

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

## Building Science

Adventures In Building Science

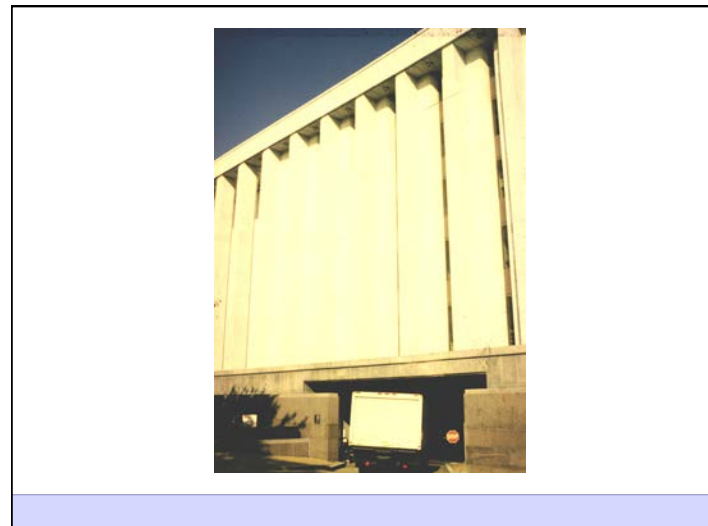
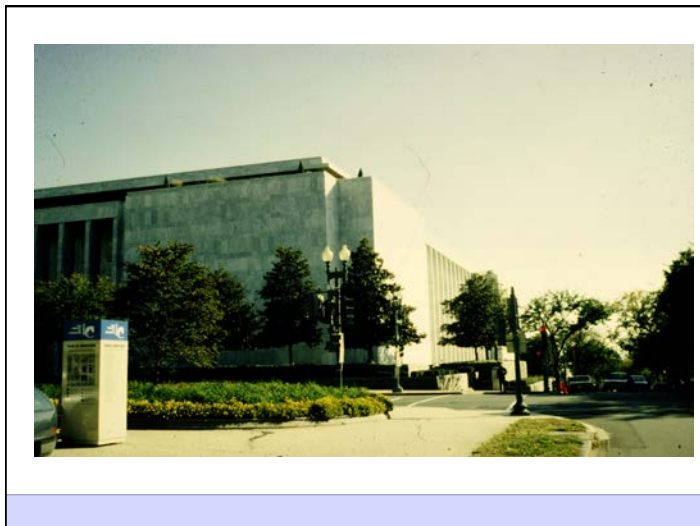
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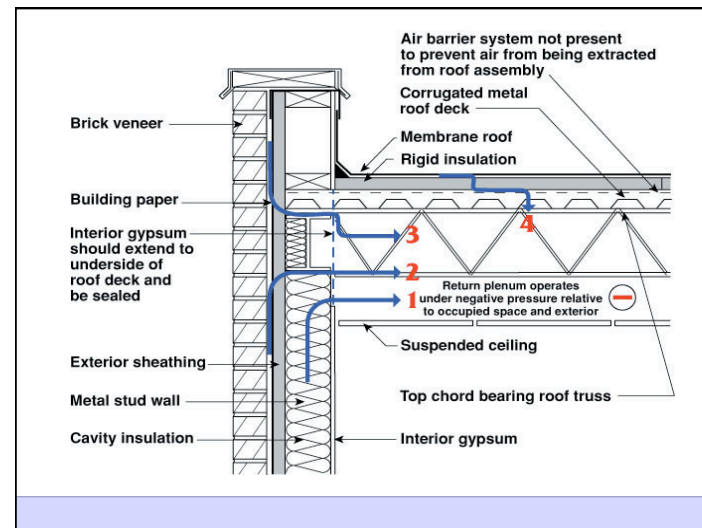
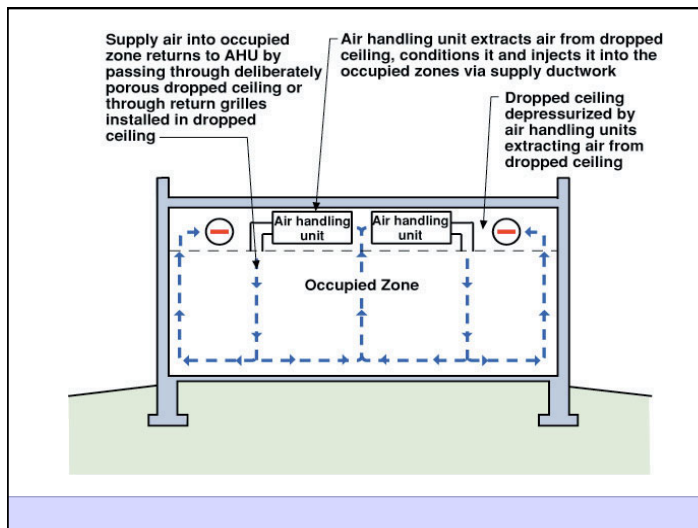
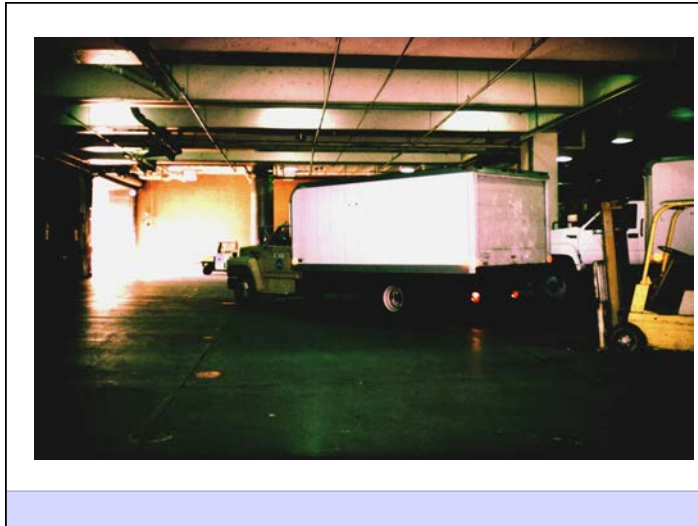
Life is Tough Enough As it Is...

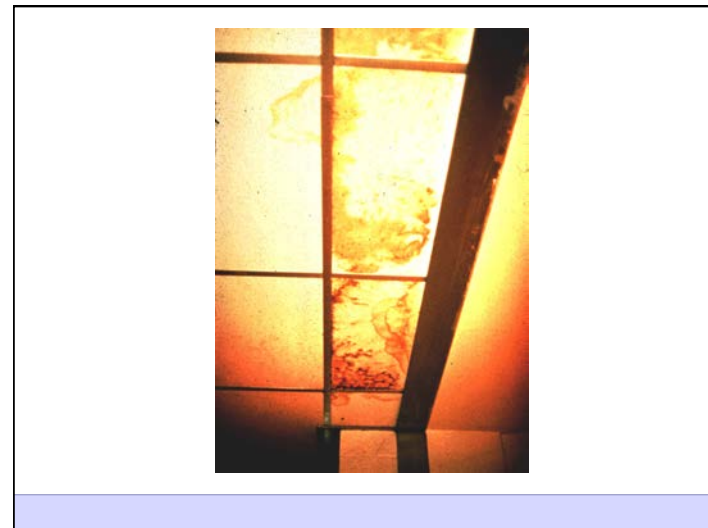
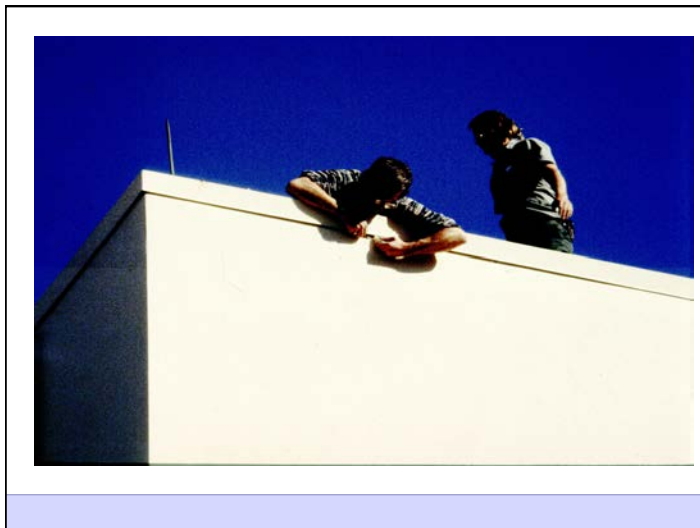
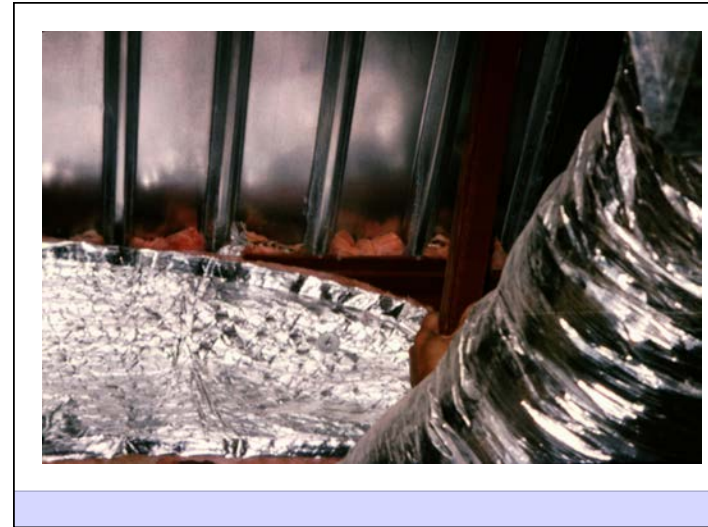
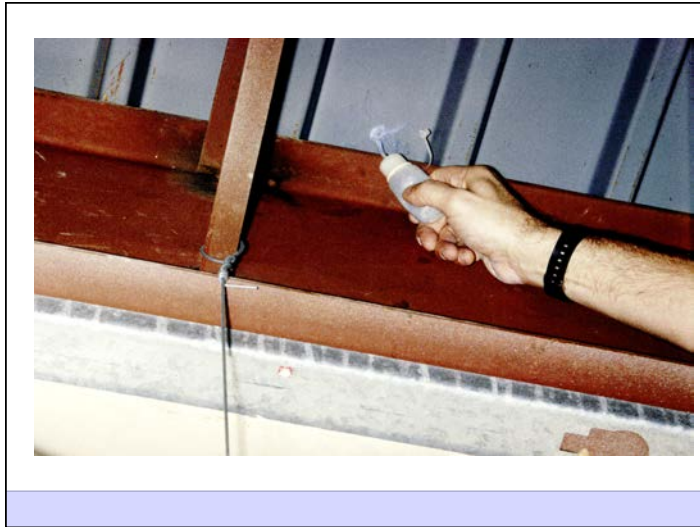
Life is Tough Enough As it Is...  
It's Harder When You Are Stupid

Don't Do Stupid Things

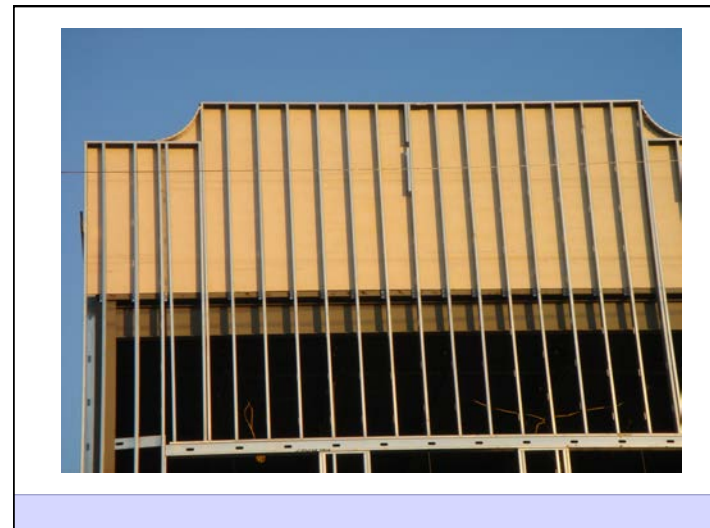
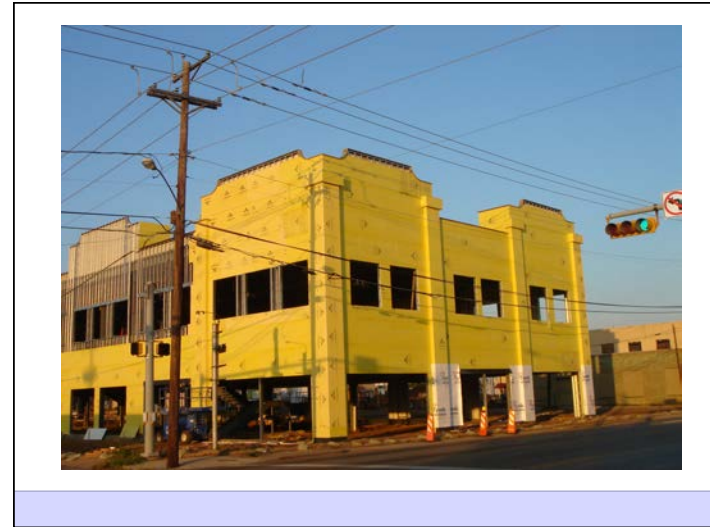
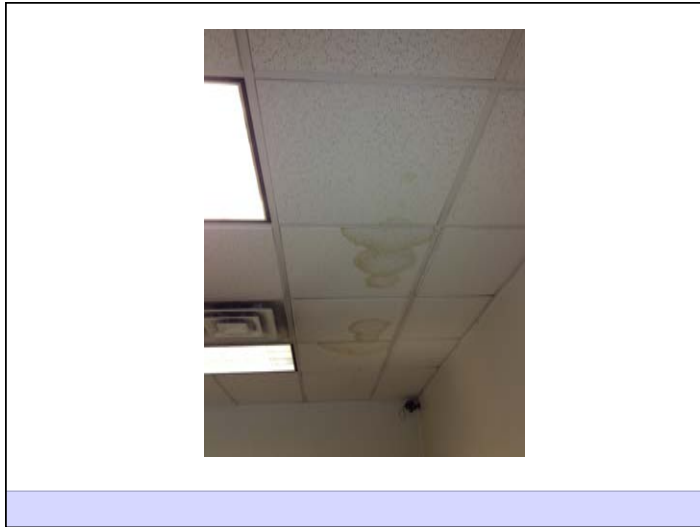
People  
Pollutant (hot, wet, UV, ozone)  
Path  
Pressure

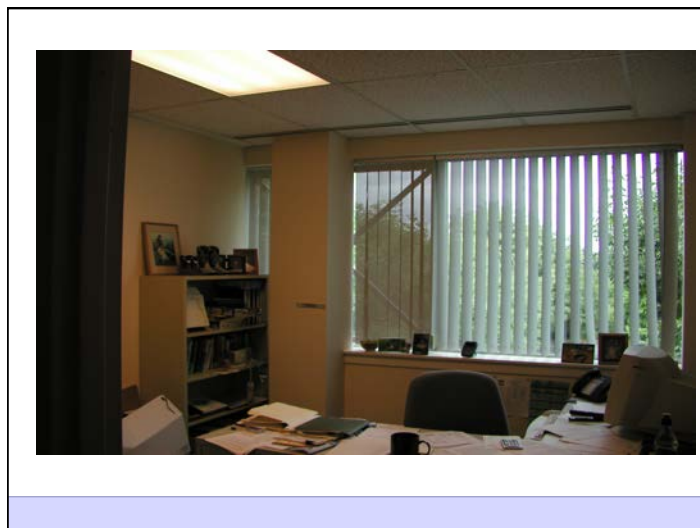
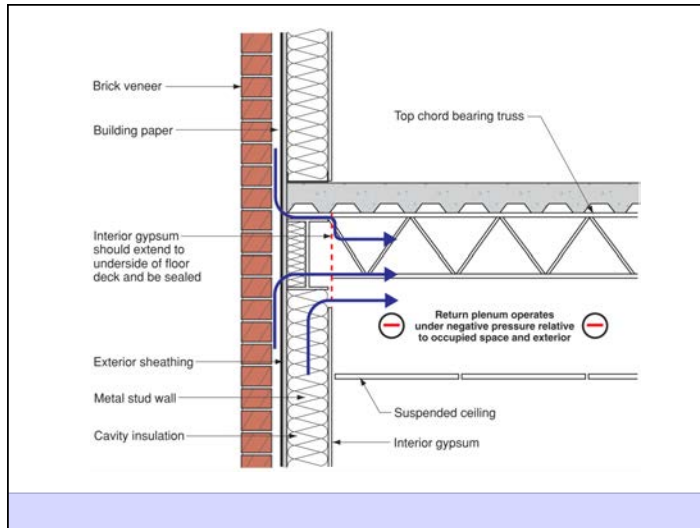


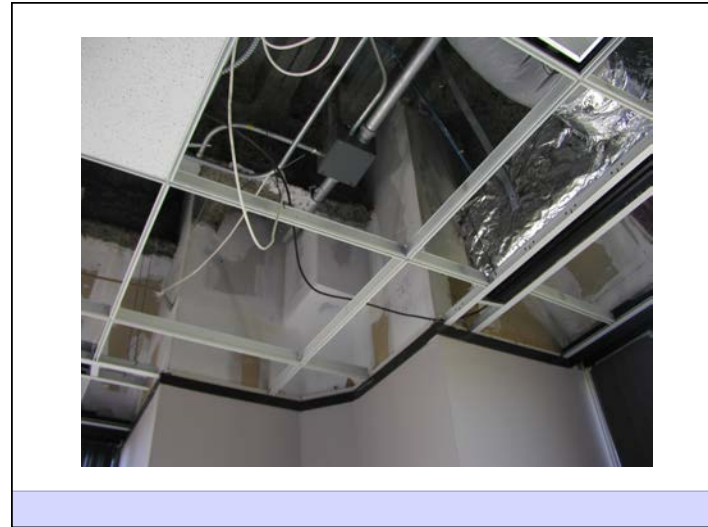
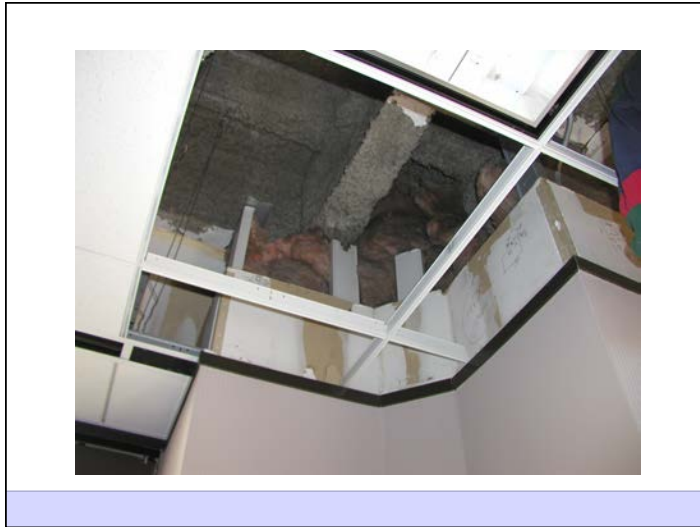


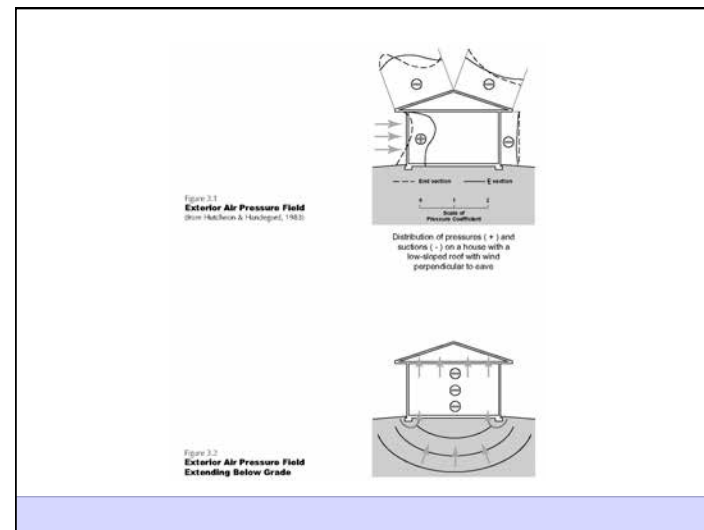
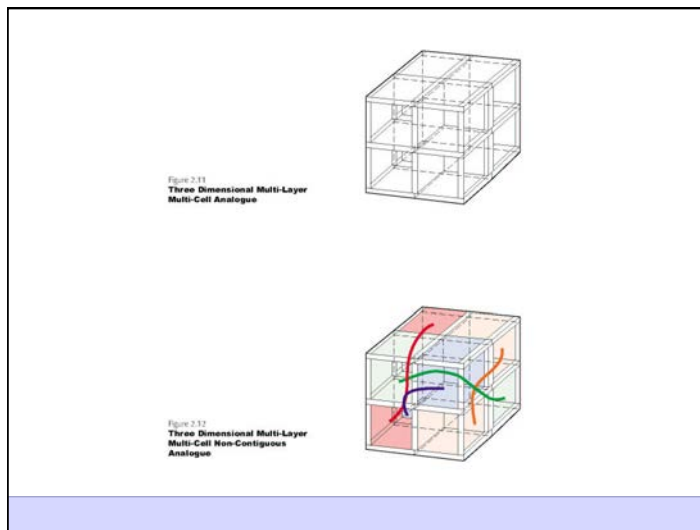
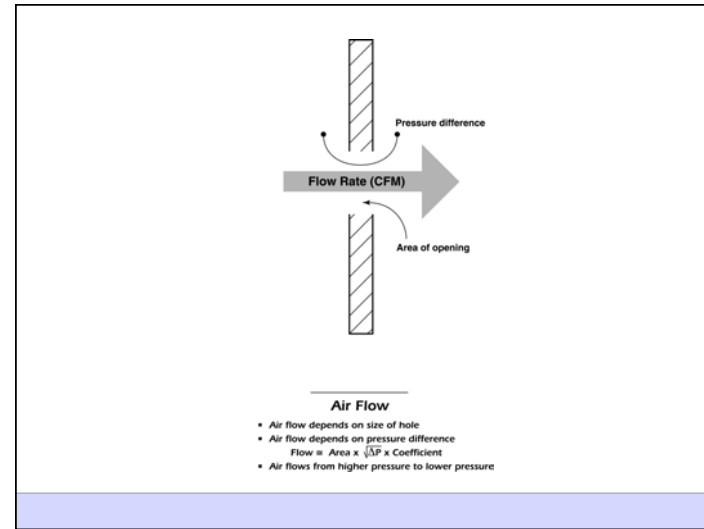
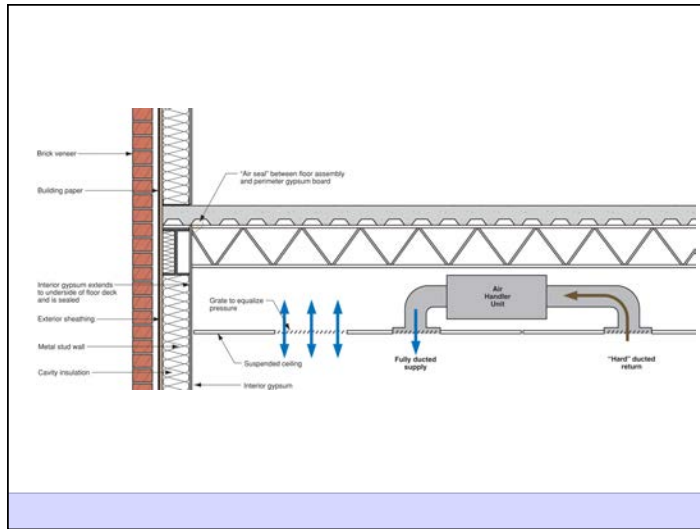




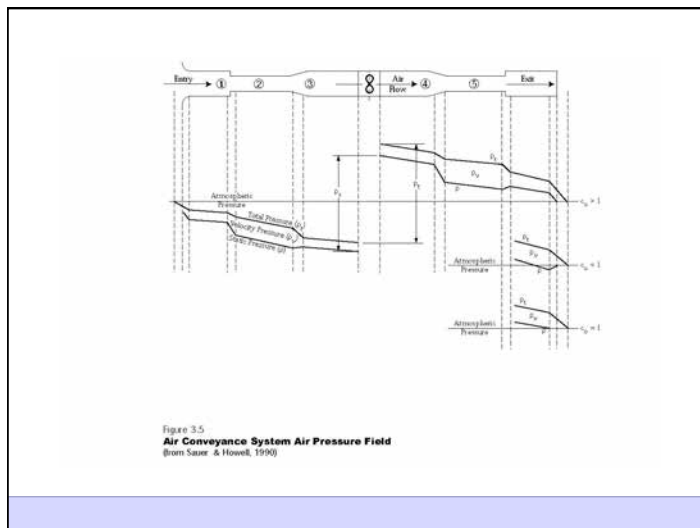
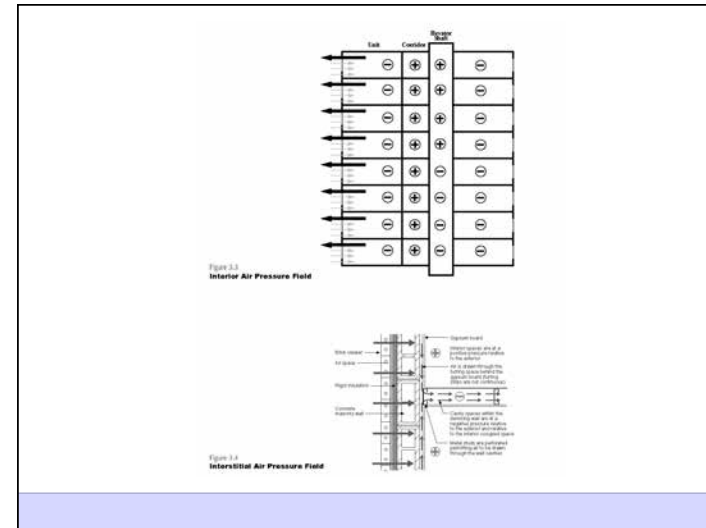
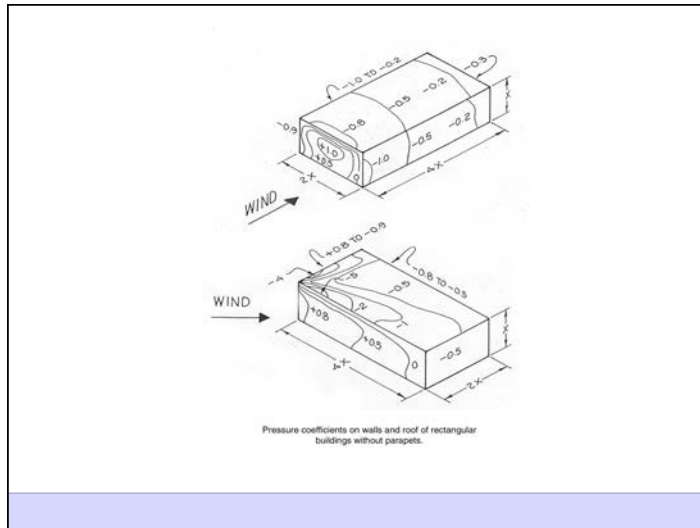


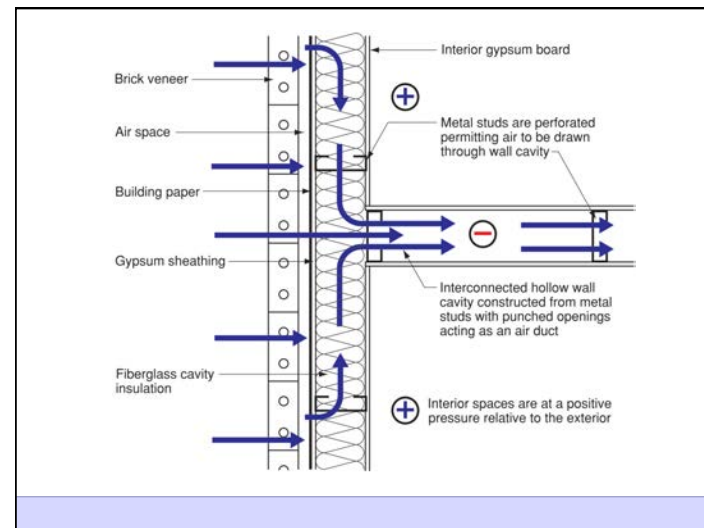
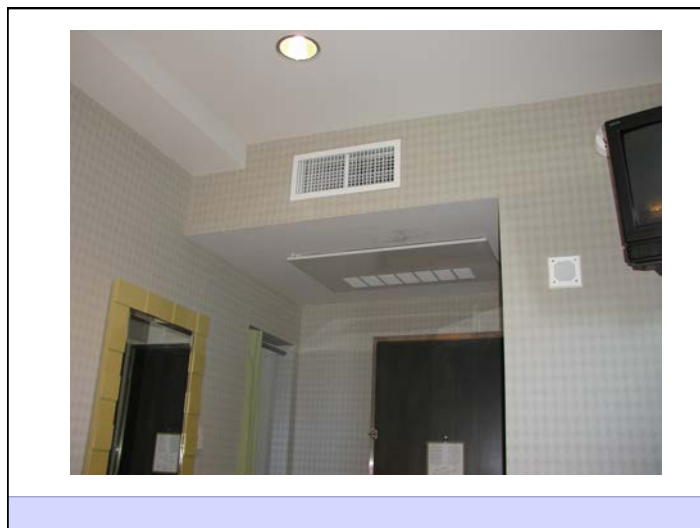
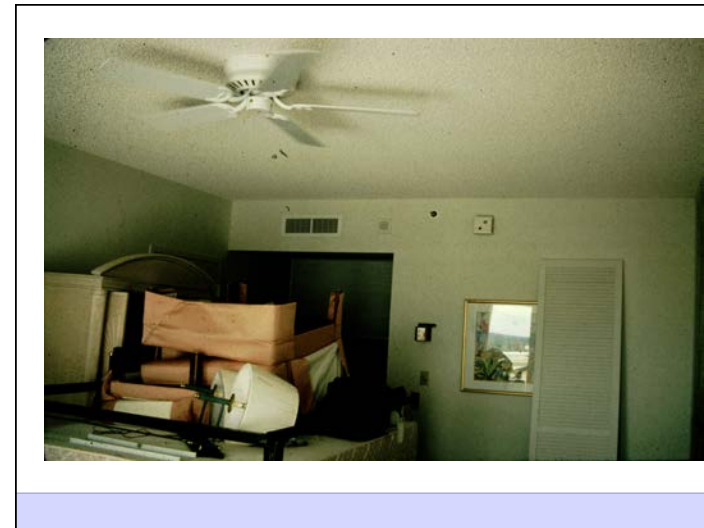
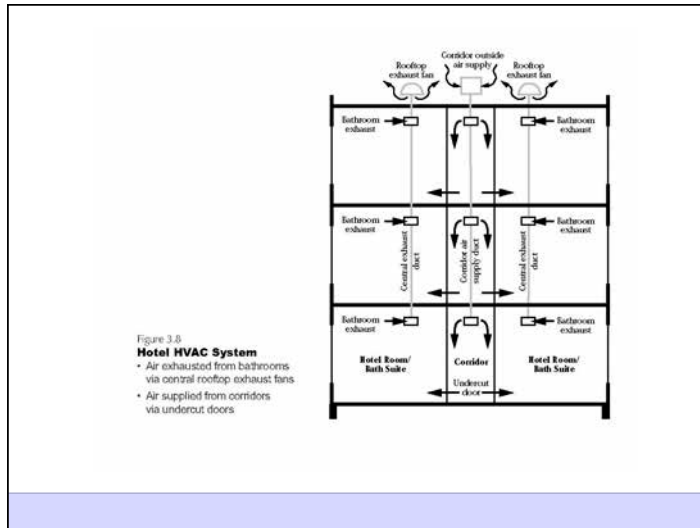


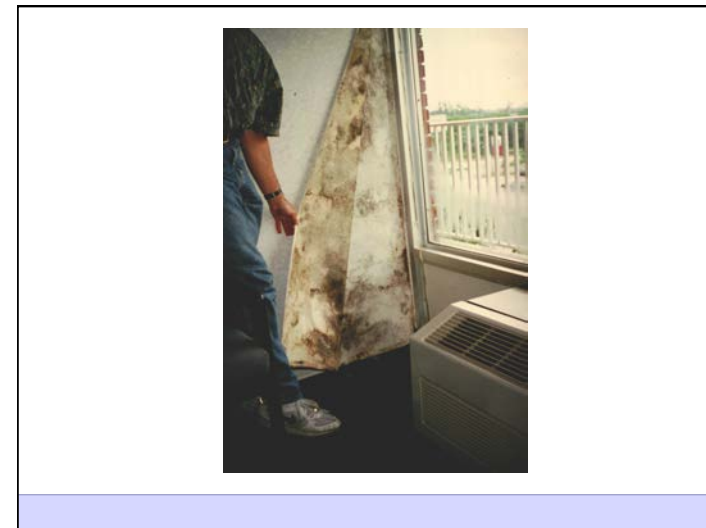
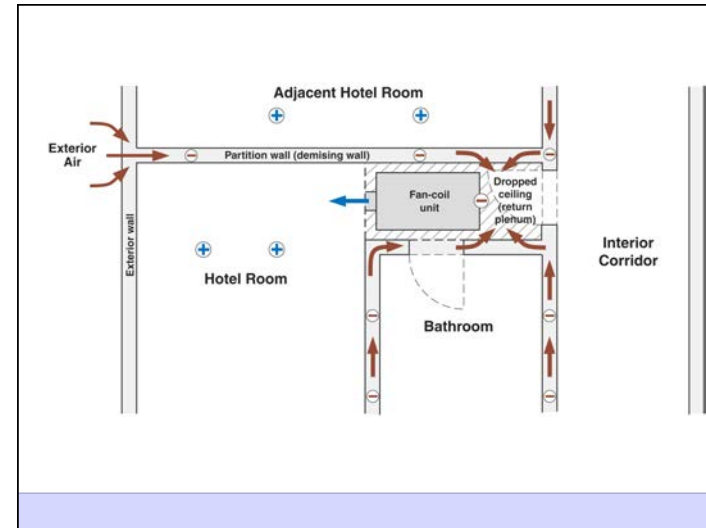
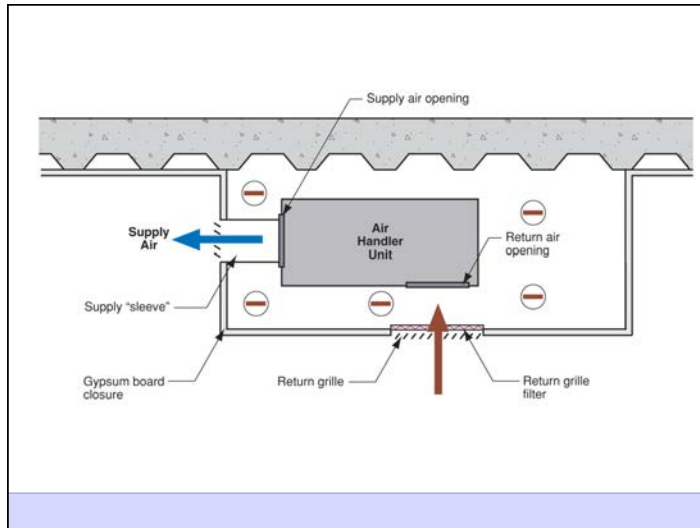


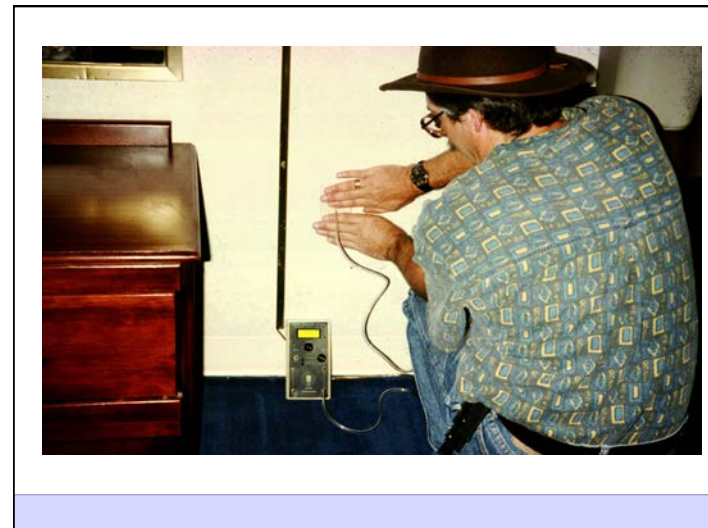
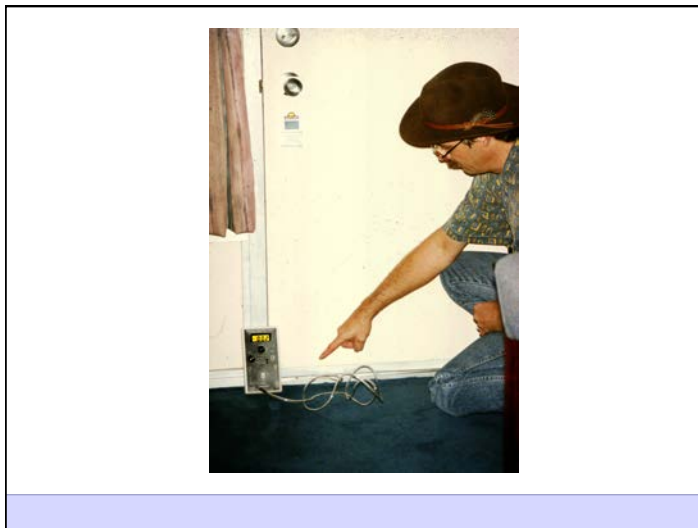
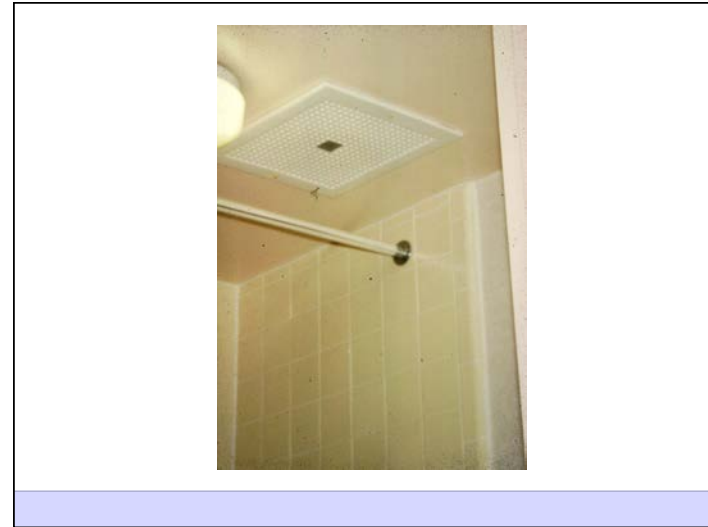
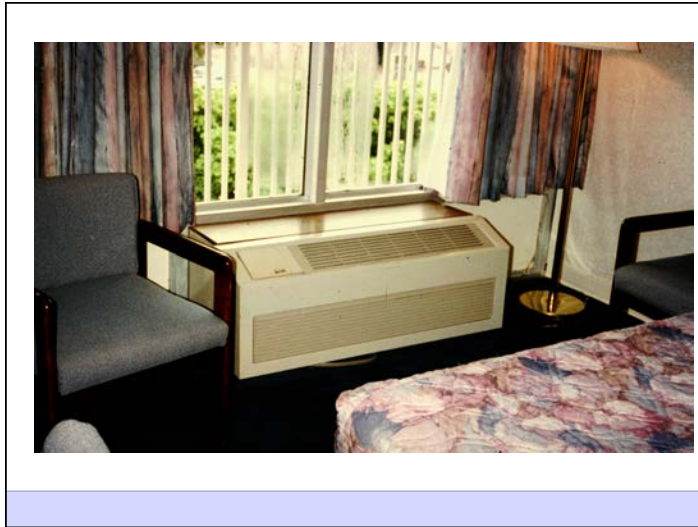




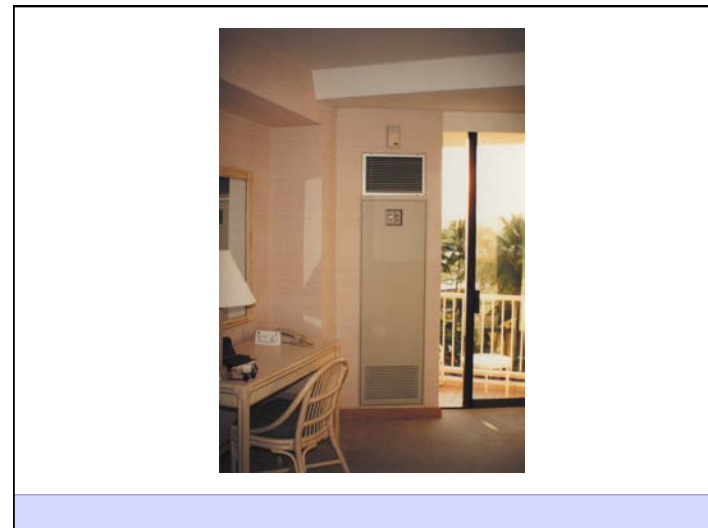
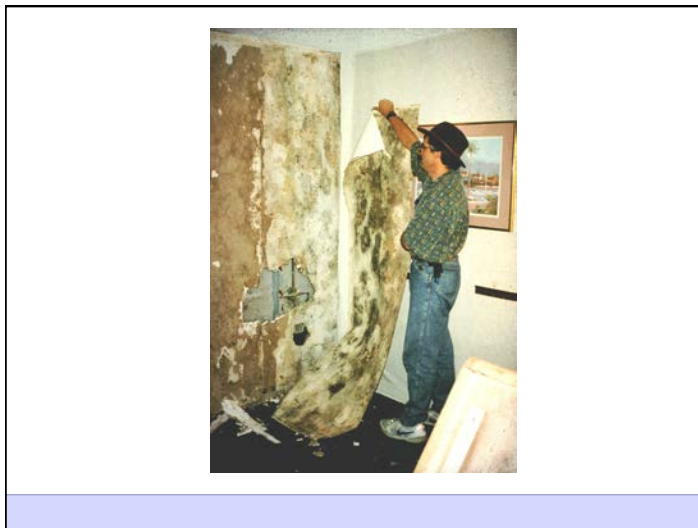
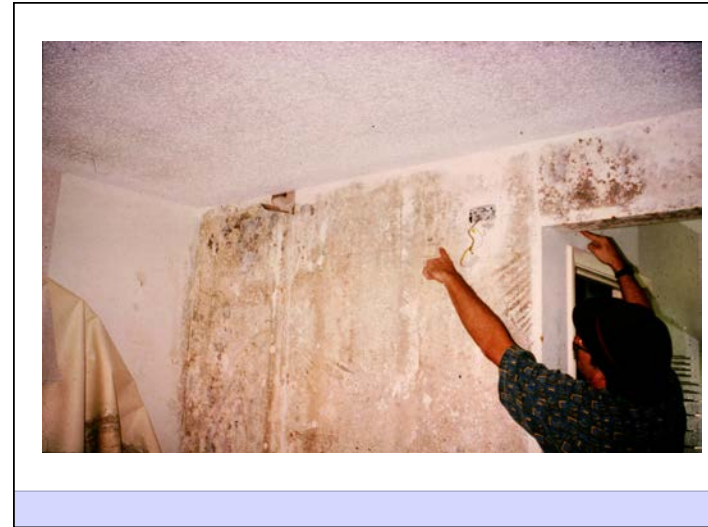
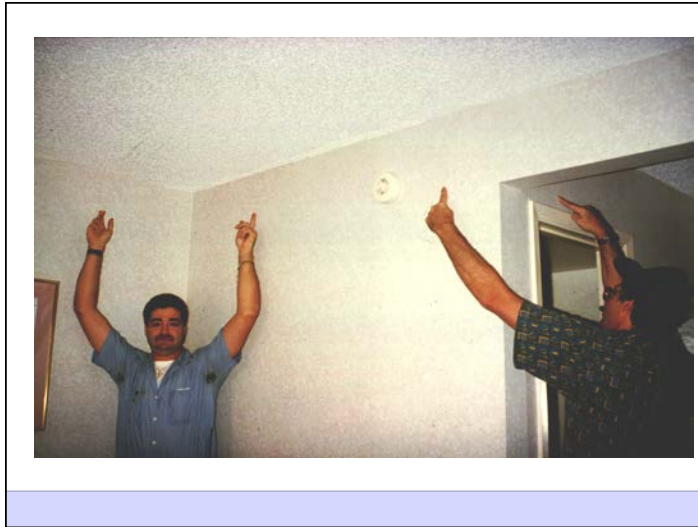


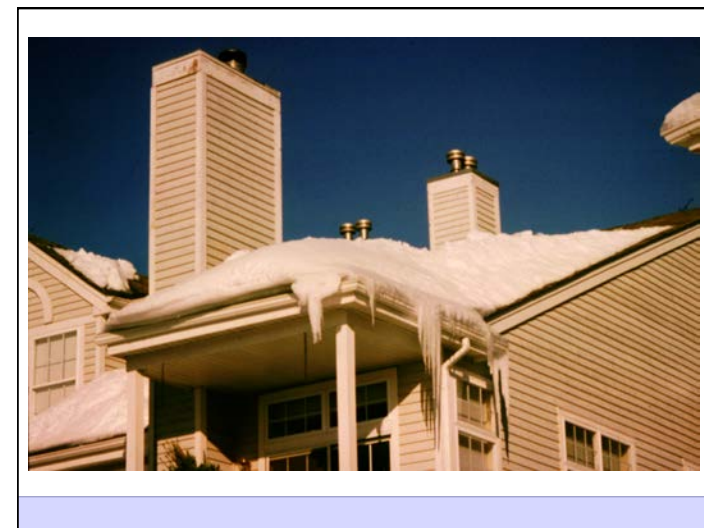
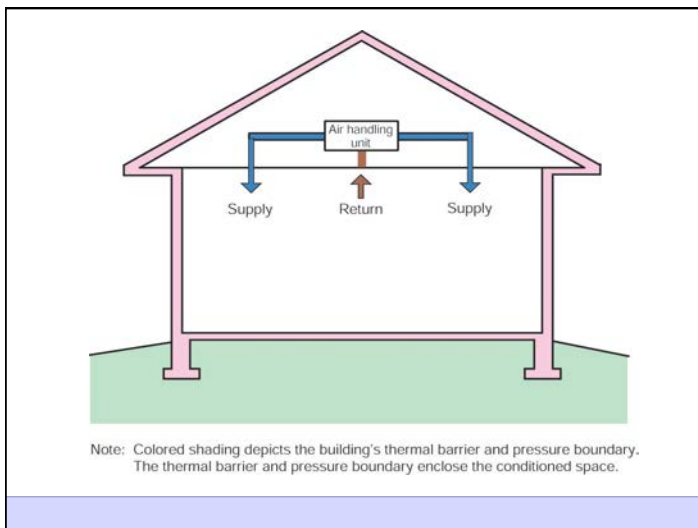
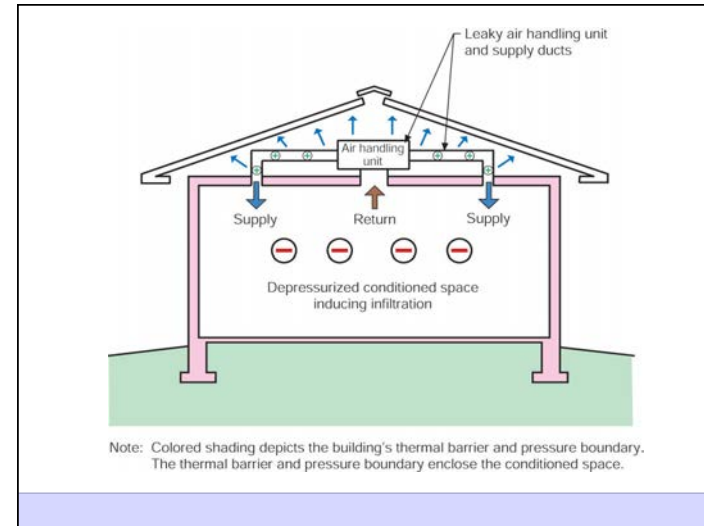
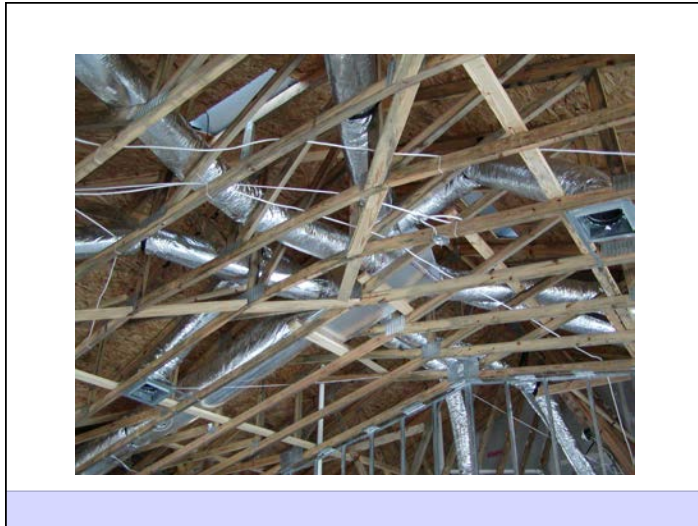


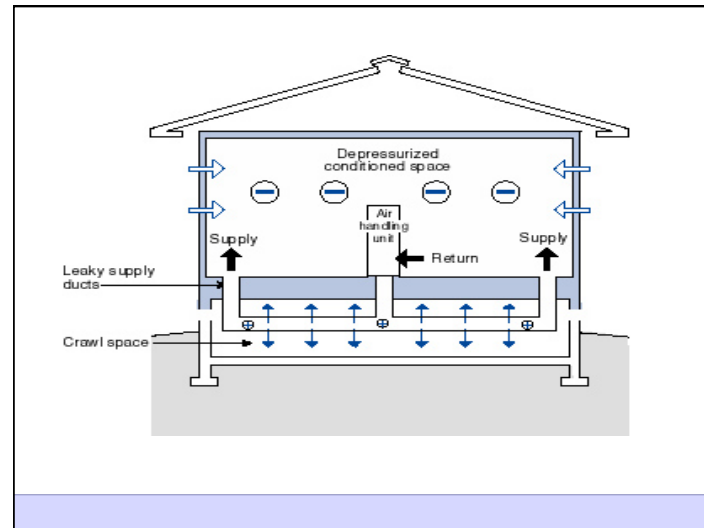
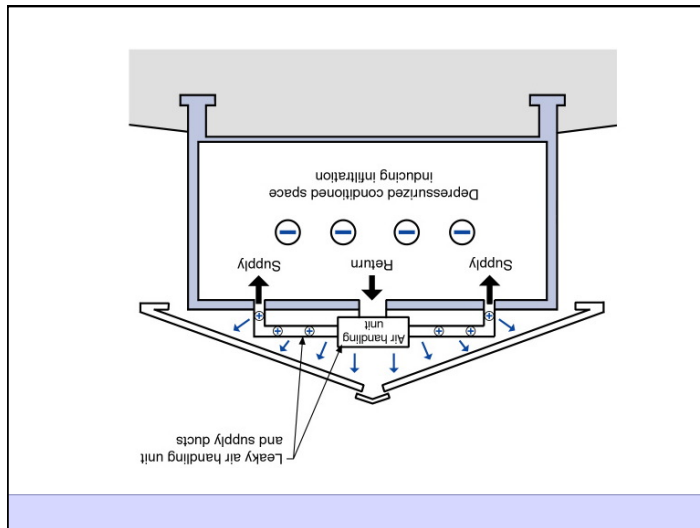
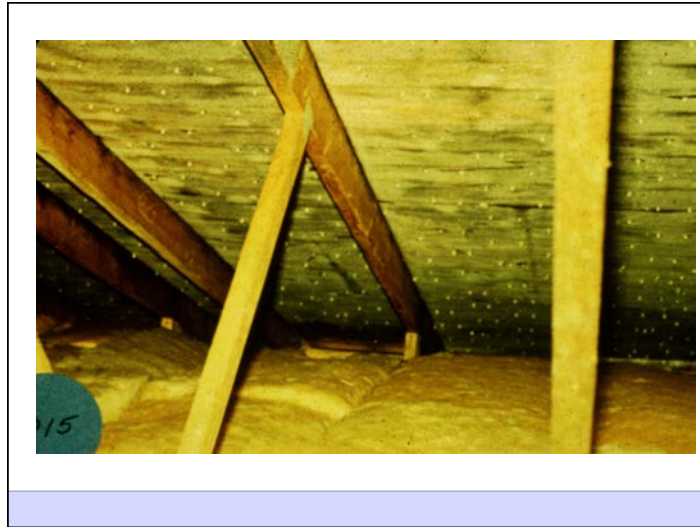




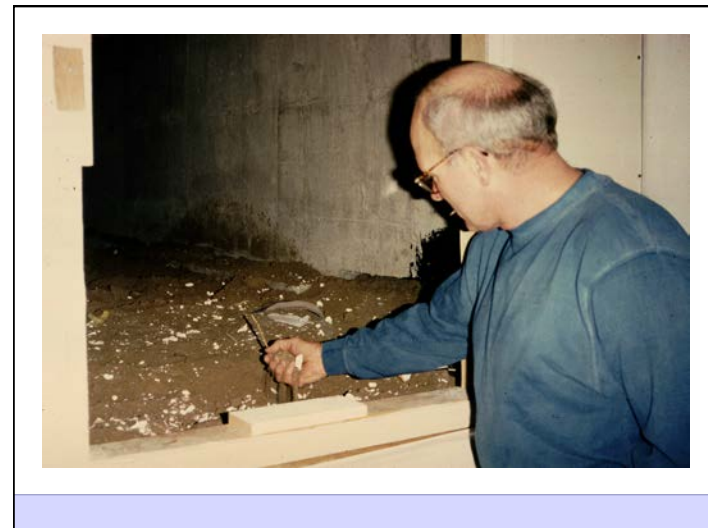




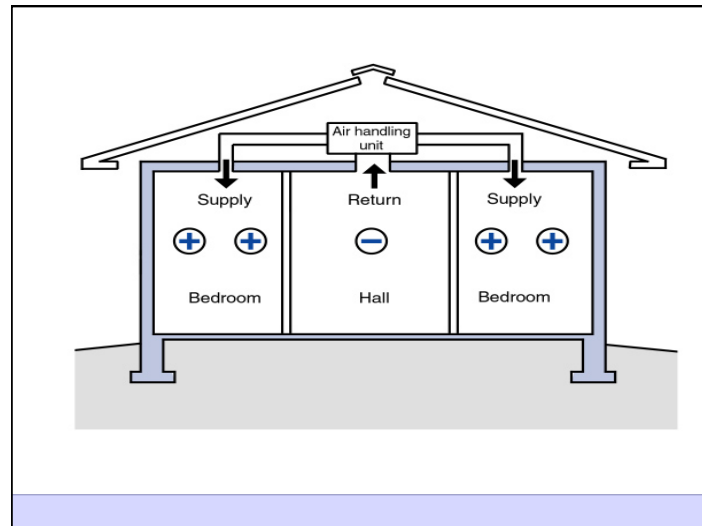
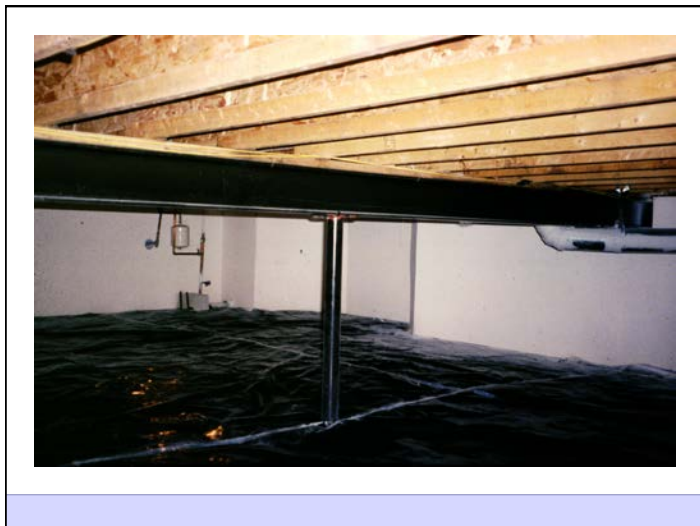
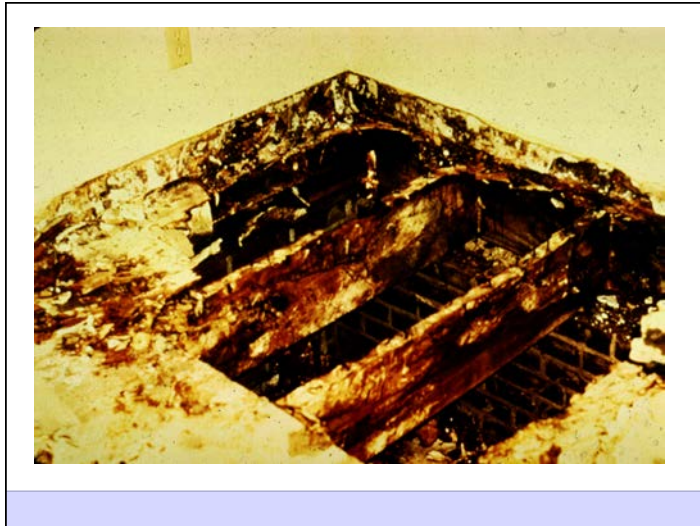


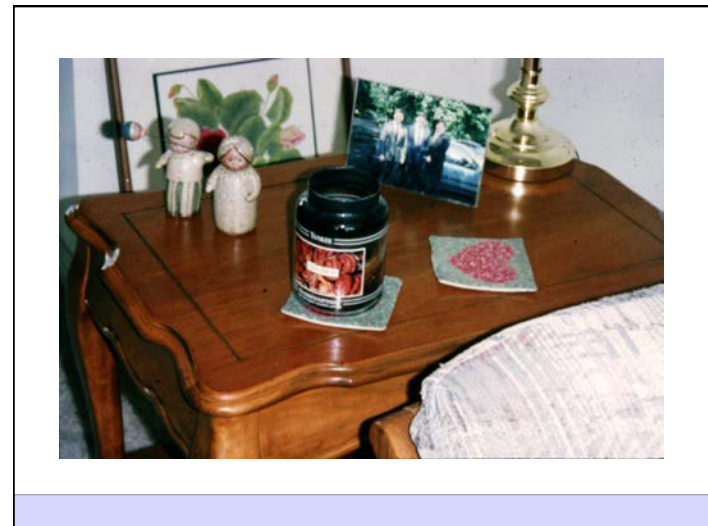
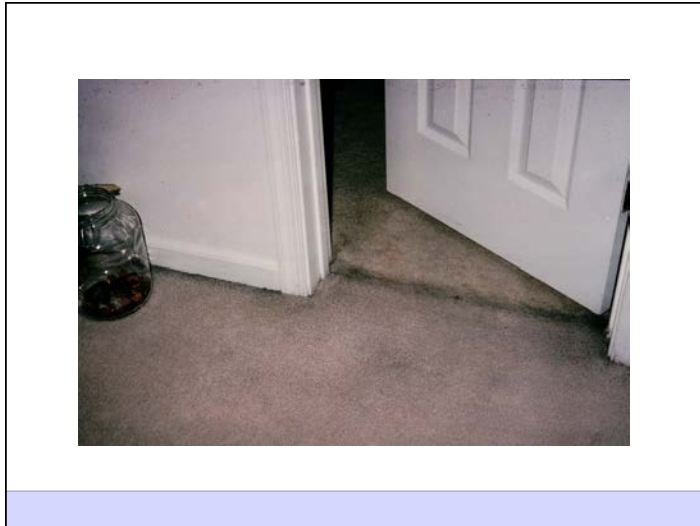


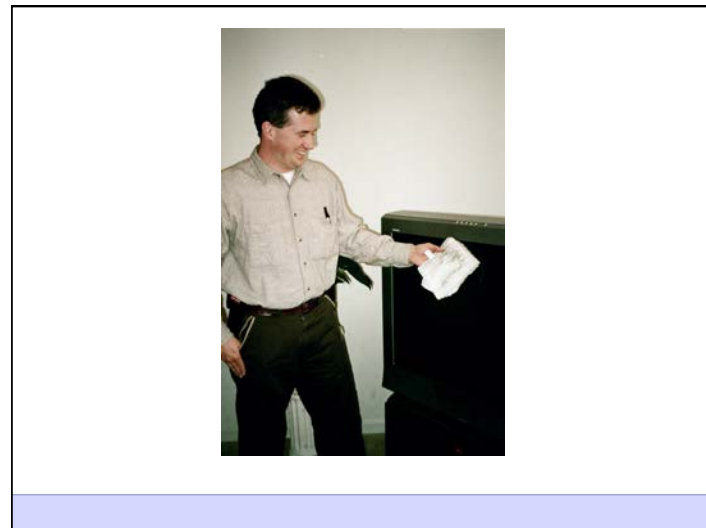
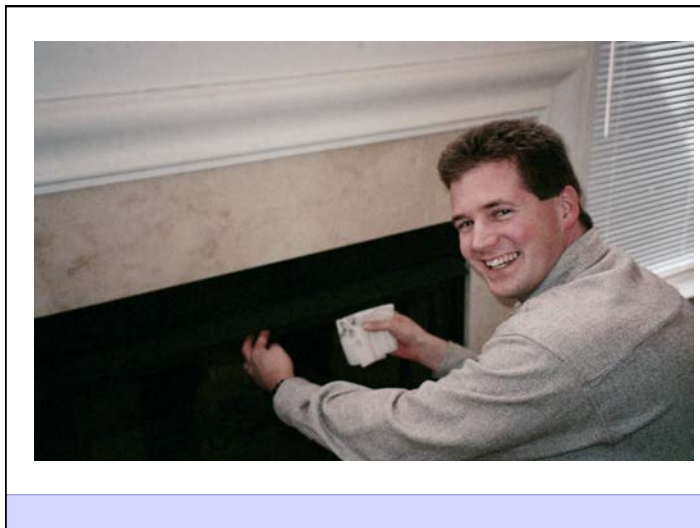


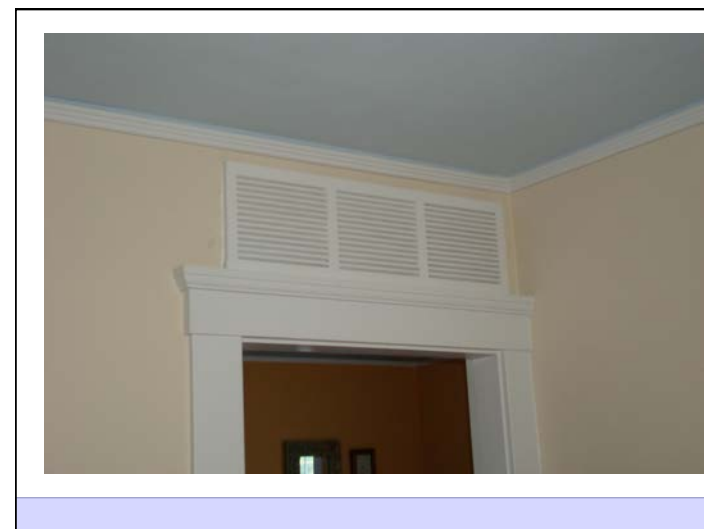
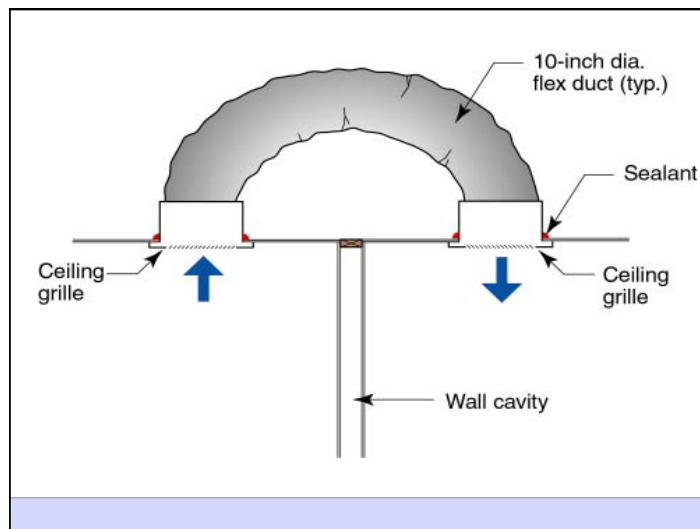
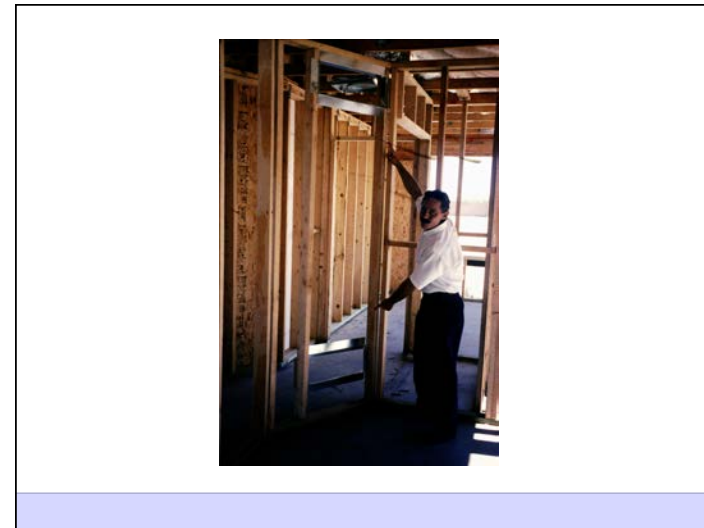
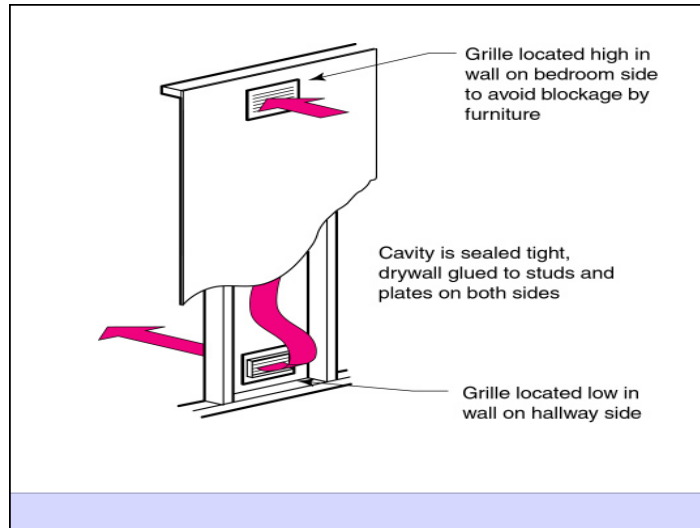




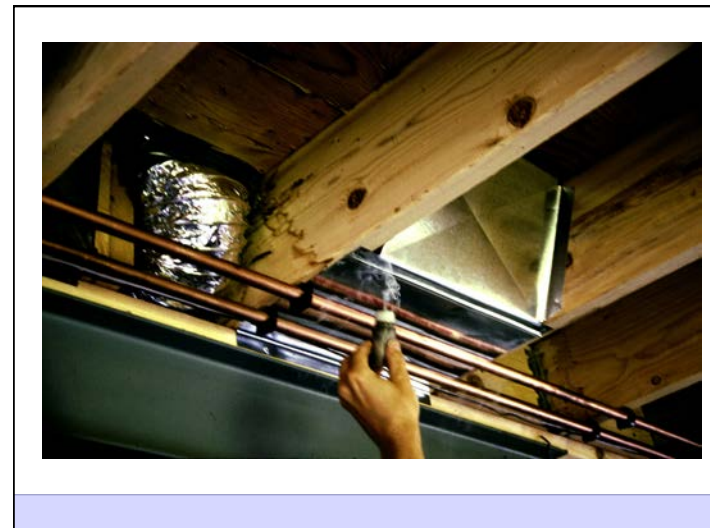
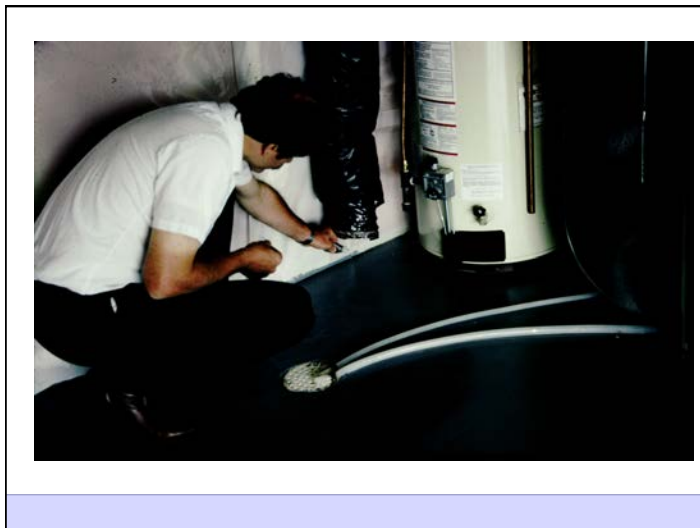
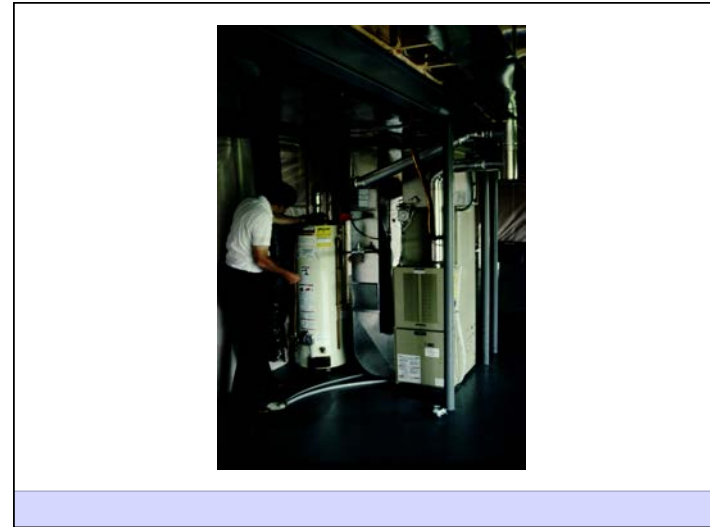
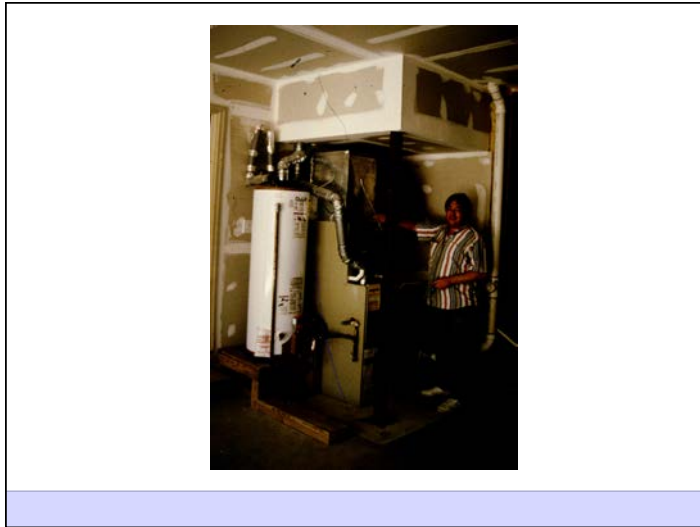


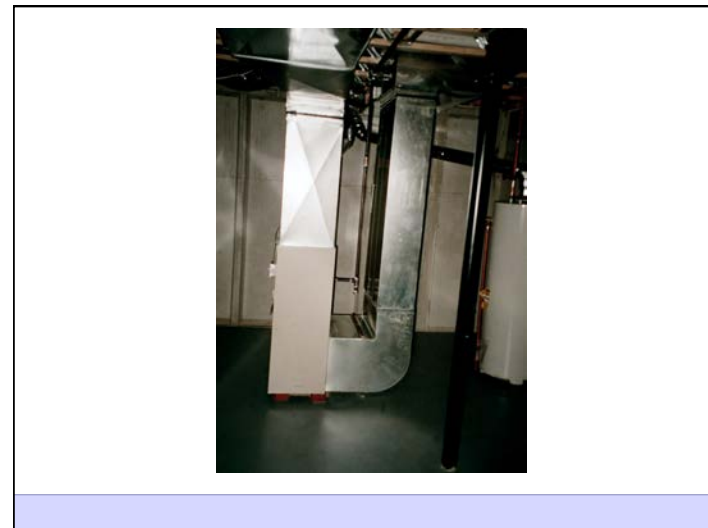
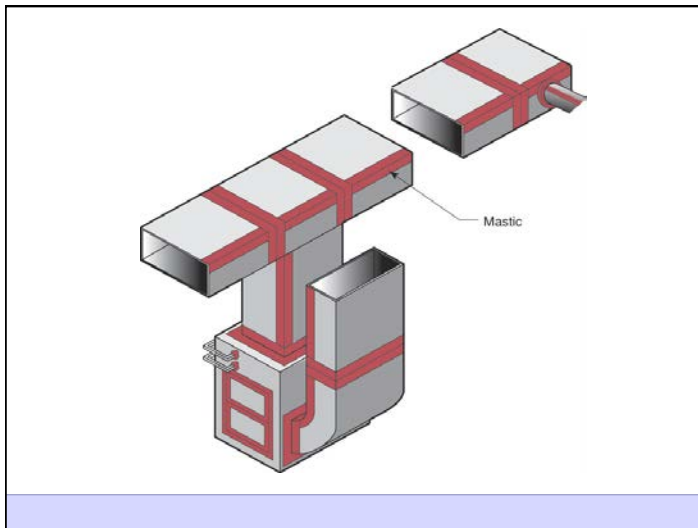






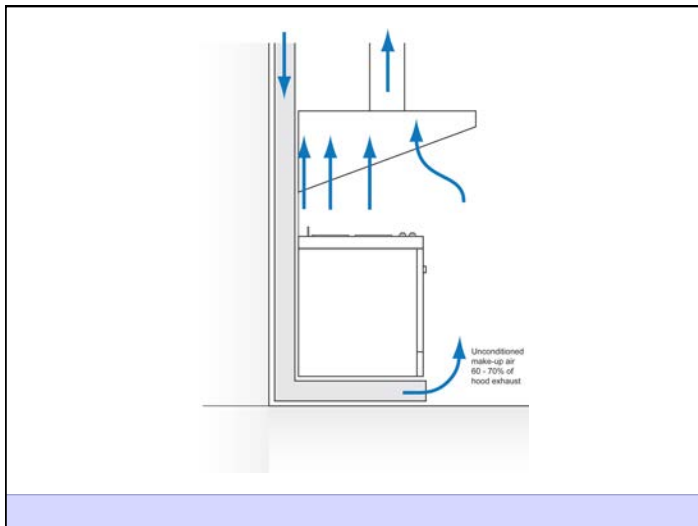


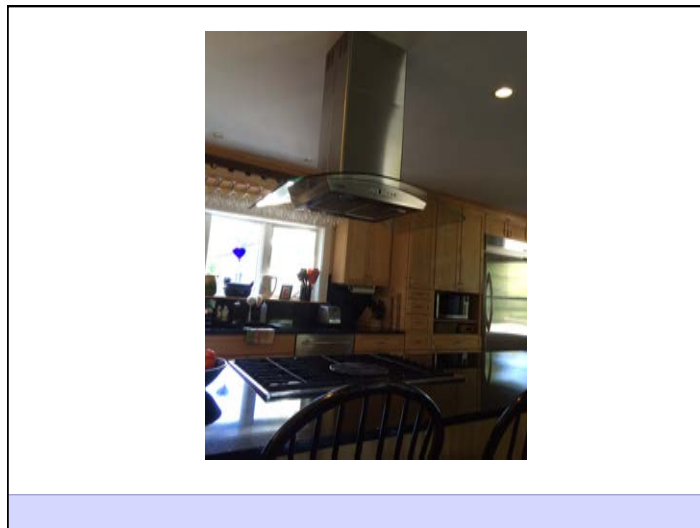
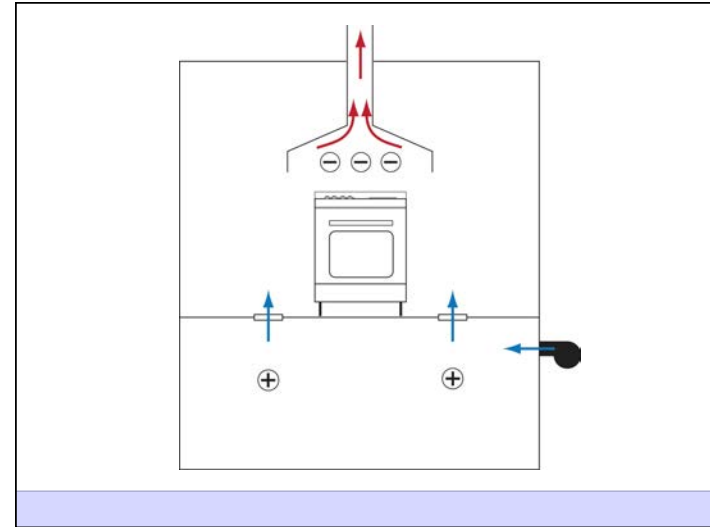
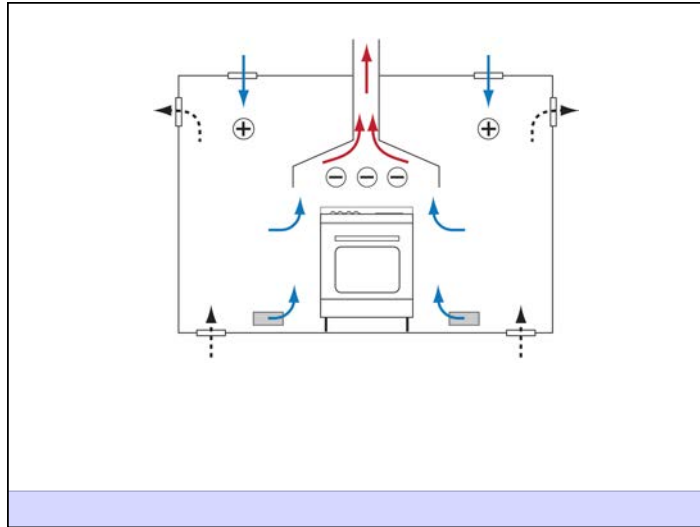




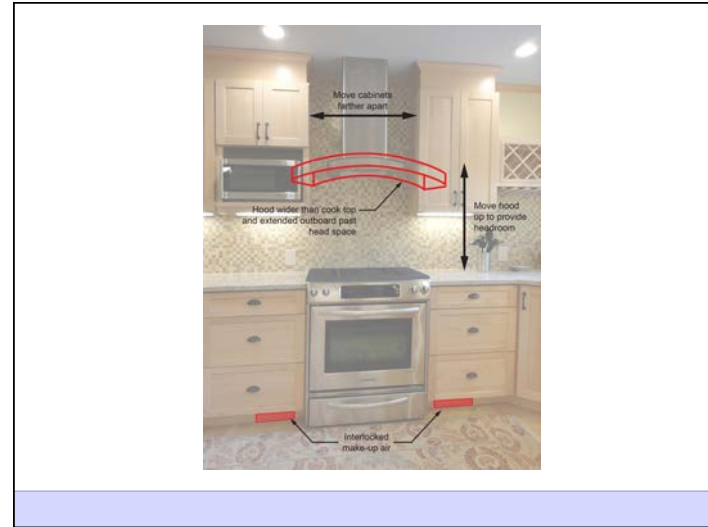
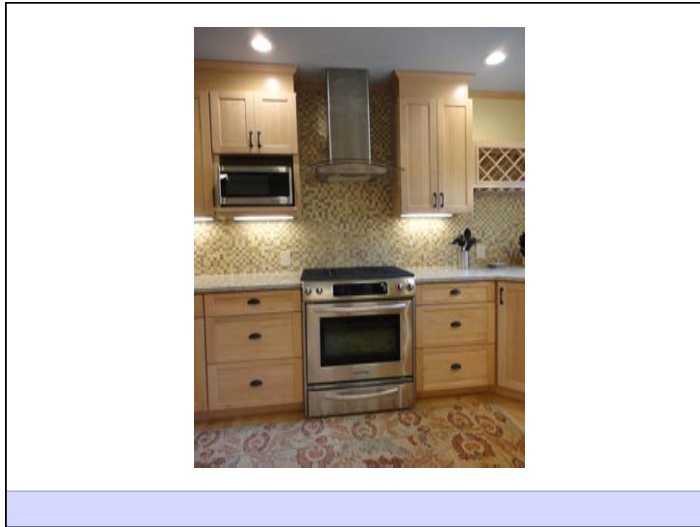


## Kitchen Exhaust Hoods



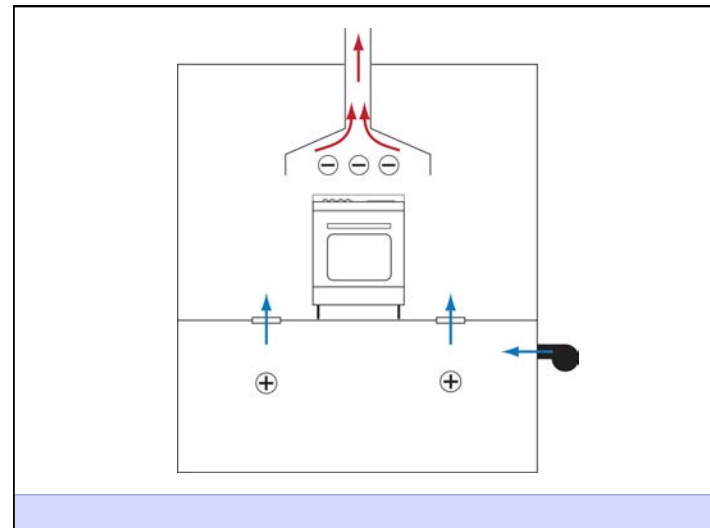
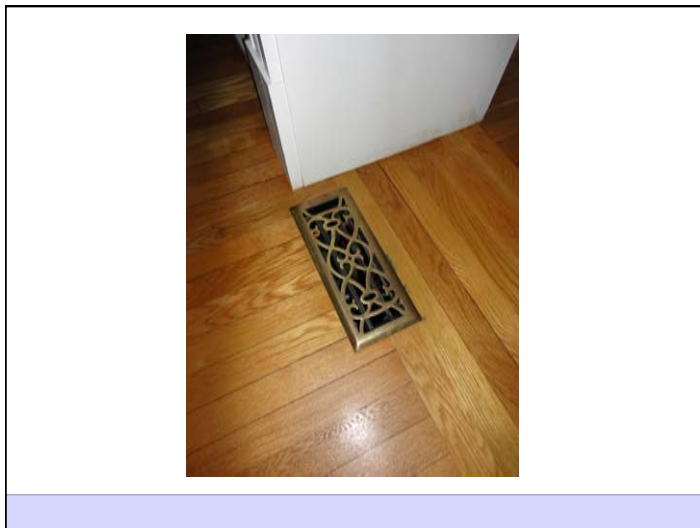
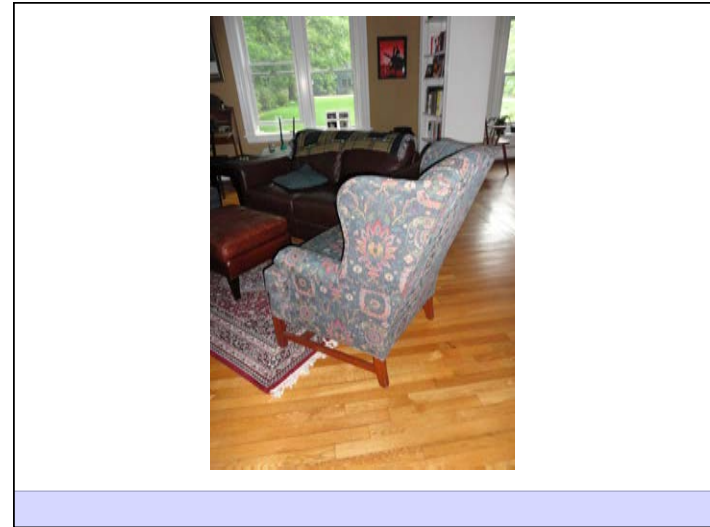
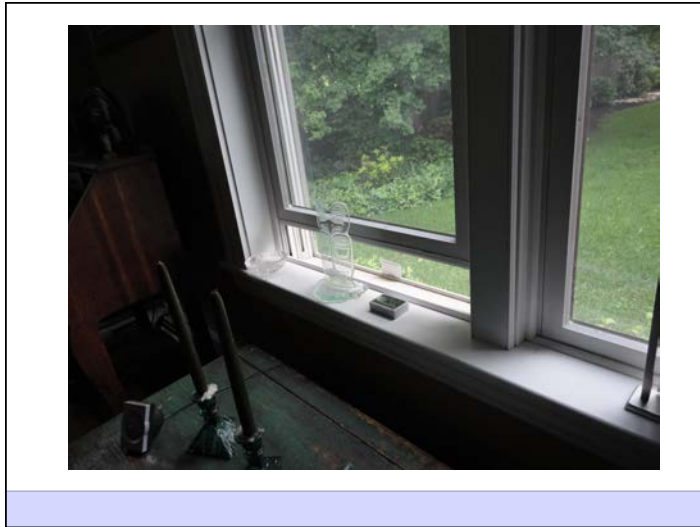






Clothes Dryers





Build Tight - Ventilate Right

Build Tight - Ventilate Right  
How Tight?  
What's Right?

#### Air Barrier Metrics

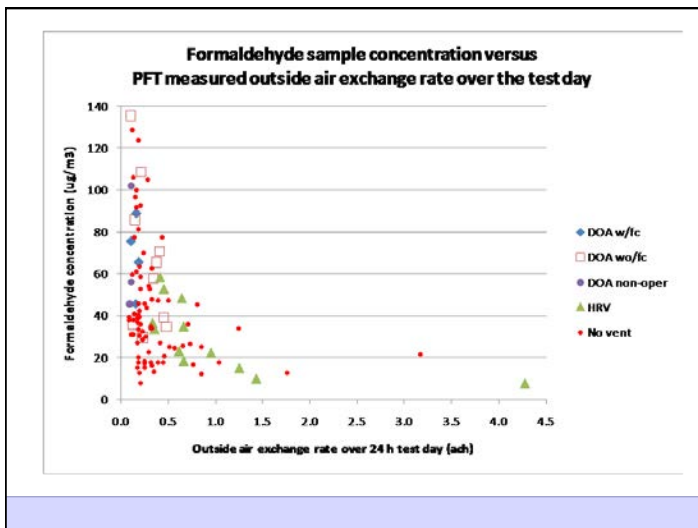
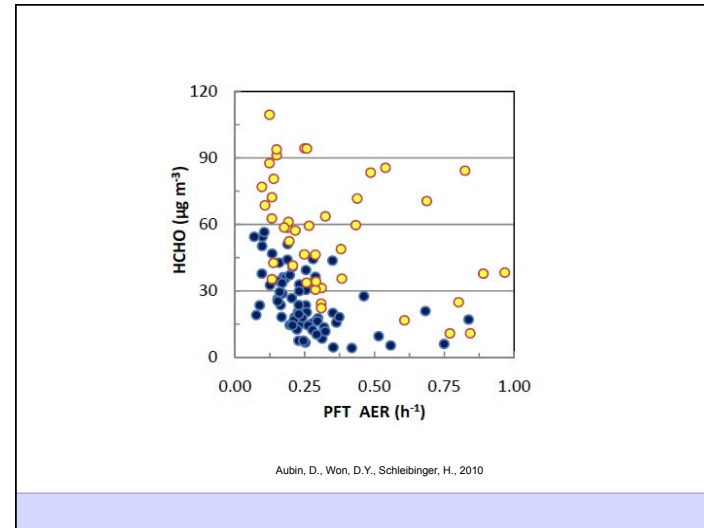
Material	0.02 l/(s-m <sup>2</sup> ) @ 75 Pa
Assembly	0.20 l/(s-m <sup>2</sup> ) @ 75 Pa
Enclosure	2.00 l/(s-m <sup>2</sup> ) @ 75 Pa
	0.35 cfm/ft <sup>2</sup> @ 50 Pa
	0.25 cfm/ft <sup>2</sup> @ 50 Pa
	0.15 cfm/ft <sup>2</sup> @ 50 Pa

Getting rid of big holes	3 ach@50
Getting rid of smaller holes	1.5 ach@50
Getting German	0.6 ach@50



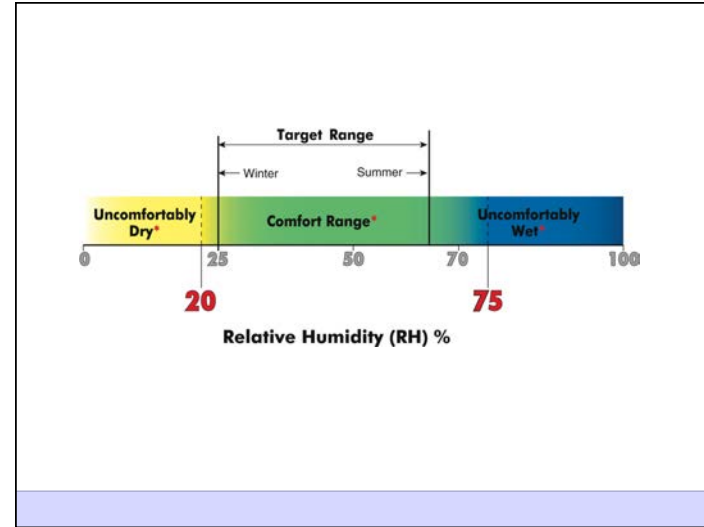
Best

As Tight as Possible - with -  
 Balanced Ventilation  
 Energy Recovery  
 Distribution and Mixing  
 Source Control - Spot exhaust ventilation  
 Filtration  
 Material selection

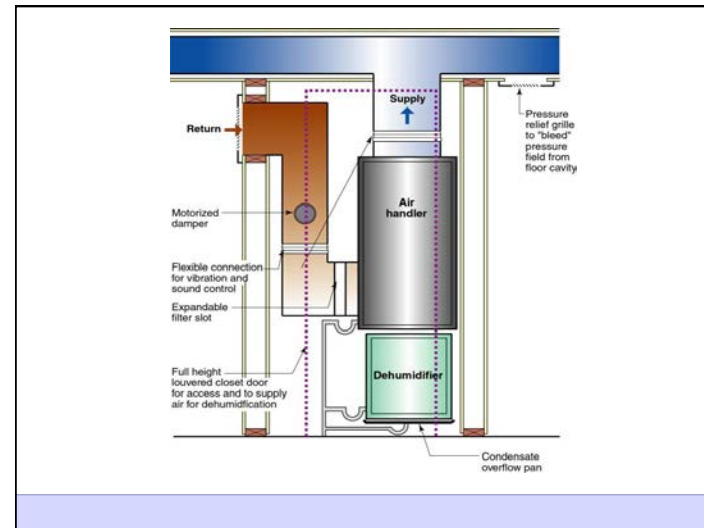


Dilution Is Not The Solution To Indoor  
 Pollution  
 Source Control

Dilution For People  
 Source Control For The Building



Recommended Range of Relative Humidity  
 Above 25 percent during winter  
 Below 70 percent during summer





Ventilation Rates Are Based on Odor Control  
Health Science Basis for Ventilation Rates is  
Extremely Limited

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Almost Nothing Cited Applies to Housing

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The Applicable Studies Focus on Dampness

ASHRAE Standard 62.2 calls for 7.5 cfm per person plus 0.03 cfm per square foot of conditioned area

Occupancy is deemed to be the number of bedrooms plus one

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Outcome is often bad – part load humidity problems, dryness problems, energy problems