

AIR QUALITY

We all hear about air quality, but what does that mean?

or

Does outdoor air make indoor air bad?

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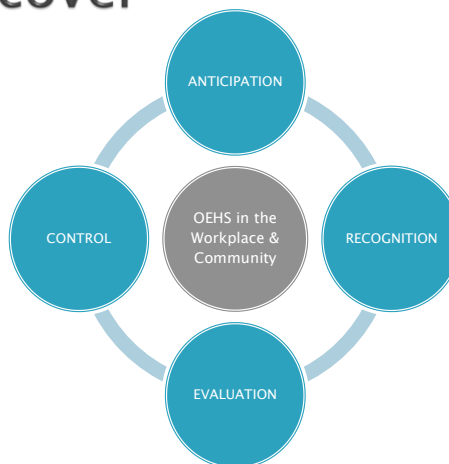
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What we plan to cover

- ▶ Air quality basics
 - Outdoor & indoor
 - Health effects
- ▶ Monitoring outdoor & indoor air quality
- ▶ Control & mitigation of poor air quality
- ▶ Challenges in today's
Volatile,
Uncertain,
Complex,
Ambiguous world



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What Makes Air Bad

Air pollutants are airborne particles and gasses that occur in concentrations that endanger the health and well-being of organisms or disrupt the orderly functioning of the environment.



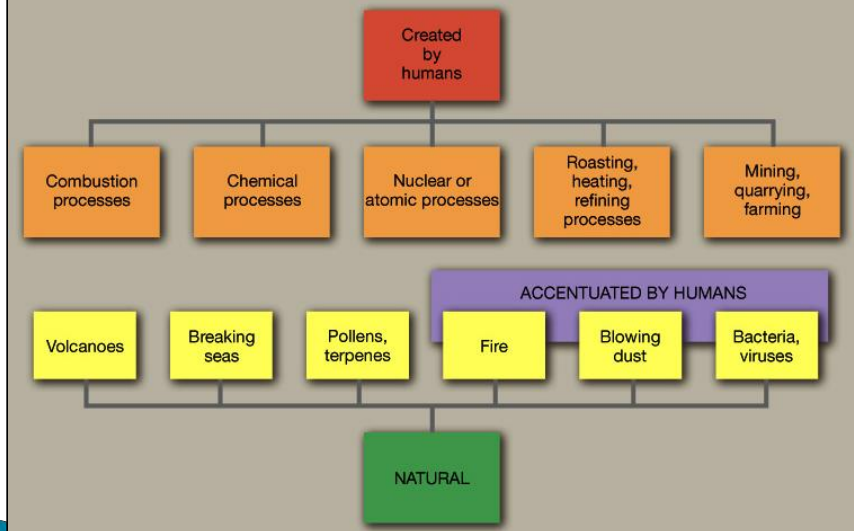
PRIMARY POLLUTANTS

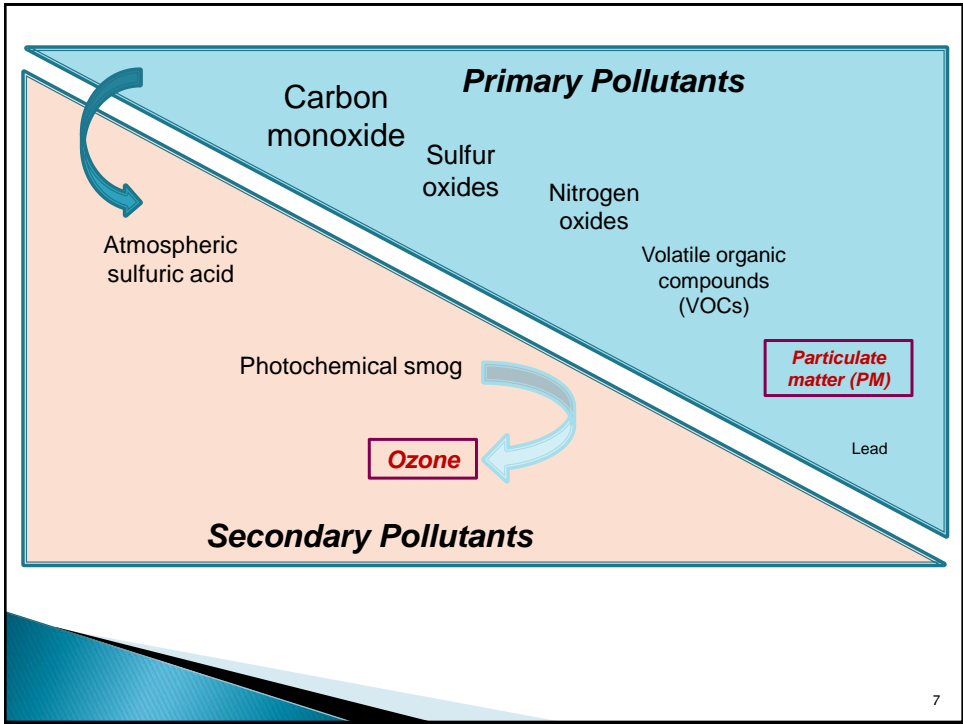
Emitted directly from identifiable sources

SECONDARY POLLUTANTS

Produced in the atmosphere when certain chemical reactions take place among primary pollutants.

SOURCES OF PRIMARY POLLUTANTS





PARTICULATE MATTER: WHAT IS IT?

A complex mixture of extremely small particles and liquid droplets.


HUMAN HAIR
50-70 μm
(microns) in diameter

FINE BEACH SAND
90 μm
(microns) in diameter

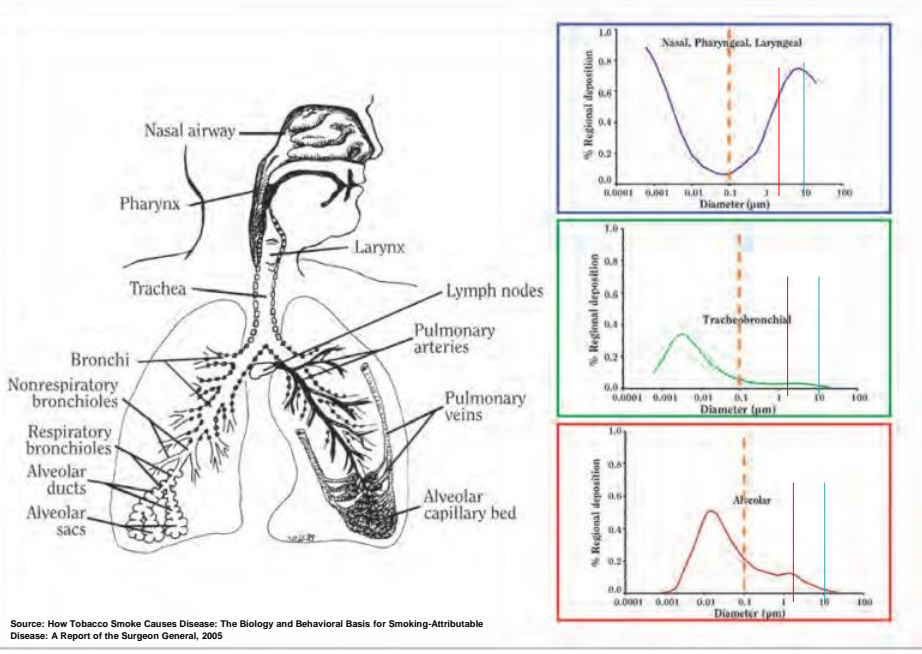
PM_{2.5}
Combustion particles, organic compounds, metals, etc.
< 2.5 μm (microns) in diameter

PM₁₀
Dust, pollen, mold, etc.
< 10 μm (microns) in diameter

Image courtesy of the U.S. EPA



Why does size matter?



Wood-Burning Stoves **Power Plants** **Forest Fires**

Industrial Sources **Fine and Coarse Particles Can Be Emitted Directly or Formed in the Air from Gases** **Heavy Duty Diesel Engines**

Non-Road Vehicles **Natural Sources** **Cars and Trucks**

Ozone and particle pollution



Can cause eye, nose & throat irritation



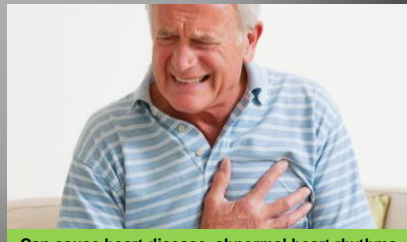
Can cause coughing & difficulty breathing



Can trigger asthma attacks



Can affect the development of children's lungs



Can cause heart disease, abnormal heart rhythms, congestive heart failure, stroke, & premature death

Acceptable Indoor Air Quality

ASHRAE 62.1-2022: Air in which there are *no known contaminants at harmful concentrations* as determined by cognizant authorities, and a *substantial majority (80% or more) of the people exposed are not expressing dissatisfaction* with air quality.



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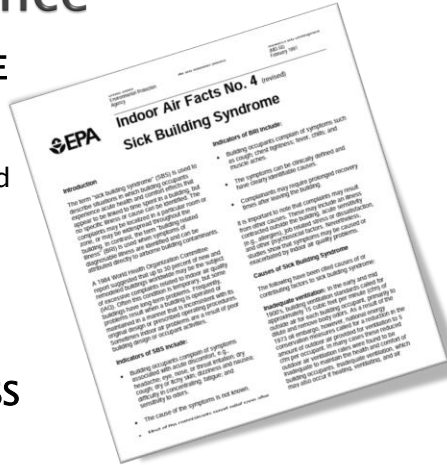
Know the difference

▶ SICK BUILDING SYNDROME (SBS)

- A building that has a large number of complaints derived from occupants.
- Complaints *may not be clinically diagnosed or medically verified*

▶ BUILDING RELATED ILLNESS (BRI)

- When the *illness is diagnosable*.



Source: EPA Indoor Air Facts No. 4, Sick Building Syndrome, 1991

Cause & effect?

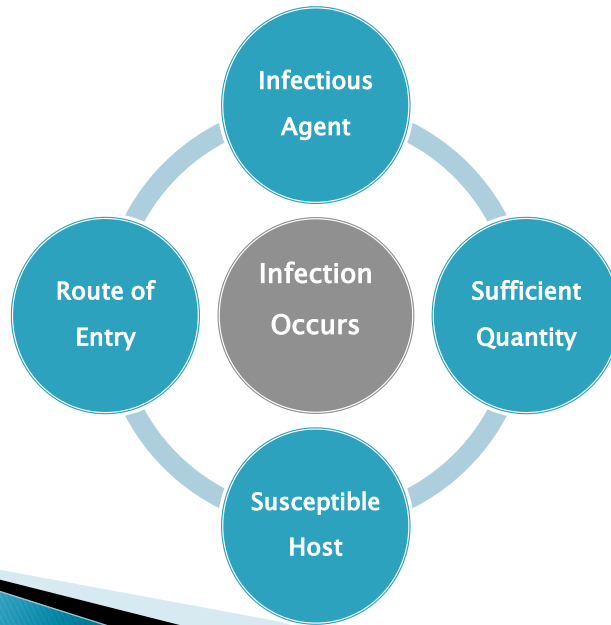
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|----------------------------|--------------------------------|
| ▶ Air temperature | ▶ Headache |
| ▶ Radiant temperature | ▶ Fatigue |
| ▶ Relative air velocity | ▶ Shortness of breath |
| ▶ Relative humidity | ▶ Sinus congestion |
| ▶ Indoor pollution sources | ▶ Cough |
| ▶ Moisture | ▶ Sneezing |
| ▶ Intrusion & infiltration | ▶ Skin irritation |
| ▶ Outdoor air quality | ▶ Dizziness |
| ▶ Occupant health | ▶ Nausea |
| | ▶ Eye, nose, throat irritation |
| | ▶ Chronic disease |

Indoor Environment Variables

Reported Health Effects

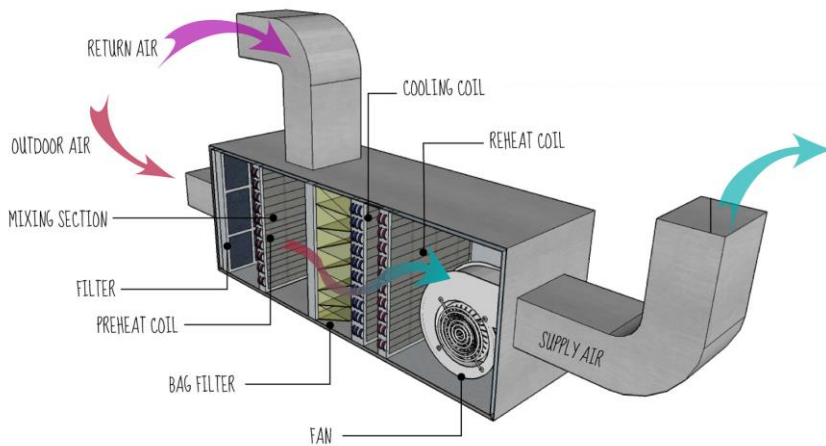
NIOSH studies have shown that *over 50%* of the complaints in a building are in some way related to the heating, ventilating and air conditioning system (HVAC)

Disease Transmission Basics



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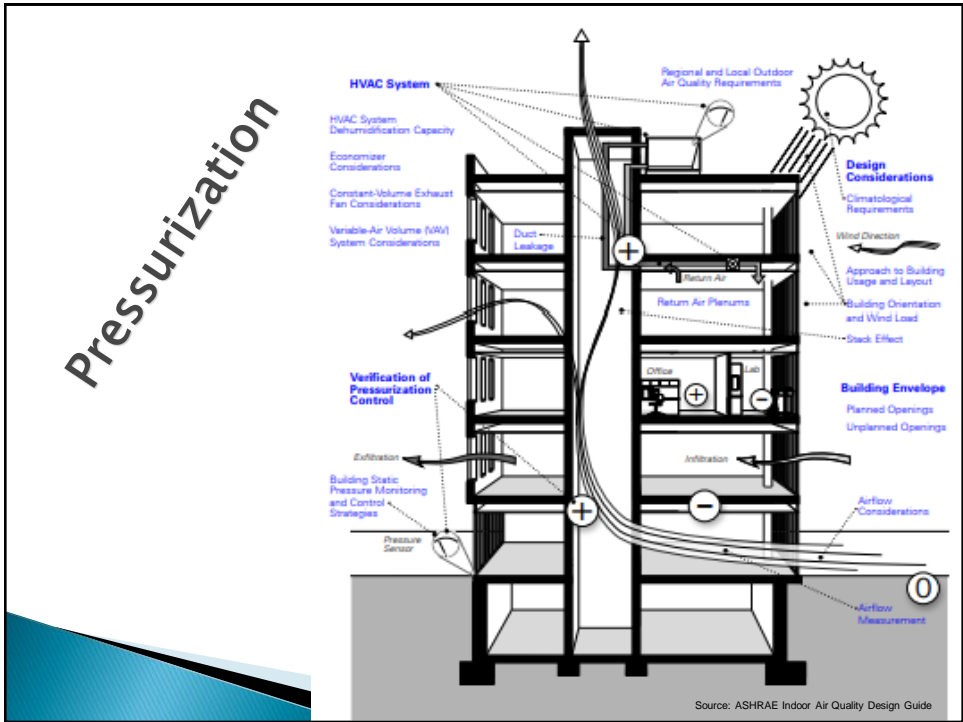
THE HVAC SYSTEM (simplified)



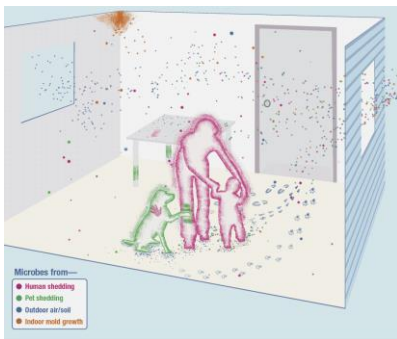
Source: Fanturk.org

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Pressurization



Monitoring - why?



- ▶ Sources
 - Indoor & outdoor
- ▶ Ventilation
 - Sufficient ventilation
 - Moisture control
- ▶ Clean air
 - Contaminant removal

Monitoring – how?

Source	Ventilation	Clean air
<ul style="list-style-type: none"> ▶ Inventory/visual <ul style="list-style-type: none"> ◦ Asbestos ◦ Carbon monoxide ◦ Formaldehyde ◦ Lead ◦ Nitrogen dioxide ◦ Pesticides ◦ SHS/ETS ◦ Water intrusion/mold growth ▶ <i>Testing??</i> 	<ul style="list-style-type: none"> ▶ Visual inspection <ul style="list-style-type: none"> ◦ HVAC component maintenance ◦ Filters ◦ Condensation trays/pans ◦ Ductwork ▶ Carbon dioxide ▶ Temperature ▶ Relative humidity ▶ Air flow velocity & volume ▶ Directional air flow 	<ul style="list-style-type: none"> ▶ Particulates ▶ Vapor intrusion ▶ Radon ▶ Inventory outdoor sources ▶ Outdoor air quality <div style="text-align: center;"> <p>Good Moderate Unhealthy for Sensitive Groups Unhealthy Very Unhealthy</p> </div>

Control & mitigation

- ▶ Sources → Eliminate individual sources of pollution or to reduce their emissions
 - Indoor & outdoor

- ▶ Ventilation → Increase the amount of outdoor air coming indoors; maintain acceptable humidity levels
 - Sufficient ventilation
 - Moisture control

- ▶ Clean the air → Effectiveness depends on how well it collects pollutants from indoor air and how much air it draws through the cleaning or filtering element.
 - Contaminant removal

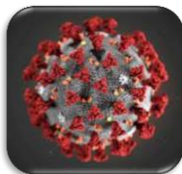
EPA: For most indoor air quality problems, source control is the most effective solution.

Pandemic Discussion – HVAC

▶ Filtration

- MERV 13,14 Filters (Pressure Drop)
- Carbon filters
- Polarized Media Air Cleaners
- Ultraviolet

Challenges in a VUCA world



COVID



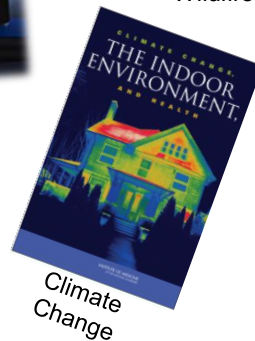
Floods



Power Outages



Wildfires



Climate Change

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Got Questions?

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