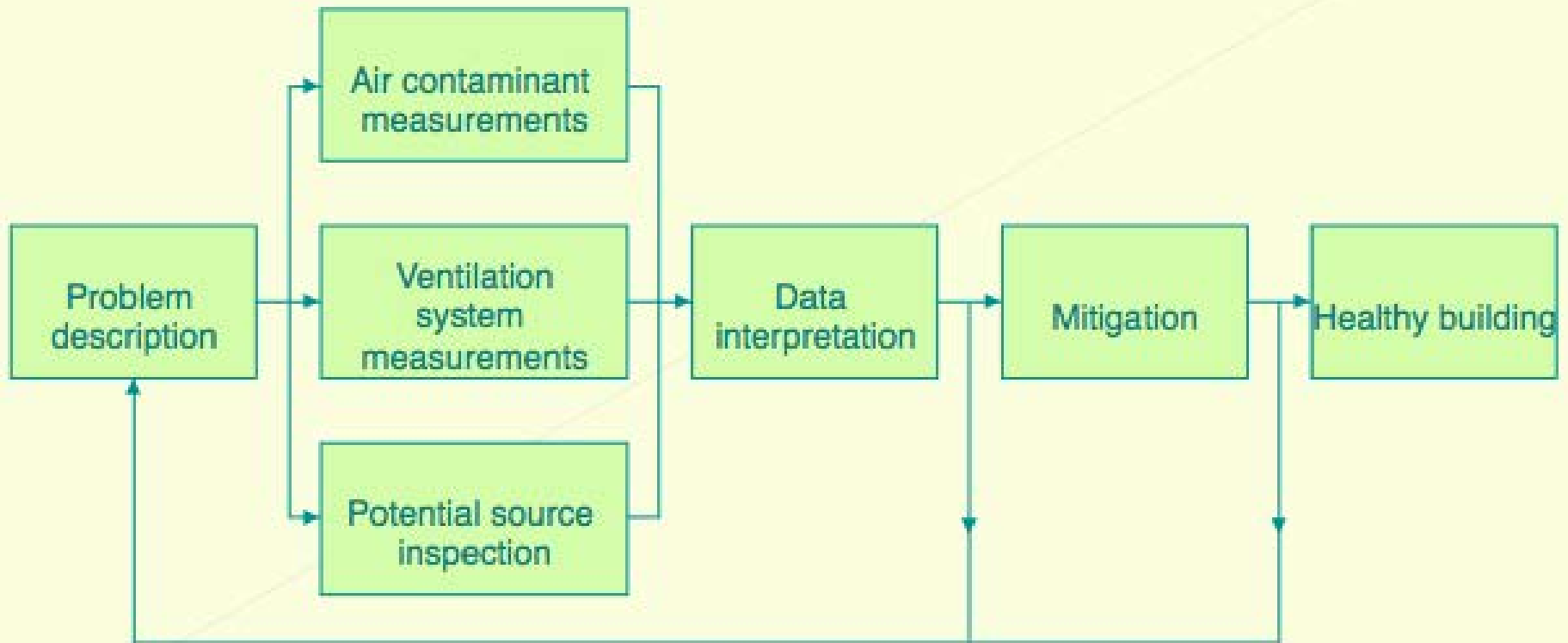
The main and essential TOOL for ALL types of IAQ investigations is a rational

## INVESTIGATIVE PLAN.



# IAQ Investigative Plan

## INVESTIGATIVE PLAN for Reactive Investigations- Occupant Complaints



# Cost of Ventilation

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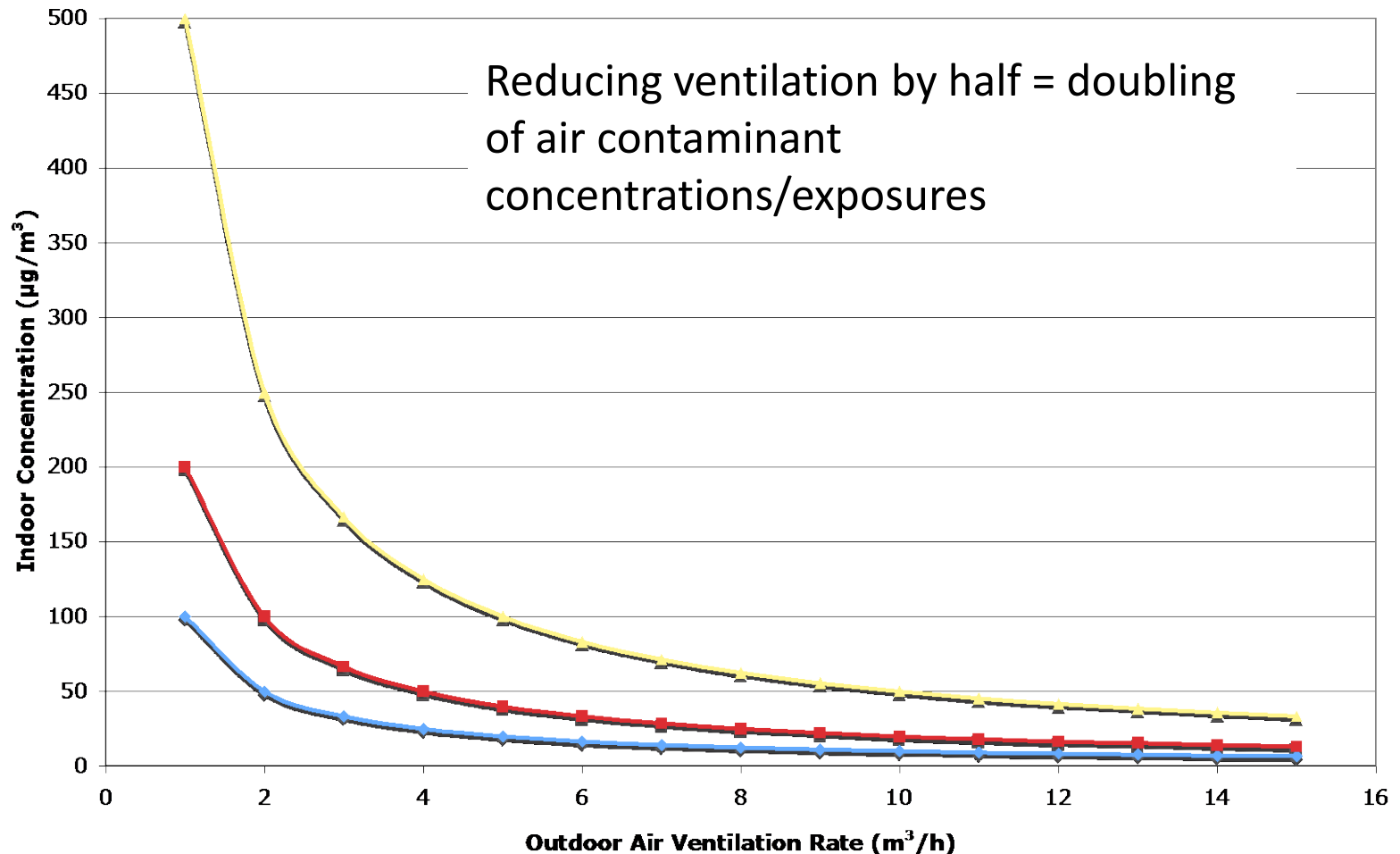
## Annual Cost of Ventilation

\$1 - \$2 /cfm for one year of operation  
(climate dependent)

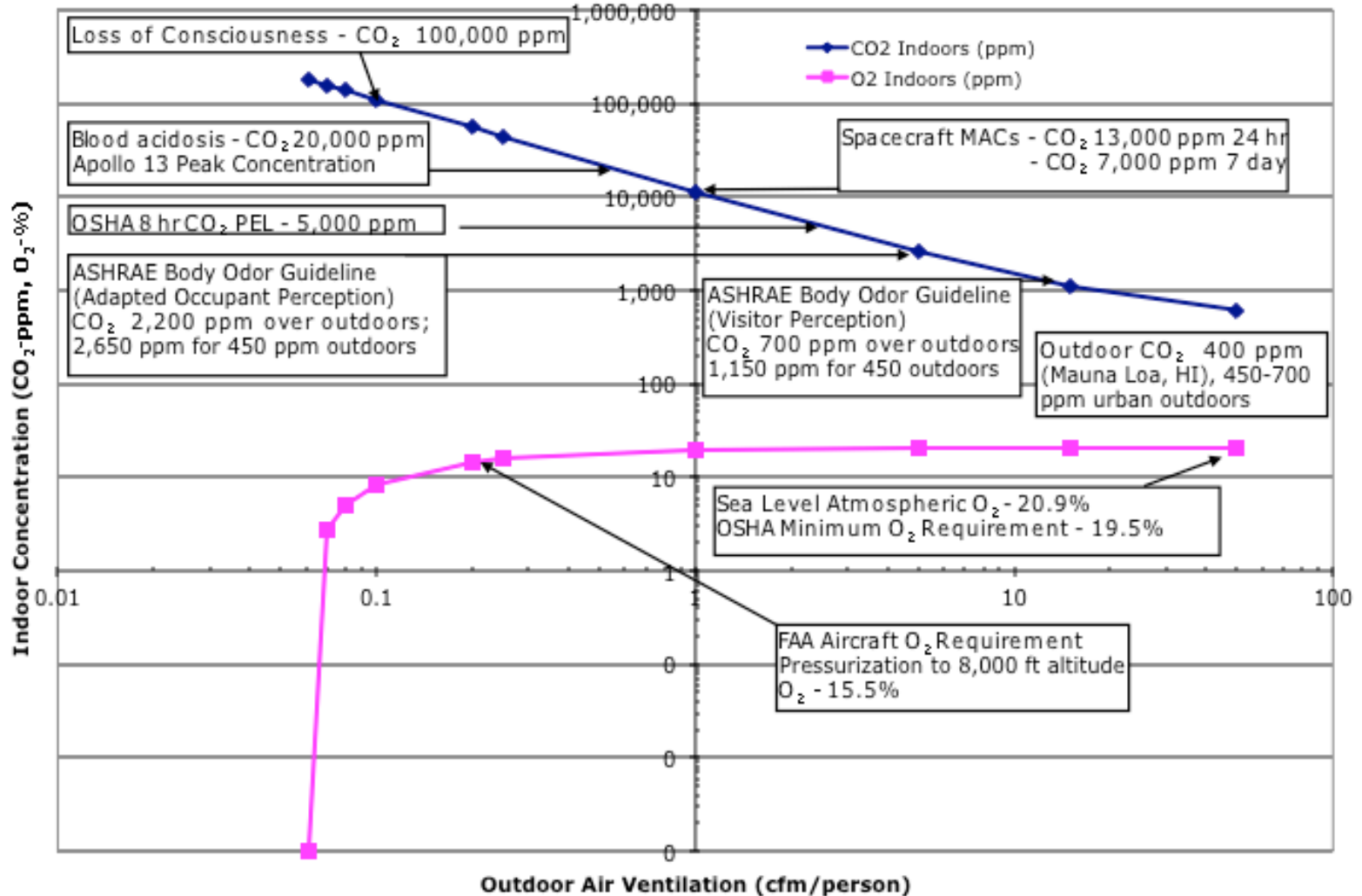
\$15 - \$40/occupant for one year of operation

# Ventilation and IAQ

**Diminishing Impacts of Increased Ventilation  
Constant Indoor Air Contaminant Emission Rates**



# Ventilation



# Ventilation

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## Ventilation *versus* Source Control

To quote the great German chemist and hygienist, Max Joseph von Pettenkofer (1818-1901)

*“If there is a pile of manure in a space, do not try to remove the odor by ventilation. Remove the pile of manure.”*

# Measuring IAQ - Defining Safe Indoor Air

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Starfleet Tricorder  
circa 2268

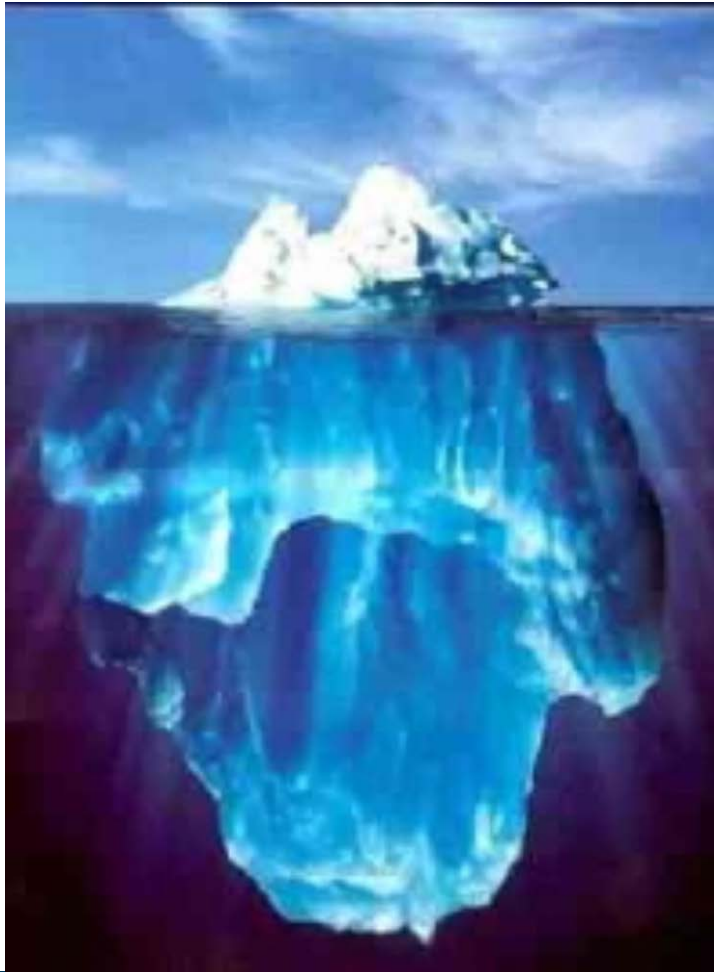


TR-590 Tricorder  
circa 2370





# Measuring IAQ - Defining Safe Indoor Air



Tip of the Iceberg Capabilities  
Measurable and have health  
based exposure data.

Measurable and have NO  
health based exposure data.

Not Measurable

# Measuring IAQ - Defining Safe Indoor Air

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At this time, we can NOT determine if indoor air is safe through air contaminant measurements.

Fortunately, there is another way.

# Creating Healthy Buildings

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We can best pursue “Safe Air” through minimization of known IAQ “Risk Factors”.

# IAQ Risk Factors

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IAQ Risk Factors by themselves:

- do not constitute evidence that the building air is NOT safe.
- are known to increase the risk of unsafe building air.

# IAQ Risk Factors

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## Some IAQ Risk Factors

- air temperature too warm ( $> 74$  °F = perception of stuffy and lack of ventilation)
- inadequate supply of outdoor air
- visible moisture condensation (e.g. mold)
- odors (e.g. mold, ETS, chemicals)
- concentrations of mold spores higher indoors than outdoors

# IAQ Risk Factors

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## Some IAQ Risk Factors

- concentrations of carbon monoxide less than exposure guidelines (i.e. 9 ppm), but higher than outdoors
- surface accumulations of dust (especially glass fibers)
- evidence of pest infestations
- elevated carbon dioxide concentrations (>1,000 ppm)

# IAQ Risk Factors

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## Some IAQ Risk Factors

- negative indoor pressure to outdoors (e.g. sick buildings suck, healthy buildings blow).
- elevated concentrations of total volatile organic compounds (TVOC) - greater than 1,000  $\mu\text{g}/\text{m}^3$ .

# Healthy Building Credo

## Don'ts

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Do NOT :

- use air cleaners/purifiers that are electrostatic, use UV light, produce ozone or negative ions.
- use air fresheners
- spray pesticides indoors
- allow chronic dampness (dry within 48 hours)



# Healthy Building Credo

## Do's

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Buildings should be designed and operated to be:

- DRY
- CLEAN
- ODOR FREE
- WELL VENTILATED (minimum of 15 cfm/occupant)
- LOW MATERIAL CHEMICAL EMISSIONS (see High Performance Products Database at <http://www.chps.net>)

# Chemical Emission Test Chambers



# Health versus Energy

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- Buildings need to be, first and foremost, built to provide healthy environments, while striving for energy efficiency and sustainability.

Bottom line: **HEALTH TRUMPS ENERGY.**

We can have BOTH healthy and energy efficient sustainable homes, through use of:

- energy efficient heat recovery ventilation systems
  - selection of low emitting building materials.
- Build **TIGHT** - Ventilate **RIGHT.**

# ??? QUESTIONS ???

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