

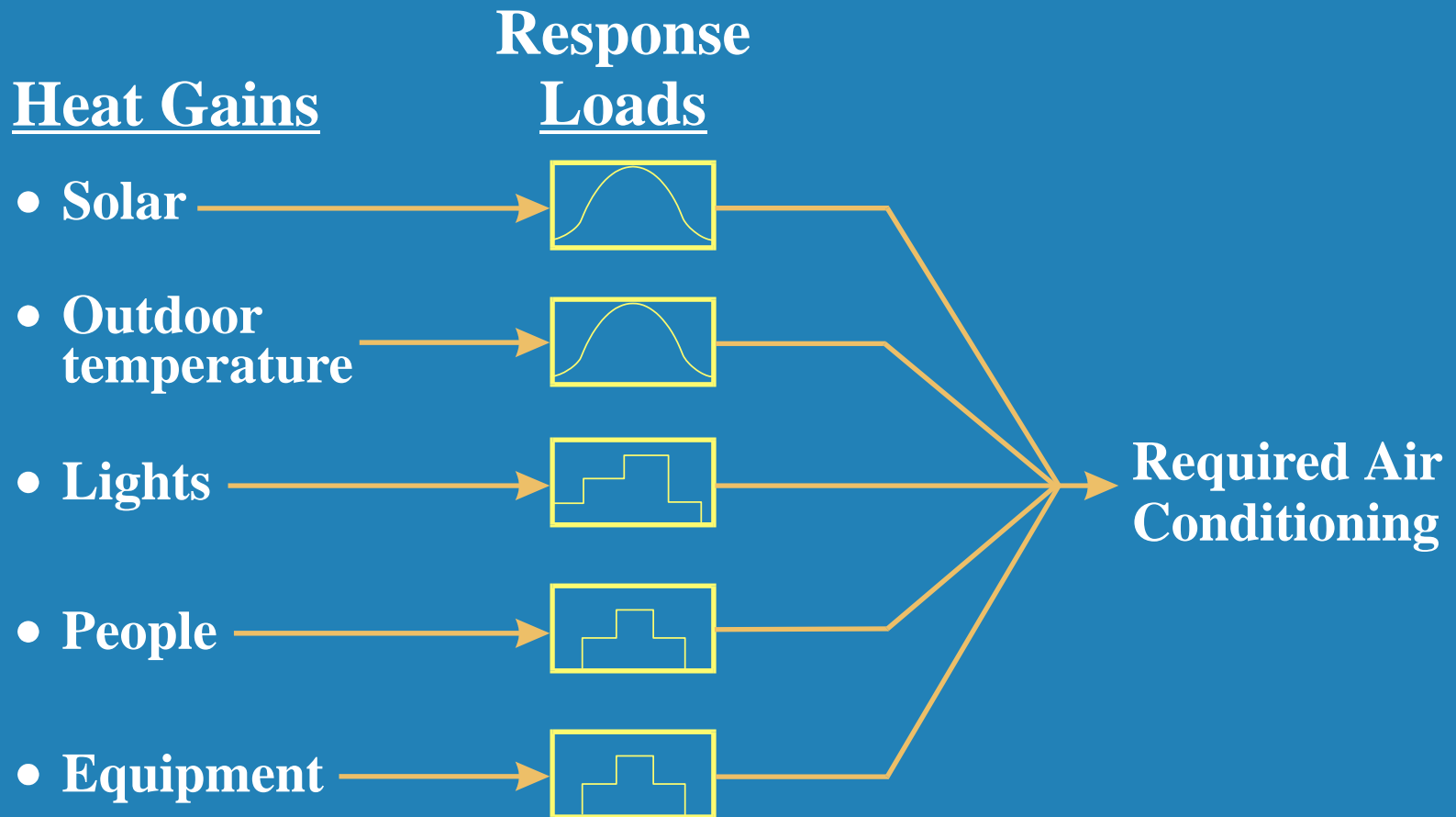
HVAC Systems and Indoor Air Quality

Douglas K. Spratt, M.Sc., P.Eng.

The 5 Senses

	Architecture	Electrical	Structural	Mechanical
Hearing	●			●
Seeing	●	●		
Smelling				●
Feeling			●	●
Tasting				

HVAC Systems are Dynamic





Presentation Agenda

- e Why We Have HVAC Systems
- e Definitions
- e HVAC Control Strategies
- e HVAC Pollutant
- e HVAC Systems

The Purpose of HVAC Systems



HVAC = Artificial Environment

The IAQ Lexicon

e Acceptable IAQ:

1. No known contaminants of harmful Concentration (*objective*)
2. >80% people satisfied with air quality (*subjective*)

e Sick Building Syndrome:

1. > 20% people complaining over 2 weeks
2. Symptoms only occur when in building

Ñ Headaches

Ñ Fatigue

Ñ Nausea

Ñ Eye irritation

Ñ Throat irritation

More Definitions

- e cfm: cubic feet per minute (flow rate)
cfm/person - usually refers to *outdoor* air
- e ACH: Air Change Rate (per hour)

Example:

Office 10' x 10' x 8' high, with one person

Supply air = 120 cfm

Outdoor air = 20% of S/A = 24 cfm/person

Air change = $(120\text{ft}^3/\text{min}) \div (10 \times 10 \times 8) \times 60 \text{ min/h}$
= 9 ACH



More Definitions

- e Conscienceness: that annoying state in between naps.
- e Dopelar effect: the tendency of stupid ideas to seem smarter when you come at them rapidly.



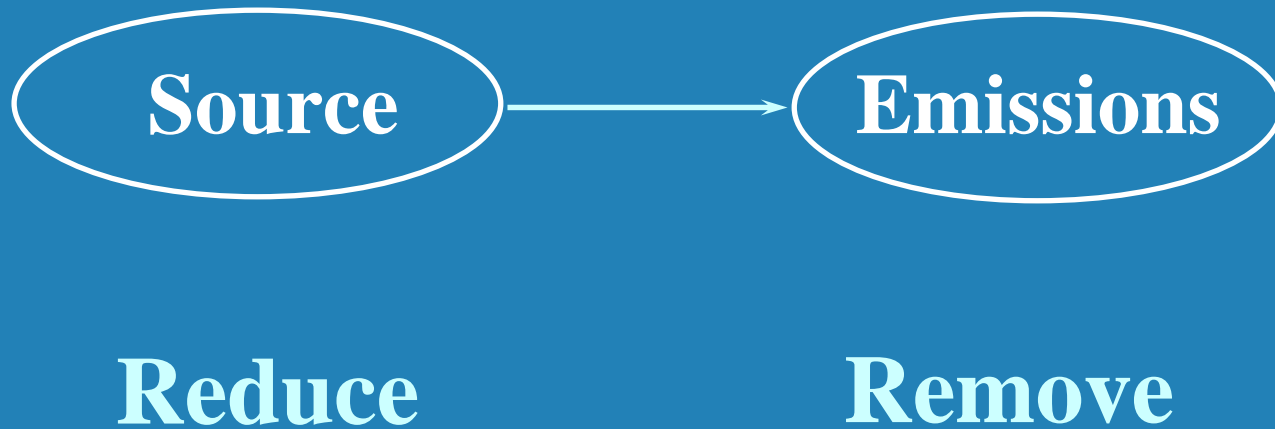
HVAC Control Strategies

e Outline

- Ventilation
- Air Cleaning
- Humidification

Ventilation

- removes emissions



A decorative vertical ribbon on the left side of the slide, featuring a blue and green gradient and a small white sphere near the top.

Two Contaminant Control Strategies

1. Source Extraction
2. Dilution



Source Extraction

e When?

- e Design
- Velocity (100 fpm)
 - Minimize Working Exposure
 - Make Up Air



Two Dilution Methods

1. Natural

- Operable Windows
- Infiltration

2. Mechanical

- Exhaust
- HVAC relief air and outdoor air



Natural Ventilation

- e Advantages
 - Low 1st Cost
 - Low Maintenance
 - Natural ("green")



Natural Ventilation

e Disadvantages

- Limited to Low Occupant Densities
- Limited to Mild Climates
- Poor Distribution
- Uncontrollable factors



Natural Ventilation

e Design

- Cross Drafts
- Stack Effects
- Hybrid Systems



Mechanical Ventilation

- e How much?
- e Depends on:
 - Type of Pollutants
 - Emission Rates
 - Ventilation Effectiveness

How Much Ventilation?

- e ASHRAE Standard 62-89:
 - cfm O/A per person
 - or go “scientific”
- e Proposed Revision to 62-89
 - o cfm/person + cfm/ft²
 - o i.e., people + building
- e Other approaches:
 - o Olf (the nose test)
 - o exposure limits



People & Pollution

- e Some emission rates correlate to people's activities
- e People consume oxygen
- e People can have diseases which are air borne
- e Carbon dioxide (CO₂) levels *can* be an indicator of overall indoor air quality

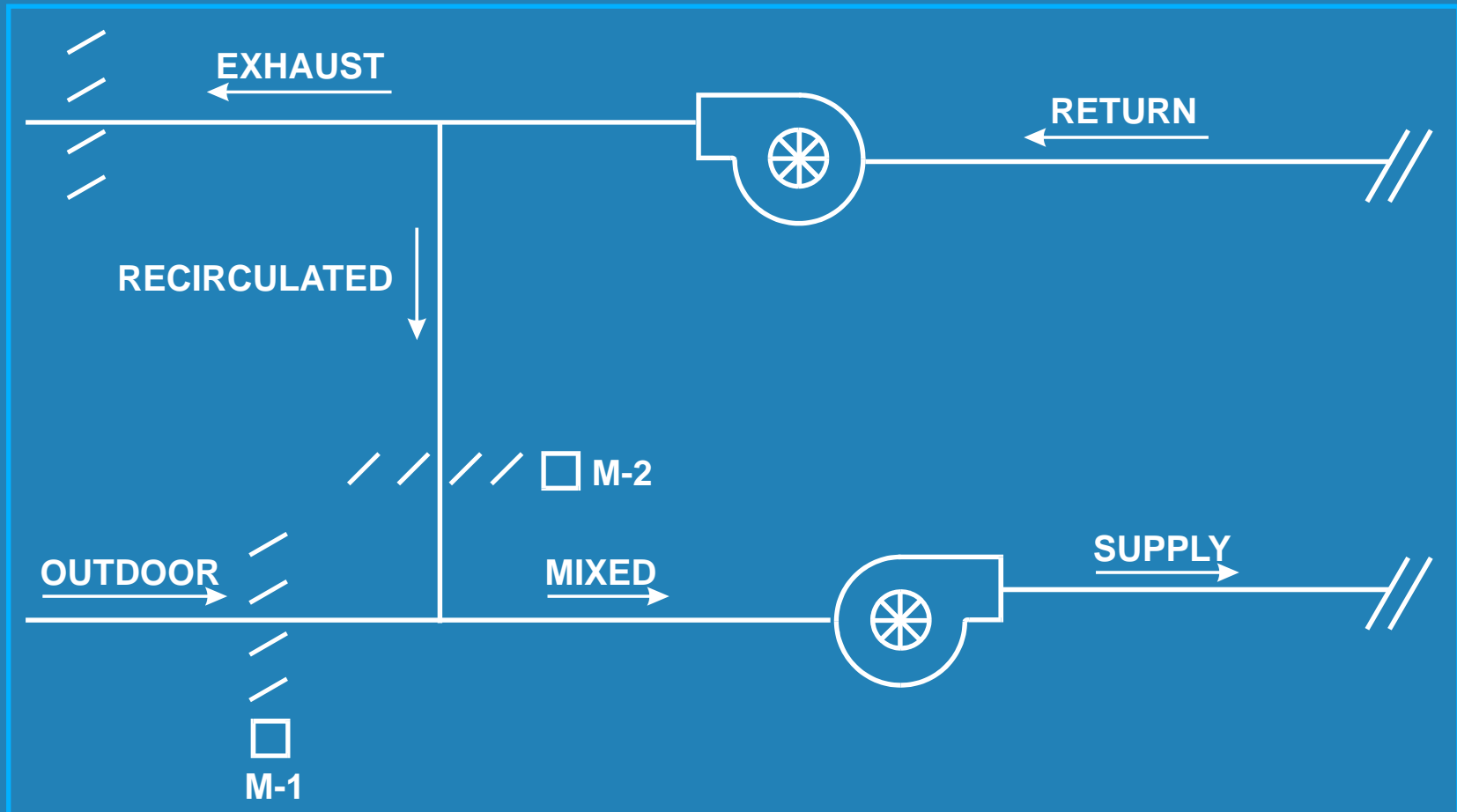


Mechanical Ventilation

e Methods

- Exhaust Fan
- Exhaust With Make-Up Air
- Mixed Supply Air
 - Fixed Dampers
 - Modulating Dampers

The Economizer Section



Example

20 ton Roof-top unit

9,000 cfm supply

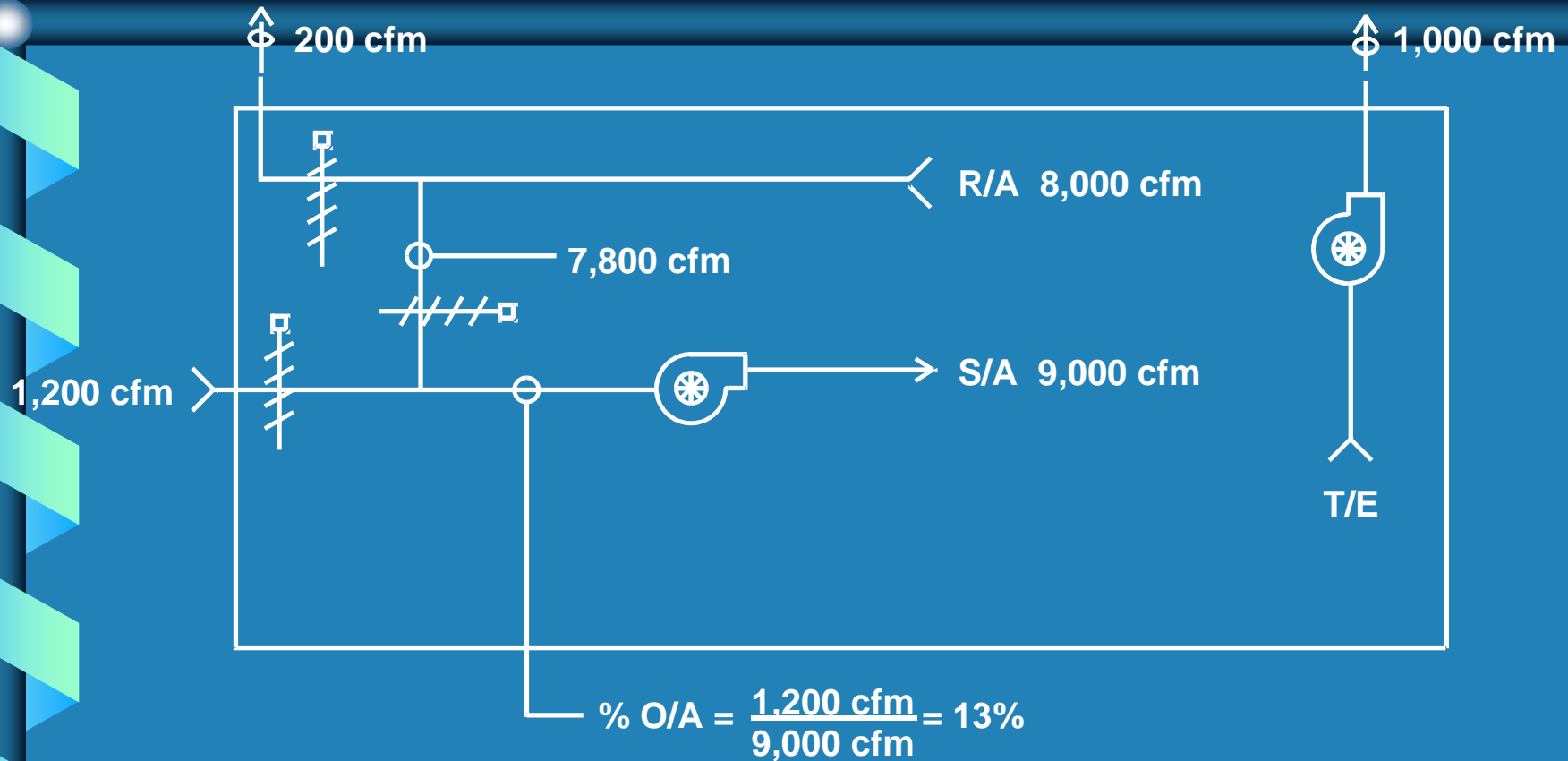
1,000 cfm toilet exhaust

9,000 ft² floor space

Office space with 150 ft²/person

$$\begin{aligned} 62-89 \text{ O/A} &= 20 \text{ cfm/person} \times \frac{9,000 \text{ ft}^2}{150 \text{ ft}^2/\text{person}} \\ &= 1,200 \text{ cfm} \end{aligned}$$

Ignoring Infiltration



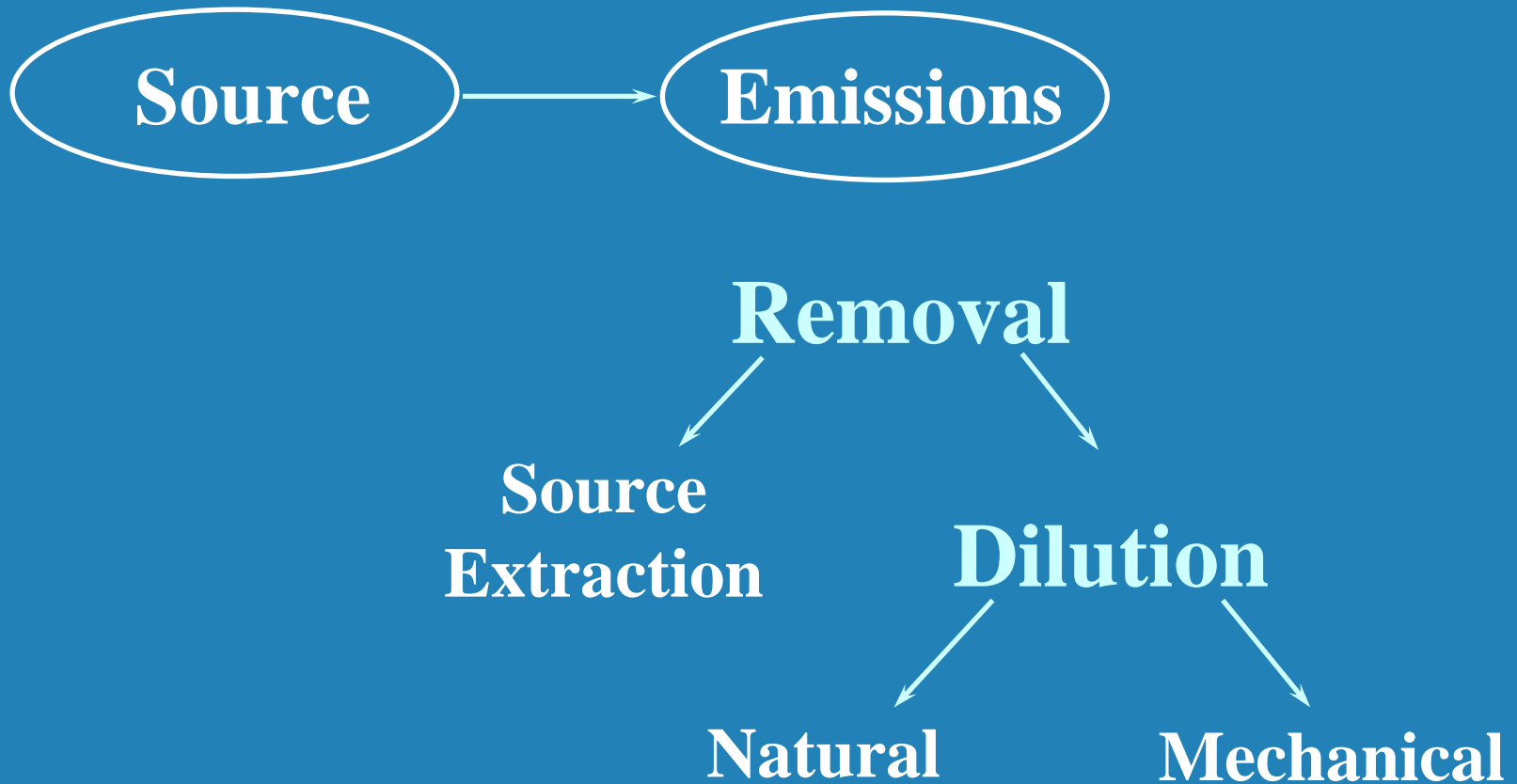


Mechanical Ventilation

e Distribution Effectiveness

- Grilles & Diffusers
- Location

Ventilation Summary

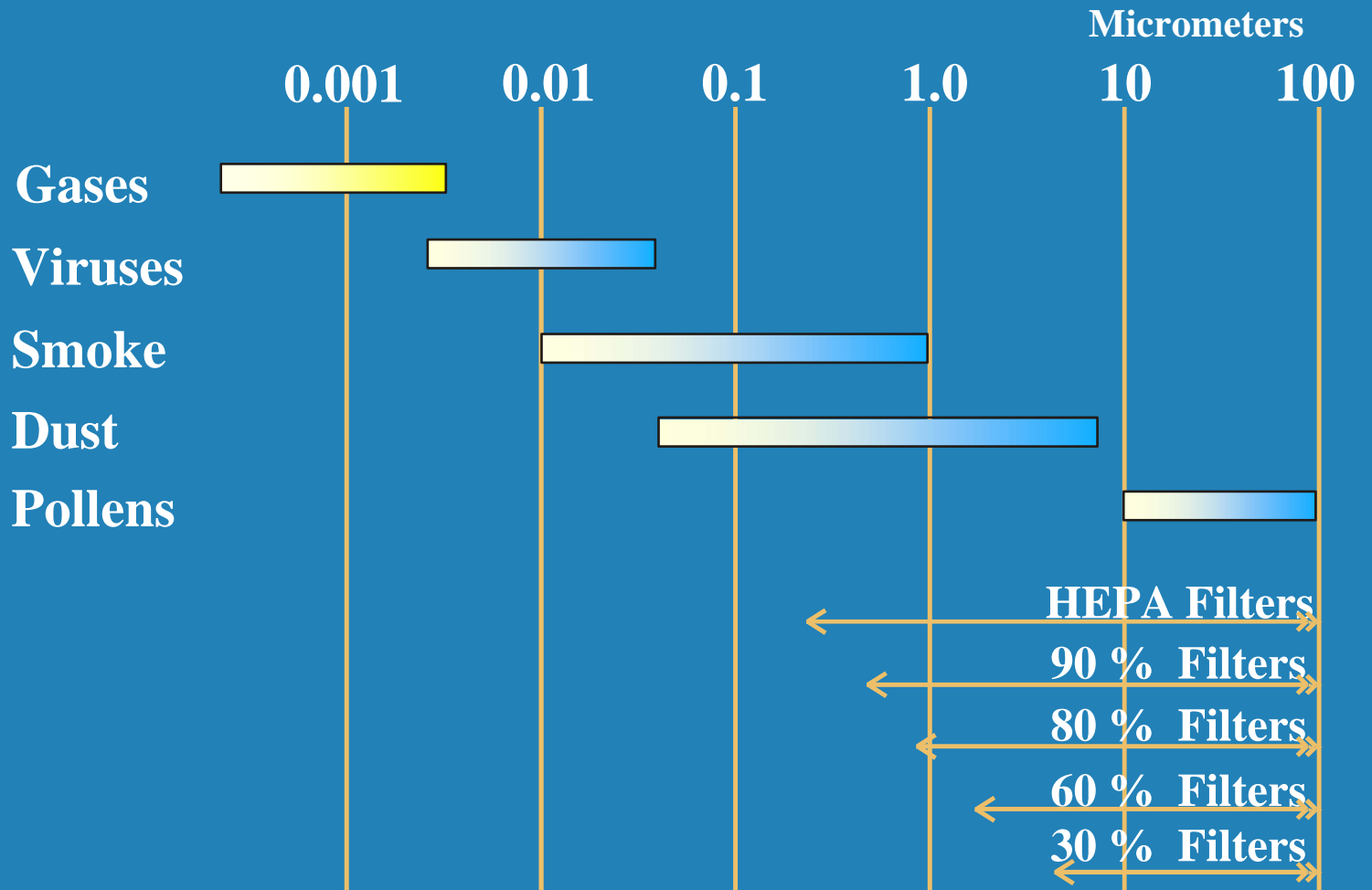


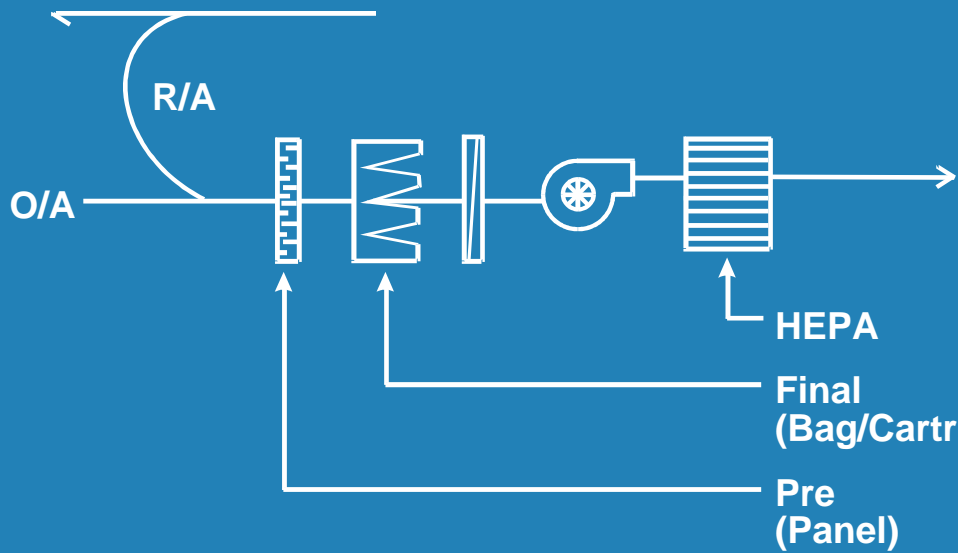


HVAC Control Strategies

- e **Ventilation**
- e **Air Cleaning**

Filters





**ASHRAE 52.1
Test Procedure Efficiencies**

DOP Penetration Test	99.77% @ 0.3 μm
Atmospheric Dust-Spot	60-90%
Atmospheric Dust-Spot	20-30%



Filter Types

- e Standard (panel, pleated, bag, etc.)
- e Electrostatic
- e Sorption



HVAC Control Strategies

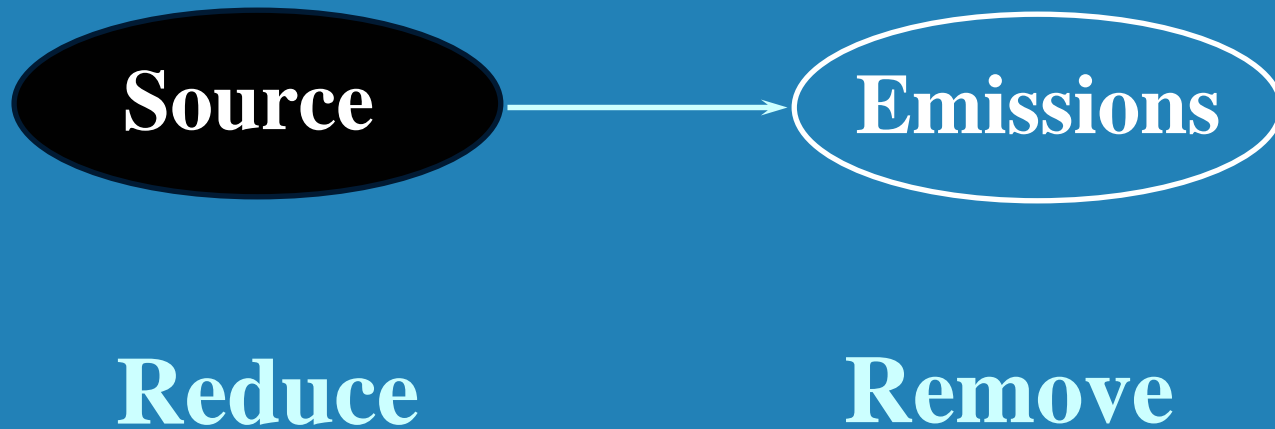
- e **Ventilation**
- e **Air Cleaning**
- e **Humidification**



Humidification

- e Desired Range 30 - 40%
- e Limitations (Covered Later)
- e Means Steam & Water

HVAC Pollutant Sources





Ducts

Sources:

- Acoustic Lining
- Ceiling Plenums
- Tenant Changes
- Dust and Moisture



Ducts

e Strategies

- Inspection
- Cleaning
- Sealing



Intakes

e Proximity to Exhausts:

- Kitchen
- Flues
- Vehicles
- Smokers



Intakes

e Strategies

- Discharge Location
- Terminus
- Velocity



Moisture

e Sources

- Humidifiers
- Cooling Towers
- Cooling Coils
- Uninsulated Ducts



Moisture

e Strategies

- Eliminate
- Treat



Combustion

e Sources

- Faulty Heat Exchangers
- Faulty Flues
- Back Drafting



Combustion

e Strategies

- Inspection
- Testing
- O/A Control