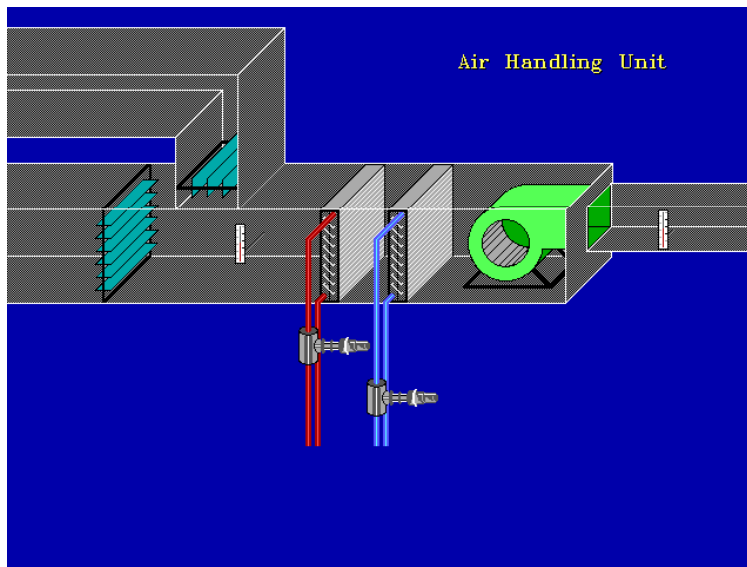# HVAC Systems and Vapor Intrusion

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Harrison, ME/Concord, NH

1-800-439-3446
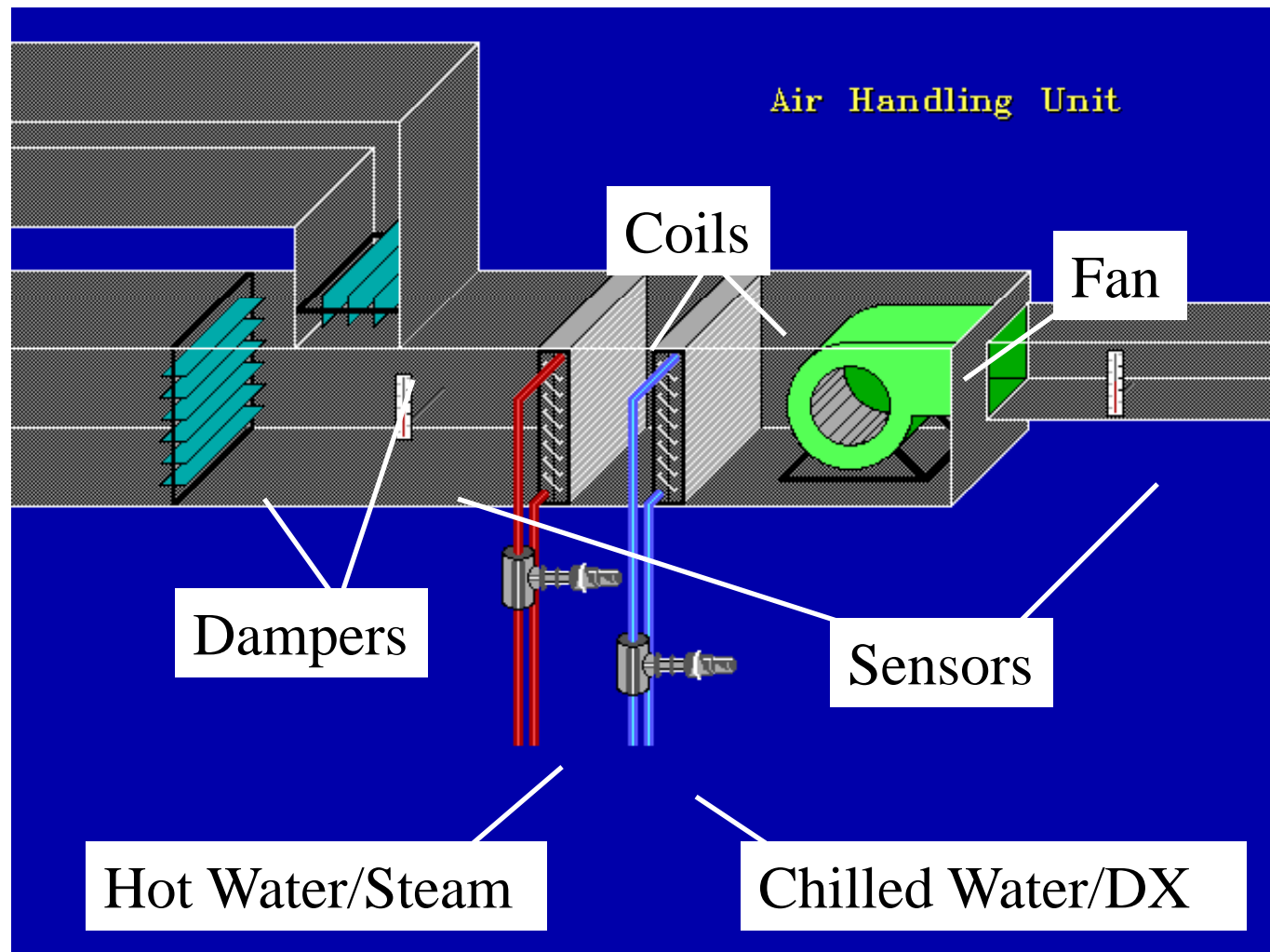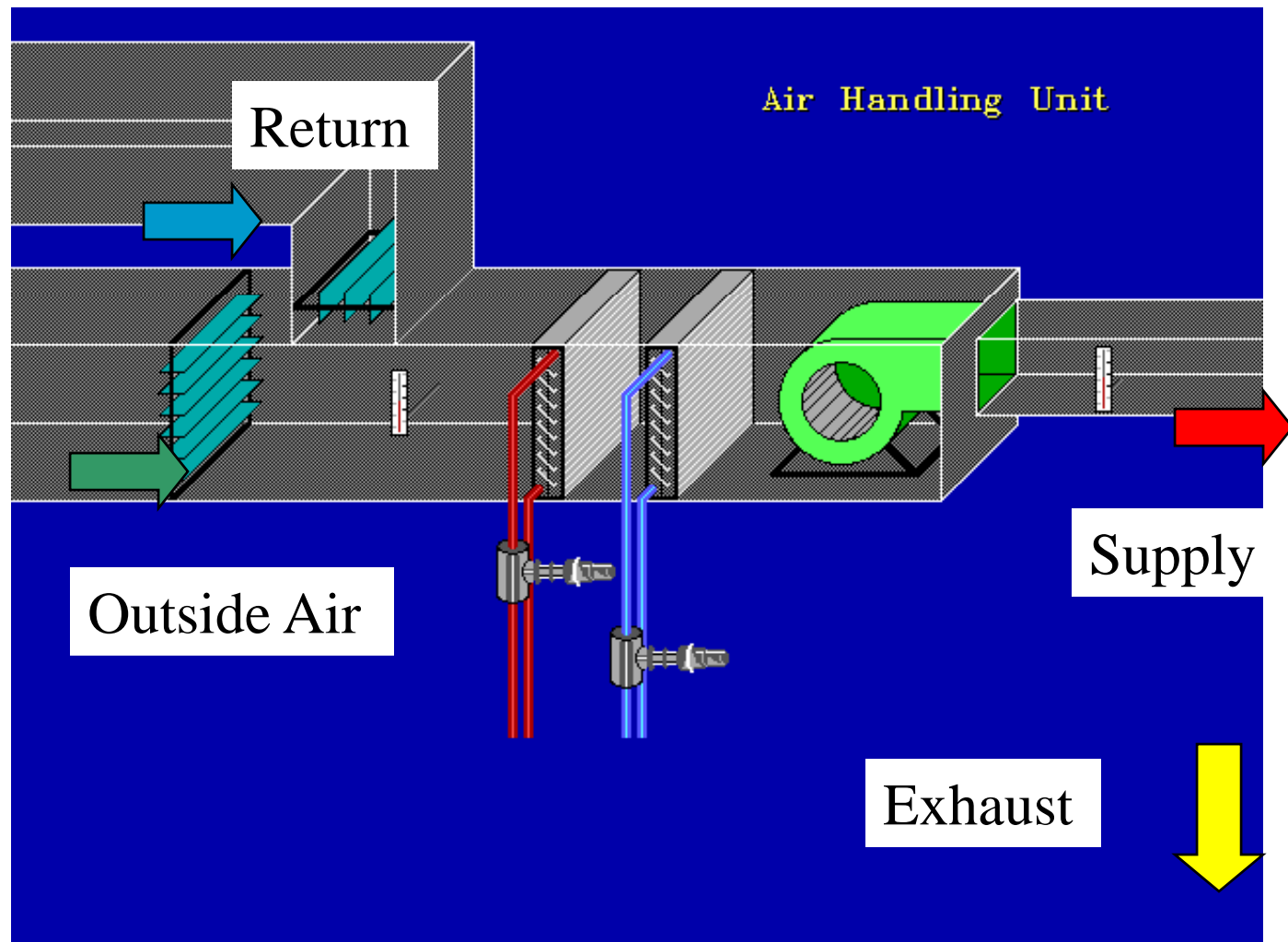
Air Handling System Components

Air Handling Unit

- Fan
- Coils
- Dampers
- Sensors
- Supply
- Return
- Outside Air
- Exhaust

Air Handling System Components

Air Handling Unit

Coils

Fan

Dampers

Sensors

Hot Water/Steam

Chilled Water/DX

Air Handling System Components

Air Handling Unit

Return

Outside Air

Supply

Exhaust

Air Handling System Components

- Fan
  - Moves air, provides +/- pressure
- Coils
  - Heat or cool (temper) air
- Dampers
  - Adjust air flow within ducts
- Sensors
  - Measure conditions in air handling system
 - Temperature, humidity, pressure, CO_2, etc.

Air Handling System Components

- ■ Supply
  - – Air delivered to the occupied space
    - • Positive pressure

- ■ Return
  - – Air from the space directed back to the AHU
    - • Negative pressure

- ■ Outside Air
  - – Ventilation air mixed with return at AHU

- ■ Exhaust
  - – Air removed from the occupied space

Pressure Fundamentals

- Positive Pressure
  - -More Air In Than Out

- Negative Pressure
  - -More Air Out Than In

- Neutral Pressure
  - -Equal Airflows
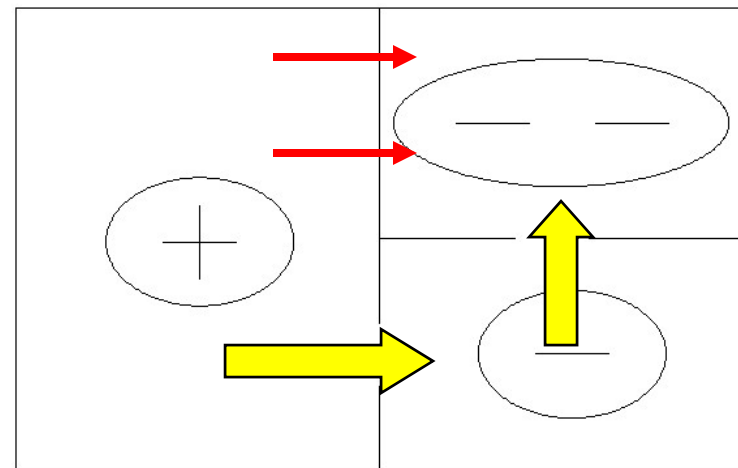
Pressure Fundamentals
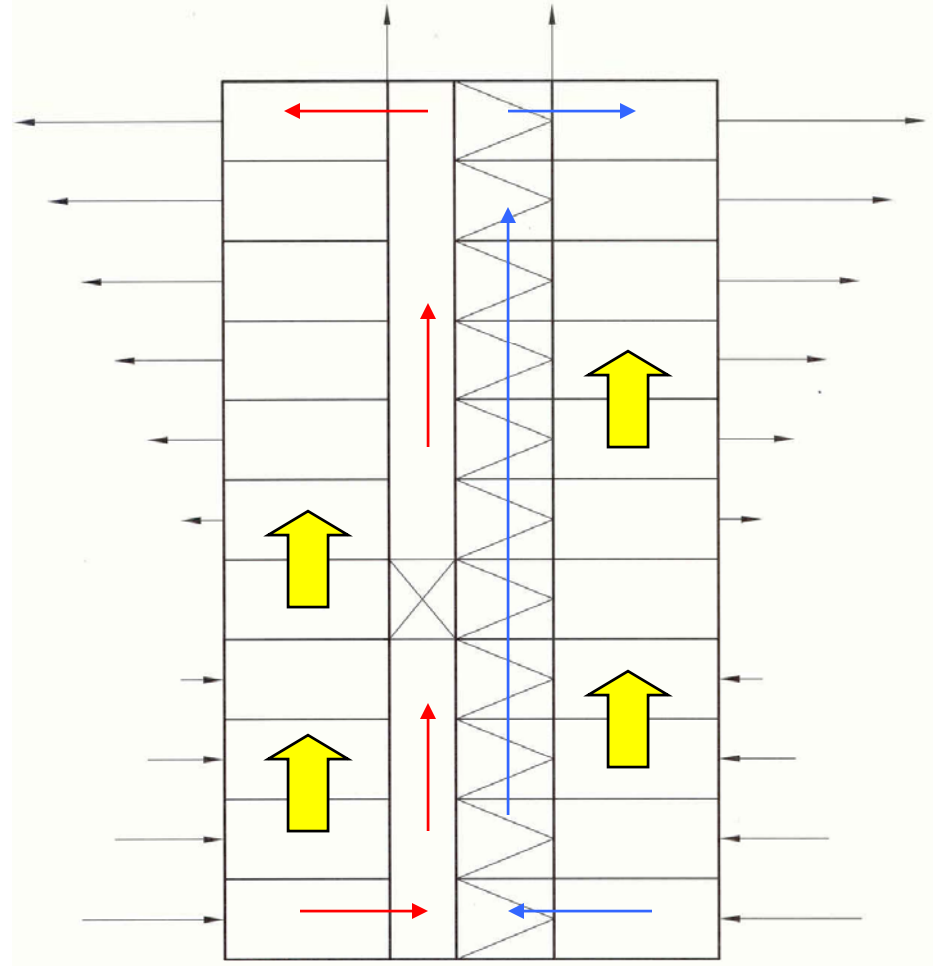
Stack Effect

- Air tends to enter a building at lower levels and exit at upper levels due to convection

- This condition is increased by the presence of connections between lower and upper floors of the building (e.g., shafts)

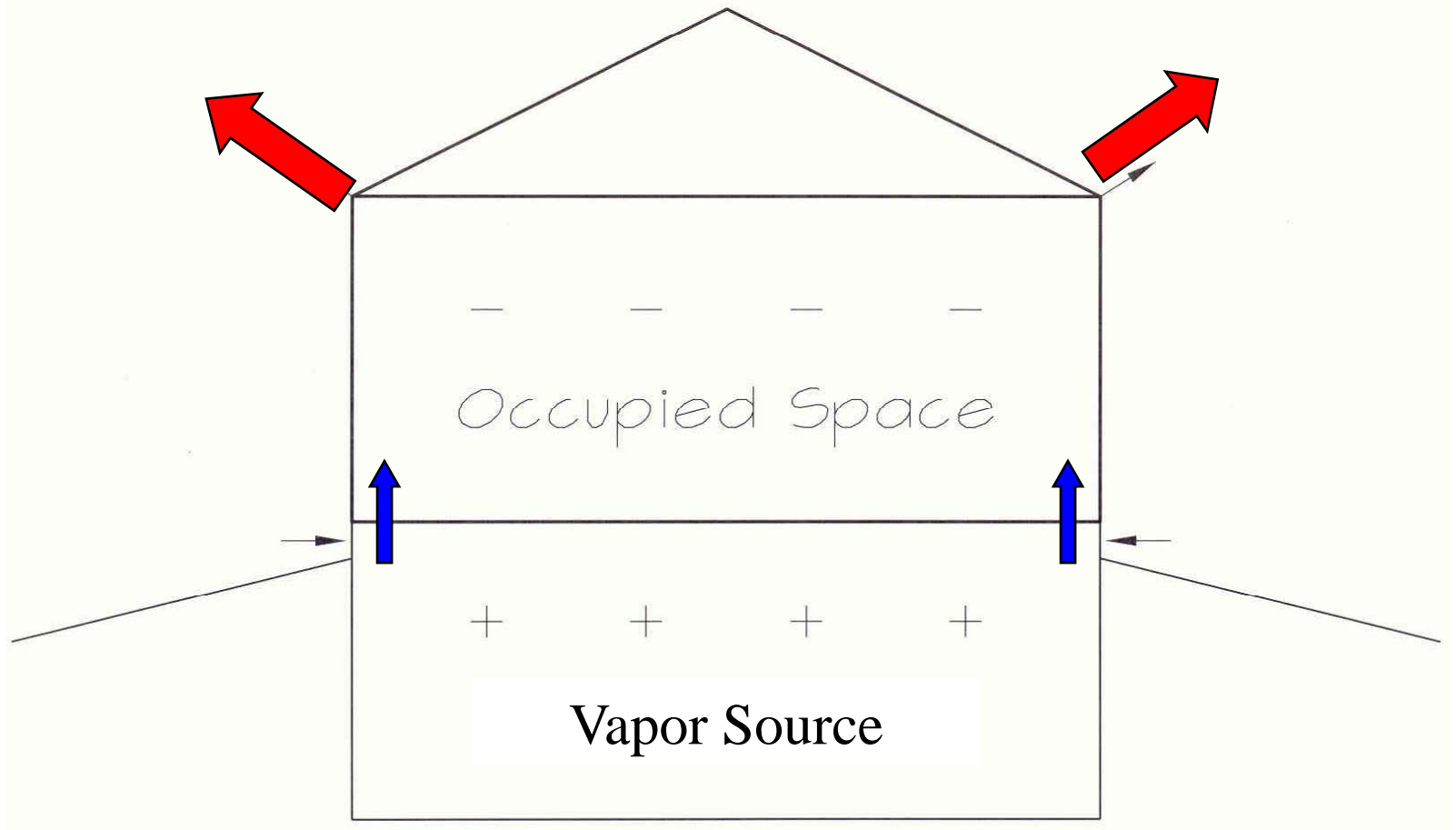- Stack effect is also greater when there are openings at the lower and upper levels

Pressure Fundamentals

- Pressure Conducting Pathways
  - Elevator Shafts
  - Stairways
  - Mechanical Chases
    - Pipe Chases
    - Conduits

Pressure Fundamentals
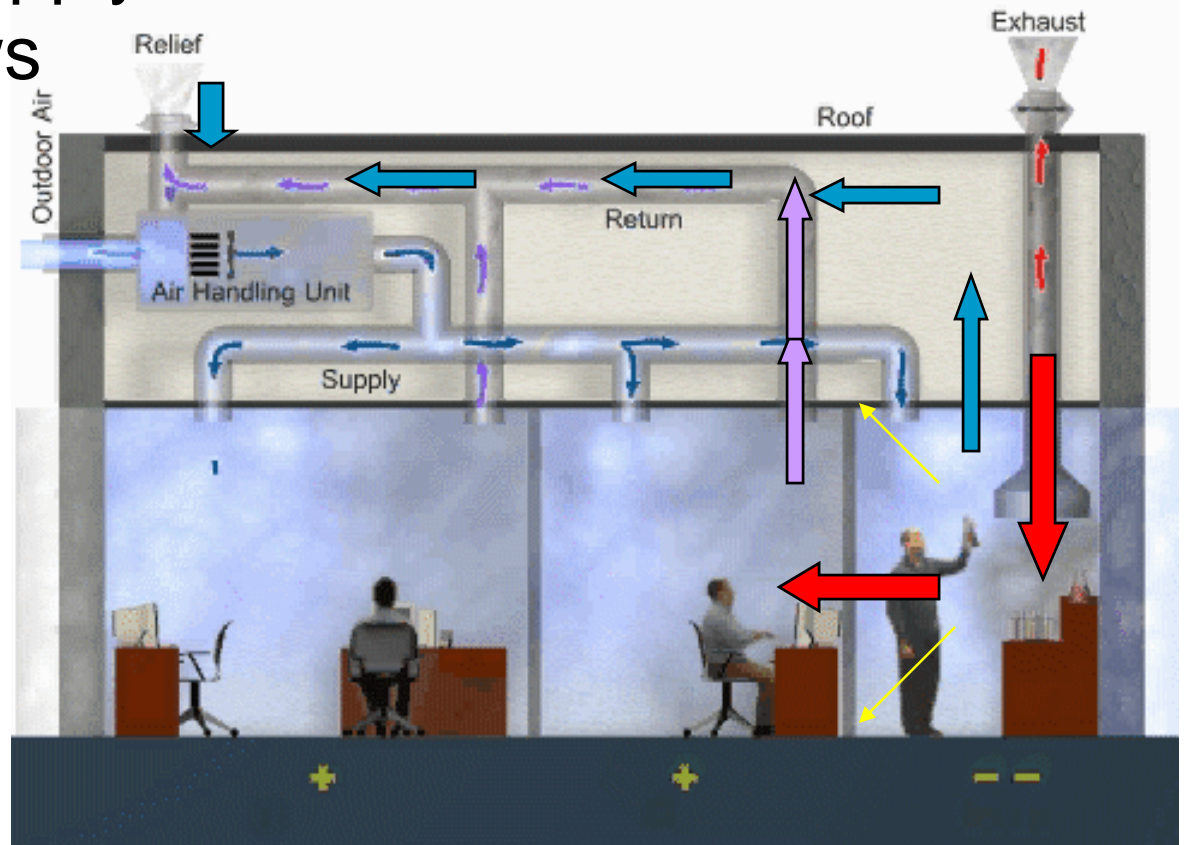
Occupied Space

Vapor Source

Pressure Fundamentals

HVAC Systems

Unbalanced supply
and return flows
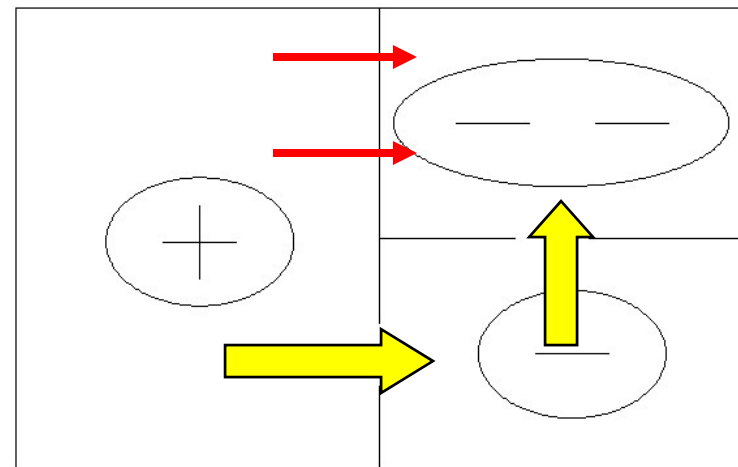
Non-functional
equipment

Return air
plenums

Copyright 2008 Turner Building
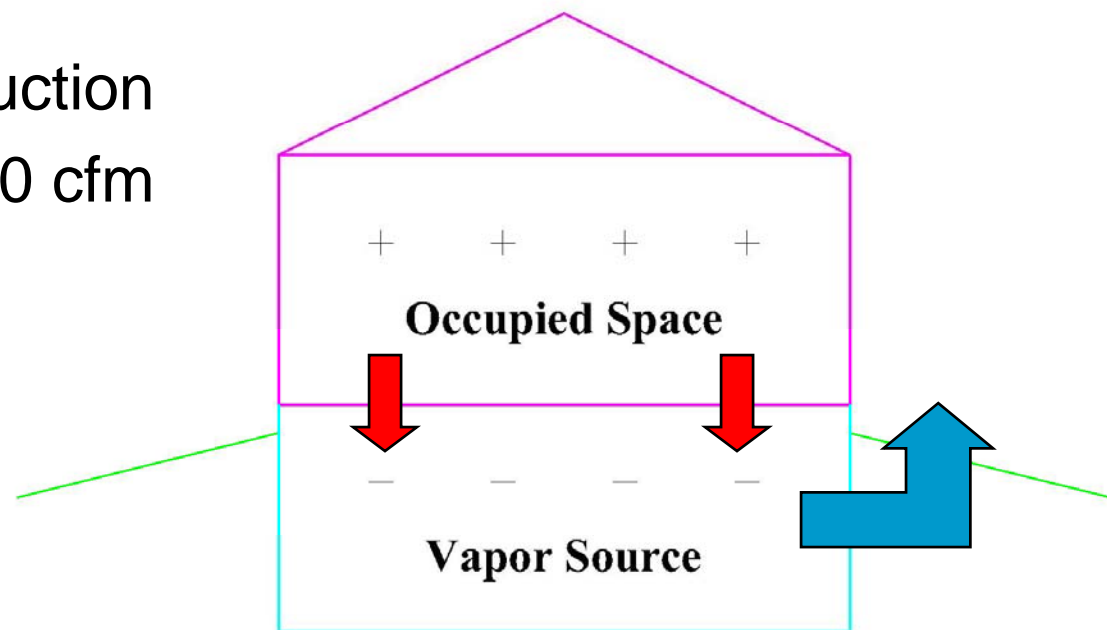Science & Design,LLC

Graphic courtesy EPA

Vapor Intrusion Control

- Negative pressure below slab
  - Sub-slab suction

- Positive pressure above slab
  - Increased ventilation

- Negative pressure between source and occupants
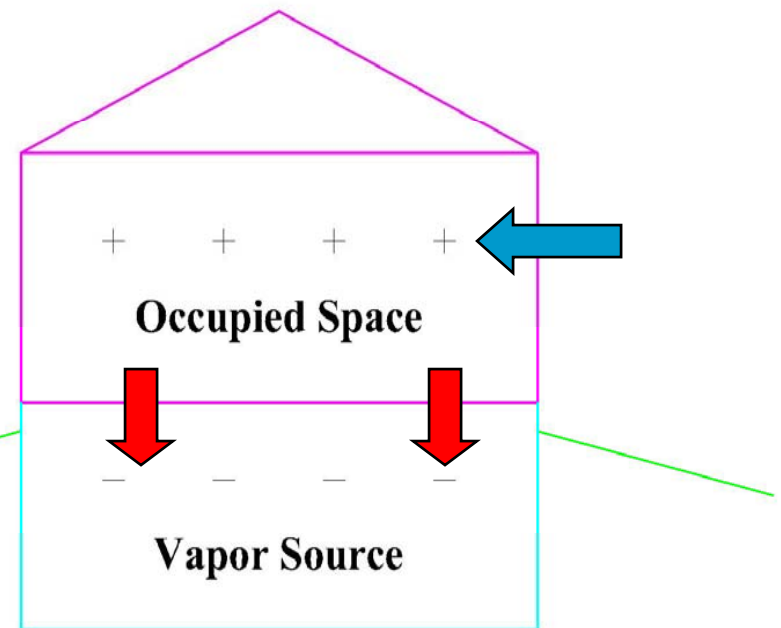 - Containment

Vapor Intrusion Control

- Negative pressure below slab
  - Sub-slab suction
  - Assume 200 cfm exhaust
  - First cost?

Occupied Space

Vapor Source

Vapor Intrusion Control

- Positive pressure above slab
  - Increased ventilation
  - Assume 2,000 cfm additional outside air
  - Change damper position to accomplish change

Occupied Space

Vapor Source

Vapor Intrusion Control Economics

In New England Conditioning Outdoor Air Is Costly ($6-$12/Yr.CFM)

Vapor Intrusion Control Economics

- **Sub-slab suction**
  - 200 cfm x $9/cfm-yr = $1,800/yr
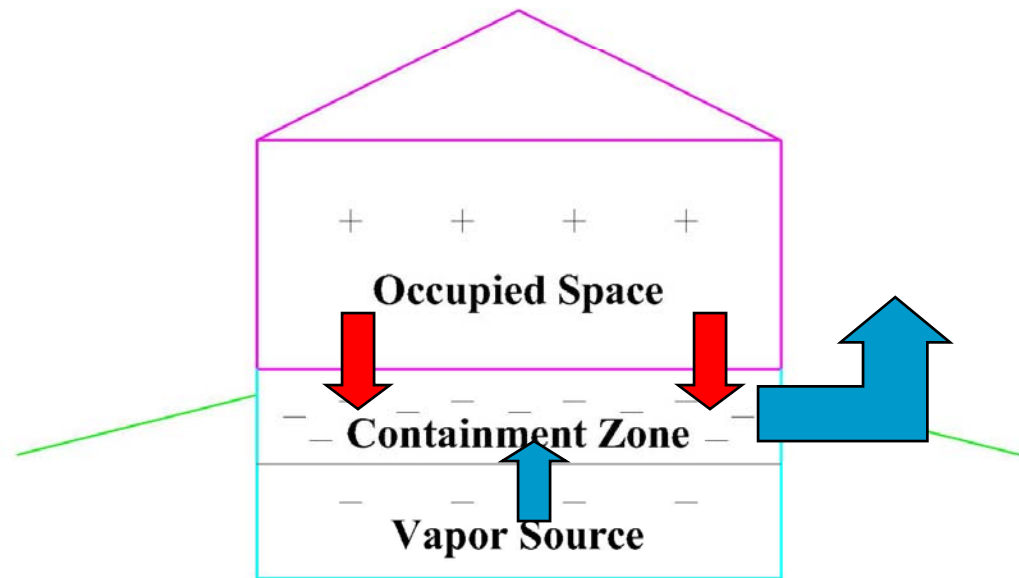 - 10 year cost of operation = $18,000
  - First Cost??

- **Increased ventilation**
  - 2,000 cfm x $9/cfm-yr = $18,000/yr
  - 10 year cost of operation = $180,000
  - First cost = ~$0
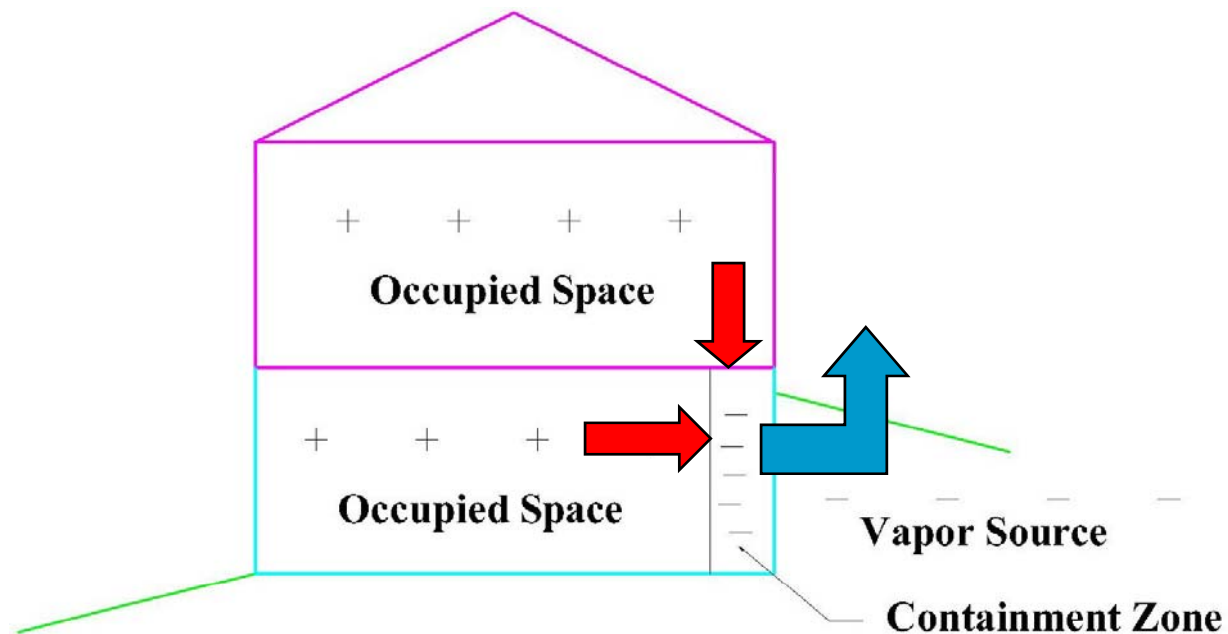
Vapor Intrusion Control

■ Negative pressure between source and occupants
- – Containment

Occupied Space

Containment Zone

Vapor Source

Vapor Intrusion Control

■ Negative pressure between source and occupants

– Walk-out Basement Example

Occupied Space

Occupied Space

Vapor Source

Containment Zone

Exhaust Reentrainment

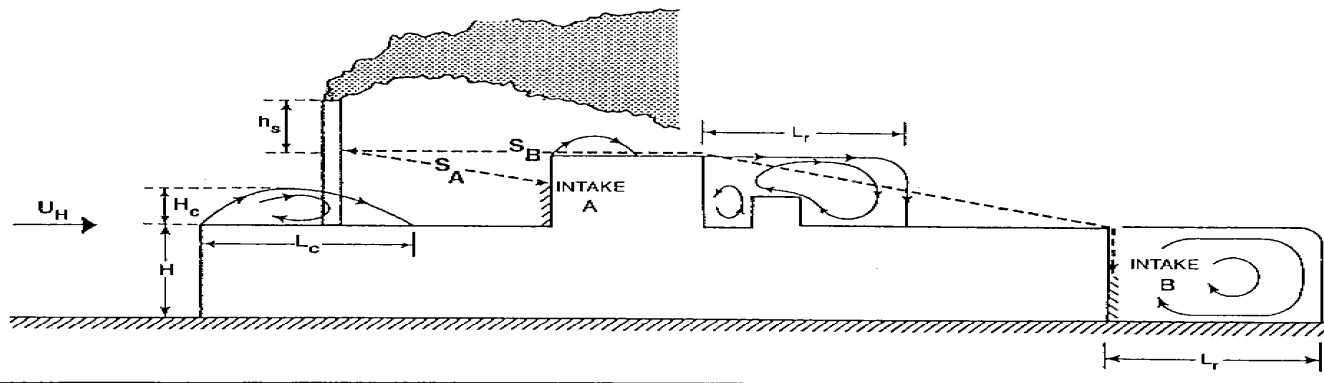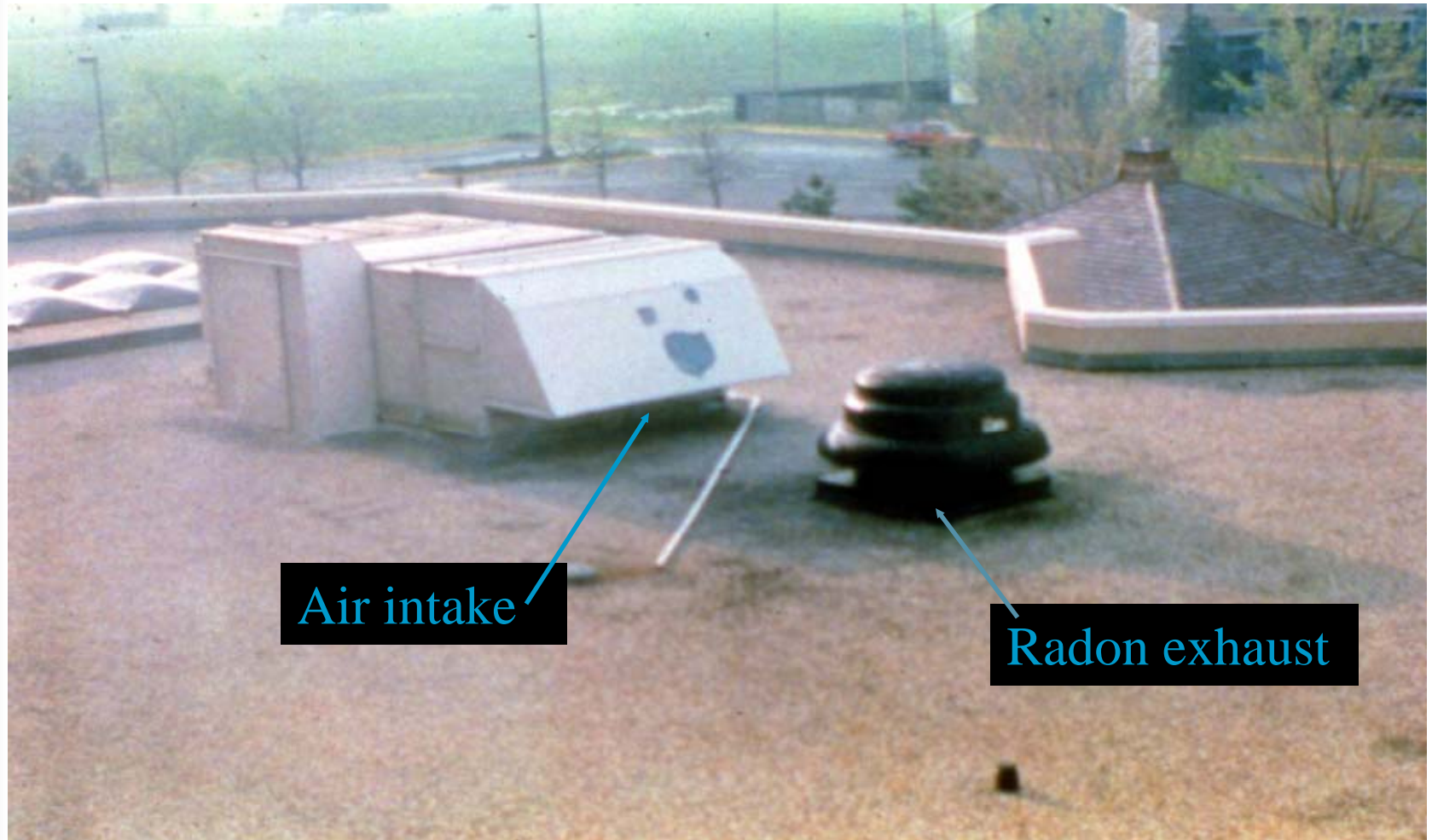■ Contaminants exhausted out of the building can be drawn in through intakes and other openings

Fig. 3 Flow Recirculation Regions and Exhaust-to-Intake Stretched-String Distances
(Wilson 1982)

Exhaust Reentrainment

Air intake

Radon exhaust

Questions & Comments…..

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