

Joseph Lstiburek, Ph.D., P.Eng, ASHRAE Fellow

Building Science

Adventures In Building Science

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Stuff That Is Not Particularly Useful But Studied
and Researched to Death

Stuff That Is Very Useful but Ignored by the
Research Community

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Stuff That Is Not Particularly Useful But Studied
and Researched to Death

“this is called Physics”

Stuff That Is Very Useful but Ignored by the
Research Community

“this is called Engineering”

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Flow Through Orifices
Turbulent Flow - “inertial effects”

Flow Through Porous Media
Laminar Flow - “viscosity effects”

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Flow Through Orifices
Turbulent Flow - "inertial effects"

Flow Through Porous Media
Laminar Flow - "viscosity effects"

"true but not useful"

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$$Q = A \times C_d \times \sqrt{2} (P)^{\frac{1}{2}} \quad \text{Bernoulli}$$

$$Q = C_k \times (P) \quad \text{Darcy}$$

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$$Q = C_k \times (P) \quad \text{Darcy}$$

$$Q = A \times C \times (P)^{\frac{1}{2}}$$

$$Q = C \times (P)$$

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$$Q = C_k \times (P) \quad \text{Darcy}$$

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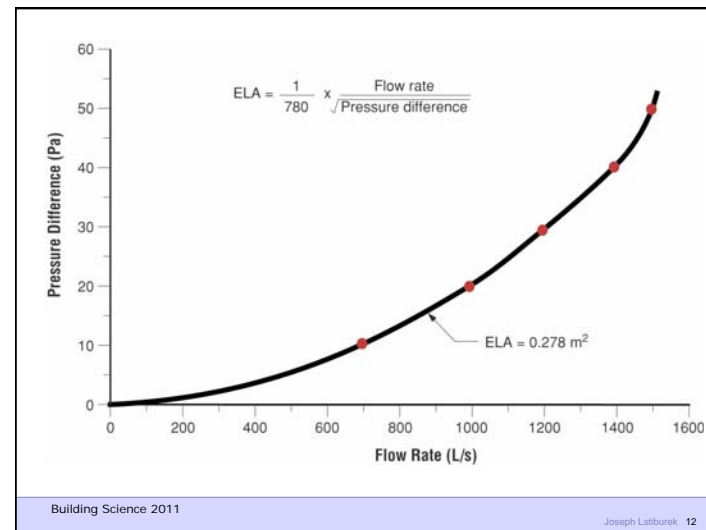
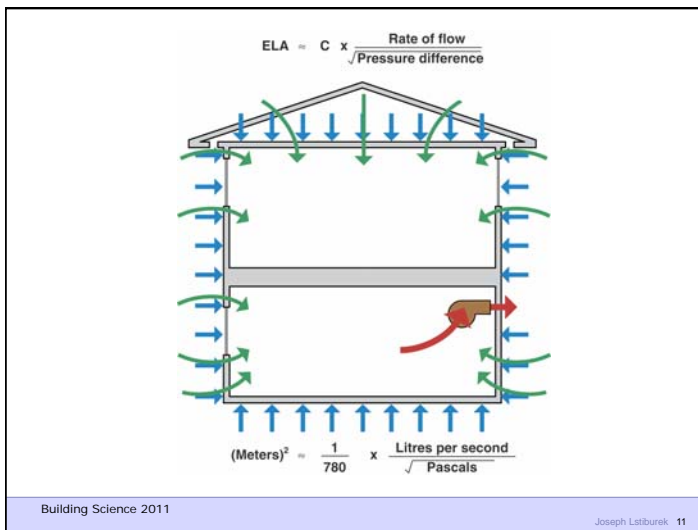
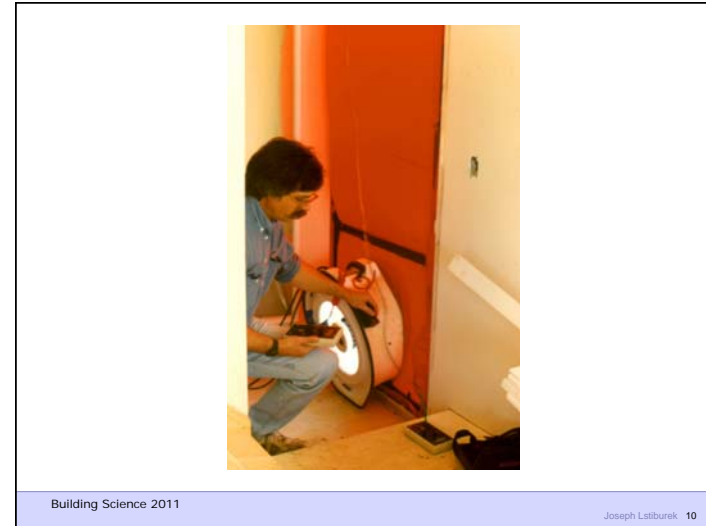
$$Q = C \times (P)$$

$$Q = A \times C \times (P)^n \quad \text{Kronval "an engineer"}$$

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The Cult of The Blower Door

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Cost of Addressing the Problems Are Less
Than The Cost of Testing To See If You
Have Problems

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Cost of Addressing the Problems Are Less
Than The Cost of Testing To See If You
Have Problems

Nike Approach - Just Do It

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Don't Do Stupid Things

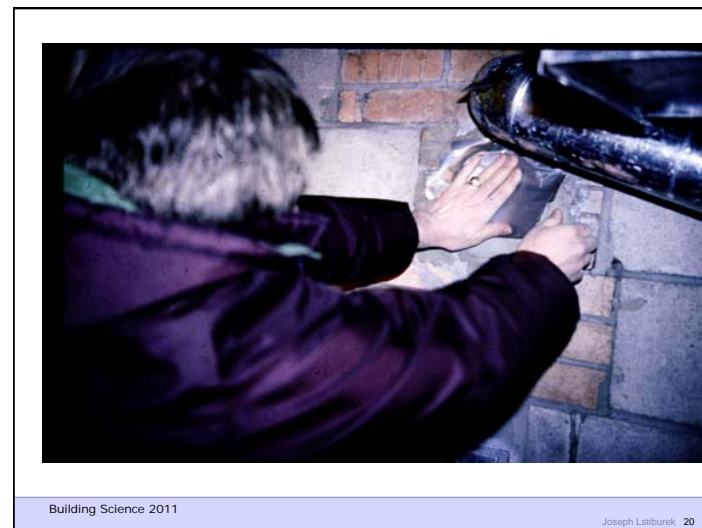
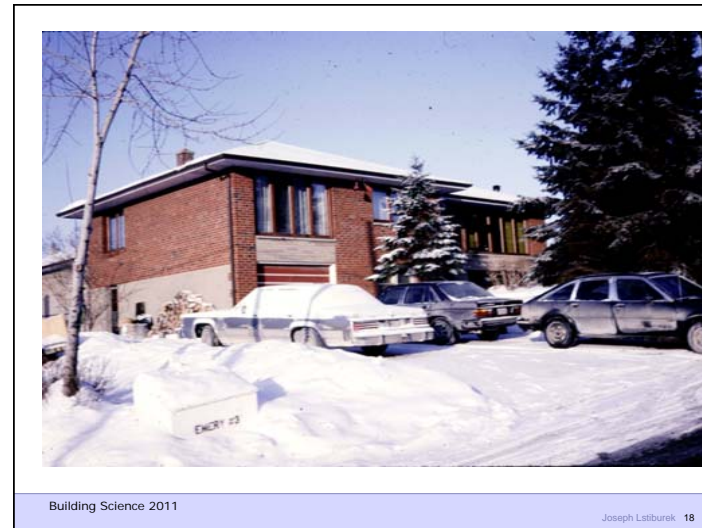
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Combustion Safety
Indoor Contaminants
Comfort
Energy

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Bring Combustion Appliances Up To Code
Control Pressures
Install Controlled Ventilation
Get Rid of Big Holes
Insulate

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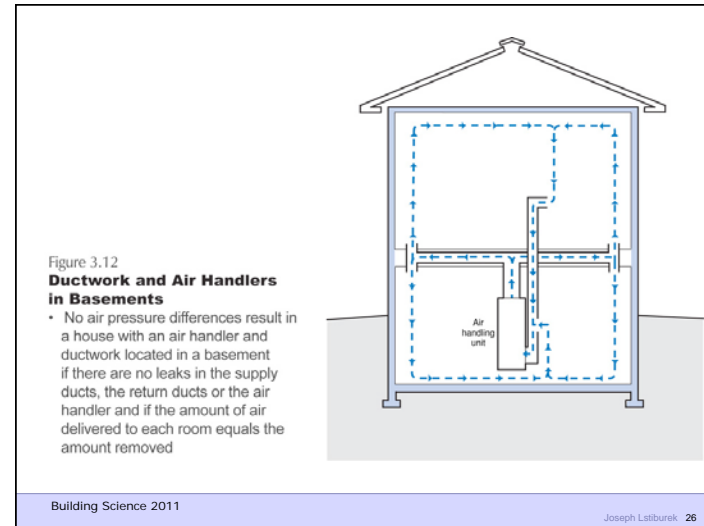
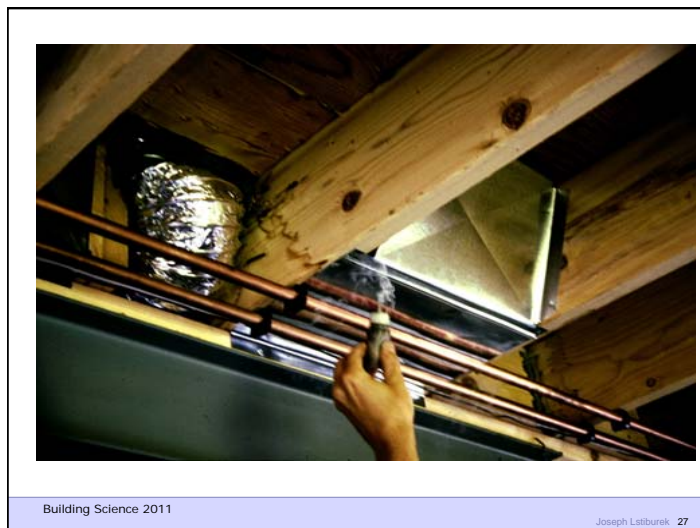


Figure 3.12
Ductwork and Air Handlers in Basements

- No air pressure differences result in a house with an air handler and ductwork located in a basement if there are no leaks in the supply ducts, the return ducts or the air handler and if the amount of air delivered to each room equals the amount removed

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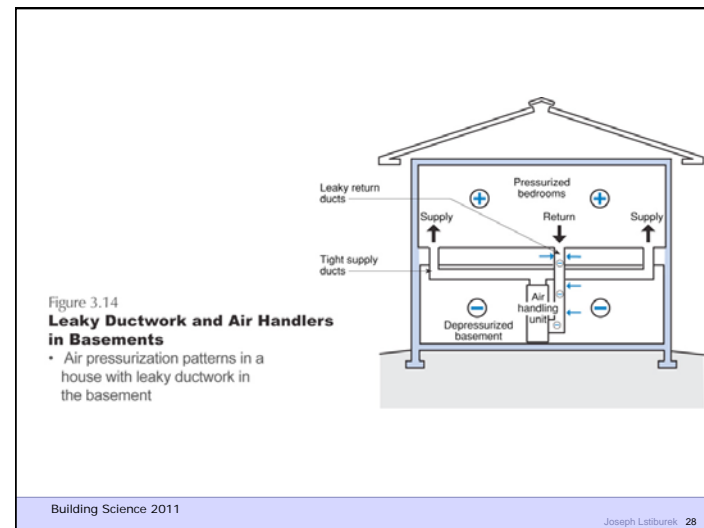
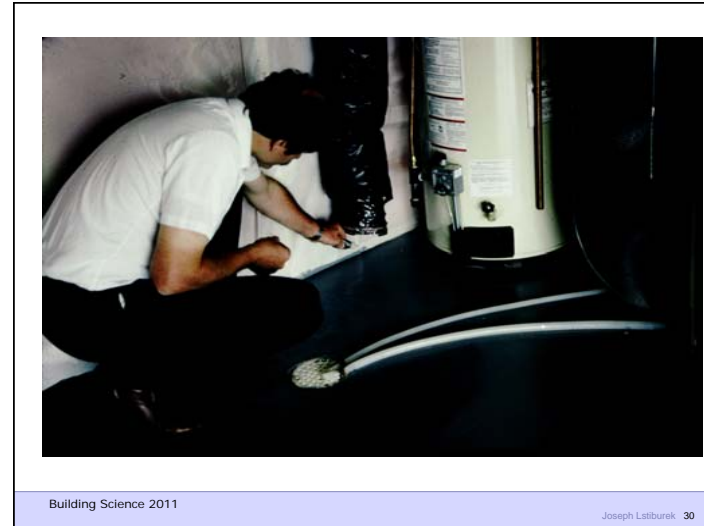


Figure 3.14
Leaky Ductwork and Air Handlers in Basements

- Air pressurization patterns in a house with leaky ductwork in the basement

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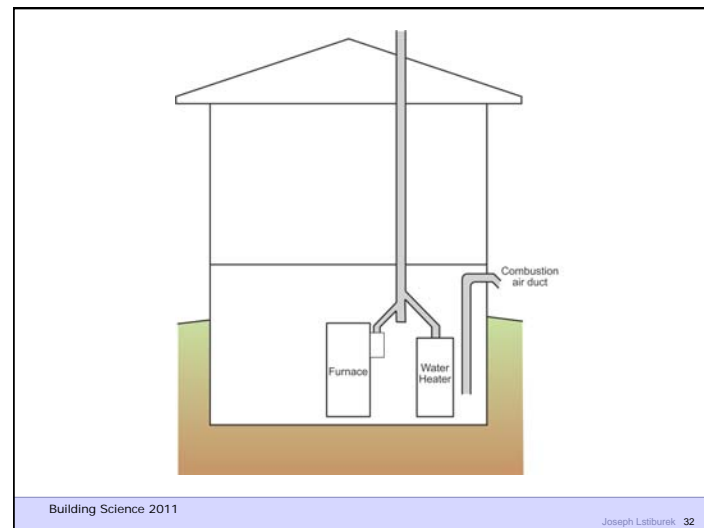
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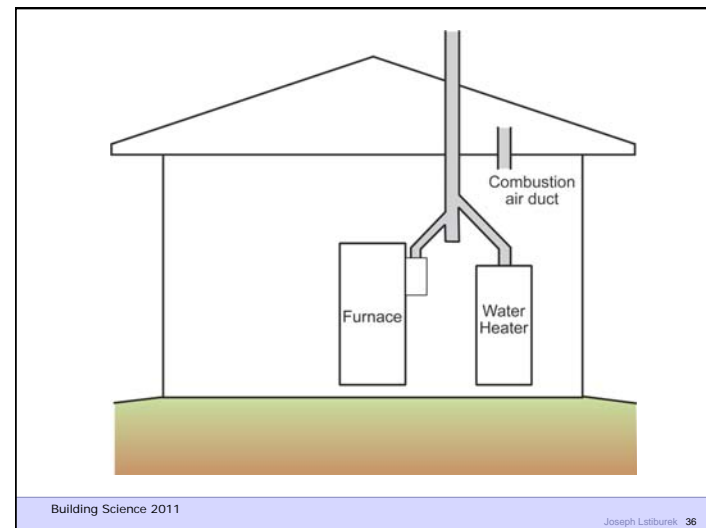
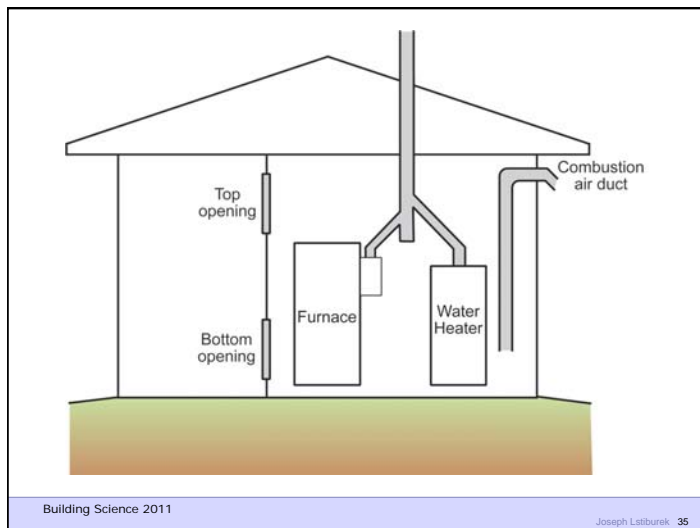
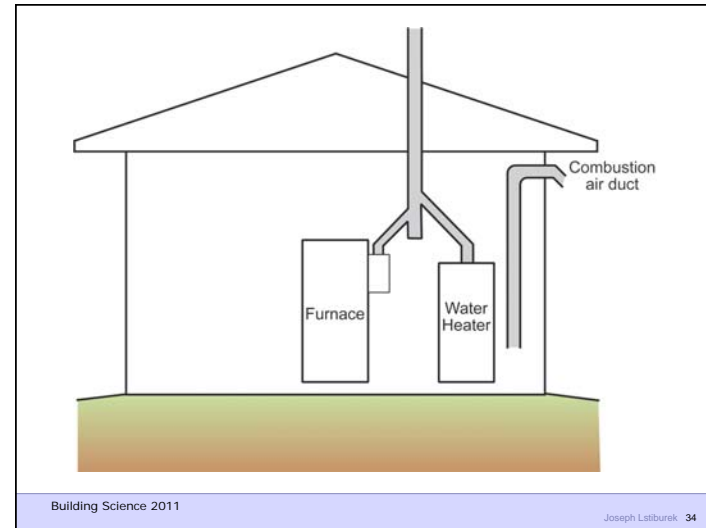
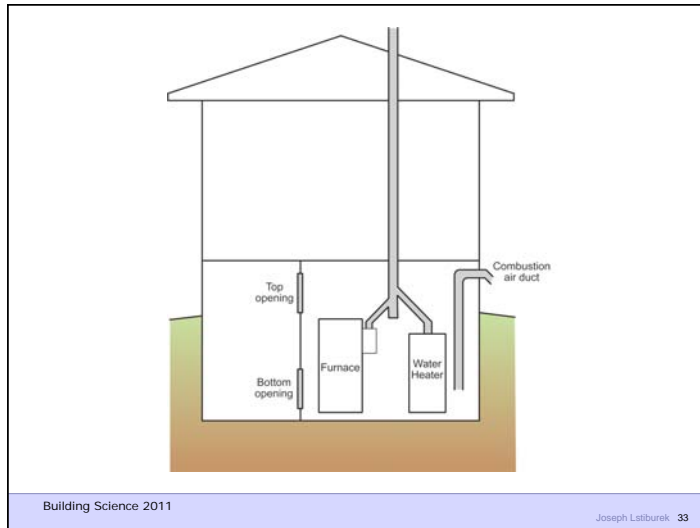


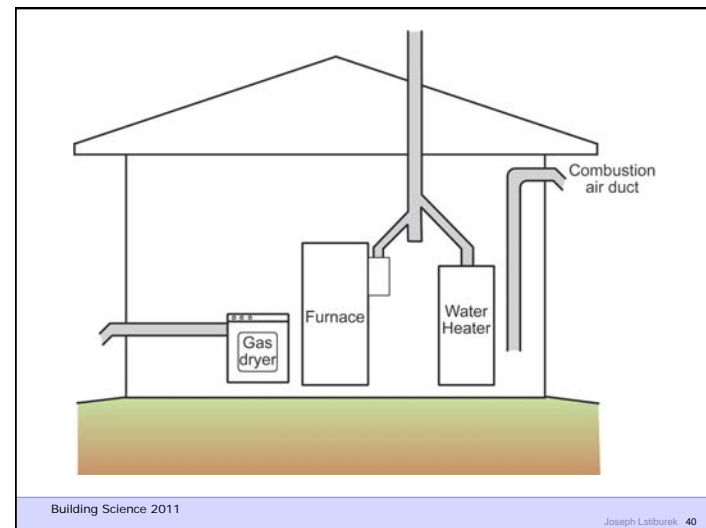
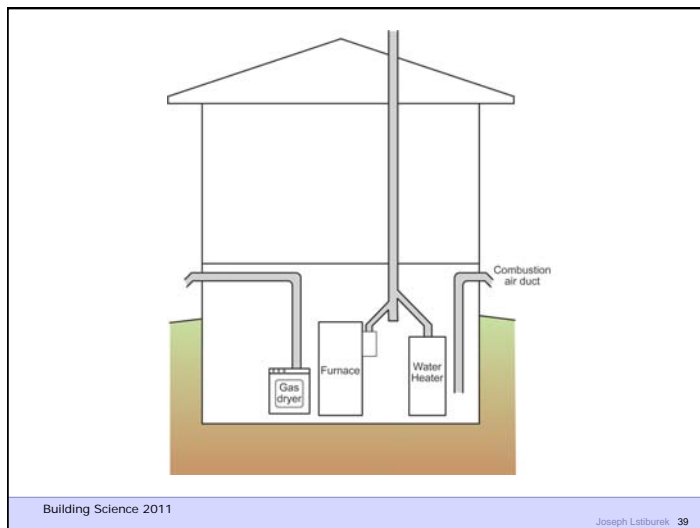
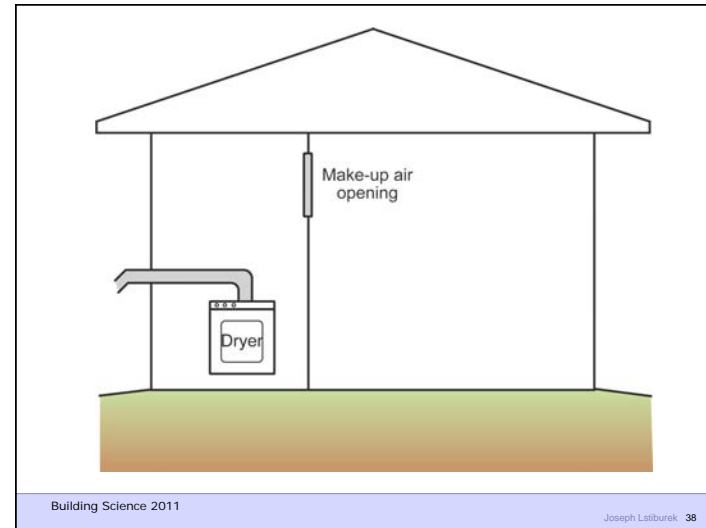
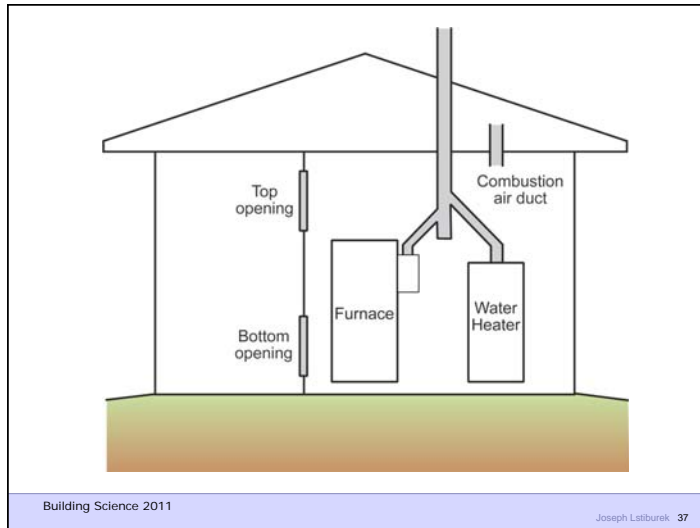
Code Compliant Combustion Air

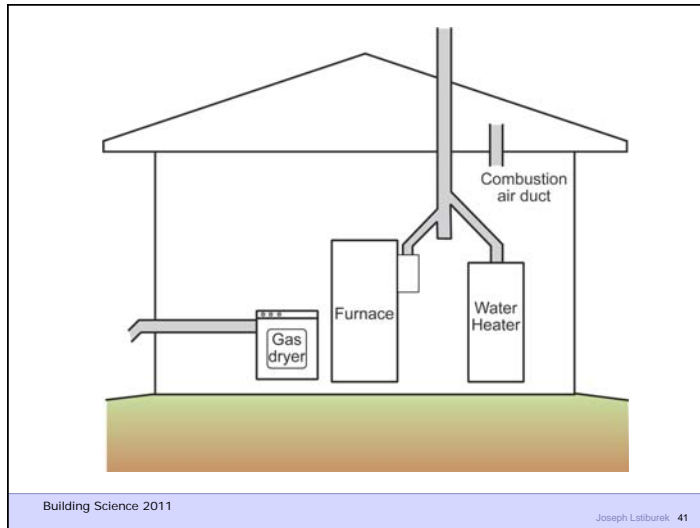
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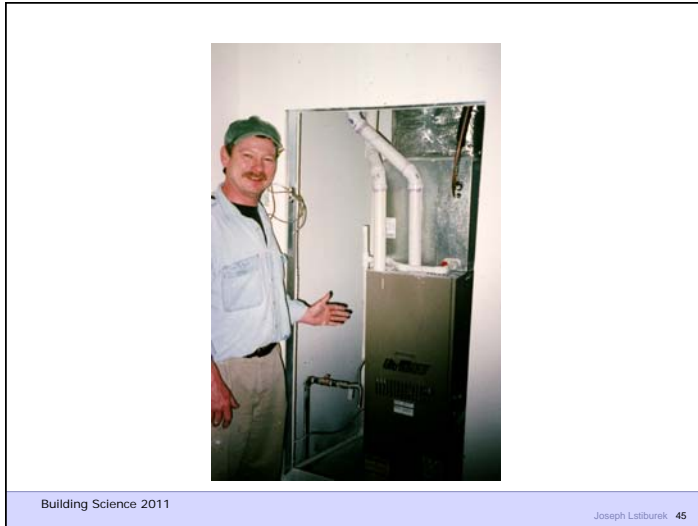




Sealed Combustion Appliances

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Control Pressures

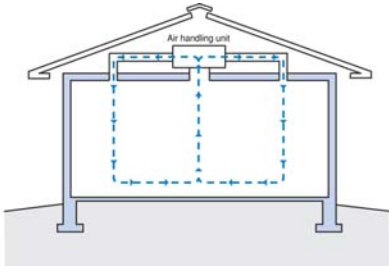
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Figure 3.13
Ductwork and Air Handlers in Vented Attics

- No air pressure differences result in a house with an air handler and ductwork located in a vented attic if there are no leaks in the supply ducts, the return ducts or the air handler and if the amount of air delivered to each room equals the amount removed

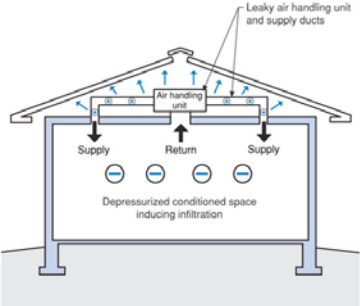


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Figure 3.15
Leaky Ductwork and Air Handlers in Vented Attics

- Supply ductwork and air handler leakage is typically 20% or more of the flow through the system

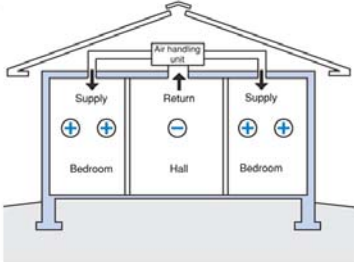


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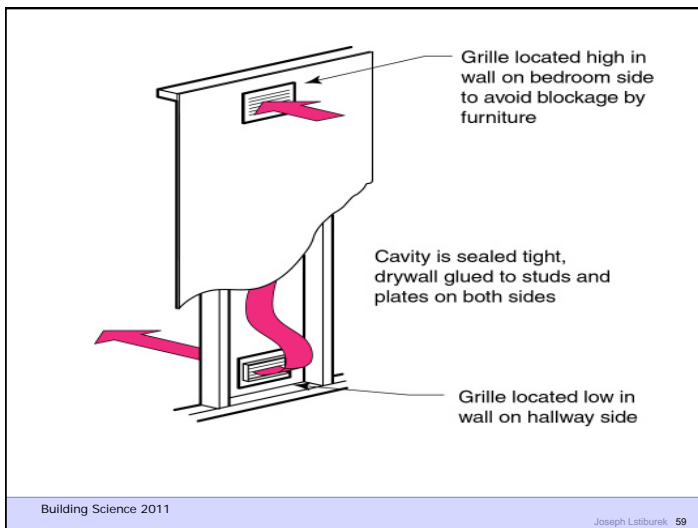


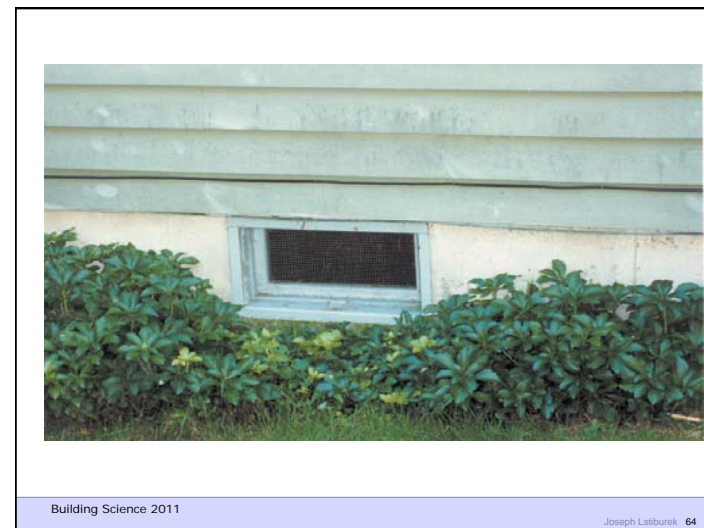
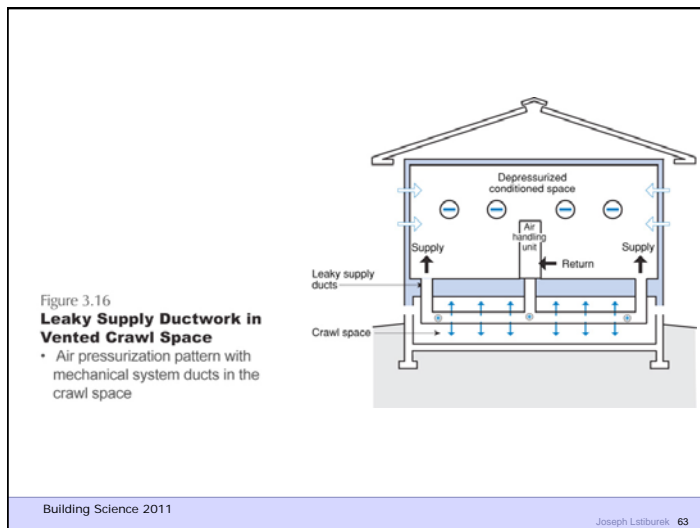
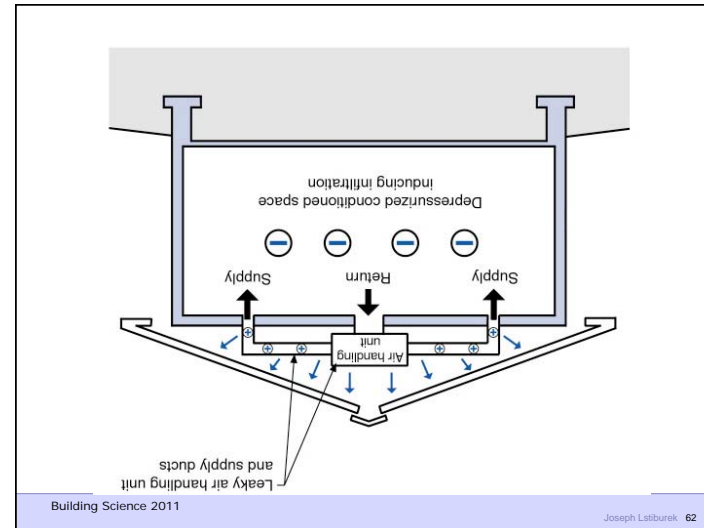
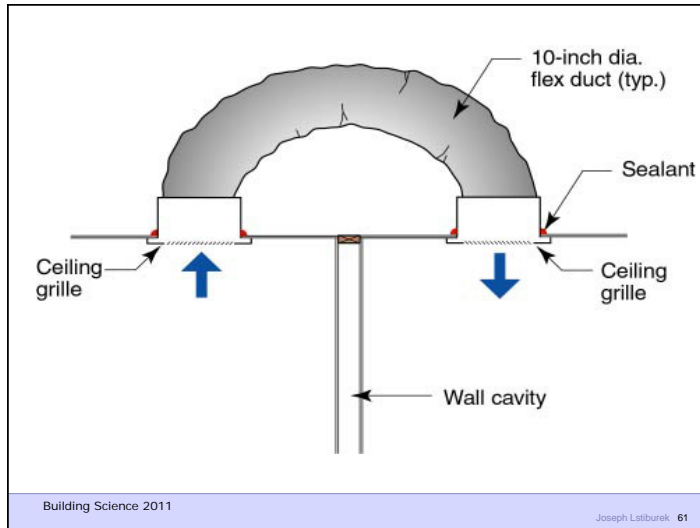
Figure 3.18
Insufficient Return Air Paths

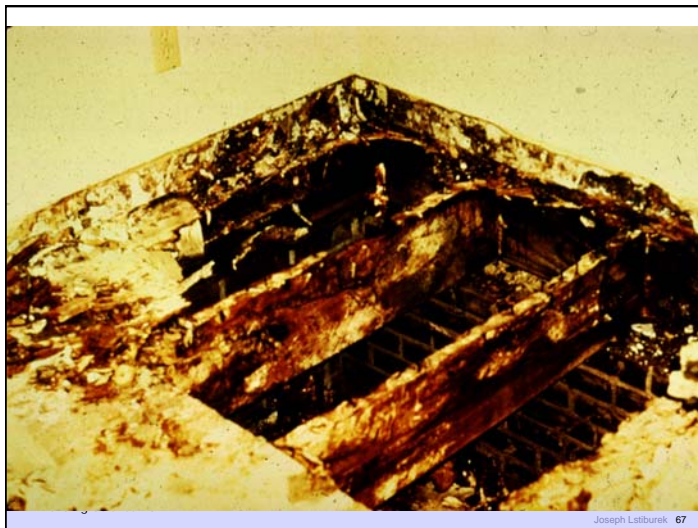
- Pressurization of bedrooms often occurs if insufficient return pathways are provided; undercutting bedroom doors is usually insufficient; transfer grilles, jump ducts or fully ducted returns may be necessary to prevent pressurization of bedrooms
- Master bedroom suites are often the most pressurized as they typically receive the most supply air
- When bedrooms pressurized, common areas depressurize; this can have serious consequences when fireplaces are located in common areas and subsequently backdraft

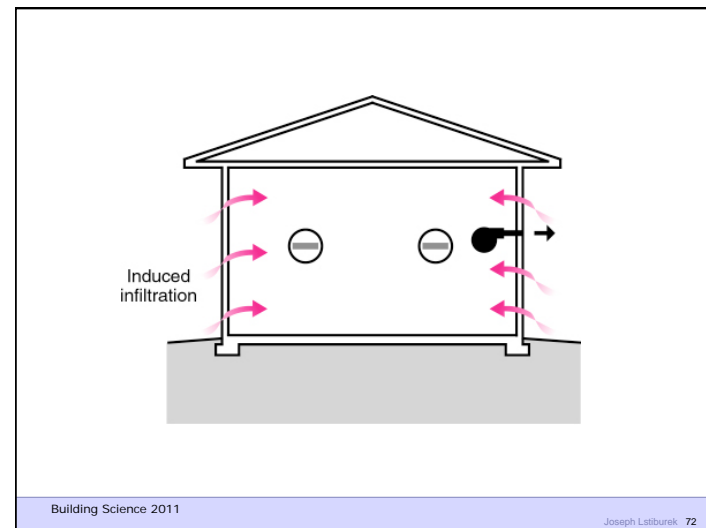
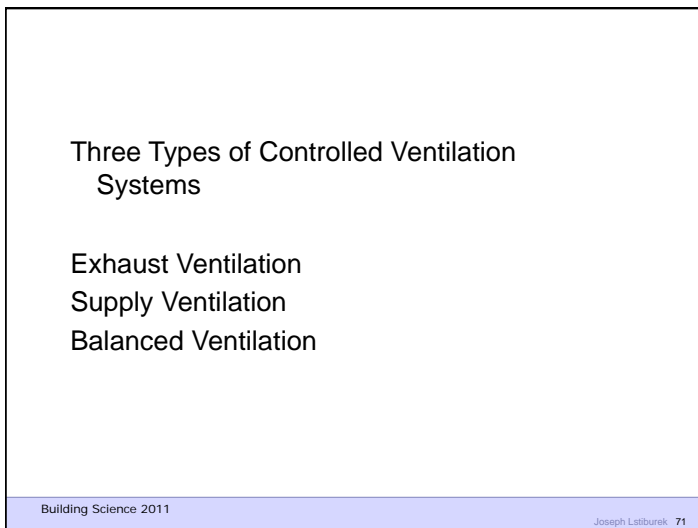
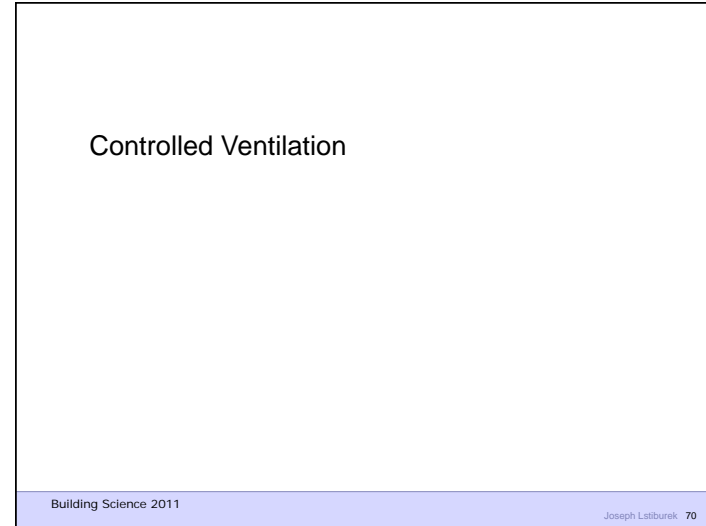


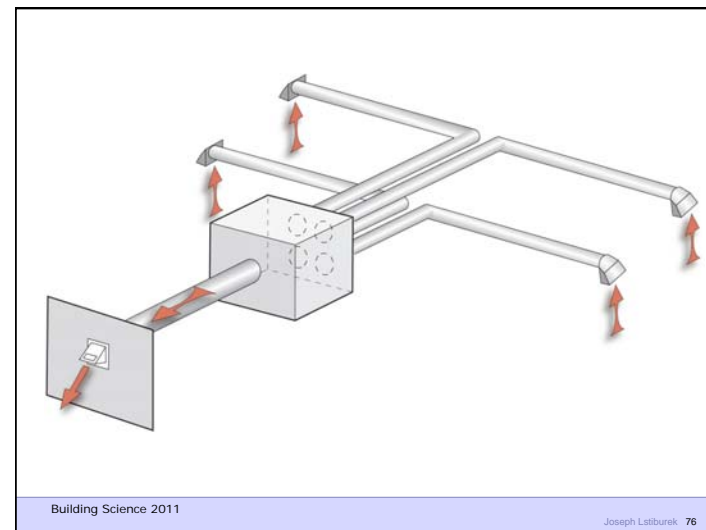
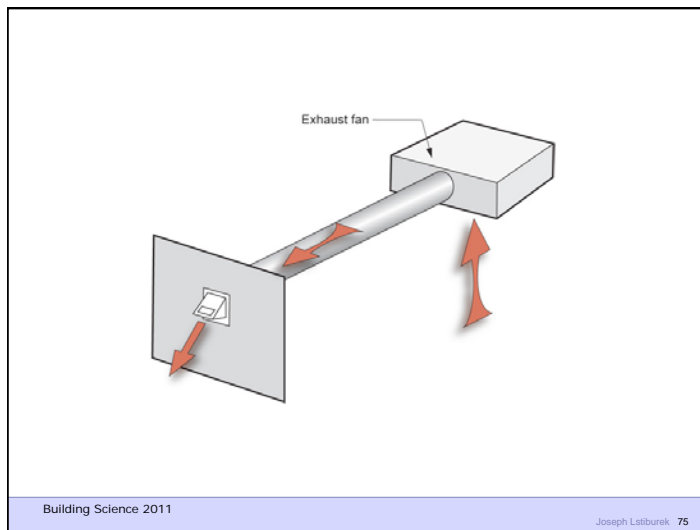
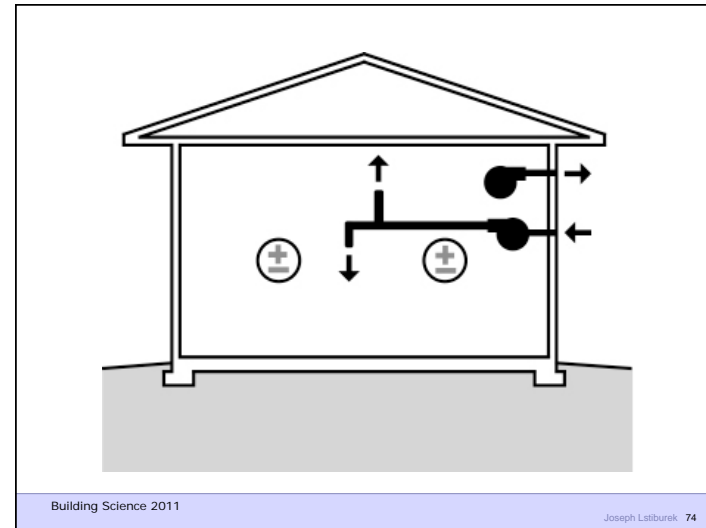
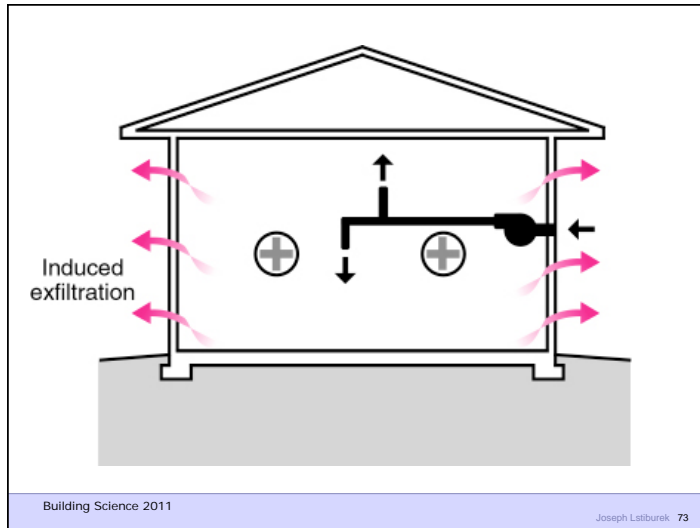
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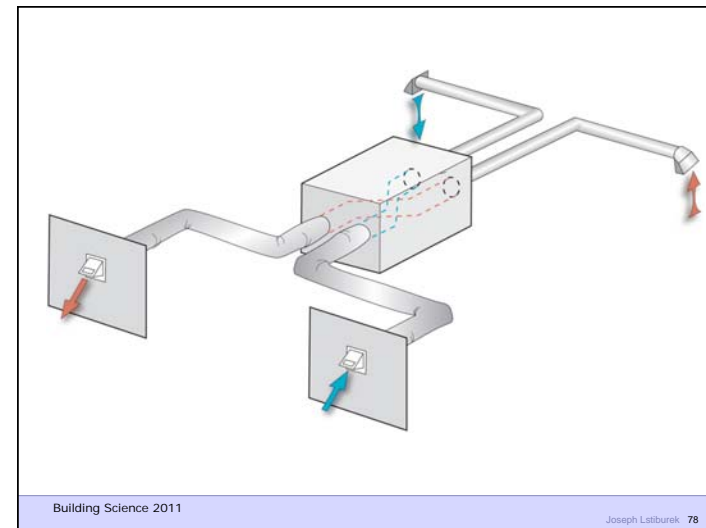
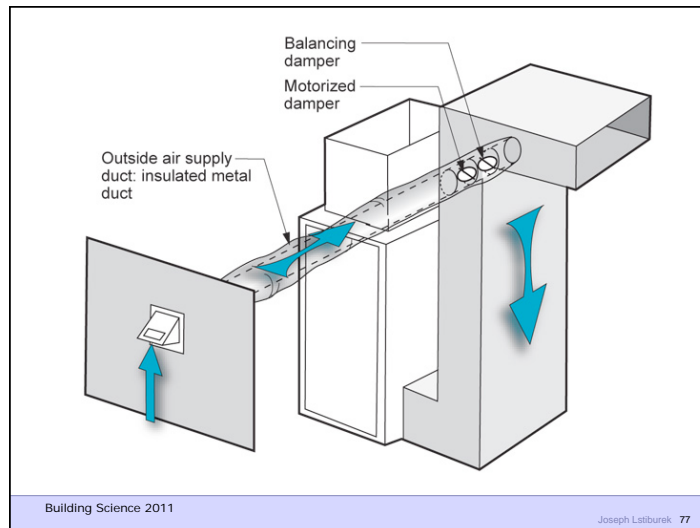












ASHRAE Standard 62.2 calls for 7.5 cfm per person plus 0.01 cfm per square foot of conditioned area

Occupancy is deemed to be the number of bedrooms plus one

Occupant Rate + Building Rate