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Building Science

Adventures In Building Science

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Ventilation In Houses

Build Tight - Ventilate Right

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How Tight?
What's Right?

Air Barrier Metrics

Material	0.02 l/(s-m ²) @ 75 Pa
Assembly	0.20 l/(s-m ²) @ 75 Pa
Enclosure	2.00 l/(s-m ²) @ 75 Pa 0.25 cfm/ft ² @ 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

Worst

Leaky - with – Nothing

Spot Ventilation in Bathroom/Kitchen

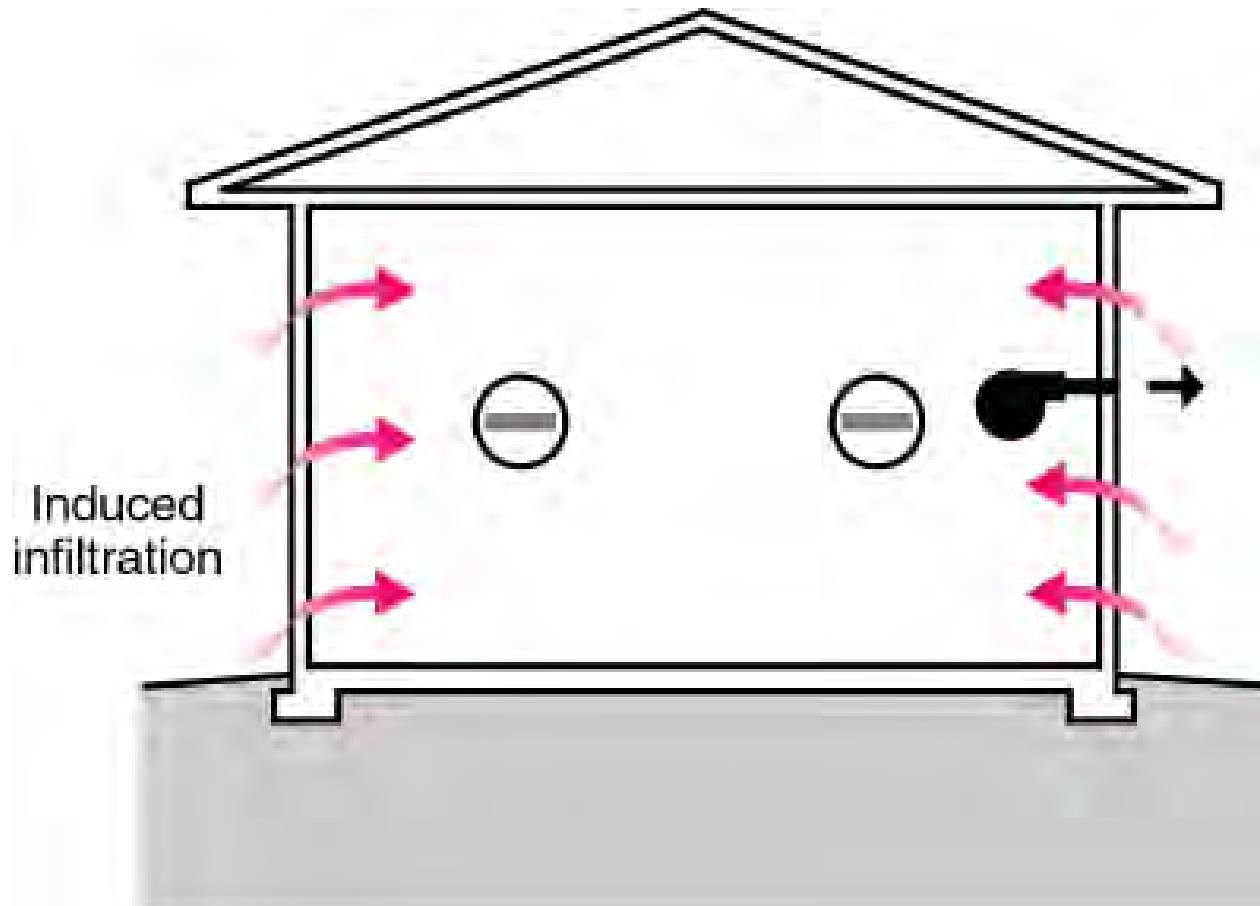
Exhaust Ventilation – with – No Distribution
and No Mixing

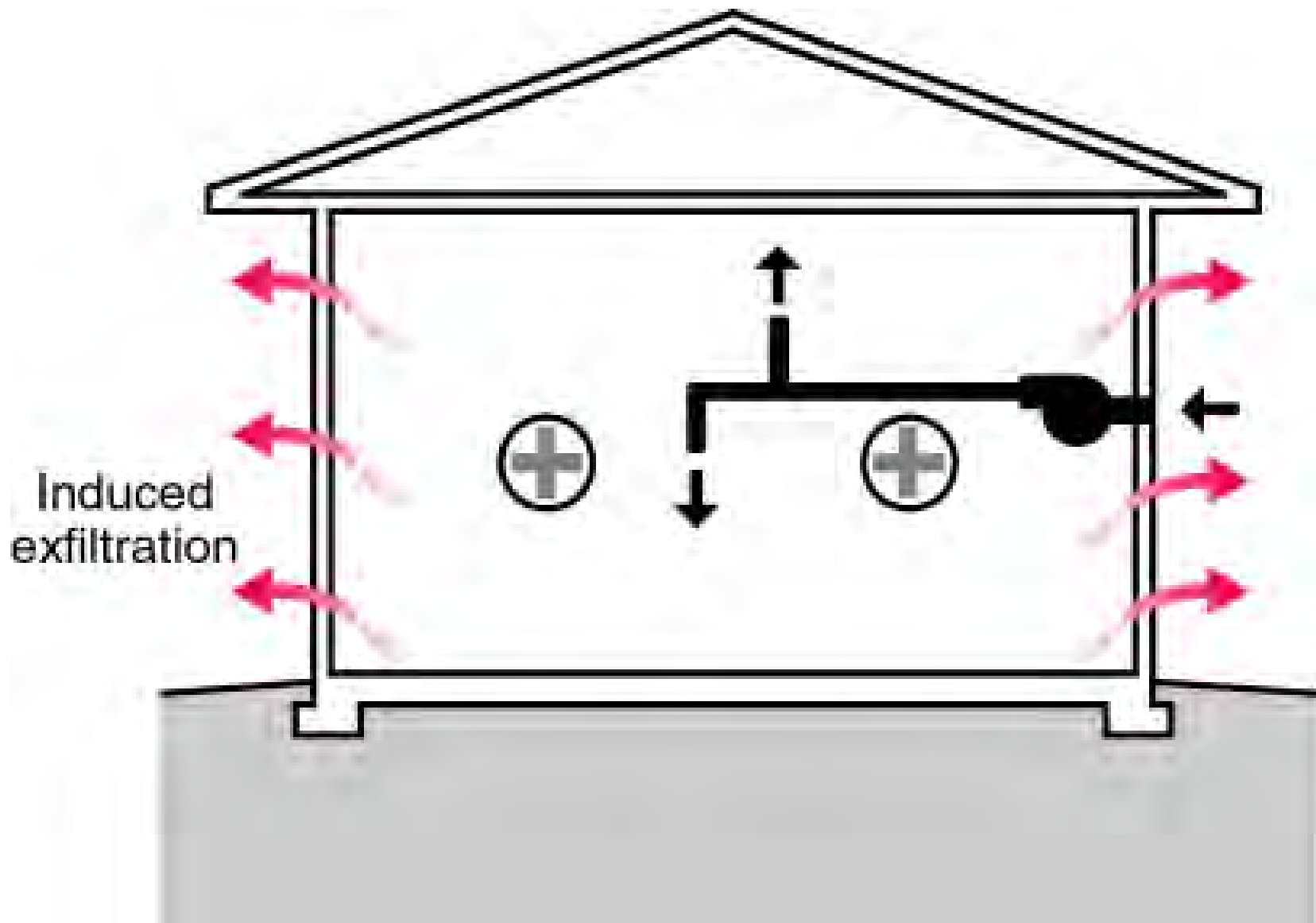
Three Types of Controlled Ventilation Systems

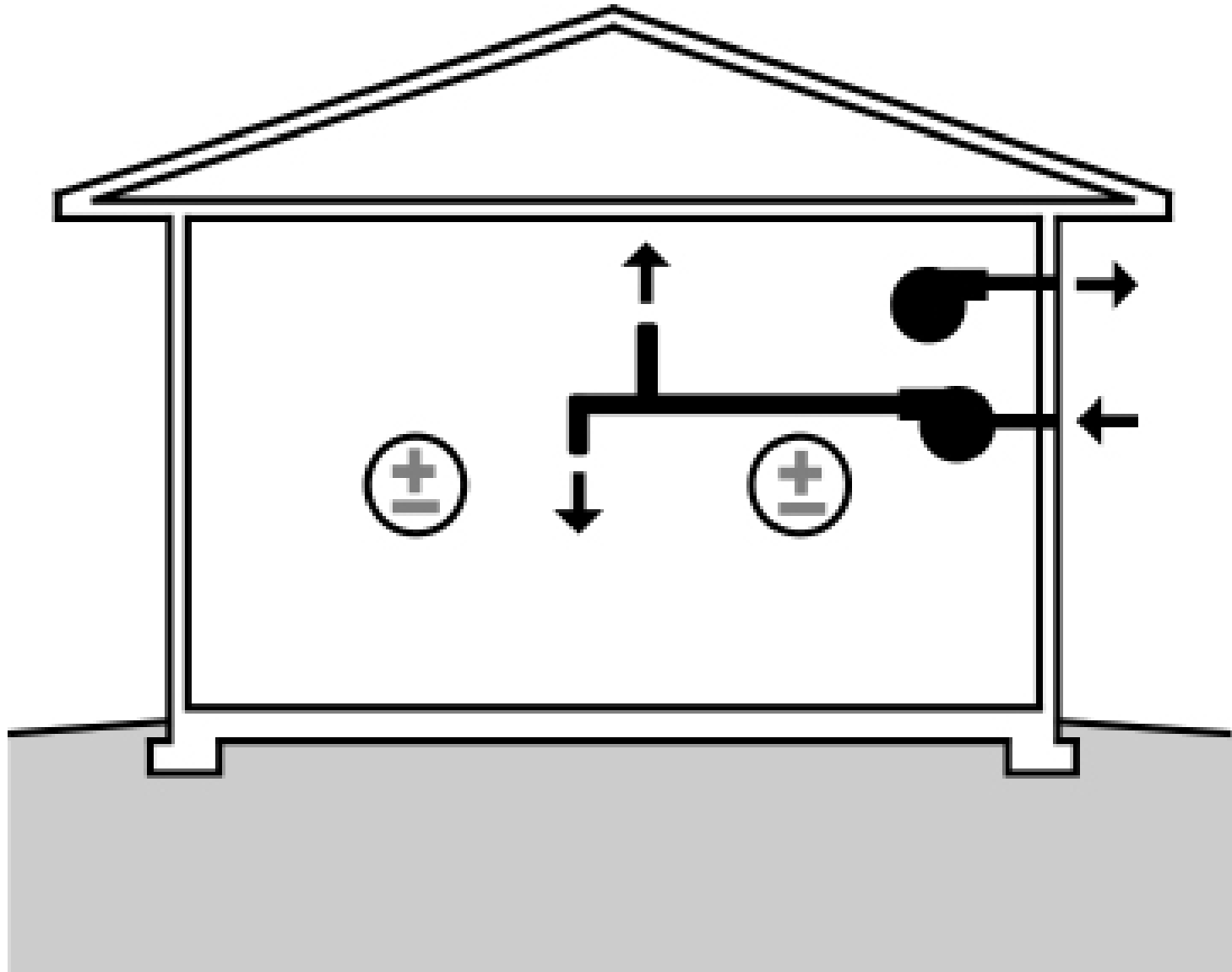
Exhaust Ventilation

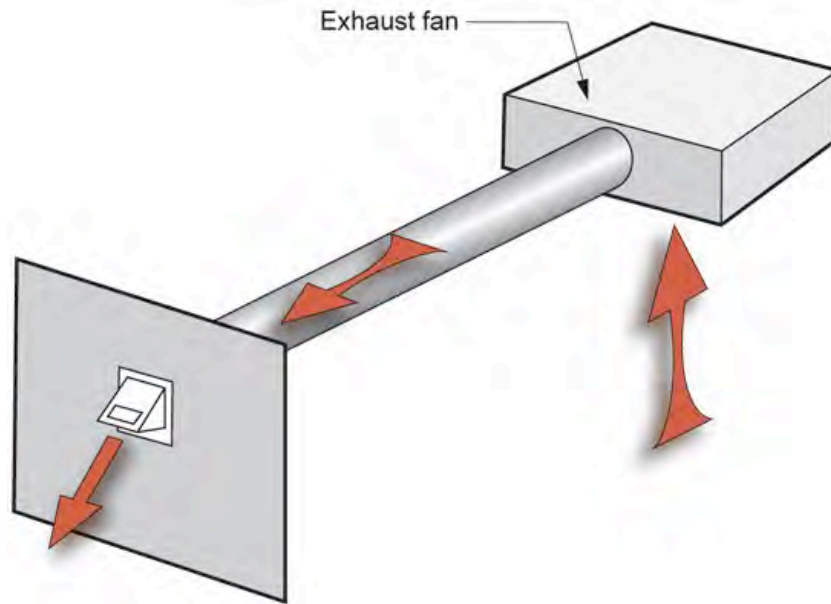
Supply Ventilation

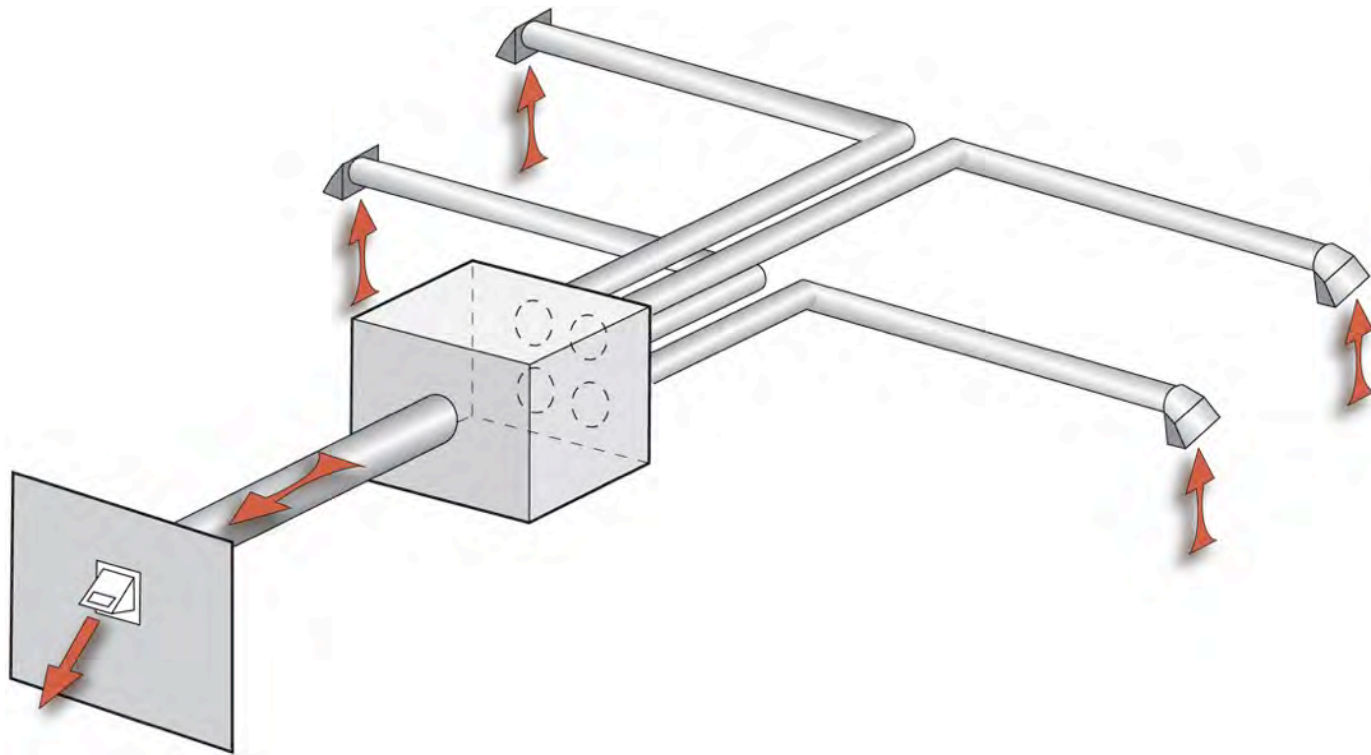
Balanced Ventilation

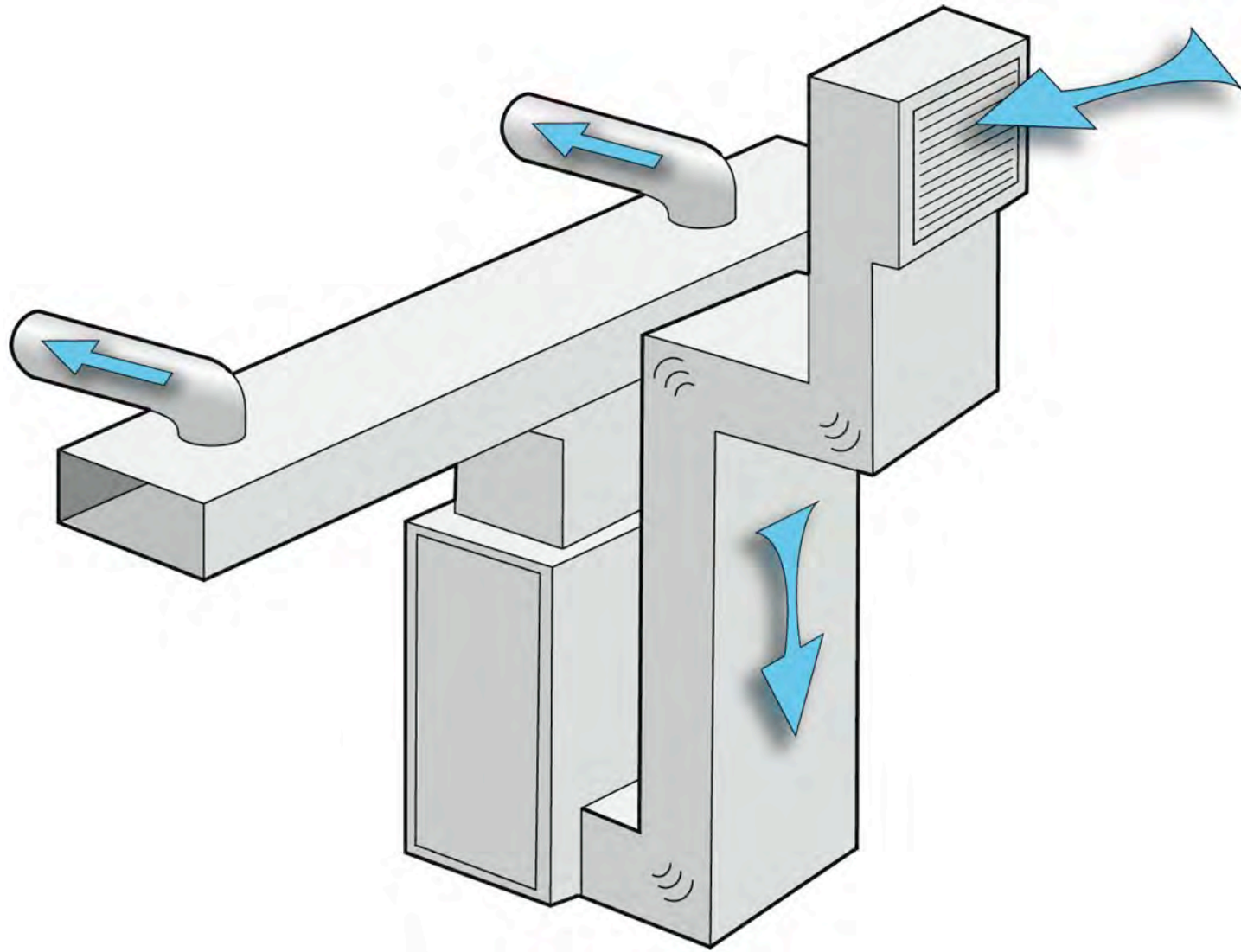


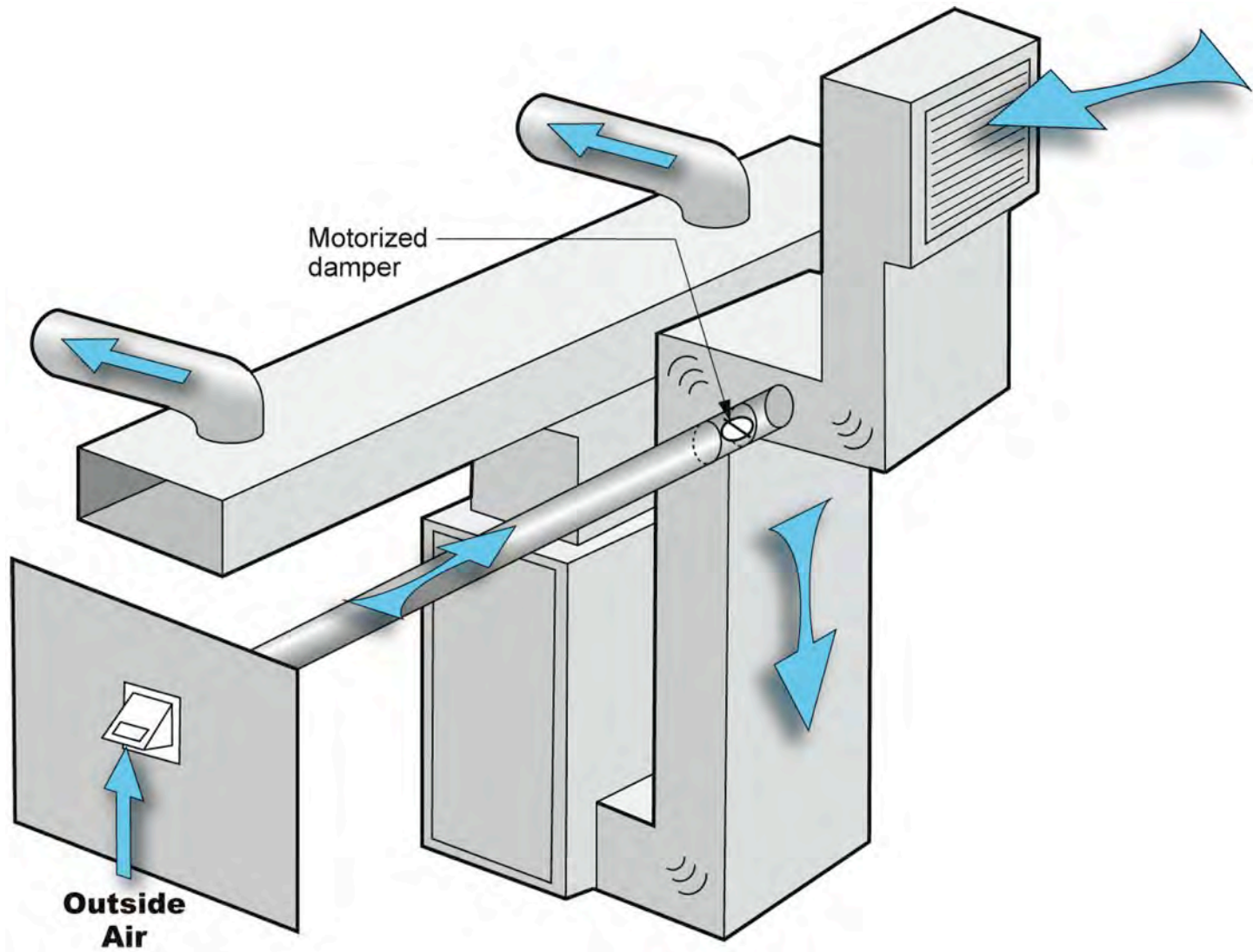


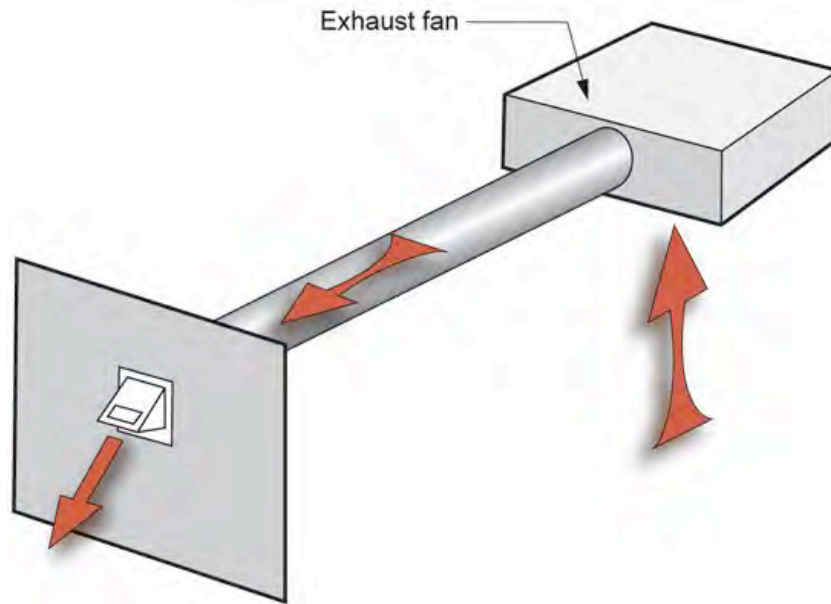


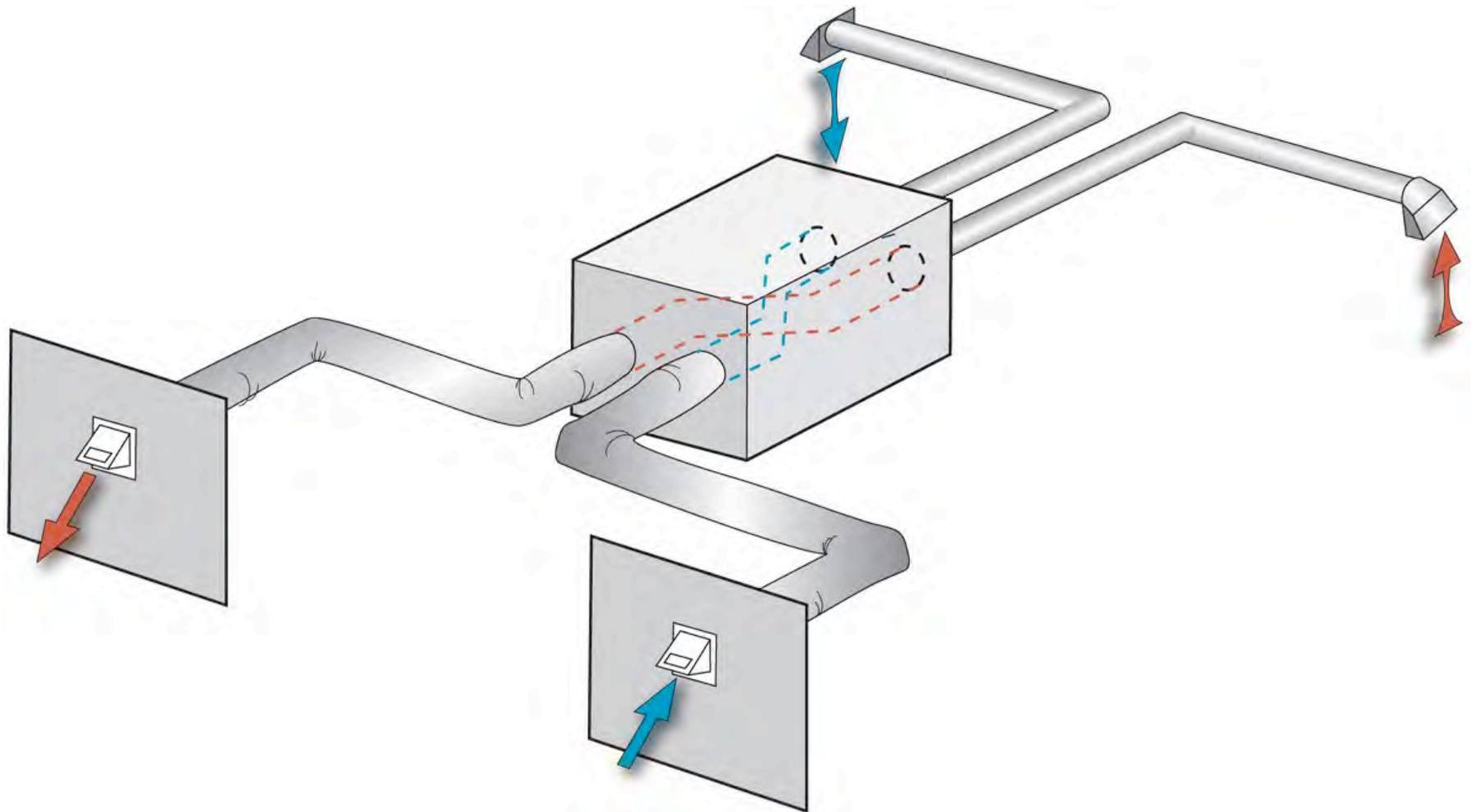












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The Applicable Studies Focus on Dampness

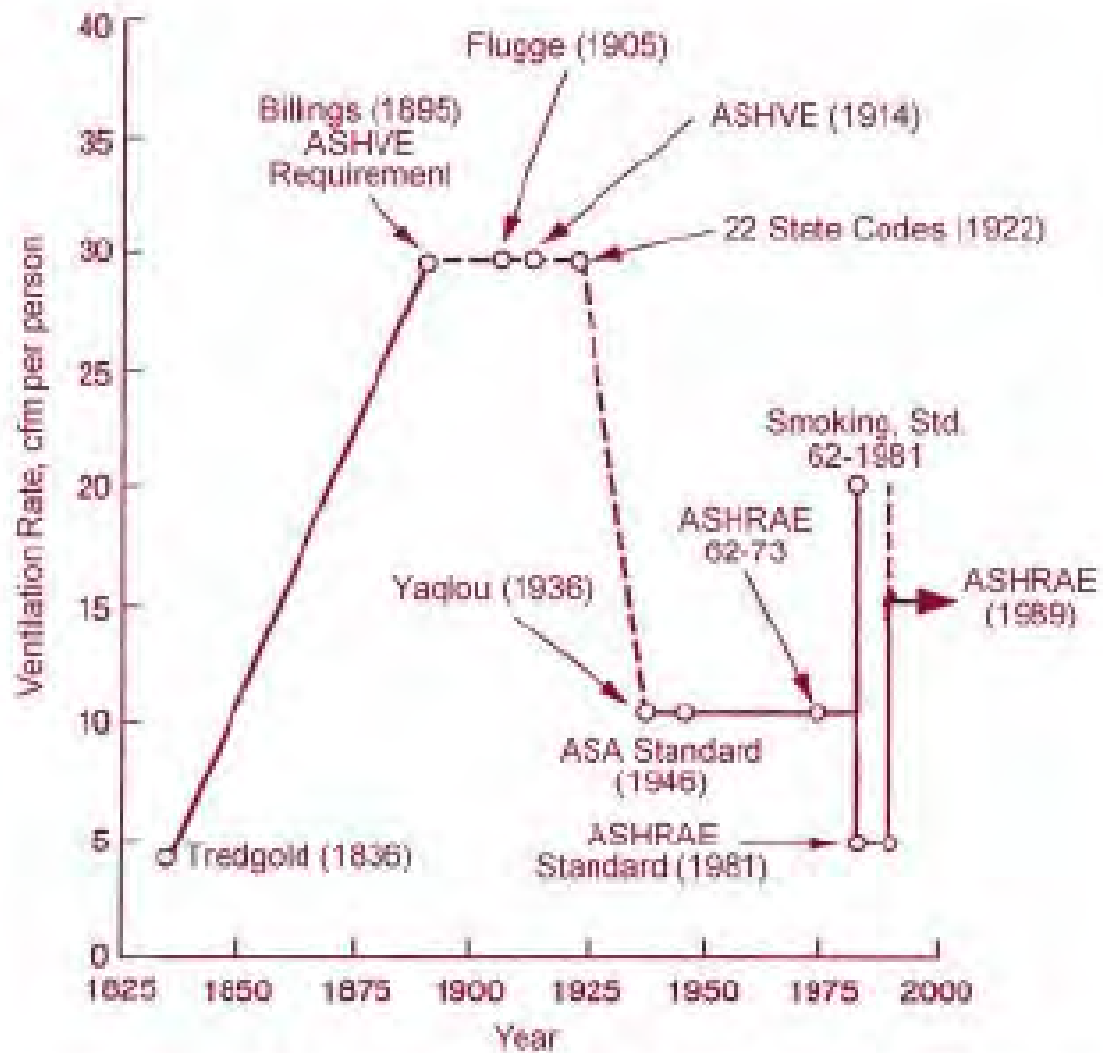


Figure 1: Minimum ventilating rate history.

House

2,000 ft²

3 bedrooms

8 ft. ceiling

Volume: 16,000 ft³

.35 ach 93 cfm

.30 ach 80 cfm

.25 ach 67 cfm

.20 ach 53 cfm

.15 ach 40 cfm

House

2,000 ft²

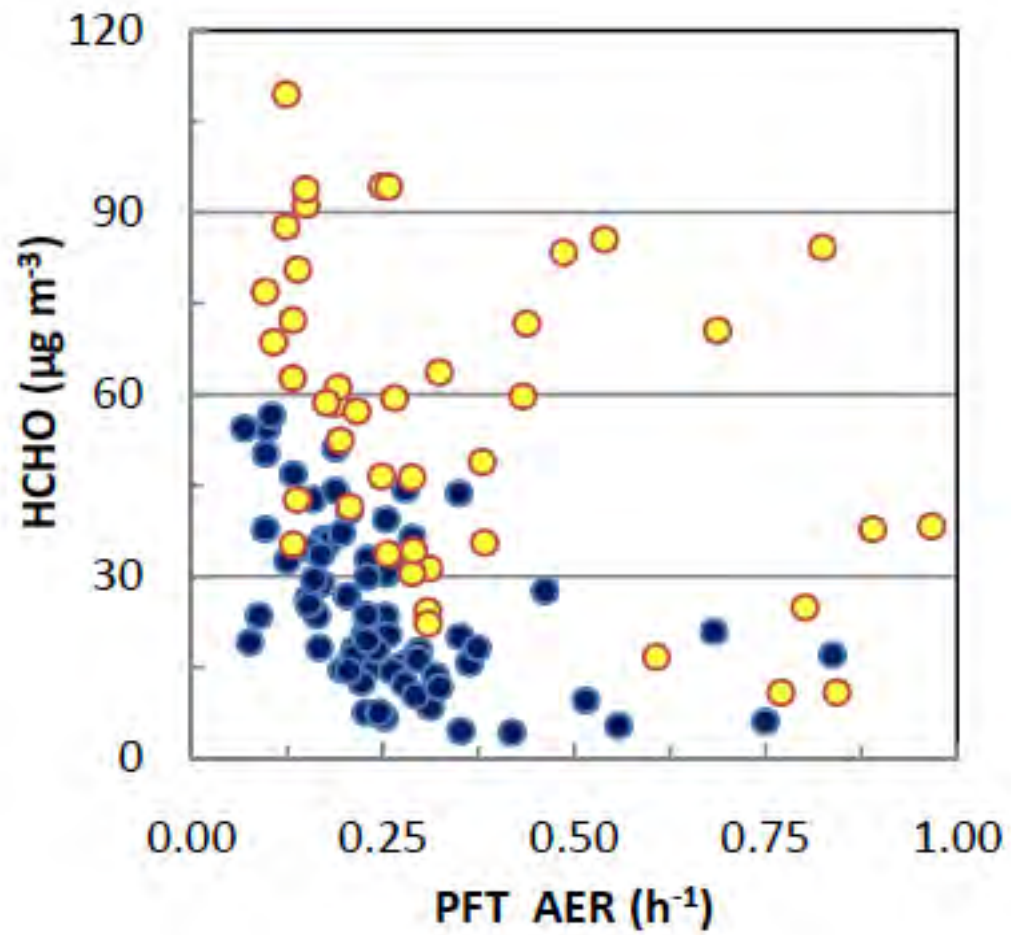
3 bedrooms

8 ft. ceiling

Volume: 16,000 ft³

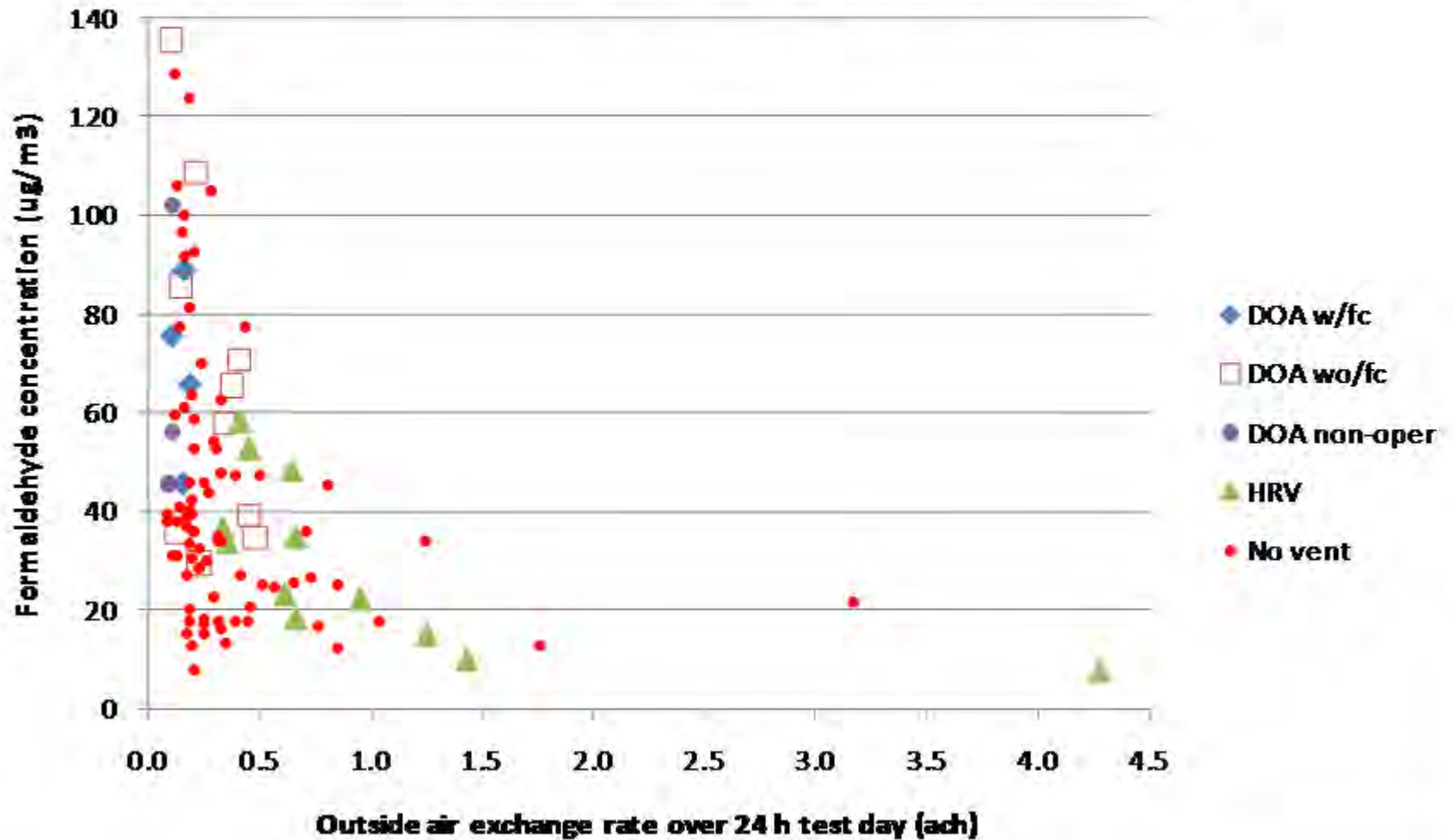
Ventilation Rates

.35 ach	93 cfm	62 - 73	5 cfm/person	20 cfm
.30 ach	80 cfm		10 cfm/person	40 cfm
.25 ach	67 cfm	62 - 89	15 cfm/person	60 cfm
.20 ach	53 cfm		.35 ach	90 cfm
.15 ach	40 cfm	62.2 - 2010	7.5 cfm/person + 0.01	50 cfm
		62.2 - 2013	7.5 cfm/person + 0.03	90 cfm



Aubin, D., Won, D.Y., Schleichinger, H., 2010

Formaldehyde sample concentration versus PFT measured outside air exchange rate over the test day



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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Occupancy is deemed to be the number of bedrooms plus one

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

IRC 2015 and 2018 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

3 Bedroom House – 2,000 ft²

30 cfm plus 60 cfm

90 cfm

3 Bedroom House – 2,000 ft²

30 cfm plus 20 cfm

50 cfm

The Cult of The Blower Door

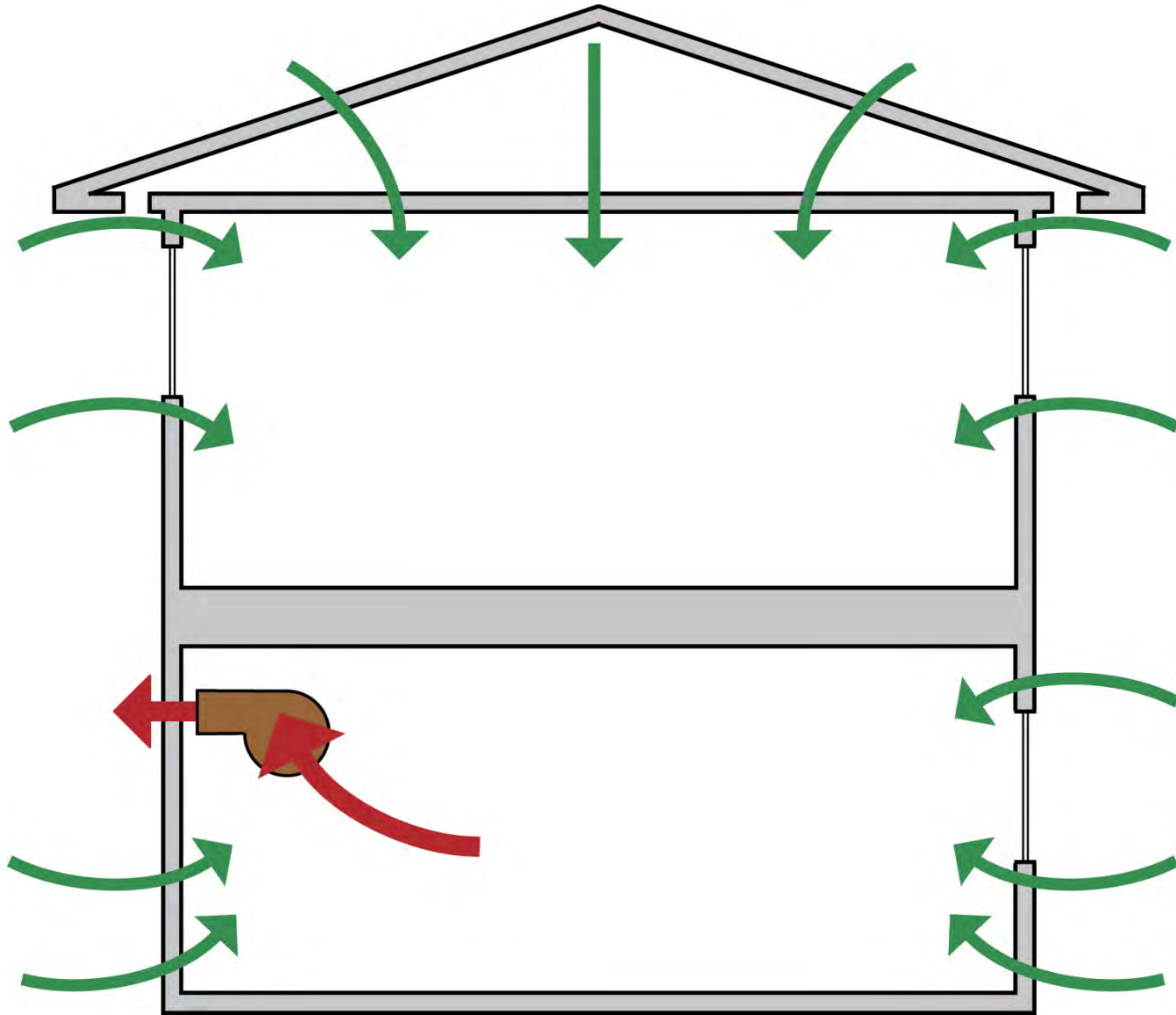


Blower Door Can't Get You The True ACH On A Short Term Basis – Hour, Day, Week

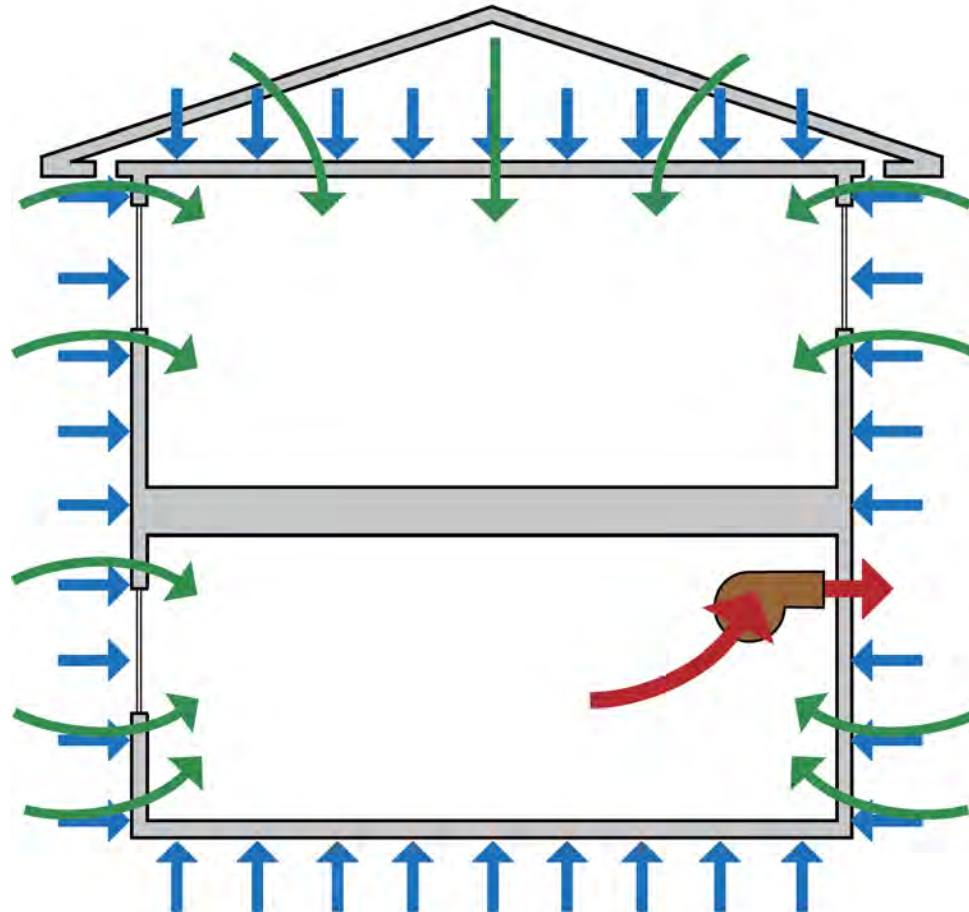
Don't Know Where The Holes Are

Don't Know The Type of Holes

Don't Know The Pressure Across The Holes



$$ELA \approx C \times \frac{\text{Rate of flow}}{\sqrt{\text{Pressure difference}}}$$



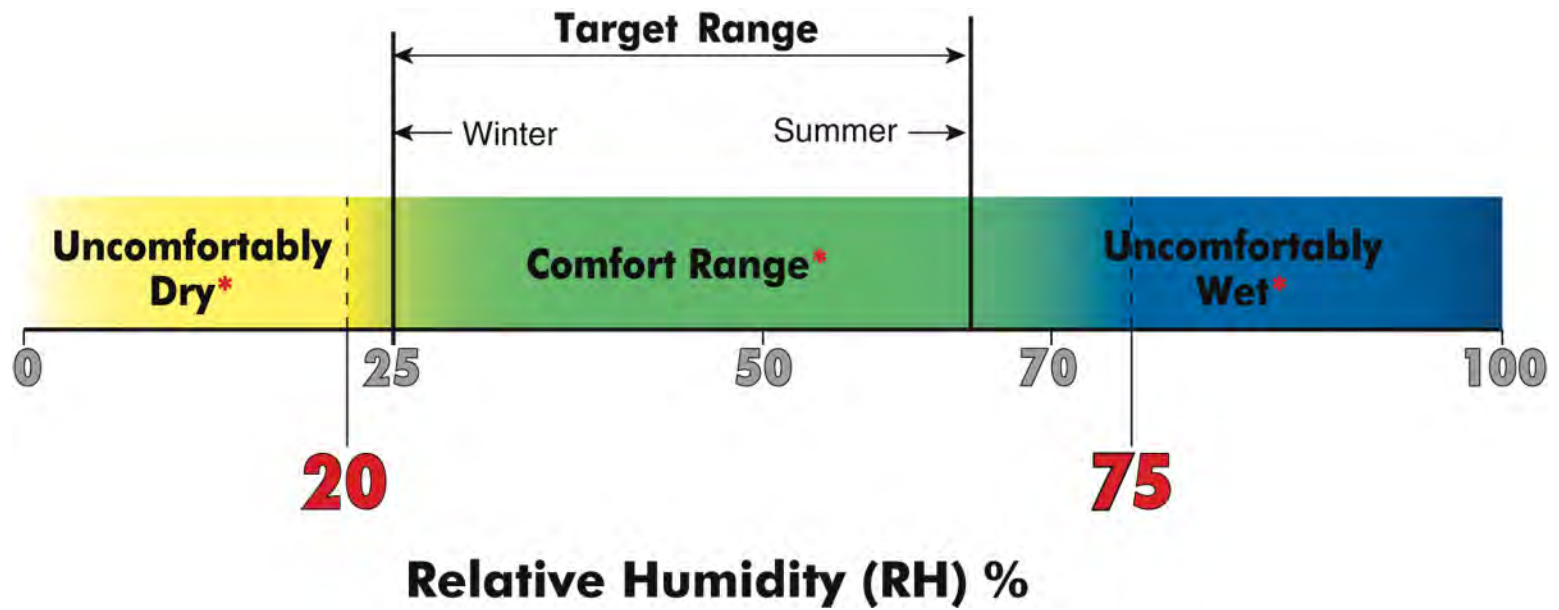
$$(\text{Meters})^2 \approx \frac{1}{780} \times \frac{\text{Litres per second}}{\sqrt{\text{Pascals}}}$$

Dilution Is Not The Solution To Indoor Pollution

Source Control

Dilution For People

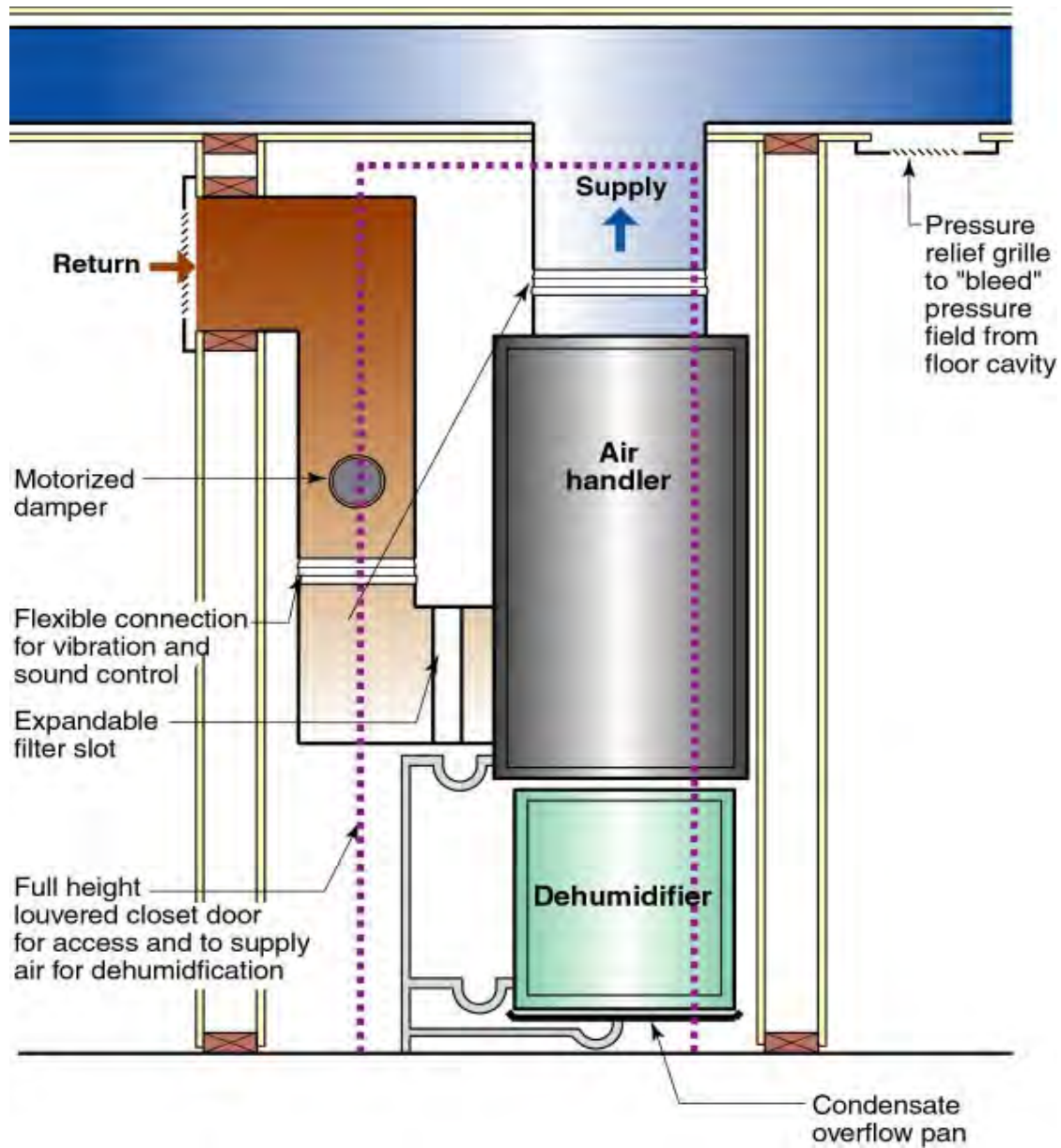
Source Control For The Building



Recommended Range of Relative Humidity

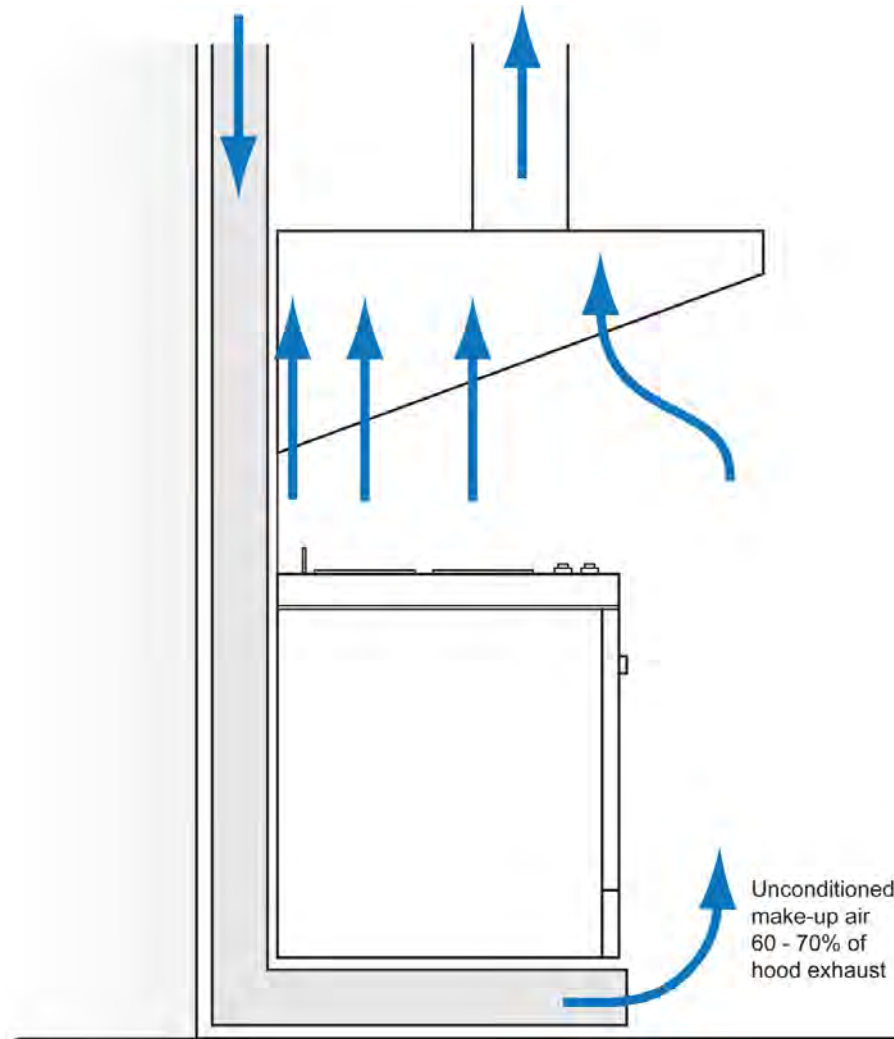
Above 25 percent during winter

Below 70 percent during summer

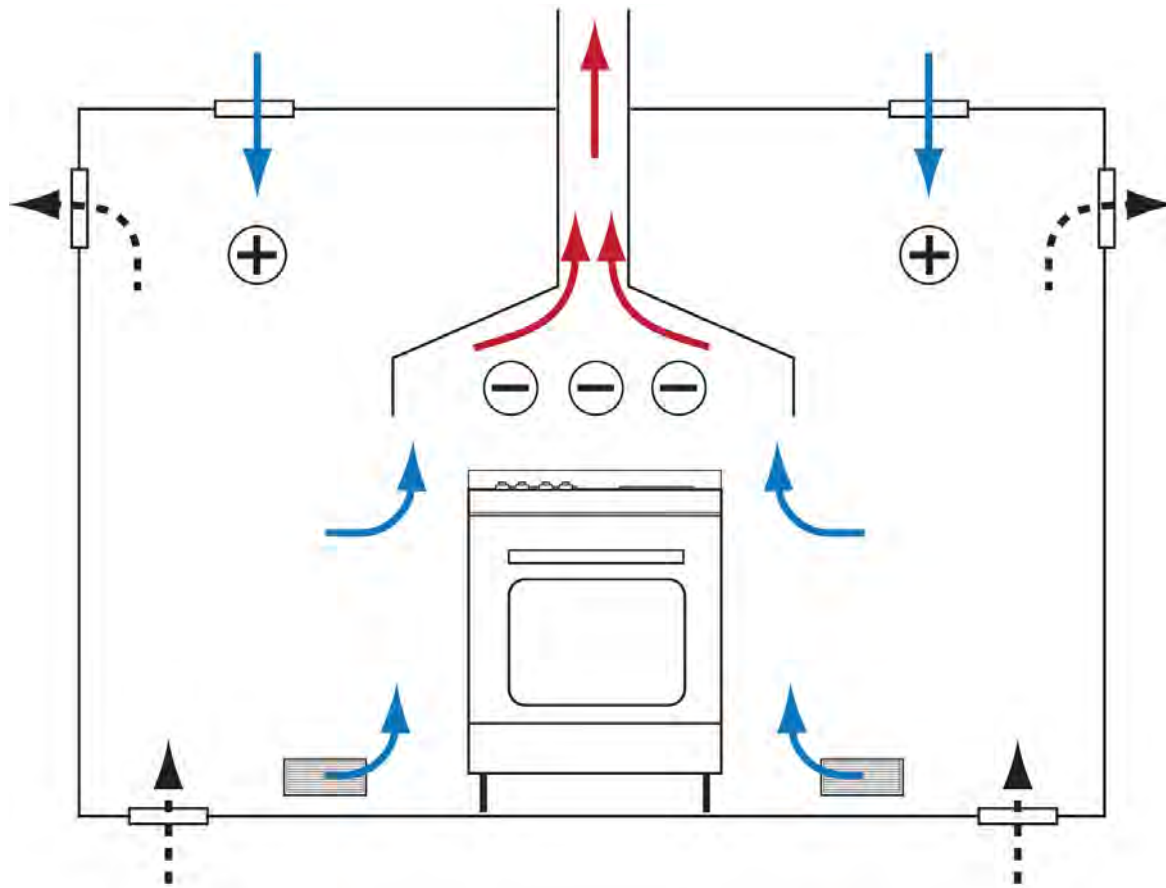


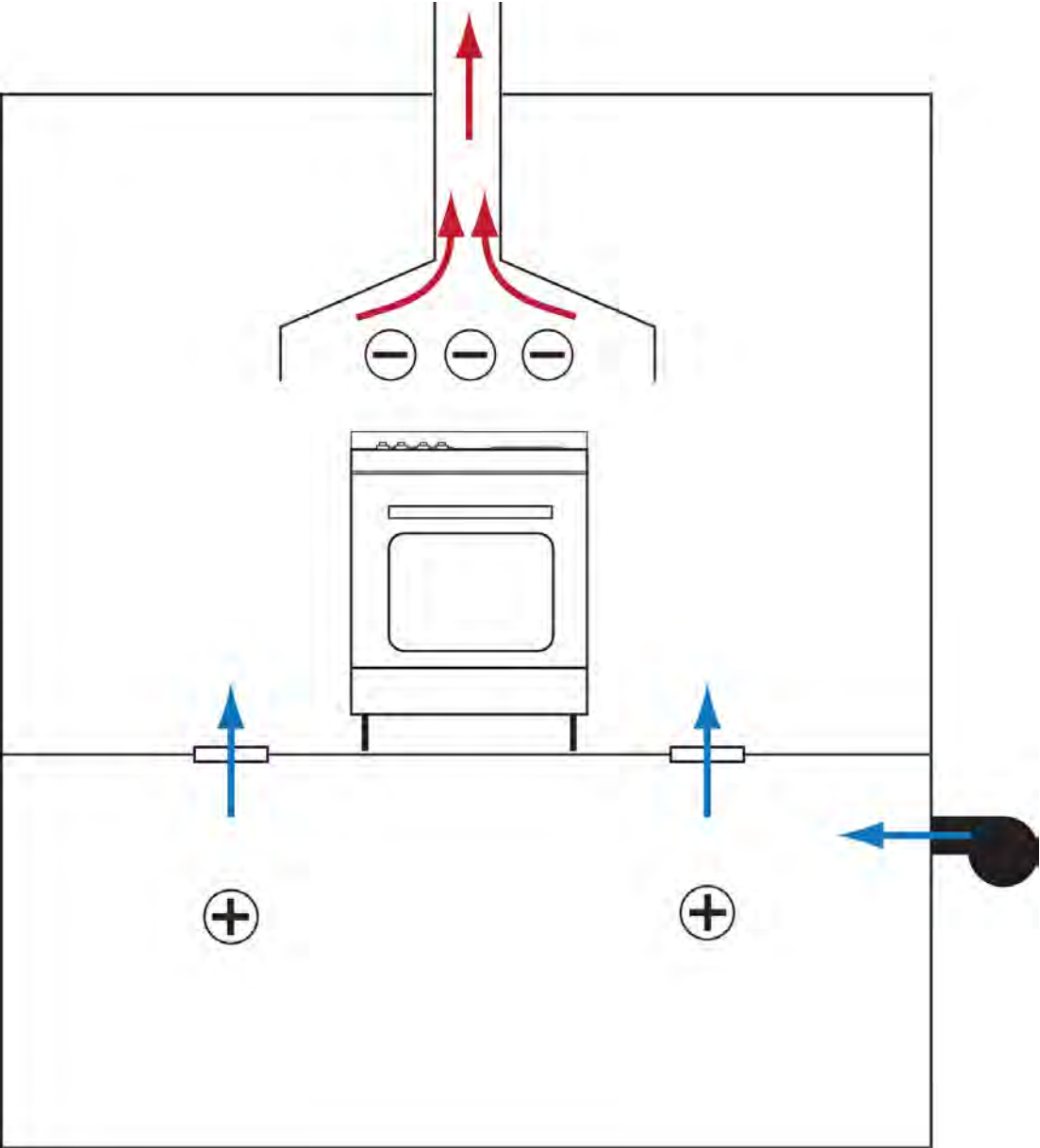


Kitchen Exhaust Hoods









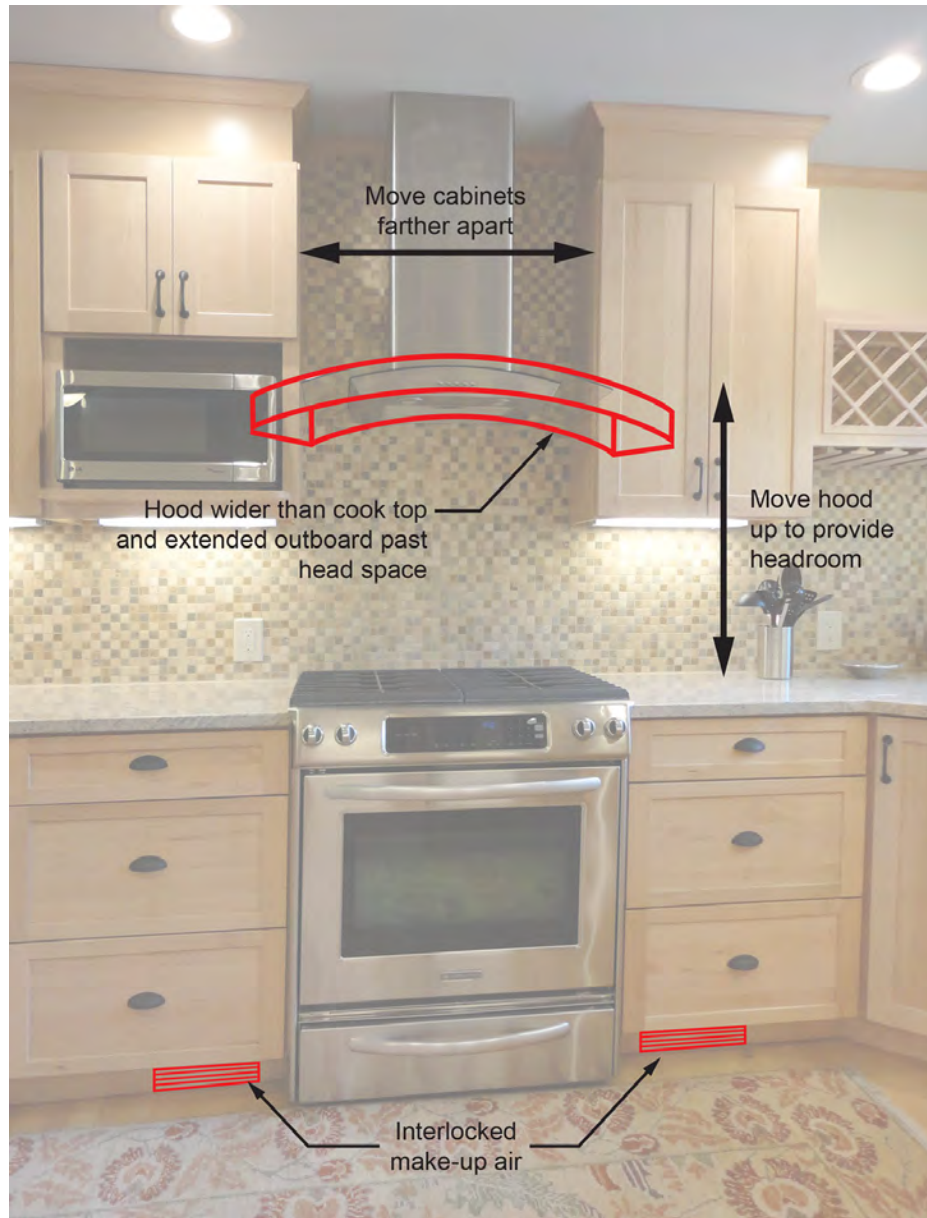
















Clothes Dryers





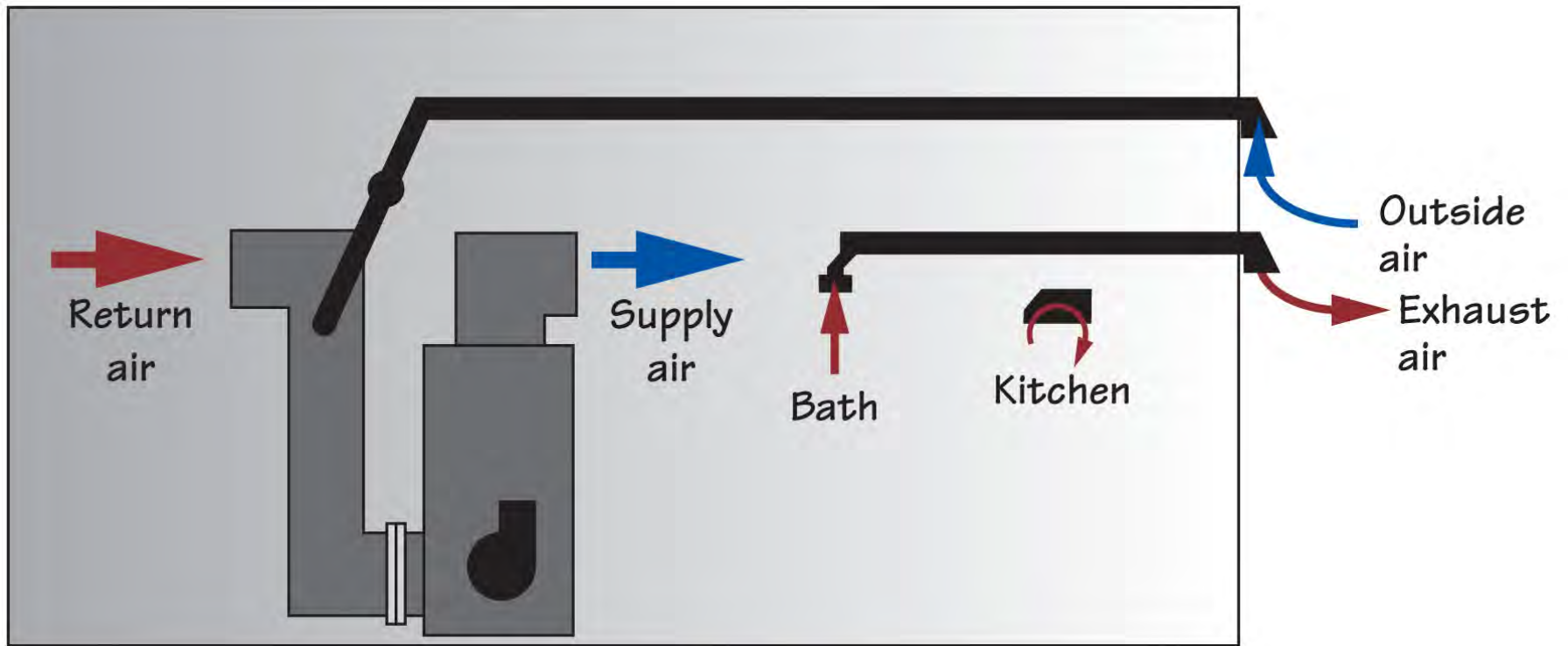
Fireplaces

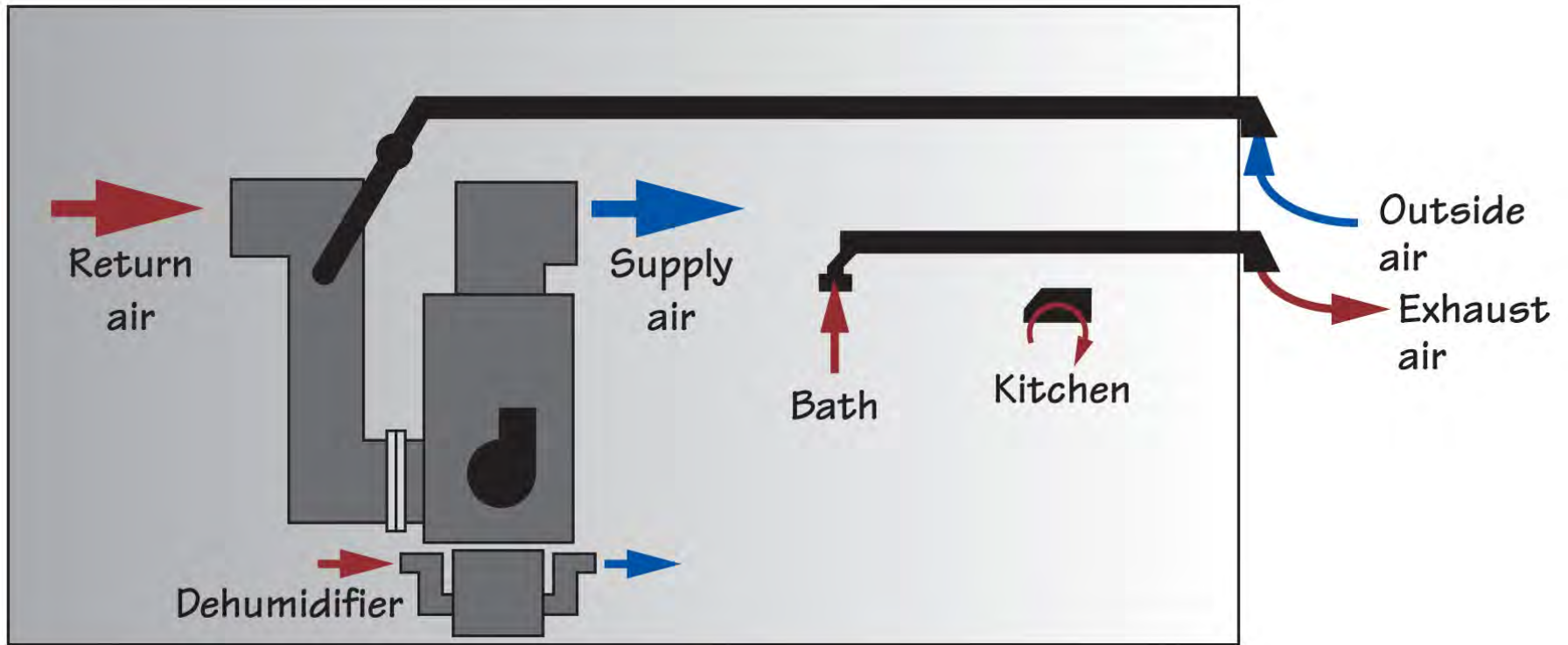


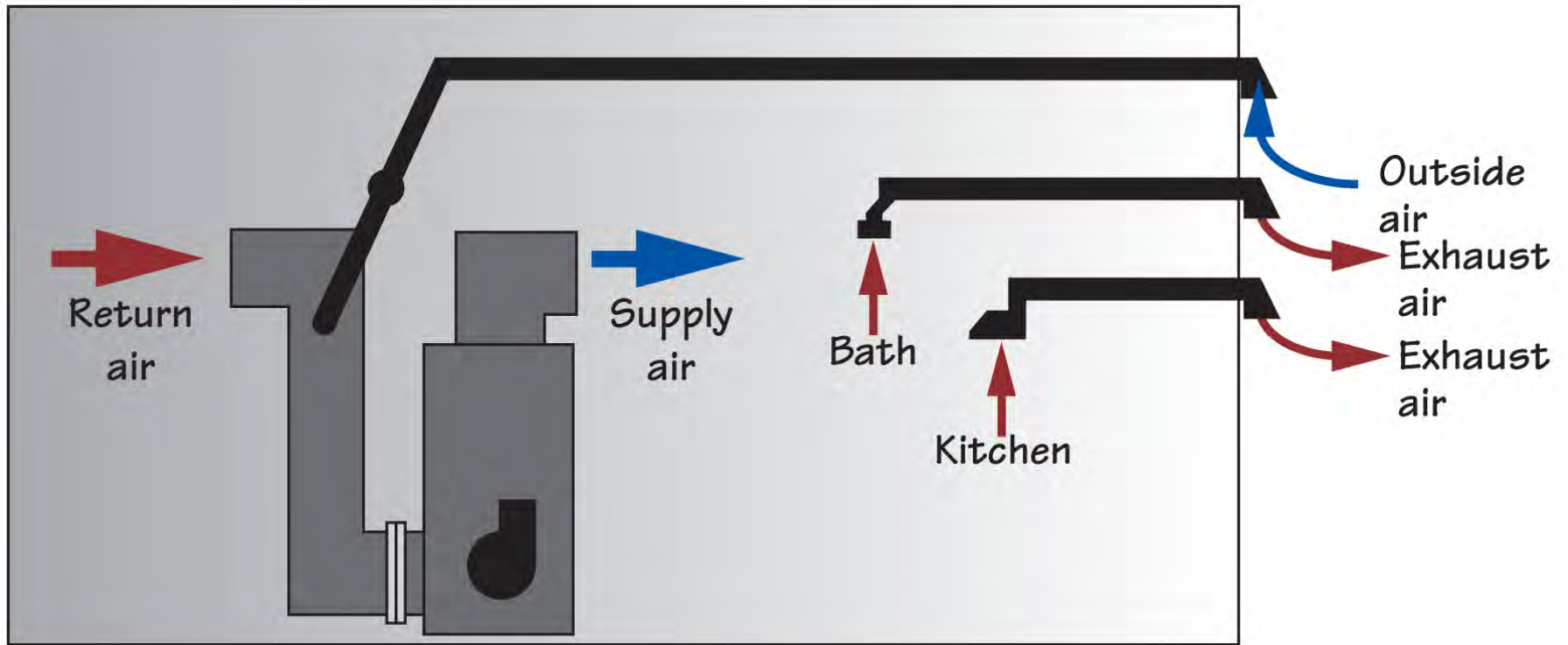


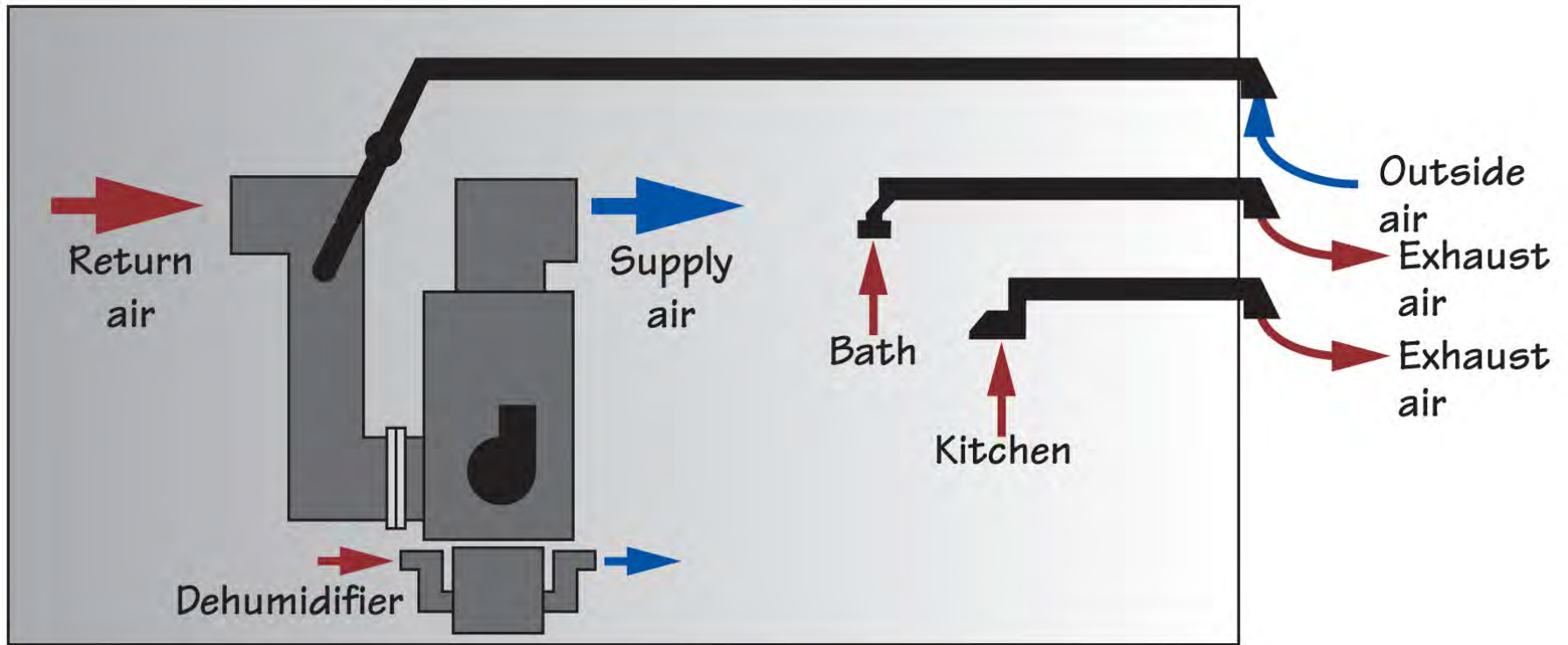


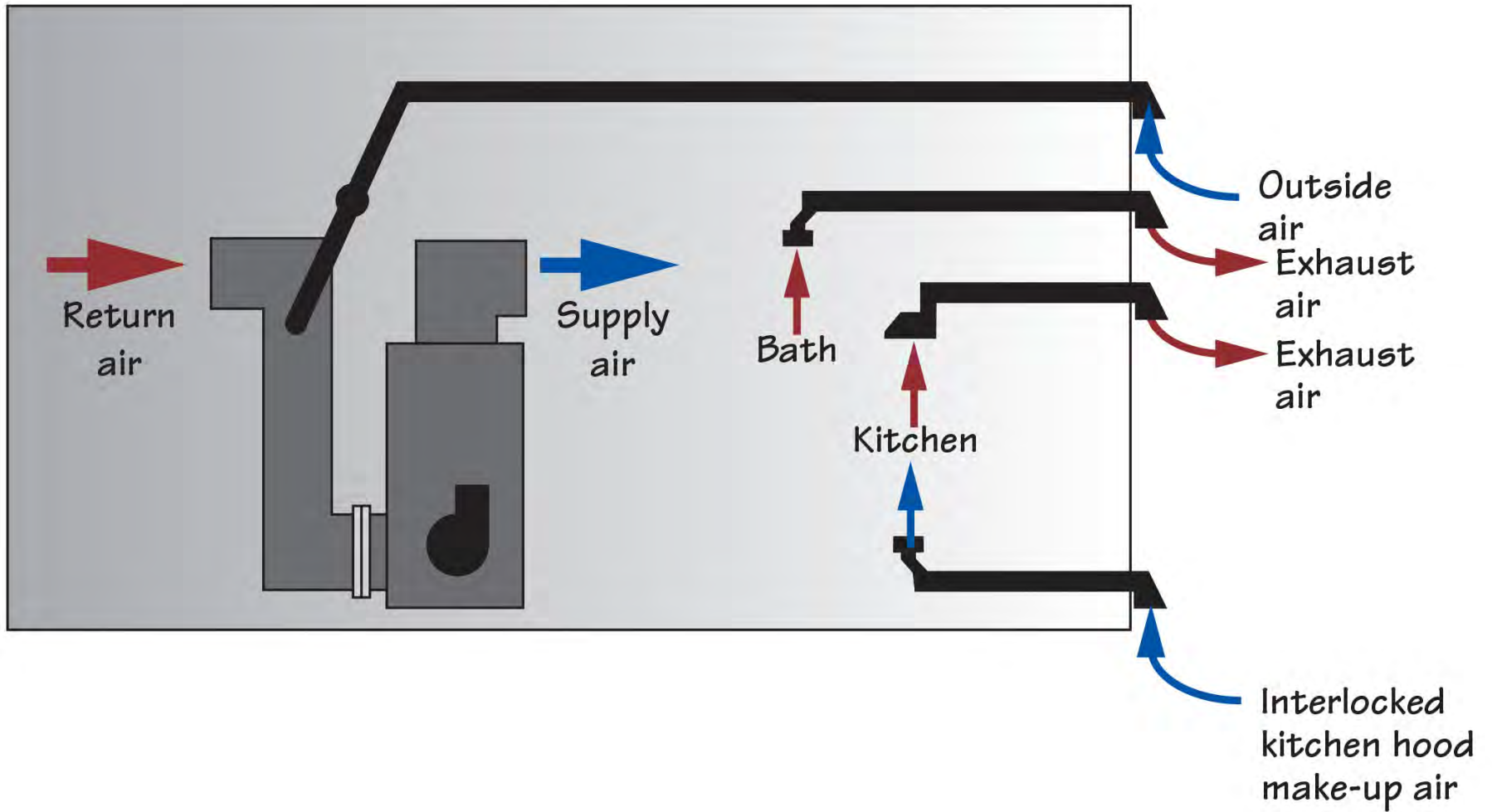


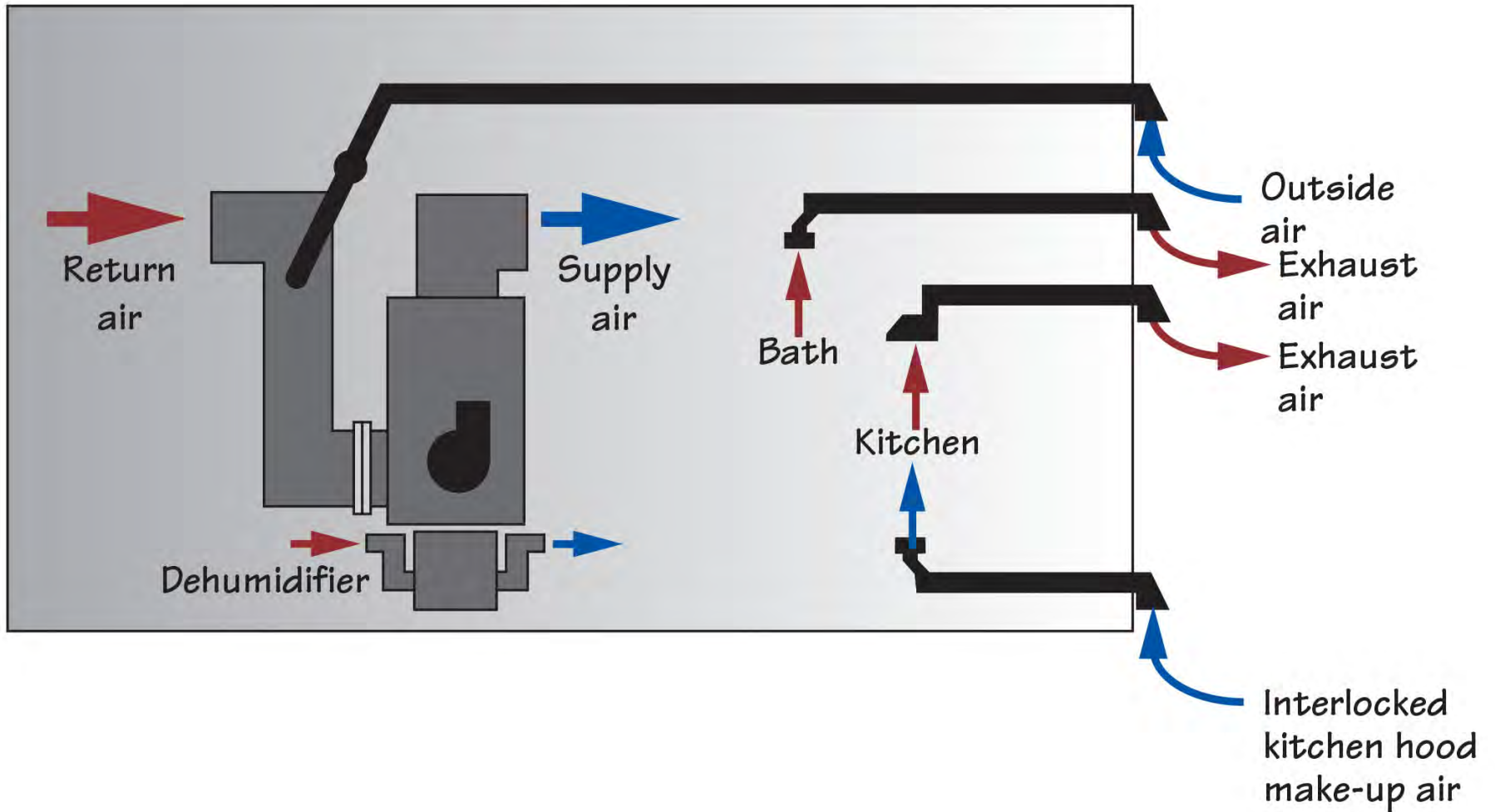


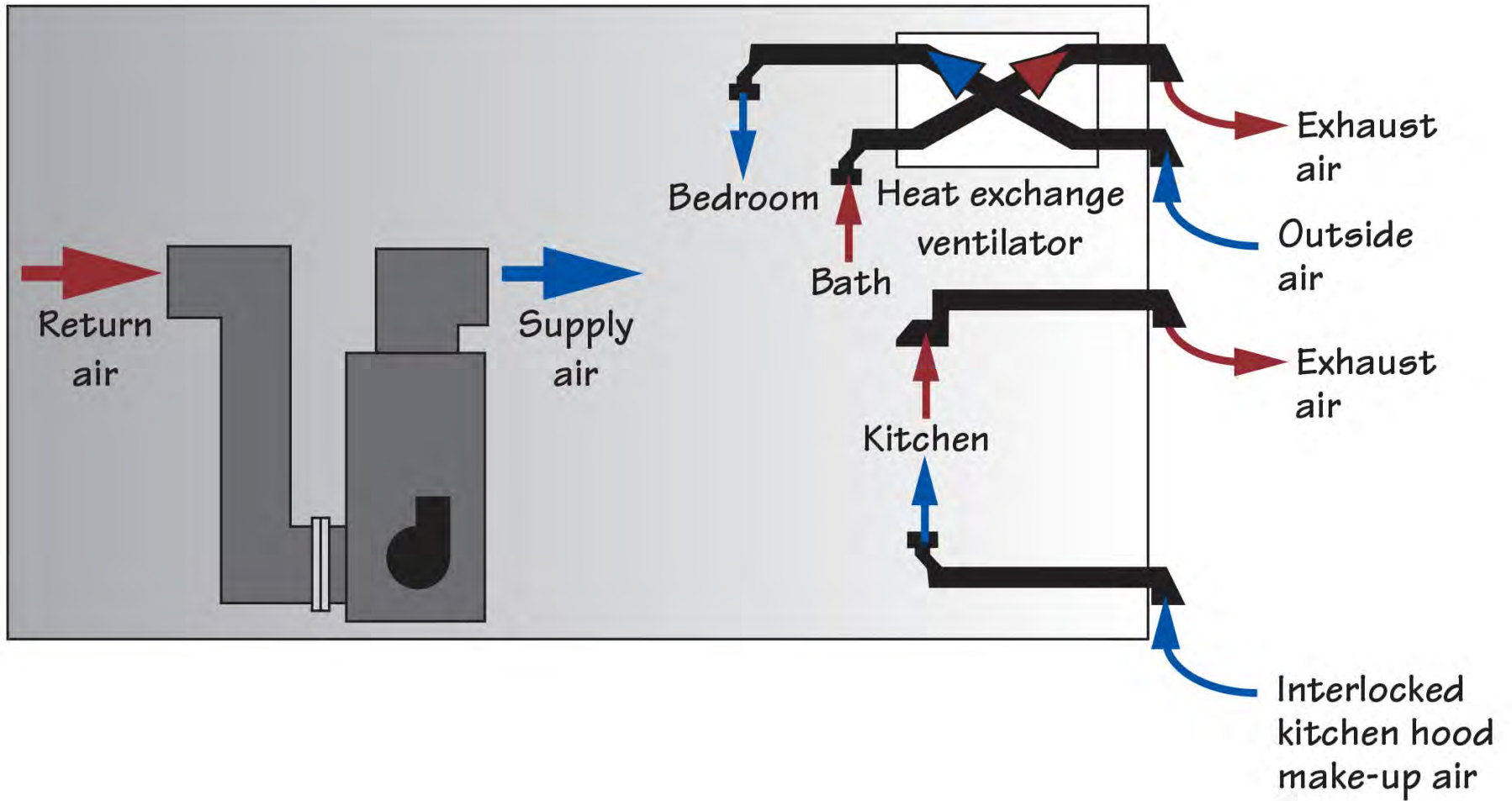


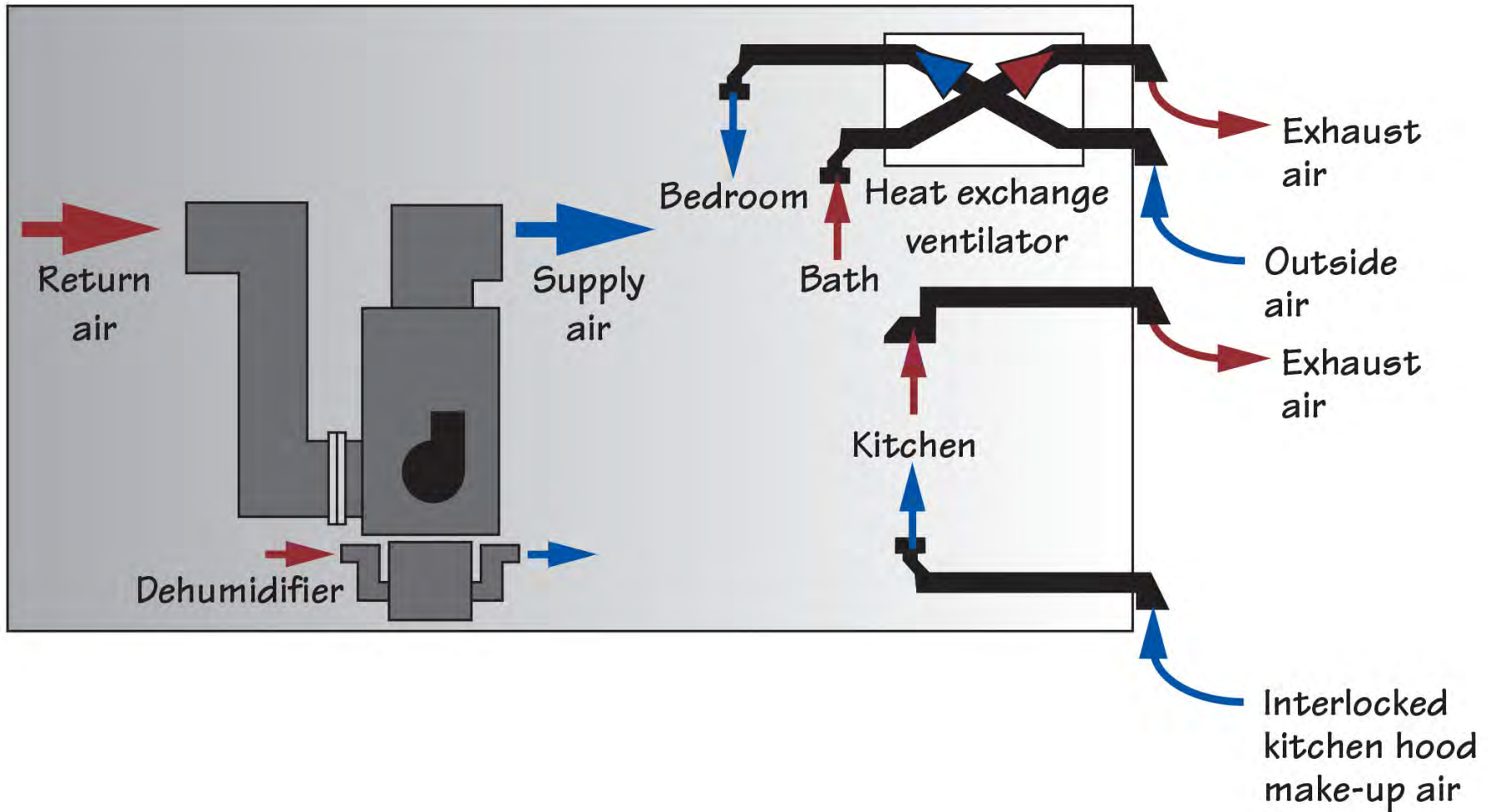


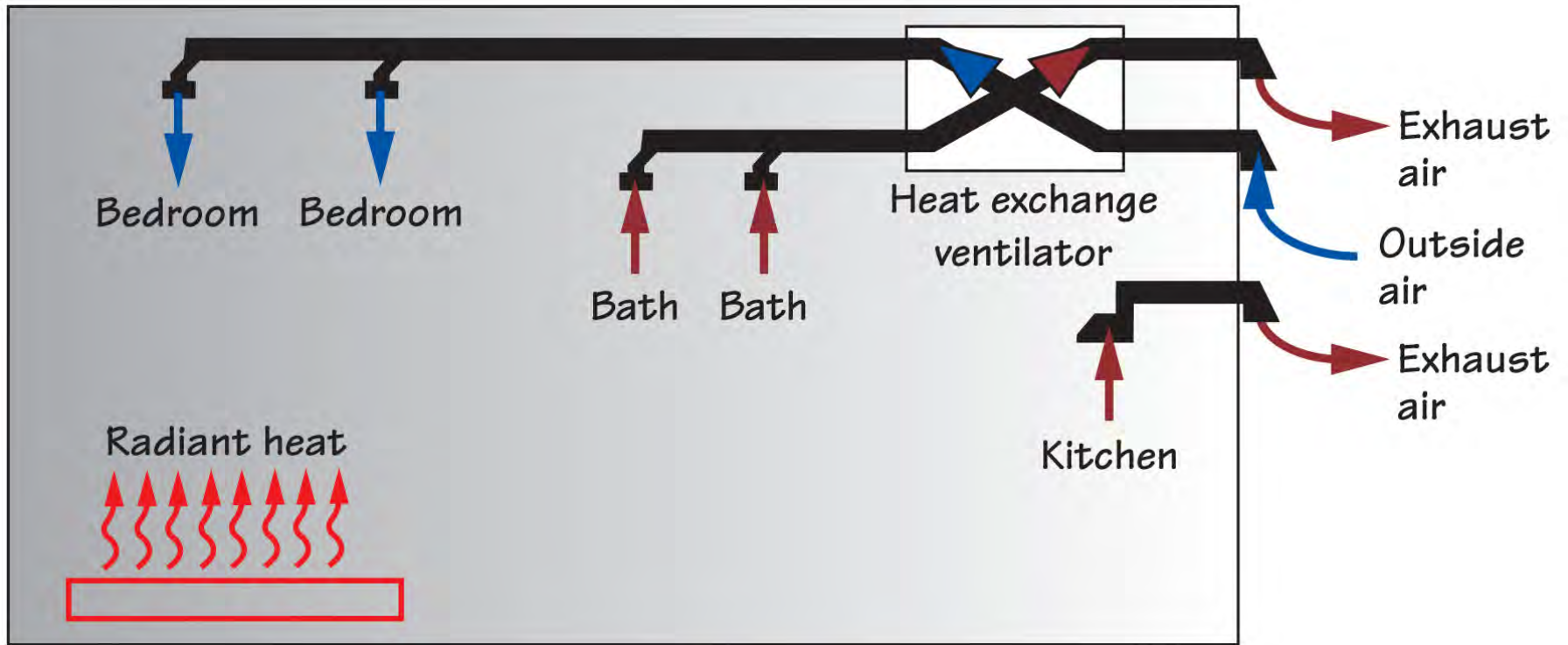


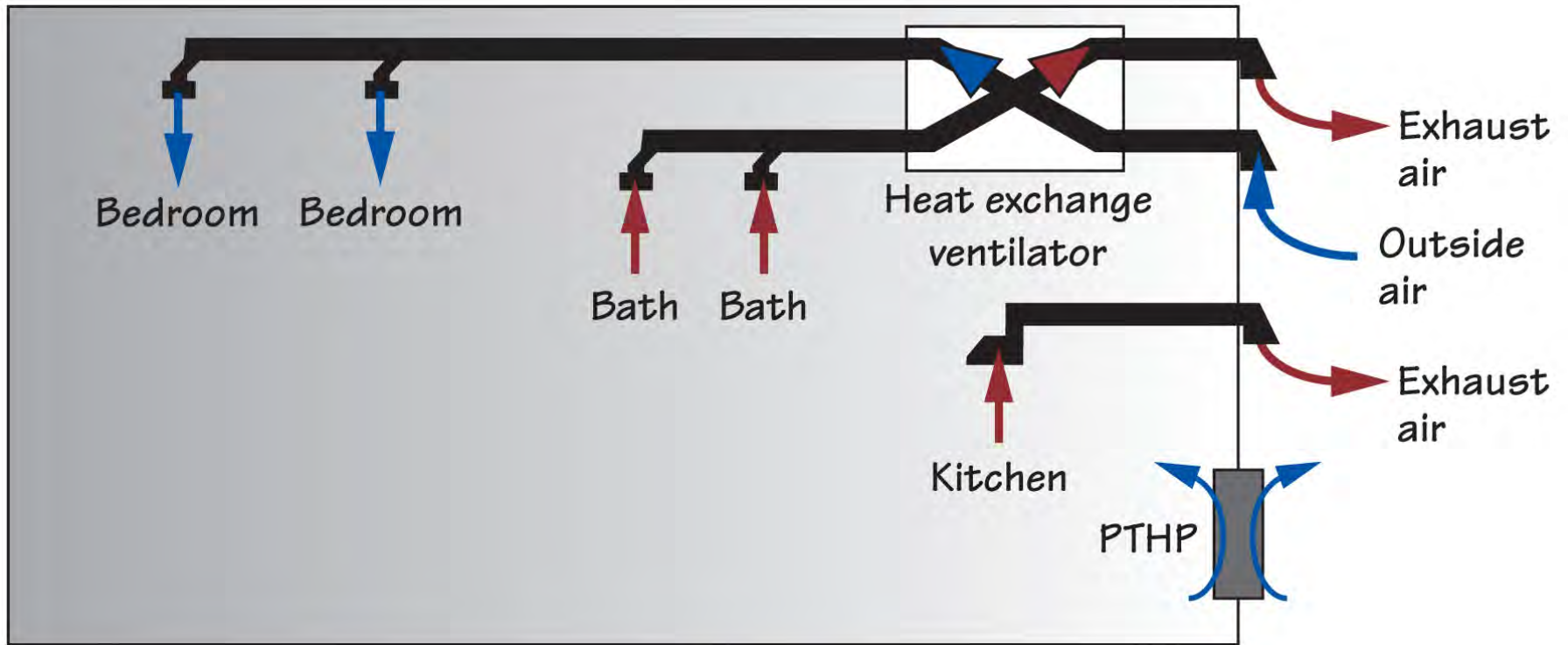


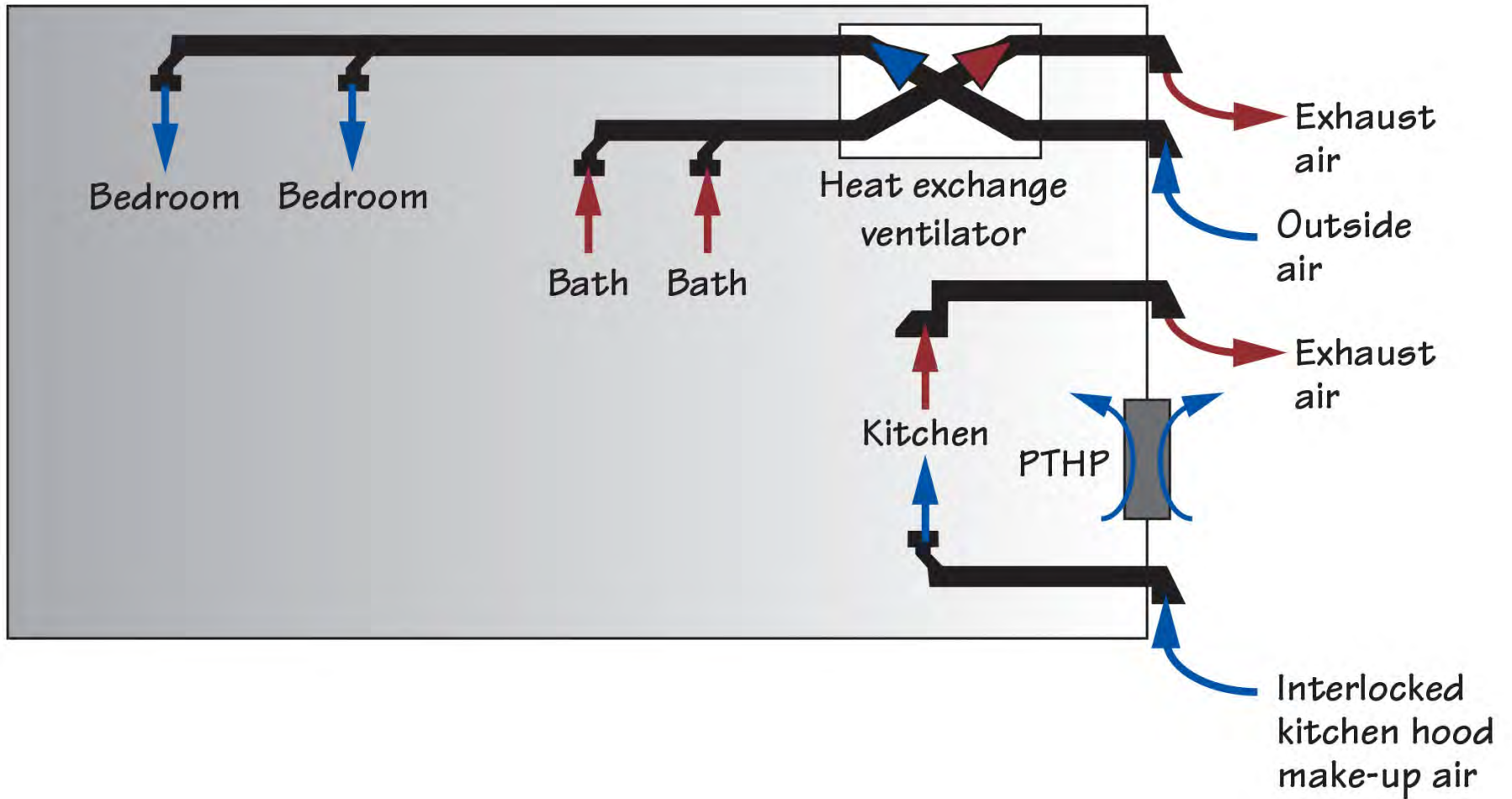












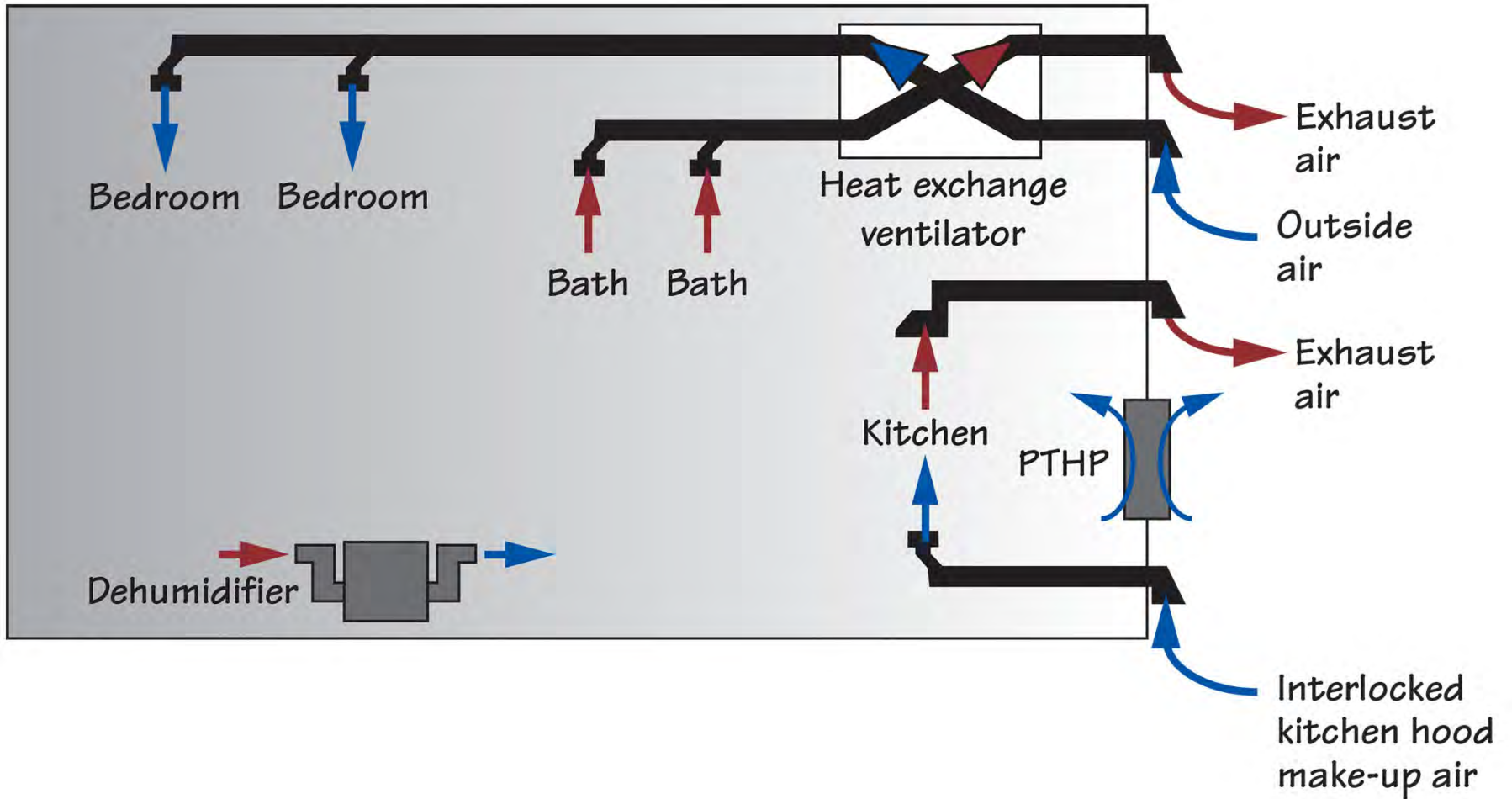








Figure 3.12

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

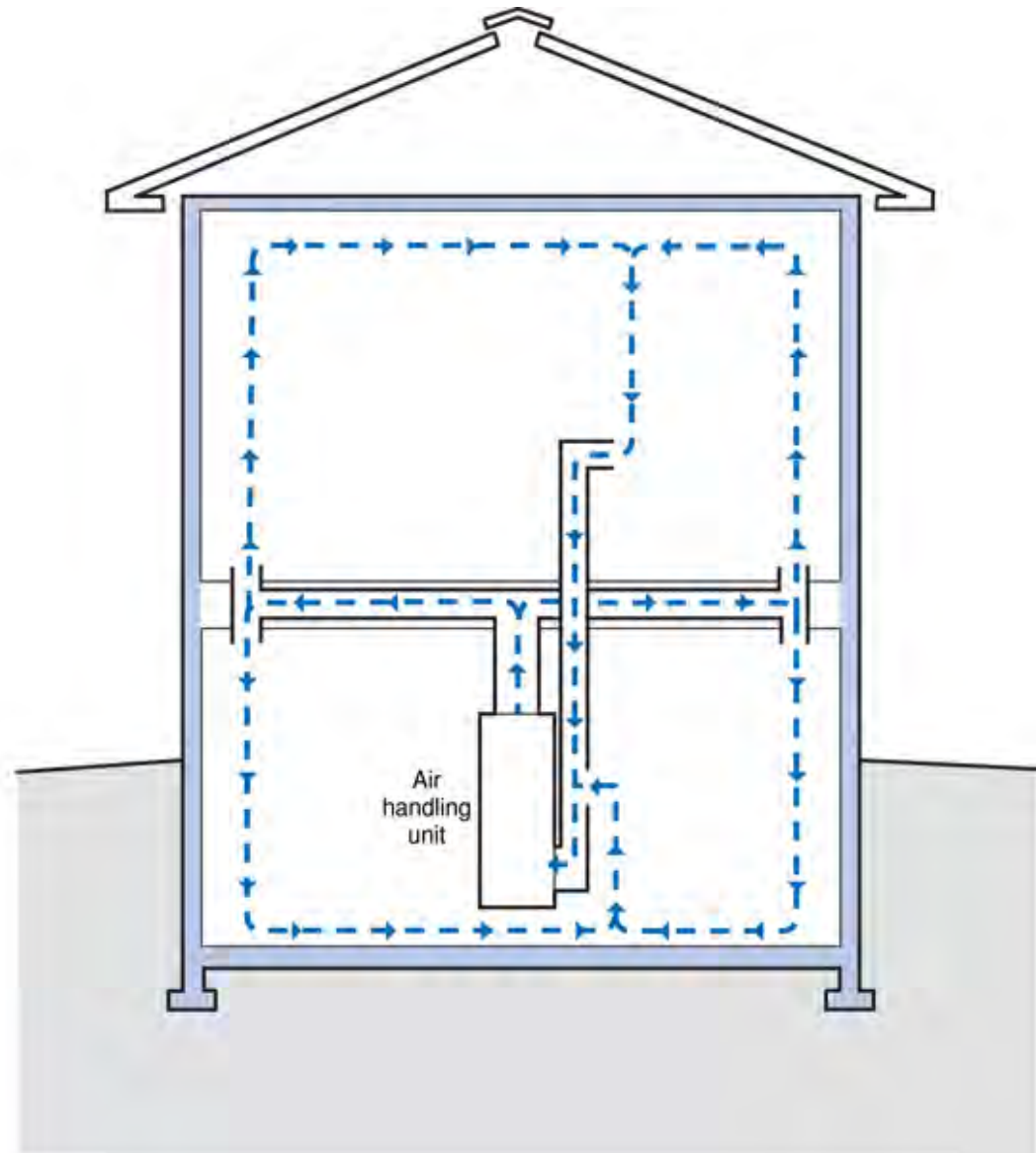
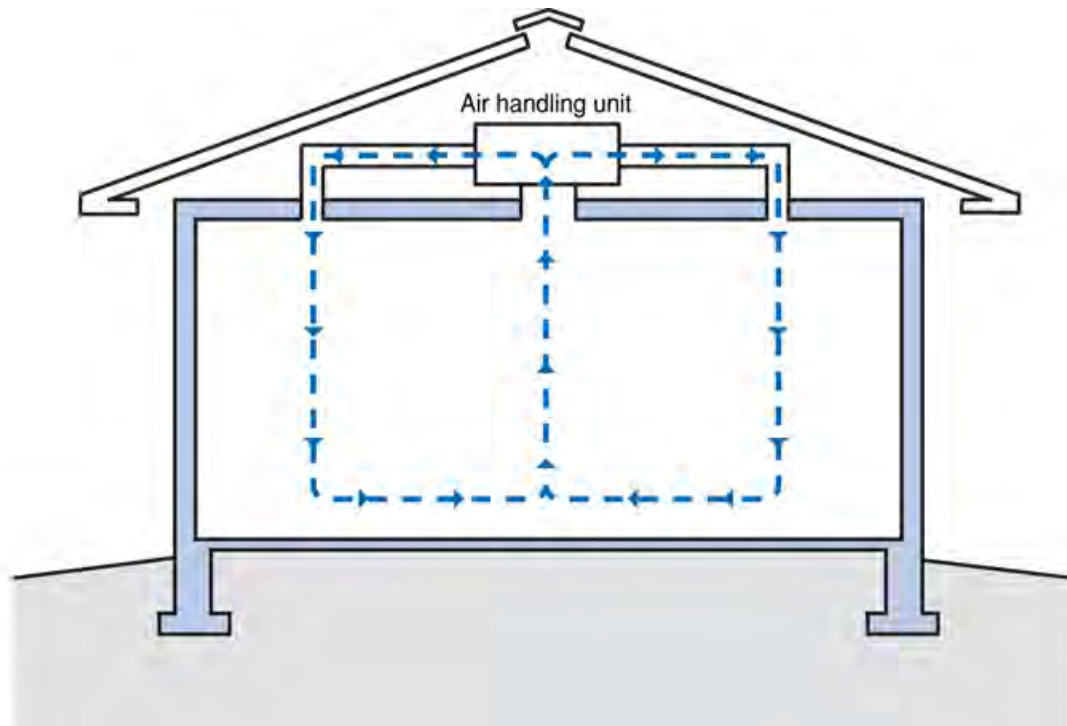


Figure 3.13

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



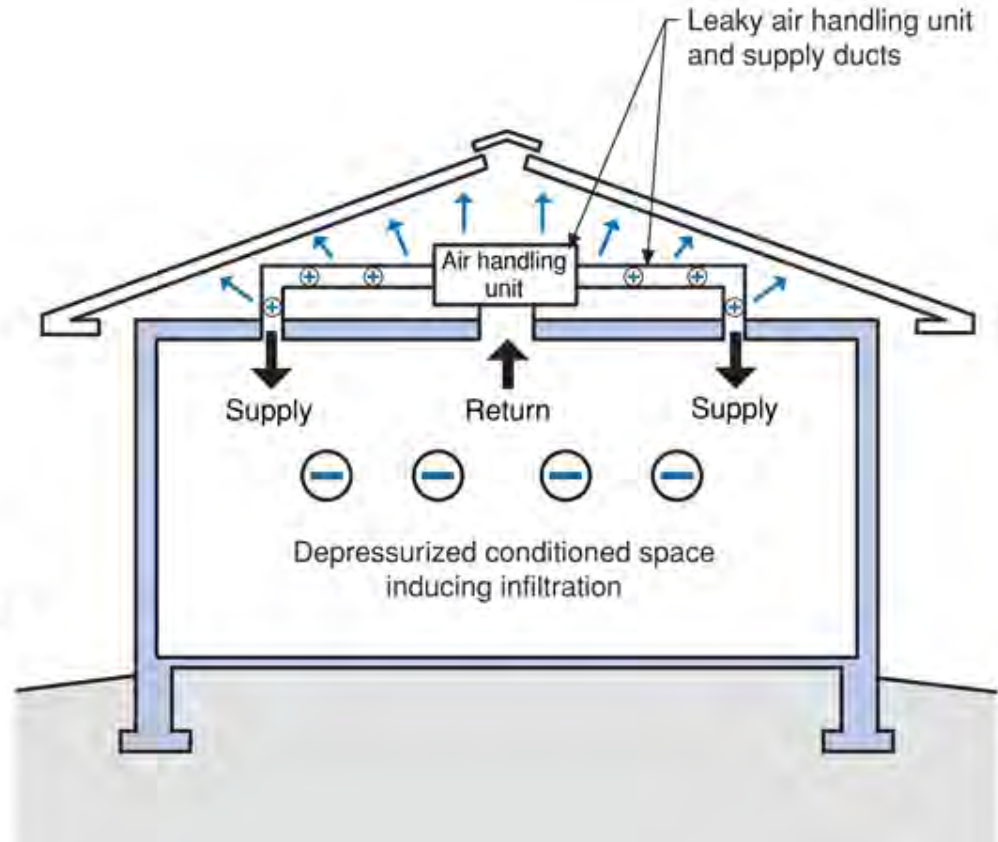


Figure 3.15

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

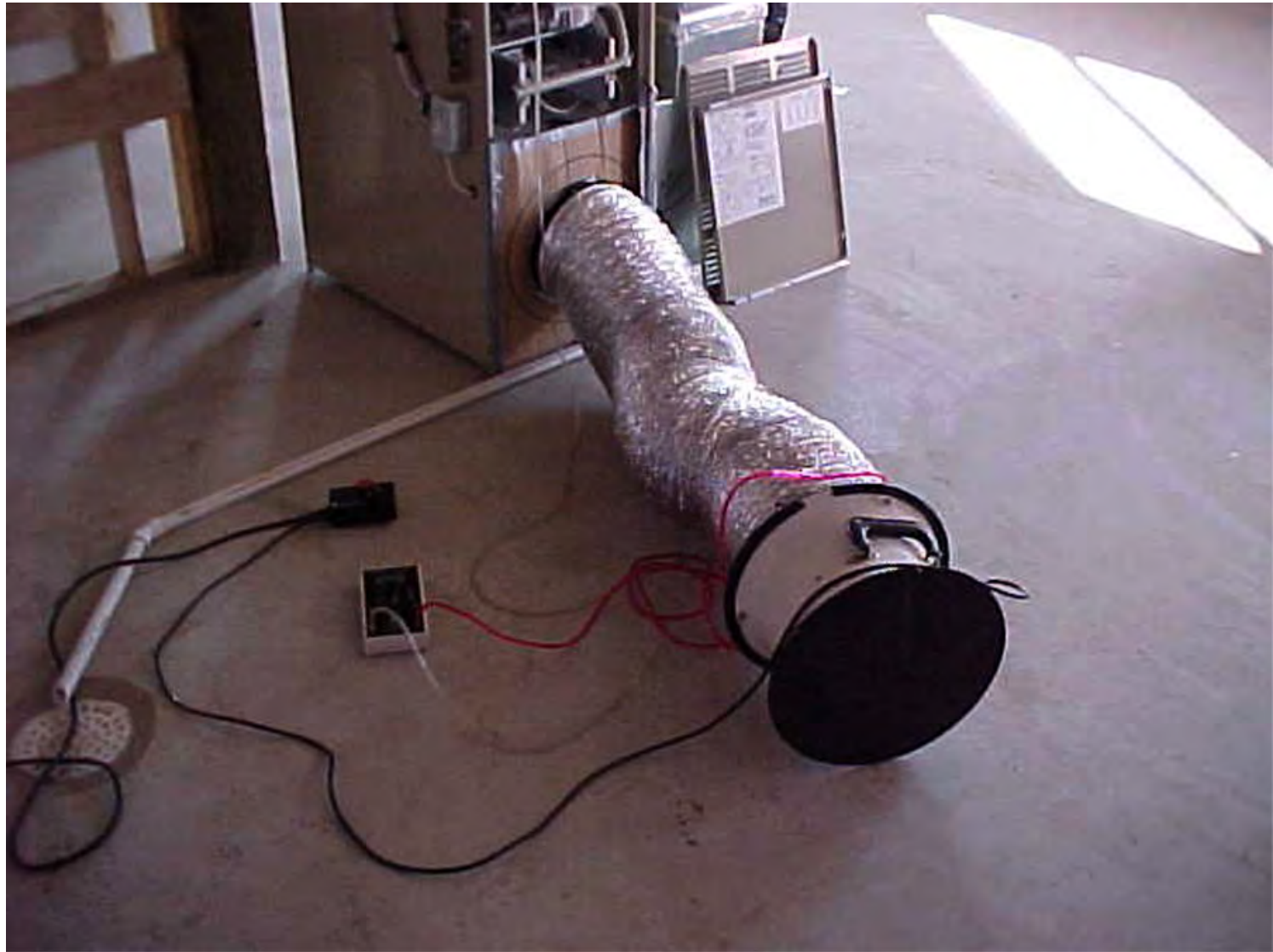




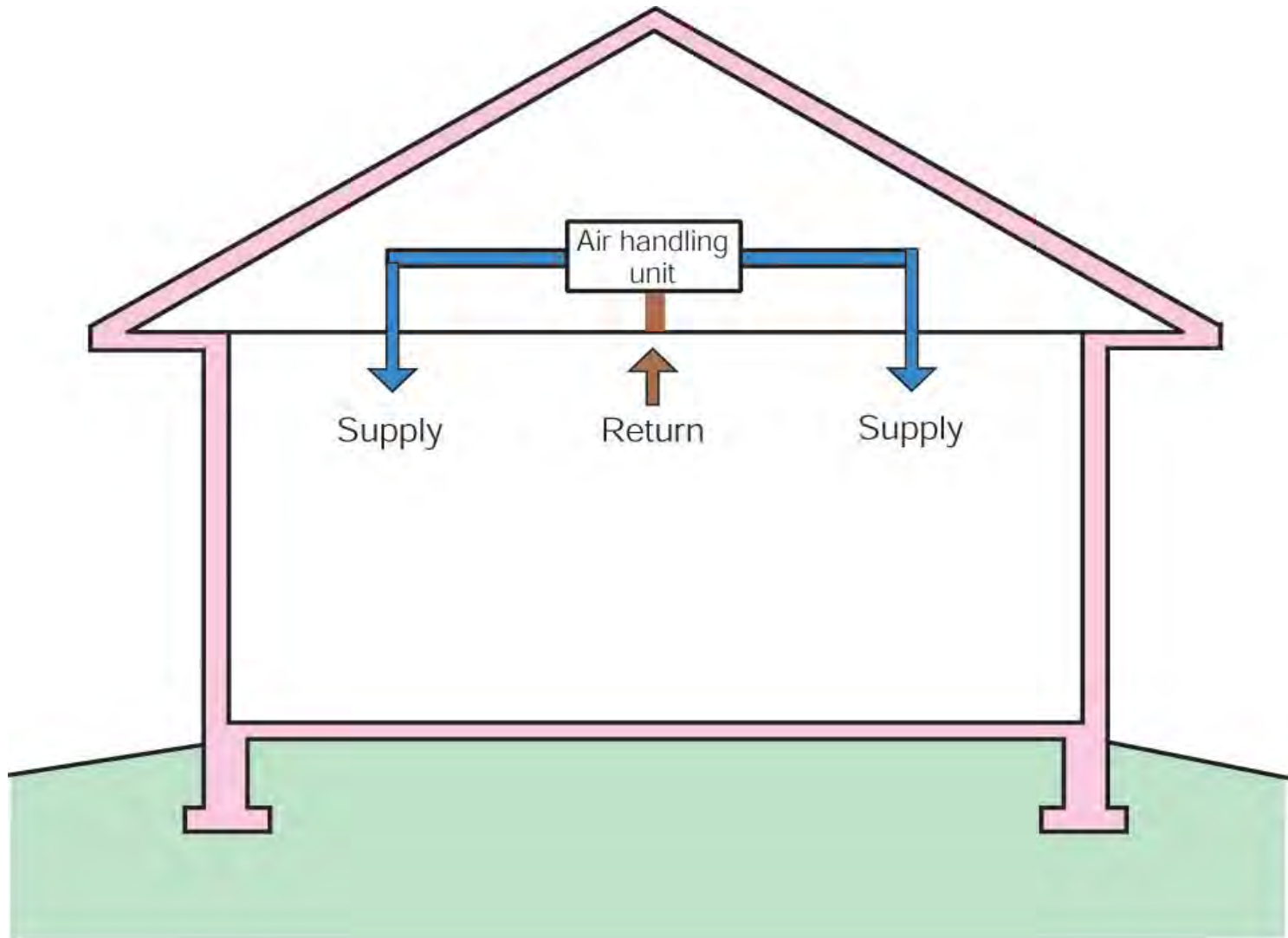








Duct Leakage Should Be Less Than 5% of Rated Flow As Tested By Pressurization To 25 Pascals



Note: Colored shading depicts the building's thermal barrier and pressure boundary. The thermal barrier and pressure boundary enclose the conditioned space.



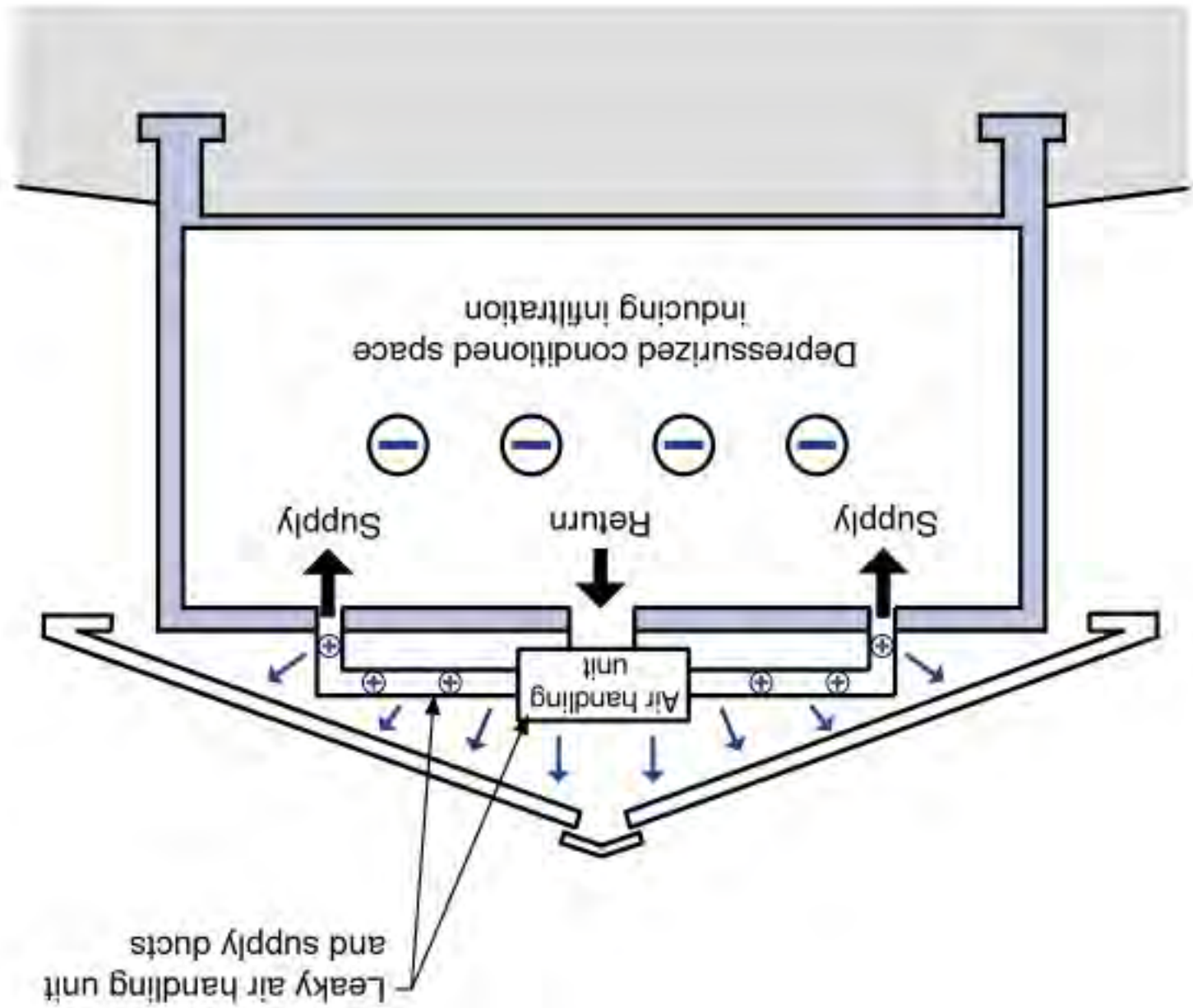
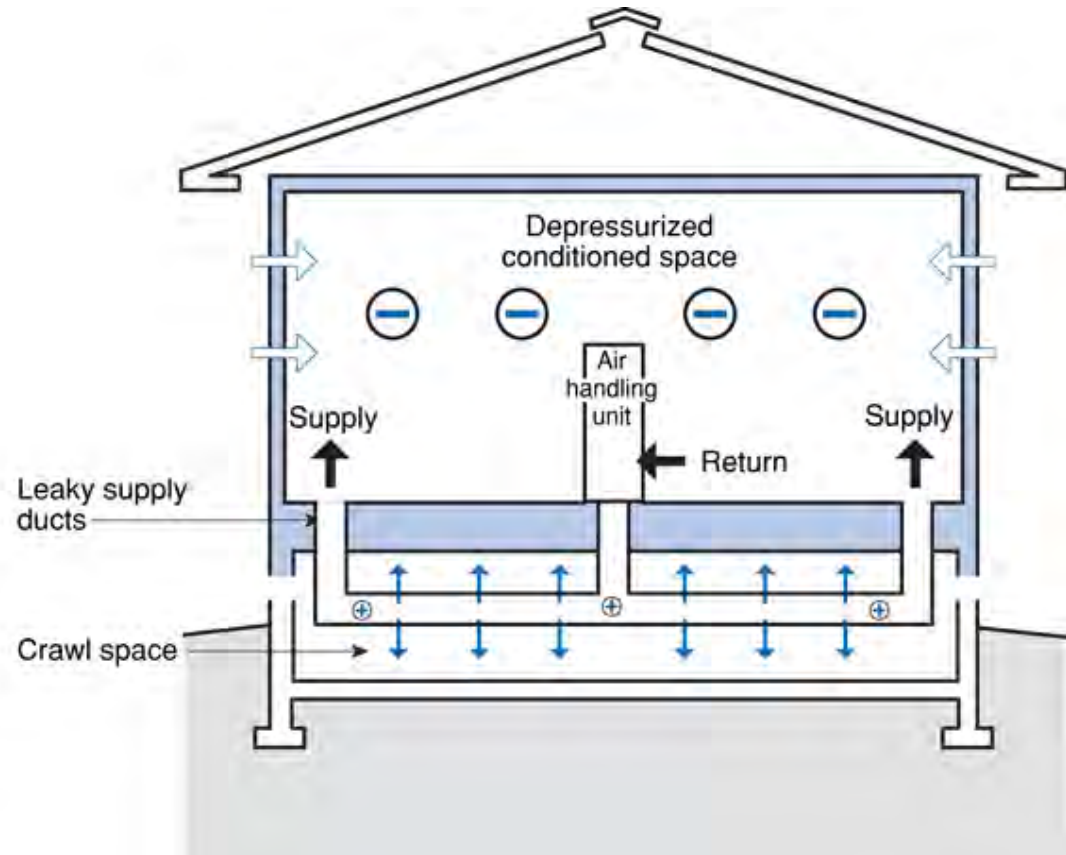


Figure 3.16

Leaky Supply Ductwork in Vented Crawl Space

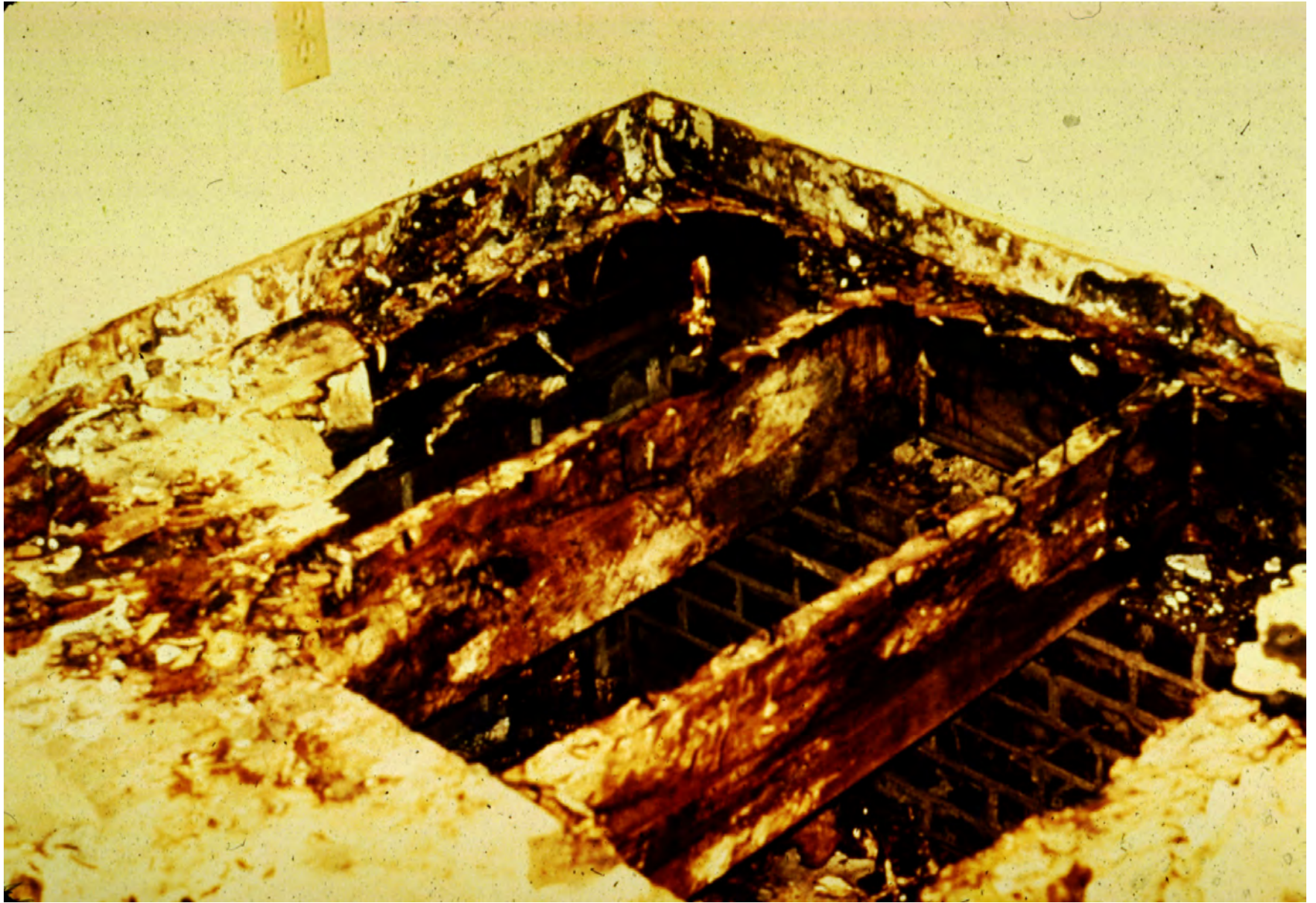
- Air pressurization pattern with mechanical system ducts in the crawl space















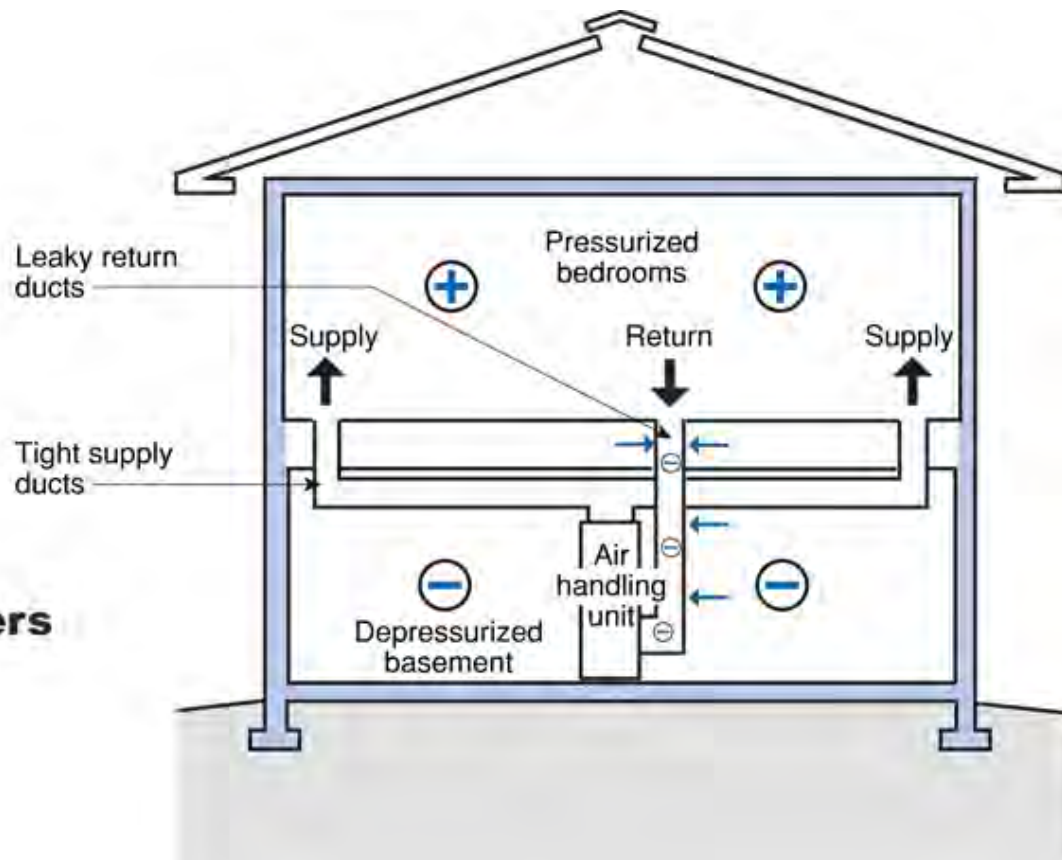


Figure 3.14

Leaky Ductwork and Air Handlers in Basements

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



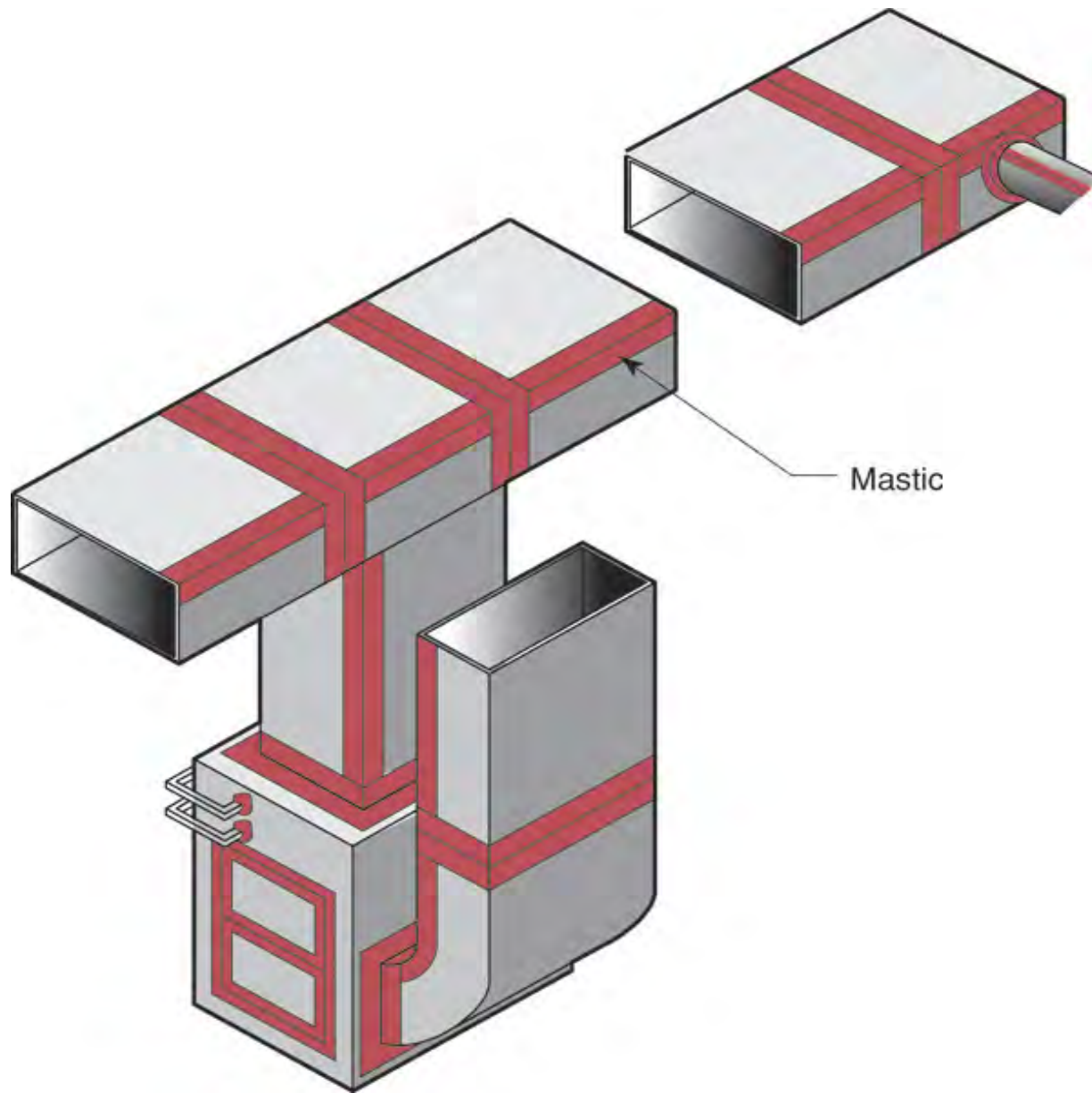












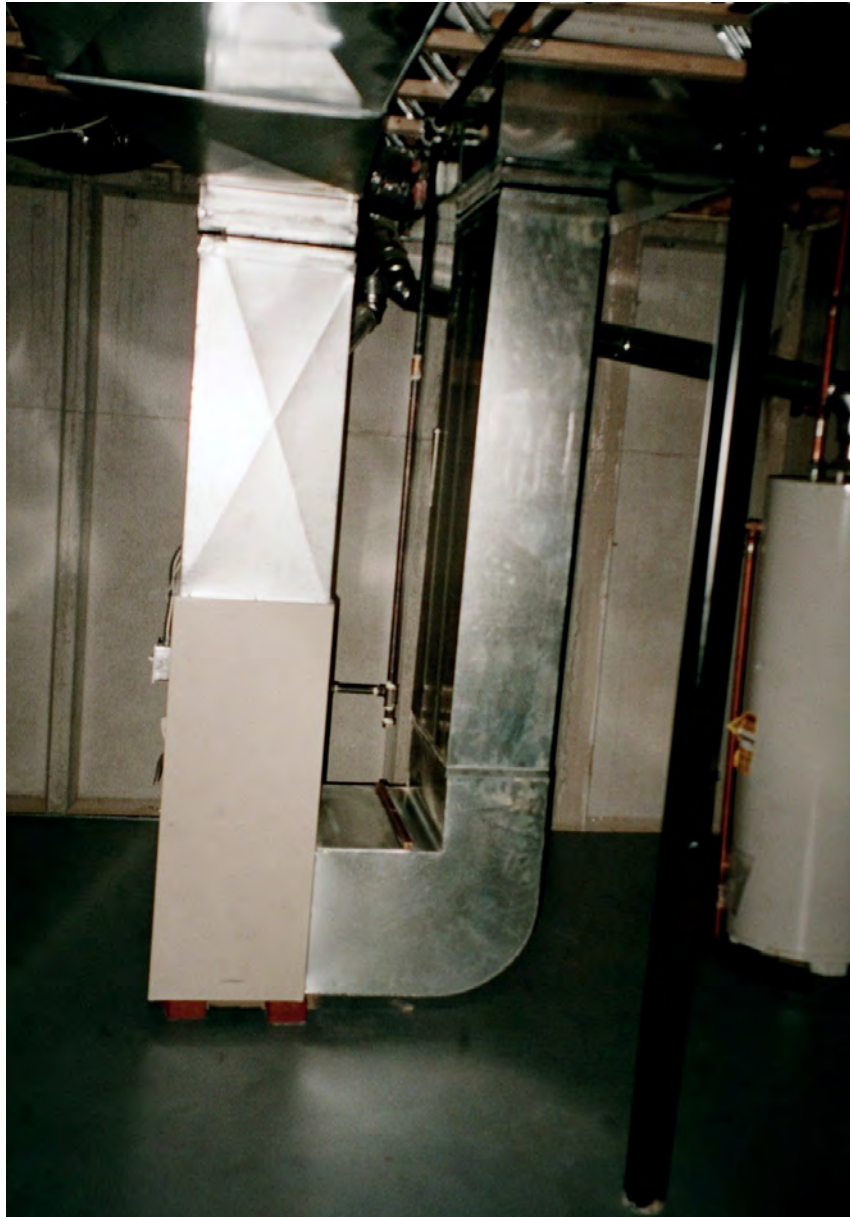




Figure 3.18

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

