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

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"

Flow Through Orifices

Turbulent Flow - "inertial effects"

Flow Through Porous Media

Laminar Flow - "viscosity effects"

Flow Through Orifices

Turbulent Flow - “inertial effects”

Flow Through Porous Media

Laminar Flow - “viscosity effects”

“true but not useful”

$Q = A\sqrt{C_D}\frac{2}{\rho}(\Delta P)^{\frac{1}{2}}$ Bernoulli

$Q = C_K \mu(\Delta P)$ Darcy

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

$Q = C(\Delta P)$

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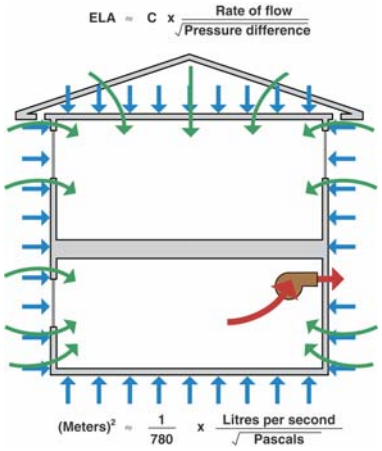
$Q = C_K \mu(\Delta P)$ Darcy

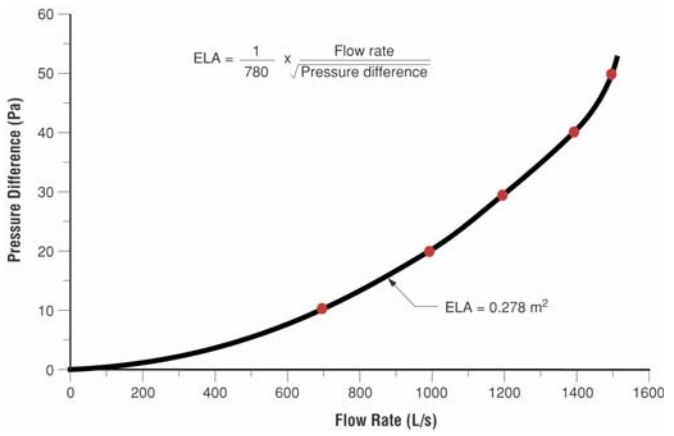
$Q = A\sqrt{C}(\Delta P)^{\frac{1}{2}}$

$Q = C(\Delta P)$

$Q = A\sqrt{C}(\Delta P)^{n}$ Kronval “an engineer”

The Cult of The Blower Door





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

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Nike Approach - Just Do It

Don't Do Stupid Things

Combustion Safety
Indoor Contaminants
Comfort
Energy

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

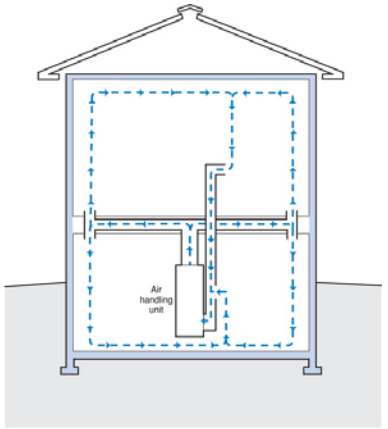

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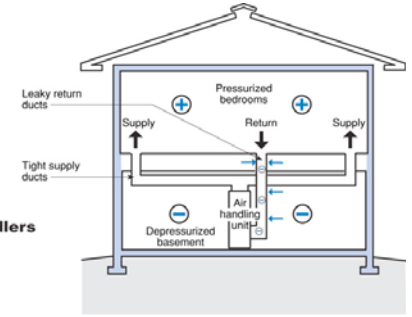
Figure 3.14
Leaky Ductwork and Air Handlers in Basements
- Air pressurization patterns in a house with leaky ductwork in the basement



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Code Compliant Combustion Air

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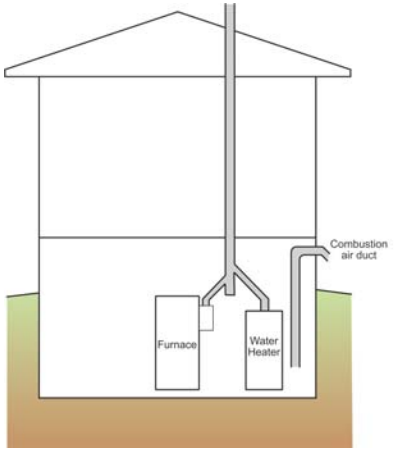

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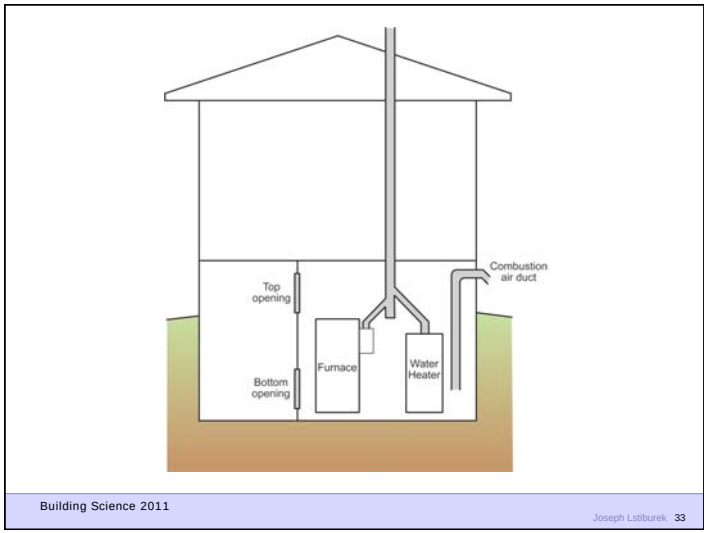
Top opening
Bottom opening
Furnace
Water Heater
Combustion air duct
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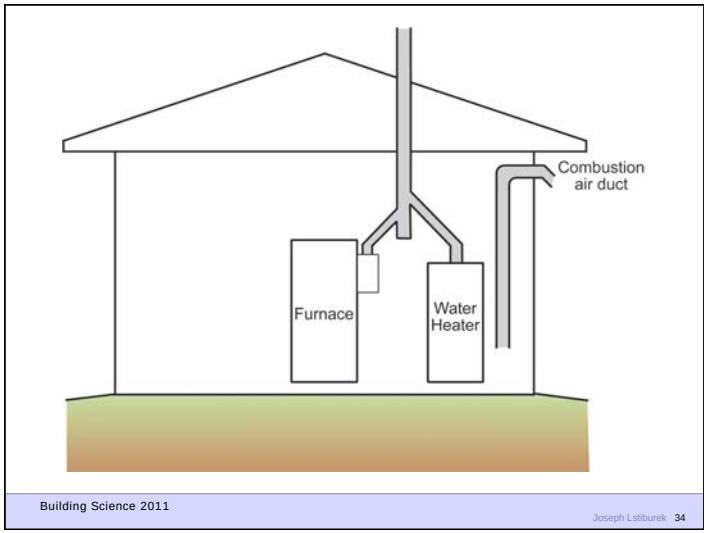
Furnace
Water Heater
Combustion air duct
Building Science 2011
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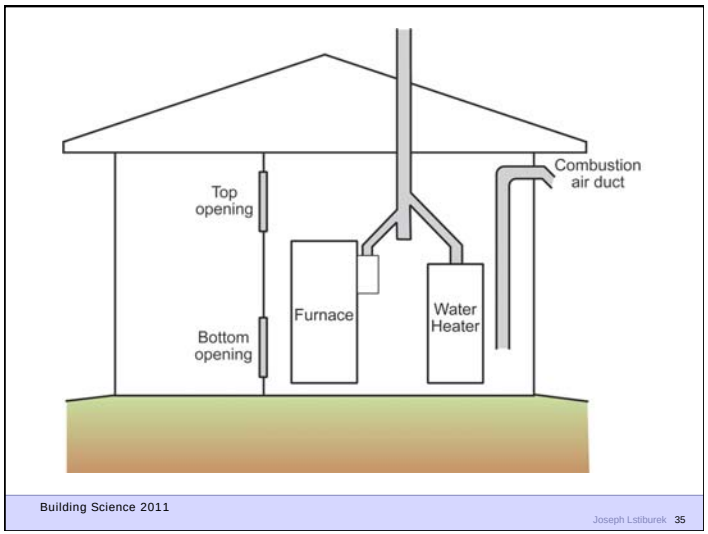
Top opening
Bottom opening
Furnace
Water Heater
Combustion air duct
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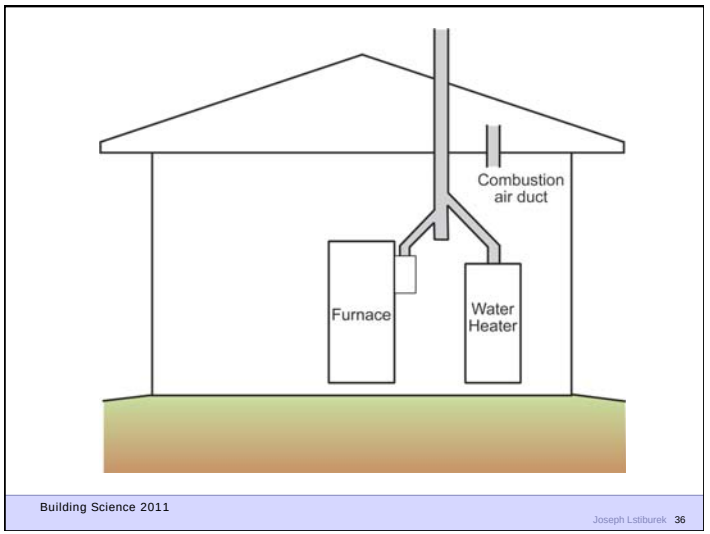
Furnace
Water Heater
Combustion air duct
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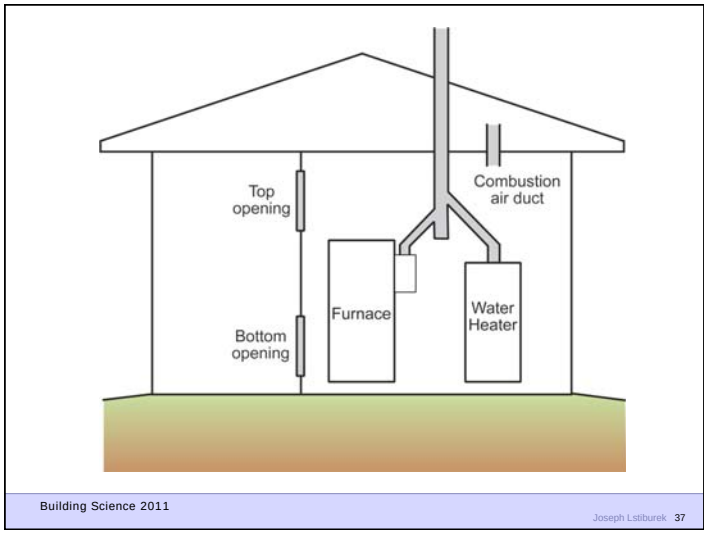
Top opening
Combustion air duct
Furnace
Water Heater
Bottom opening
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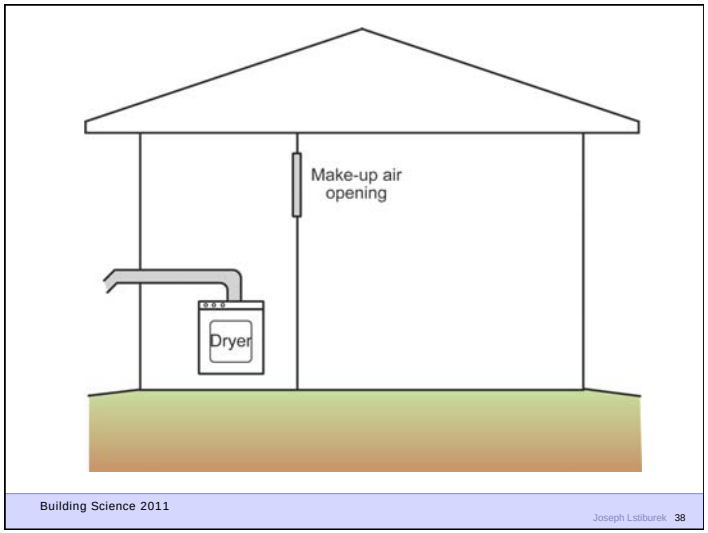
Make-up air opening
Dryer
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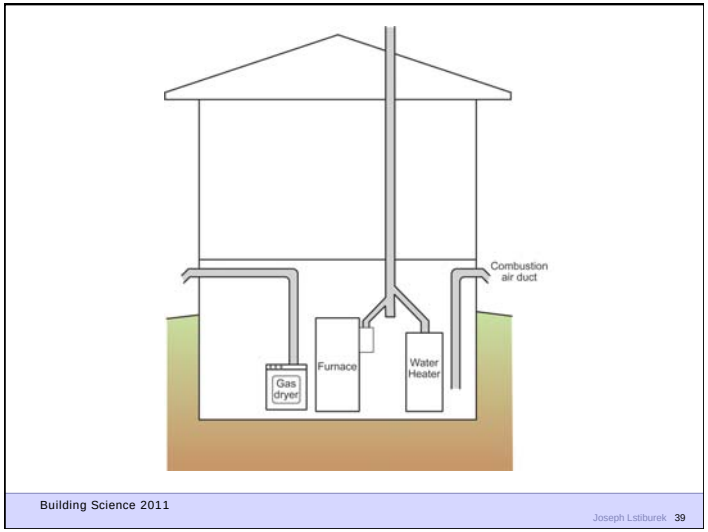
Combustion air duct
Furnace
Water Heater
Gas dryer
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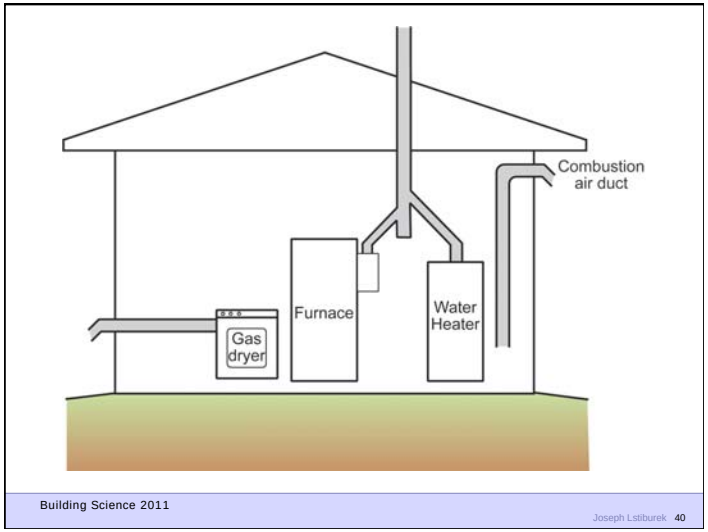
Combustion air duct
Furnace
Water Heater
Gas dryer
Building Science 2011
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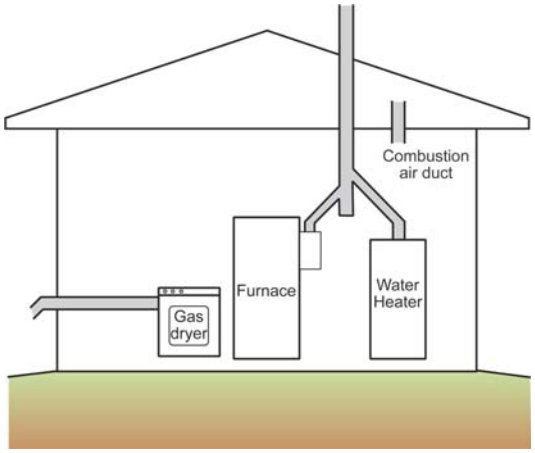

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Sealed Combustion Appliances

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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

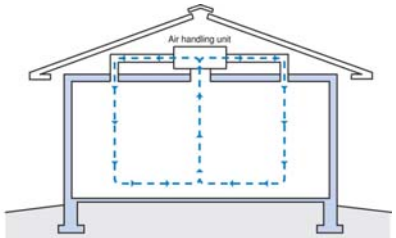

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Figure 3.15
Leaky Ductwork and Air Handlers in Vented Attics
- Supply ductwork and air handler leakage is typically 20% or more of the flow through the system

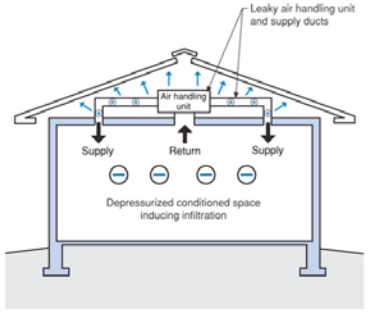

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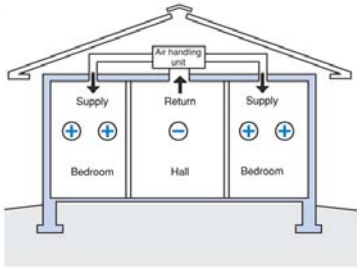
Figure 3.18
Insufficient Return Air Paths

- 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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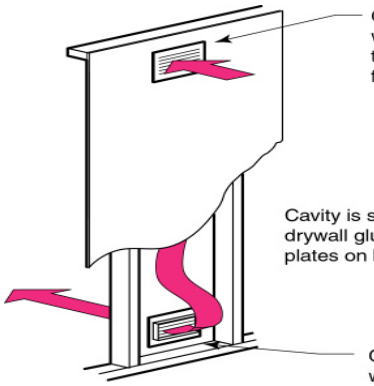

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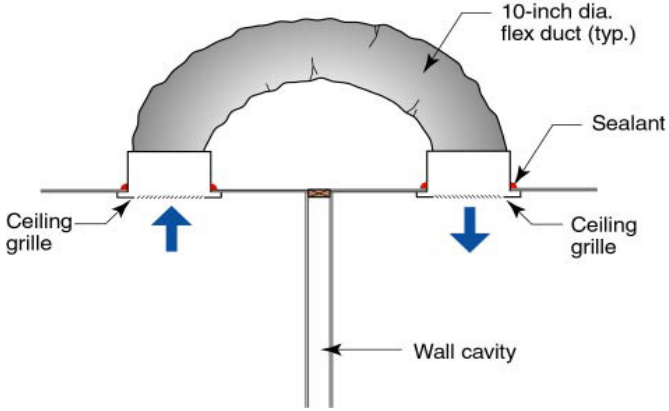

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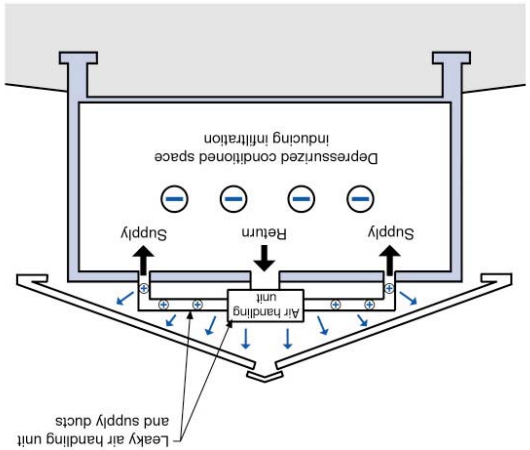

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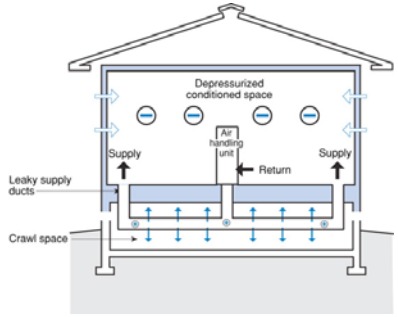

Figure 3.16
Leaky Supply Ductwork in Vented Crawl Space
- Air pressurization pattern with mechanical system ducts in the crawl space

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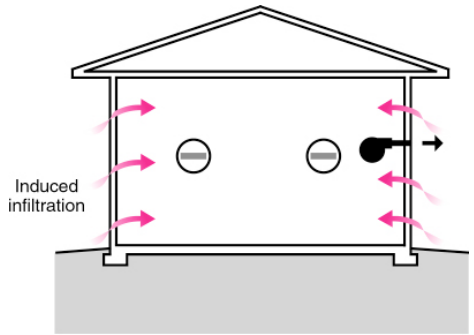
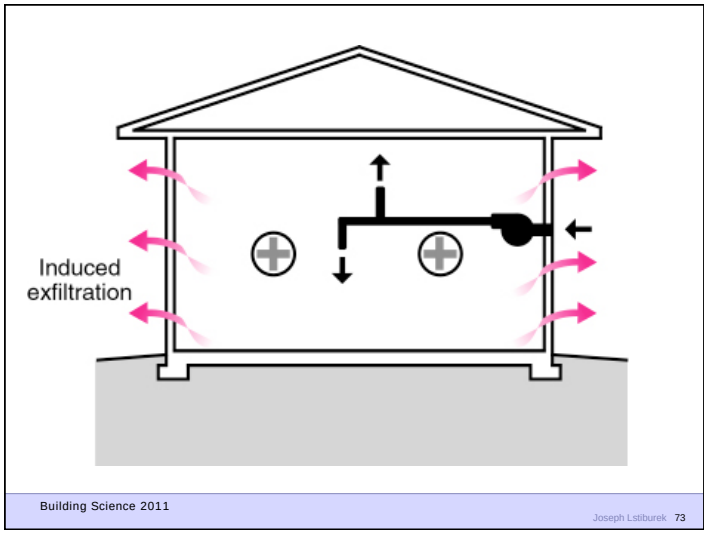
Controlled Ventilation

Three Types of Controlled Ventilation Systems

Exhaust Ventilation
Supply Ventilation
Balanced Ventilation




Induced
exfiltration
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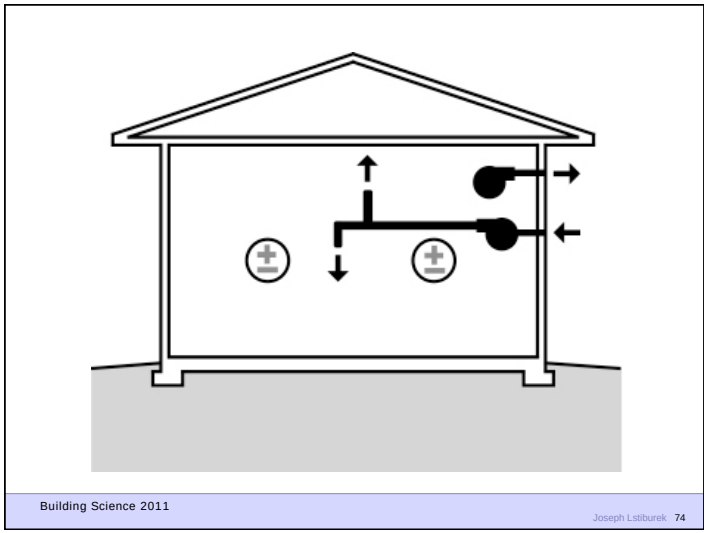
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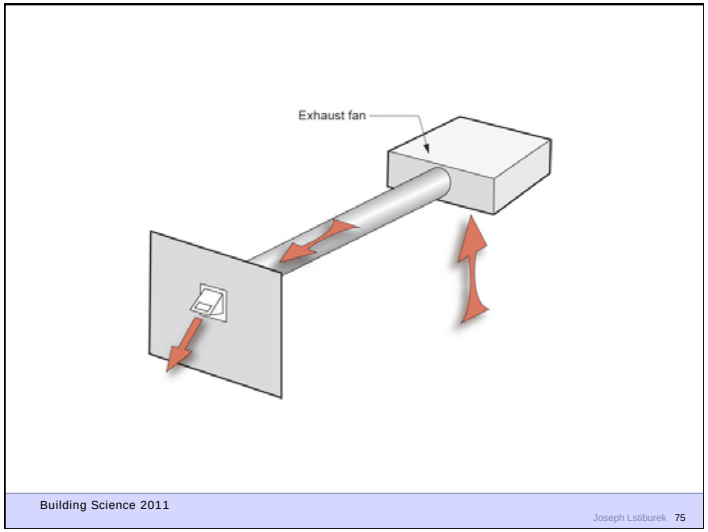
Exhaust fan
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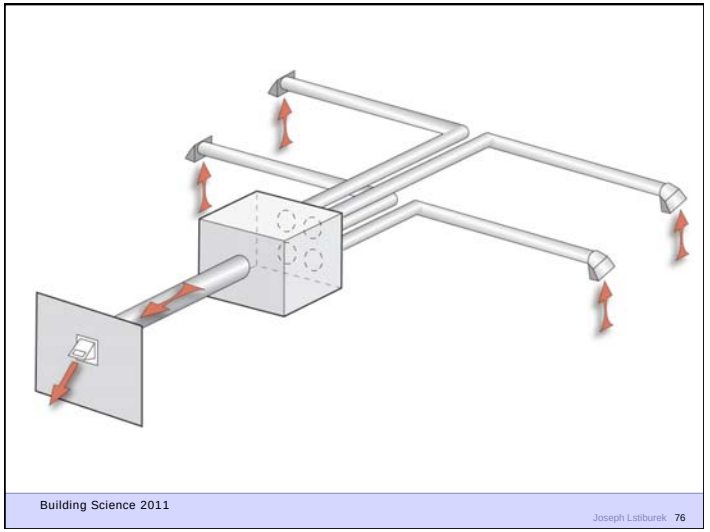
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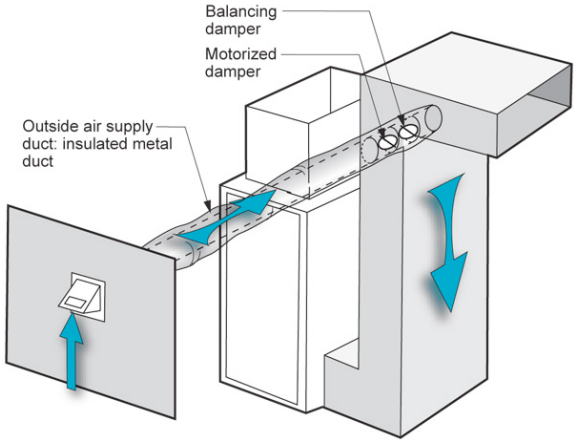

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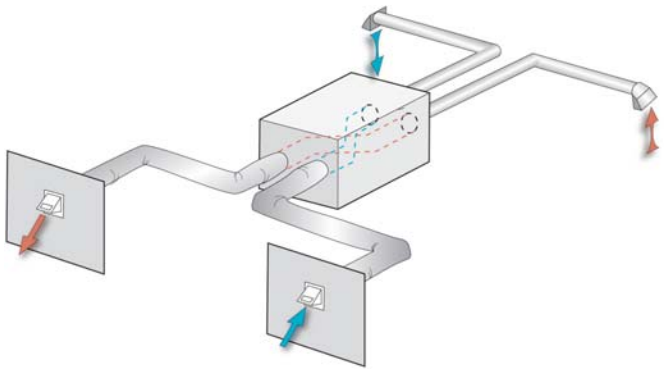

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ASHRAE Standard 62.2 calls for 7.5 cfm per person plus 0.01 cfm per square foot of conditioned area

Occupancy is deemed to be the number of bedrooms plus one

Occupant Rate + Building Rate

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