Ventilation is Coming – Deal With it!

RESNET 2015

San Diego, CA

February 16 – 18

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Why do we need ventilation anyway?

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- Homes are being built tighter
- People are indoors most of the time
- Furnishings, finishes, cleaners, cooking, etc. in the home produce VOC's and small particulate (PM2.5)
- Construction materials used in new home production contain VOC's (formaldehyde) and absorb/release moisture
- Ventilate for improved indoor air quality: "The solution to pollution is dilution"
- ASHRAE Standard 62.2-2010 defines acceptable indoor air quality as:
  "air toward which a substantial majority of occupants express no dissatisfaction with respect to odor and sensory irritation and in which there are not likely to be contaminants at concentrations that are known to pose a health risk."

  …To paraphrase: "you want air that is safe and pleasant"

Homes are getting tighter

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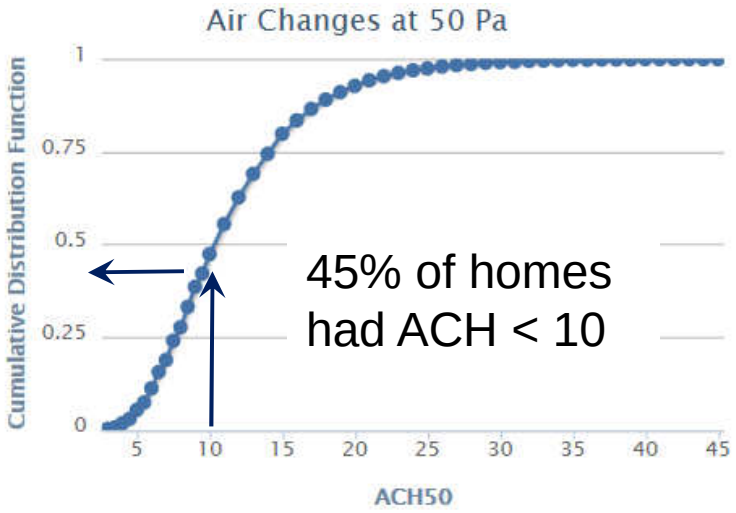
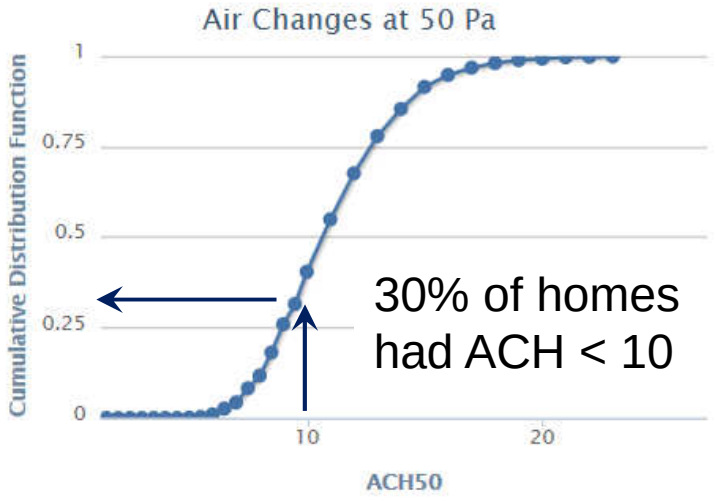
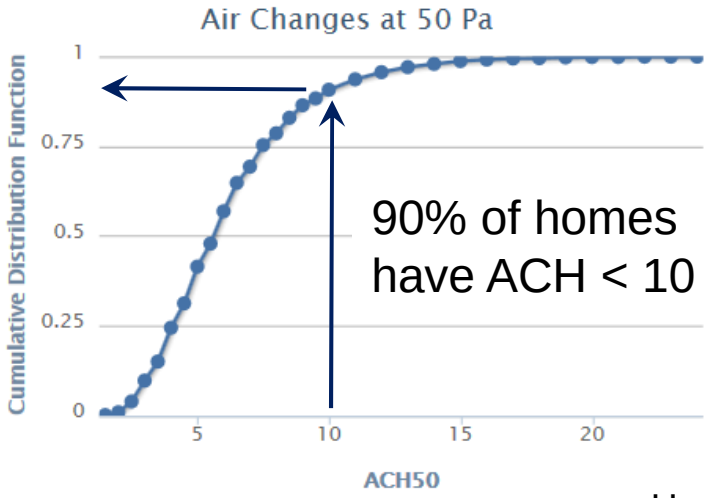
Madison

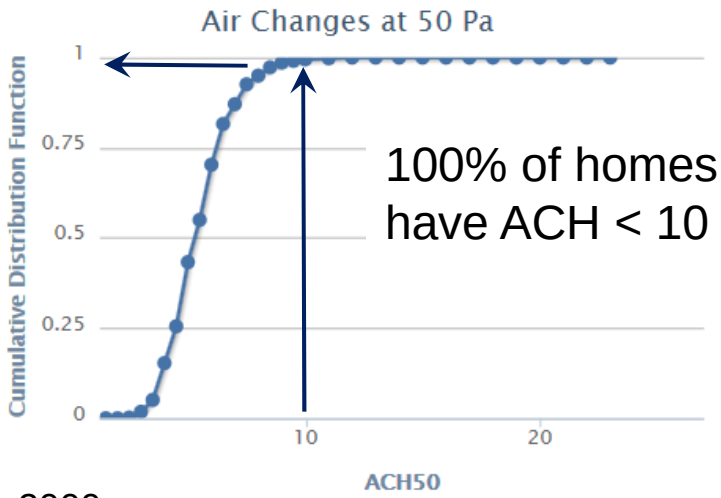


San Diego



Homes Built Before 1970





Homes Built After 2000

Data from Residential Diagnostics Database, LBNL

Homes are getting tighter

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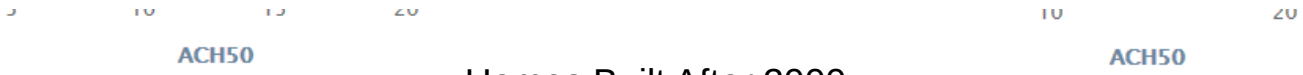
2012 IECC Requires 3 ACH50 in Climate Zones 3-8 and 5 ACH50 in Climate Zones 1 & 2



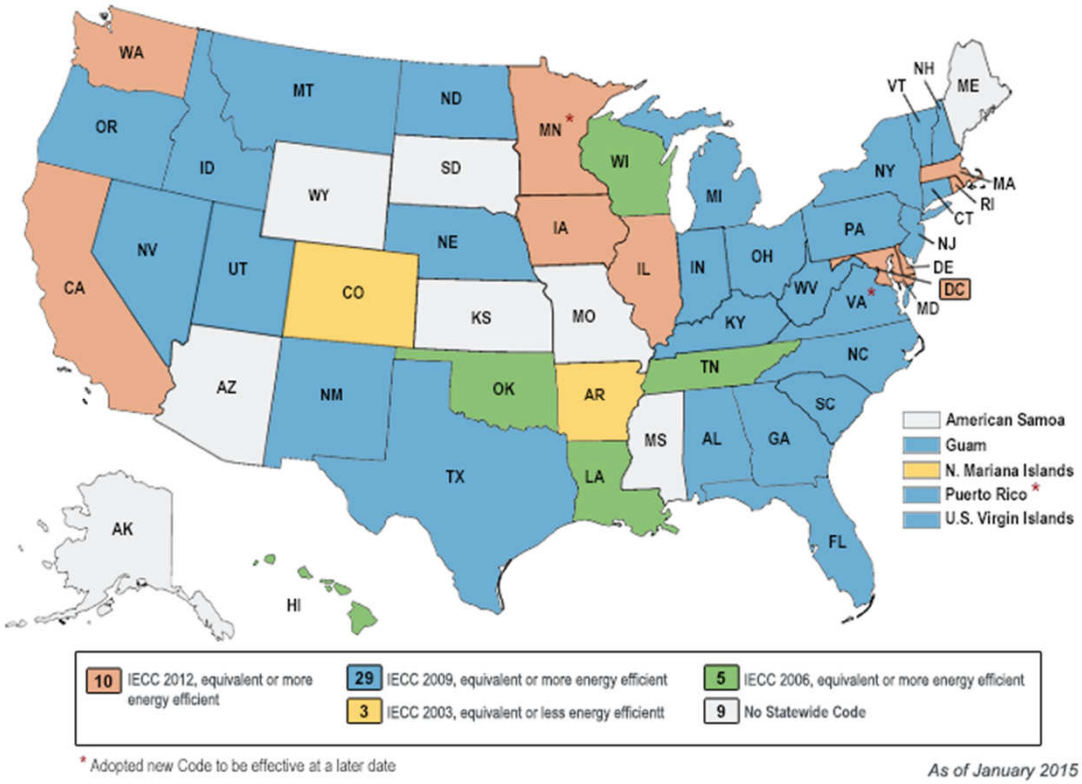
Homes Built After 2000

Data from Residential Diagnostics Database, LBNL

2012 ICC

2012 International Residential Code (IRC) & Energy Conservation Code (IECC)

- As of January 2015, ten states have ventilation requirements equivalent to the 2012 version of the IRC…and more are coming



Energy Star for Homes, EPA's Indoor airPLUS program & CEC Title 24

- Mechanical ventilation system shall be installed to meet the requirements of ASHRAE 62.2-2010

2012 ICC Requirements

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2012 International Residential Code (IRC) & Energy Conservation Code (IECC)

- Section N1103.5 (R403.5) Mechanical Ventilation (Mandatory).

  "The building shall be provided with ventilation that meets the requirements of **Section M1507** of this code or with ***other approved means of ventilation***. Outdoor air intakes and exhausts shall have automatic or gravity dampers that close when the ventilation system is not operating."

- Section N1103.5.1 (R403.5.1) Whole-house system fan efficacy

  "Mechanical ventilation system fans shall meet the efficacy requirements of Table N1103.5.1."

Type	Minimum Efficacy (CFM/watt)
In-line fan	2.8
Bath Fan <90 CFM	1.4
Bath Fan 90 CFM or greater	2.8

"Exception: Where mechanical ventilation fans are integral to tested and listed HVAC equipment, they shall be powered by an electronically commutated motor (ECM)."

2012 IRC Section M1507 Ventilation Rate (CFM)

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- Section M1507.3.2 System Controls
  "…ventilation system shall be provided with controls that enable manual override."
- Section M1507.3.3 Mechanical Ventilation Rate
  "…ventilation system shall provide outdoor air at a ***continuous rate not less than***…Table M1507.3.3(1)"

Floor Area	Number of Bedrooms				
(ft^2)	0-1	2-3	4-5	6-7	>7
<1500	30	45	60	75	90
1501-3000	45	60	75	90	105
3001-4500	60	75	90	105	120
4501-6000	75	90	105	120	135
6001-7500	90	105	120	135	150
>7500	105	120	135	150	165

This is the minimum continuous ventilation rate – the fan used for ventilation must deliver at least this much air

ASHRAE 62.2-2010 Ventilation Rate (CFM)

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Standard most commonly referenced in Codes and Energy Program requirements

Floor Area	Number of Bedrooms				
(ft^2)	0-1	2-3	4-5	6-7	>7
<1500	30	45	60	75	90
1501-3000	45	60	75	90	105
3001-4500	60	75	90	105	120
4501-6000	75	90	105	120	135
6001-7500	90	105	120	135	150
>7500	105	120	135	150	165

- OR -

CFM = Floor Area (ft^2)*.01 + (No. of bedrooms +1)*7.5

This is the minimum continuous ventilation rate – the fan used for ventilation must deliver at least this much air

Ventilation Comparison

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Item	2012 IRC/IECC *(local codes)*	ASHRAE 62.2-2010 *(Energy Star, EPA, CEC Title 24)*
Required Ventilation	Table	Table or Equation
Fan Efficacy	Required	No Requirement*
Manual Override Control	Required	Required
Infiltration Credit to Reduce Required Vent	Not Applicable	Allowed
Intermittent Operation	Allowed, 25% of every 4 hour period minimum	Allowed, 10% of every 24-hour period minimum
Dampers in Outdoor Air Intakes	Required	Not Required

* *For Energy Star for Homes, bathroom fans used as part of a whole house ventilation system must be Energy Star certified*

Common Types of Ventilation

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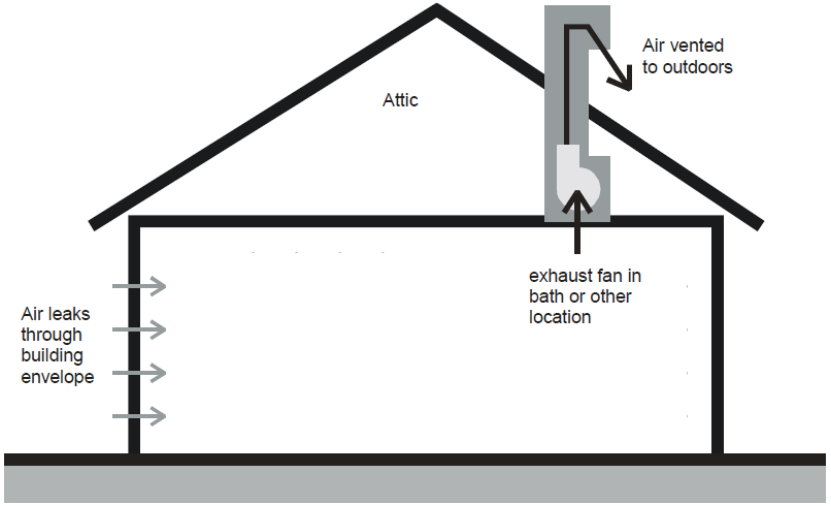
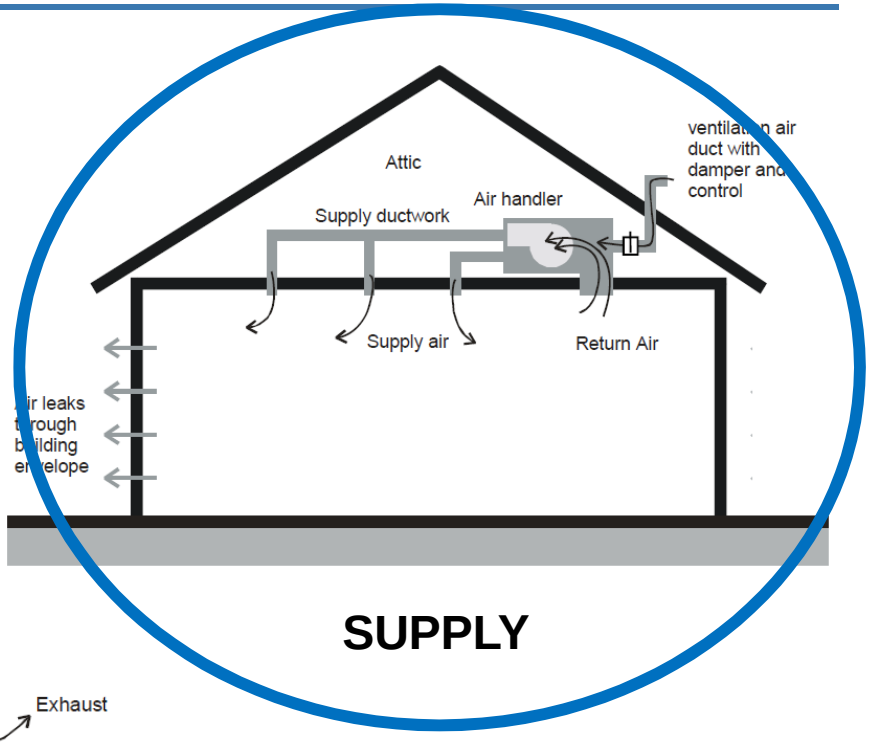
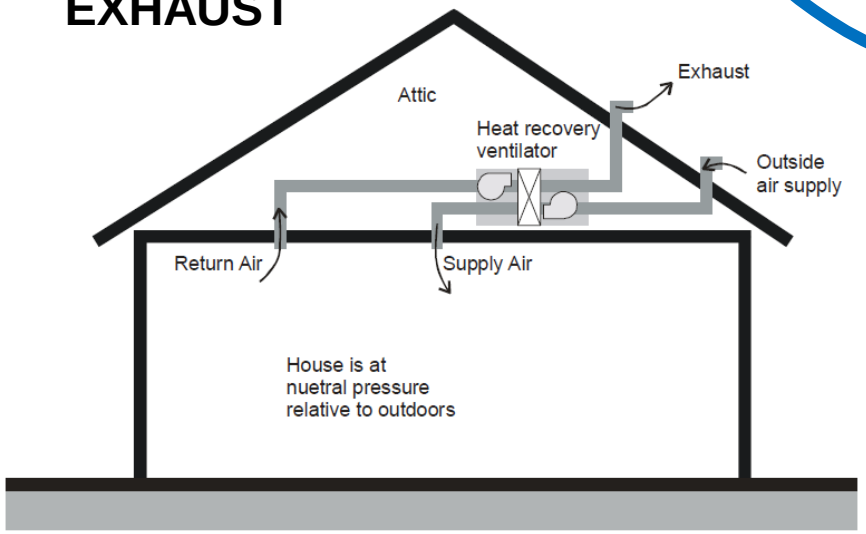


EXHAUST

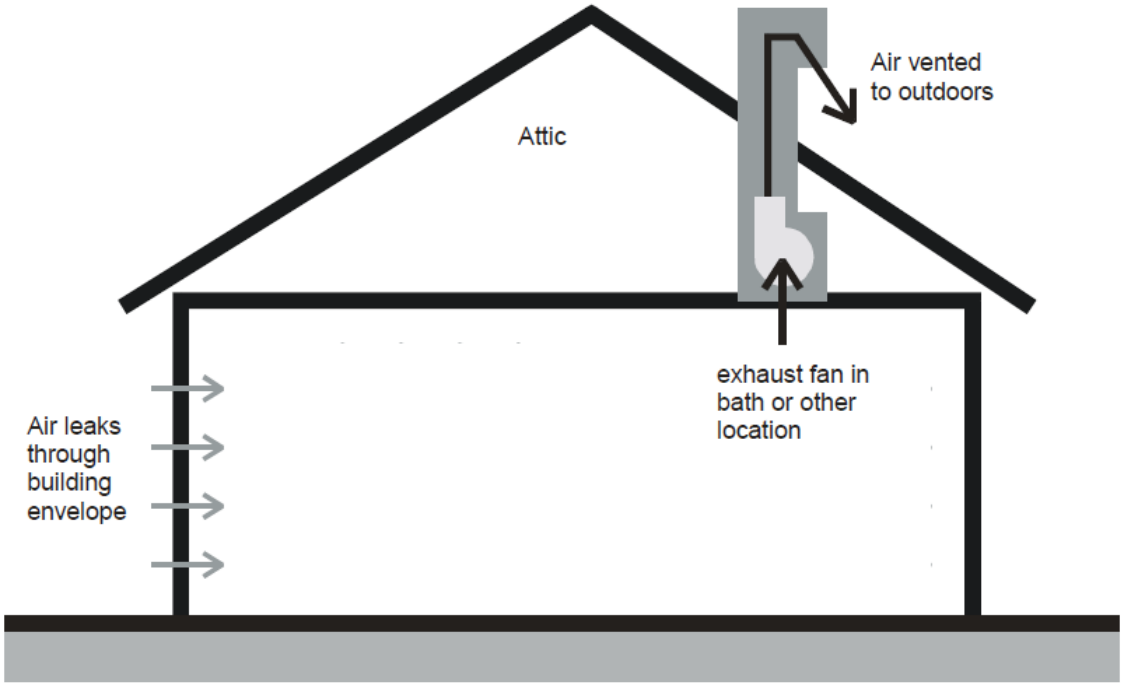


SUPPLY



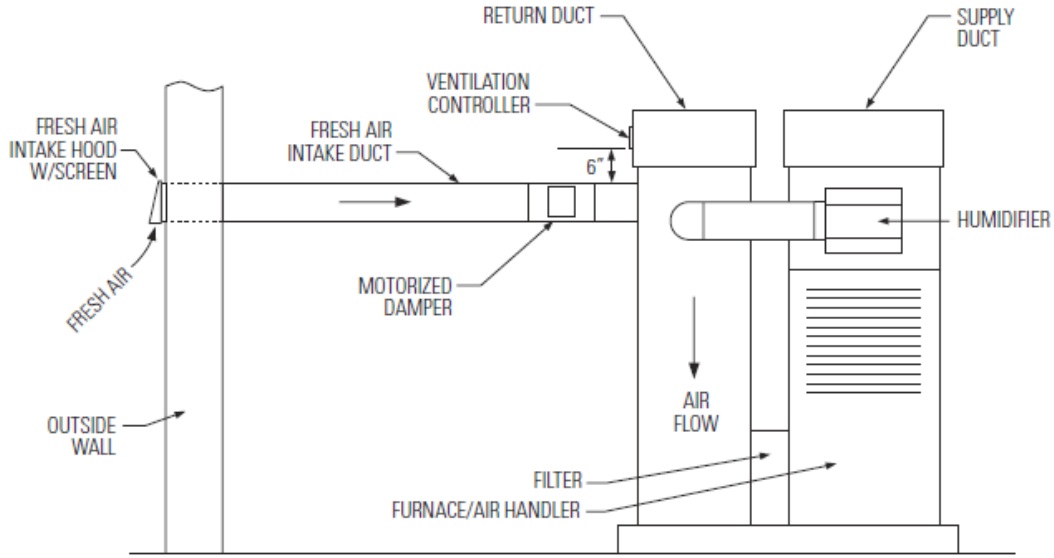
BALANCED

Requirements for Exhaust System



- Most common is bathroom exhaust fan, but could be an in-line fan with one or more pick ups throughout the house
- Airflow removed by the fan must be **at least** as much as the home ventilation requirement – airflow has to be measured
- Bath fan rated for 90 cfm or less must have efficacy rating of 1.4 CFM/watt, 2.8 cfm/watt for more than 90 cfm or for an in-line fan (Energy Star label)
- **2012 IECC Only** – Exhaust fan must have a gravity damper if run intermittently

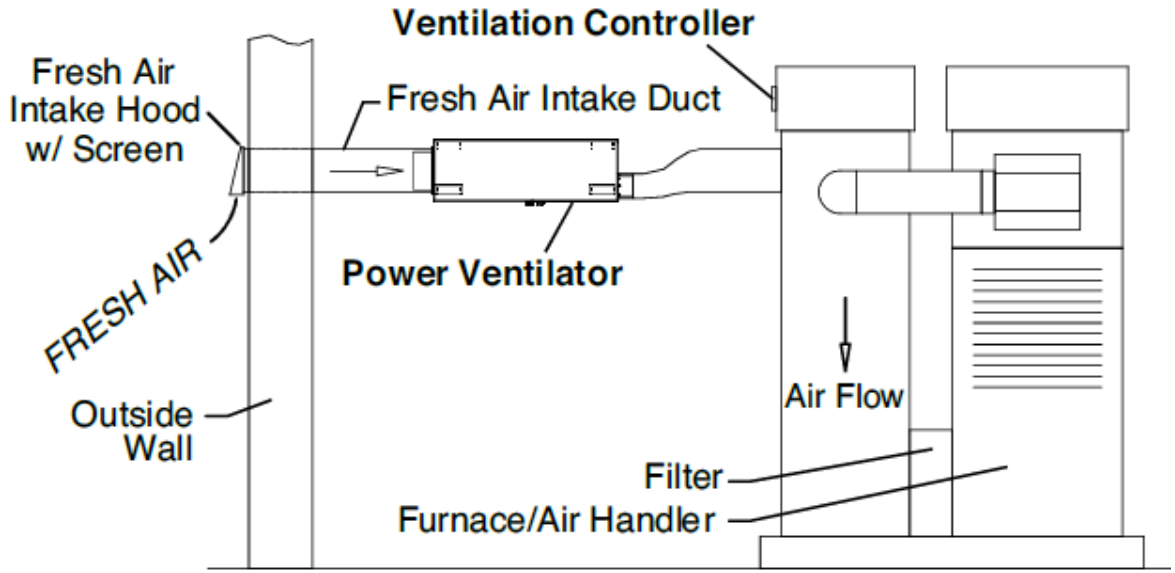
Requirements for Supply System



PASSIVE SYSTEM

- Motorized damper in fresh air duct to the return side of the HVAC system with a control
- In this particular system, ventilation requires the HVAC system fan to run, and the ventilation control must be able to operate the HVAC system fan independently of normal heating/cooling cycles
- Delivered airflow is entirely dependent on the negative pressure generated by the HVAC system and must be measured to ensure it is greater than or equal to the required CFM
- **2012 IECC only** – blower of HVAC system must use an ECM

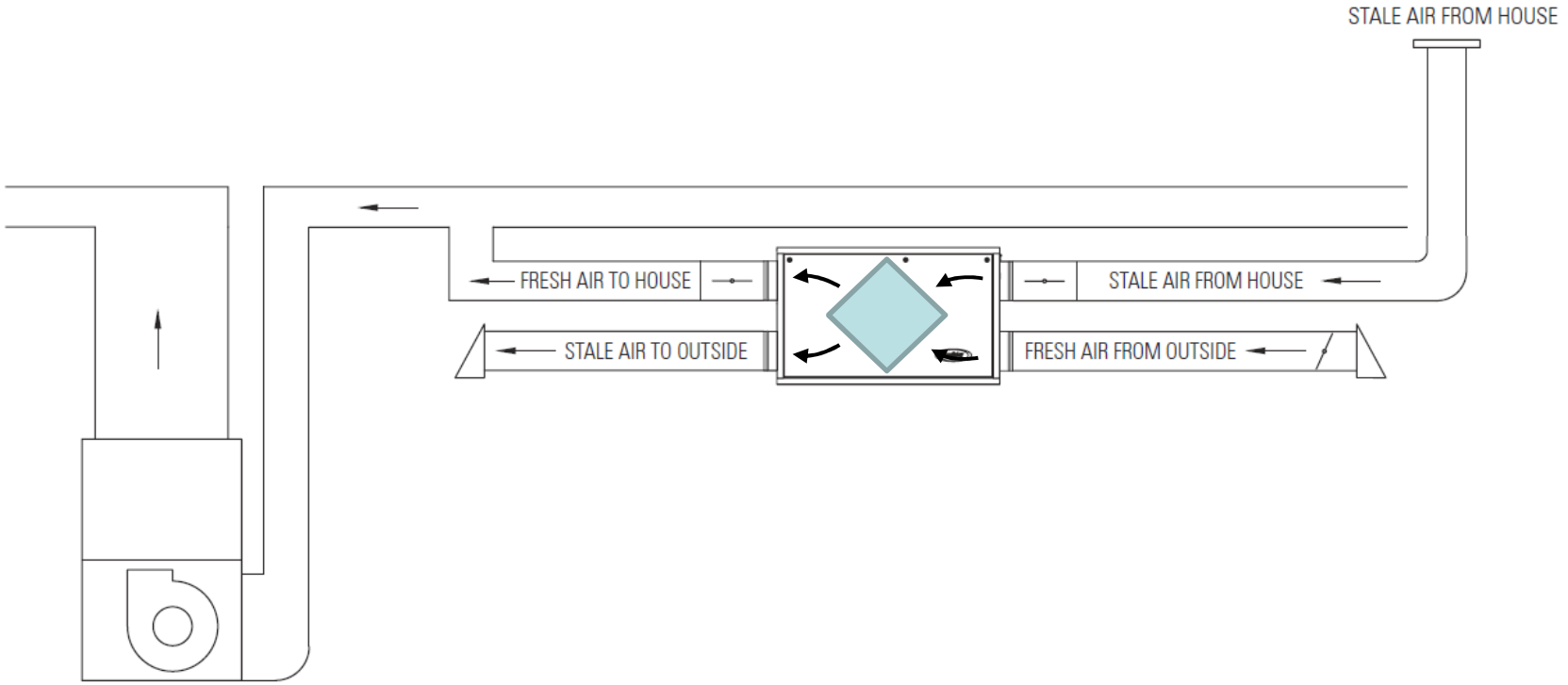
Requirements for Supply System



POWERED SYSTEM

- Powered Ventilator most likely ducted to HVAC system so air can be tempered
- If ducted to return side of HVAC system, a powered damper is required
- If ducted to the supply side of the HVAC system, a back draft damper is required
- Delivered airflow must be measured to ensure it is greater than required CFM
- **2012 IECC only** – ventilator efficacy must be at least 2.8 cfm/watt

Requirements for Balanced System



- Most common is an HRV or ERV, but could be supply and exhaust fans
- Delivered fresh air must be **at least** as much as the home ventilation requirement – airflow has to be measured
- Dampers must be installed or be integral to the unit to close when the ventilation system is not operating.

Recap #1

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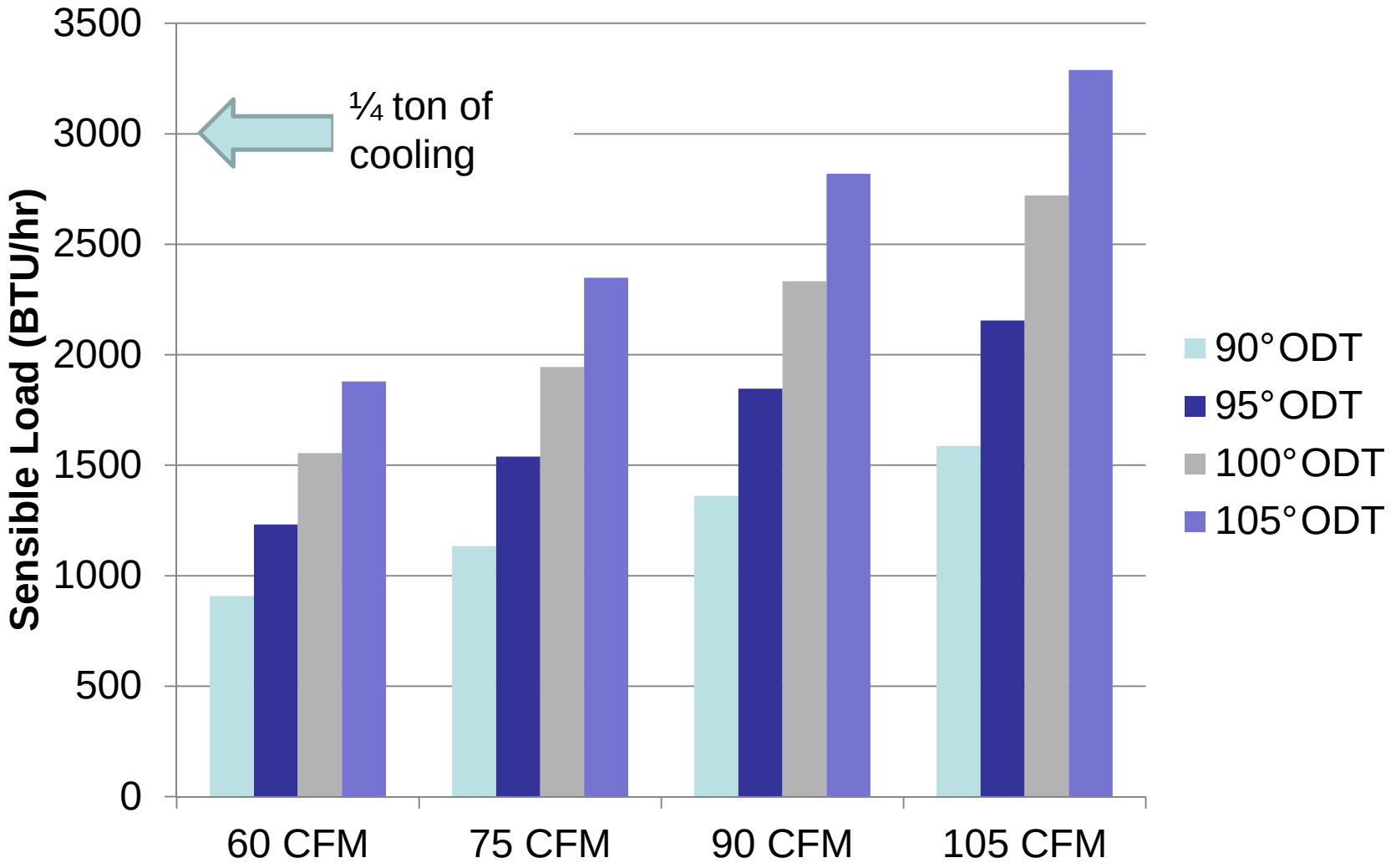
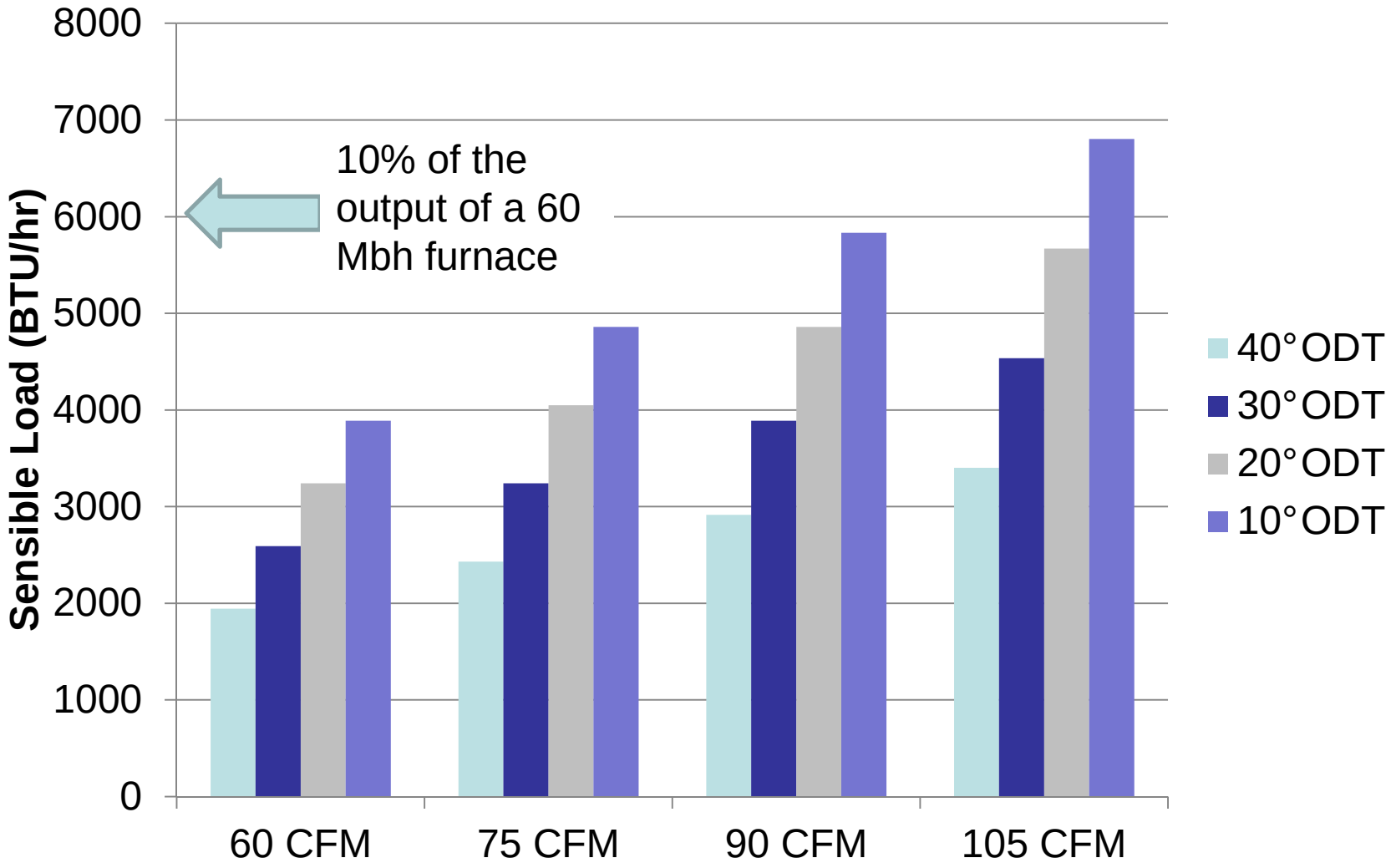
- Ventilation is needed for good indoor air quality. The government (and/or insurance companies) agrees, and codes or energy programs require or are going to require mechanical ventilation for new homes
- ASHRAE Standard 62.2-2010 (referenced by the ICC) defines the amount of mechanical ventilation that is required continuously (24/7/365)
- Three different ventilation system types exist to bring in fresh air
- So, ventilation is good…right?
- Right!…but nothing is free.

Summer- Heat Gain due to Ventilation



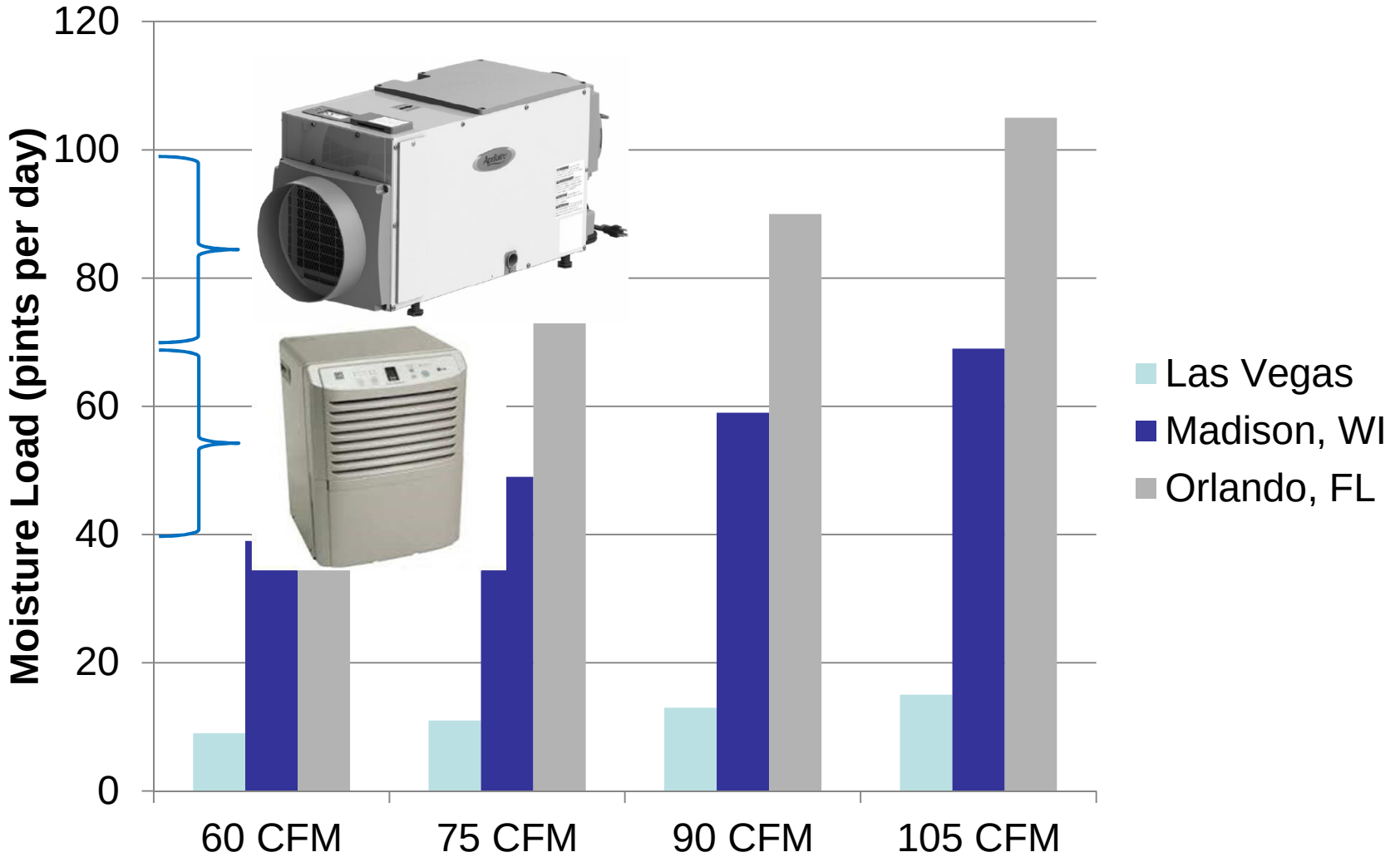
**Assumes 76°indoor temperature*

Winter - Heat Loss due to Ventilation



**Assumes 70° indoor temperature*

Moisture Load due to Ventilation



**Based on ASHRAE 2% Dehumidification Design conditions and 76˚/50% indoor conditions*

Recap #2

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- Ventilation is required, ASHRAE Standard 62.2-2010 defines the amount of outdoor airflow that is required
- Outdoor air contains heat/humidity or needs heat/humidity. This has an energy cost and can effect the comfort of the occupants
- Whatever system is installed, must deliver at least as much outdoor airflow as is required
- Mechanical system airflow delivery must be measure, and if the airflow delivered is less than the airflow requirement, then the installed system is unacceptable
- If the airflow delivered is more that the airflow requirement, then there are choices:

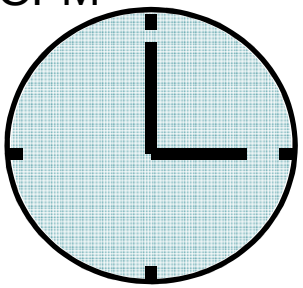
  1. Over ventilate
  2. Reduce the delivered airflow using dampers or motor controllers
  3. Run the ventilation system intermittently

Intermittent Ventilation

- ASHRAE 62.2-2010 & 2012 IRC allows intermittent operation of the ventilation system to meet the continuous CFM requirement if the installed fan is able to deliver more CFM, but the **required airflow (*Qr*) divided by the delivered airflow (*Qf*) must be equal to the fractional on time (*f*)**.

$$Qr/Qf = f = Vent\ Time/Cycle\ Period$$

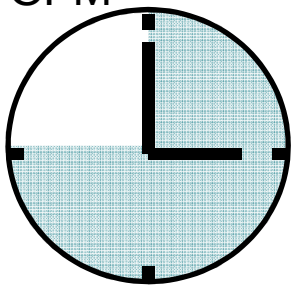
Fan = 90 CFM



60 min/hr = 60*(90/90)

100% fractional on time

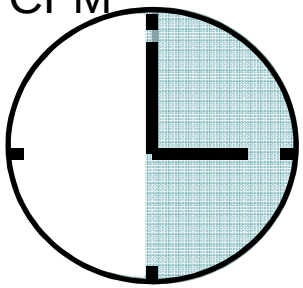
Fan = 120 CFM



45 min./hr. = 60*(90/120)

75% fractional on time

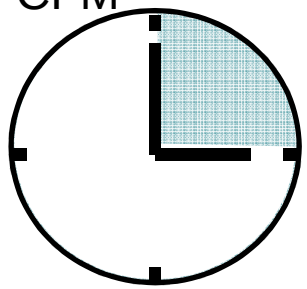
Fan = 180 CFM



30 min./hr. = 60*(90/180)

50% fractional on time

Fan = 360 CFM



15 min./hr. = 60*(90/360)

25% fractional on time

ASHRAE 62.2-2010 required continuous ventilation = 90 CFM

Effectiveness of Intermittent Ventilation

ASHRAE allows a cycle period of up to 24 hours

a. If the cycle period is longer than four hours, then the fractional on time must be increased to account for ventilation **effectiveness**

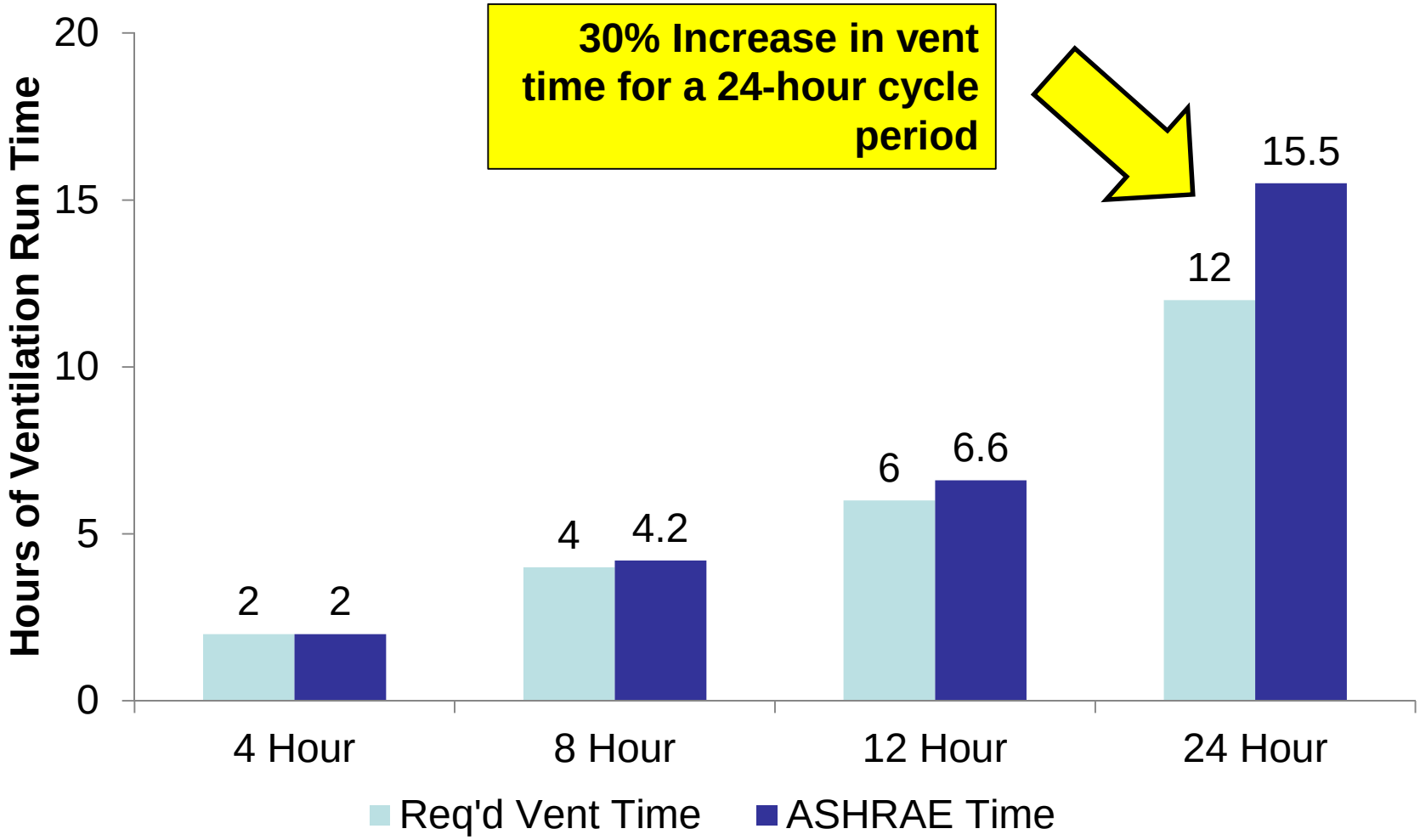
$$\frac{Qr}{Qf} = f\ (0 - 4\ \text{hour cycle period})$$

$$\frac{Qr}{Qf} = f \times \epsilon\ (\text{longer than four hours})$$

i. Ventilation for the last 12 hours of the day is not as effective at removing/diffusing odors/contaminants as ventilation 30 minutes every hour

a. How much longer?

“Effect” of effectiveness



- 60 CFM continuous ventilation required
- 120 CFM fan installed

Sensible Load Extremes – Deal With it!

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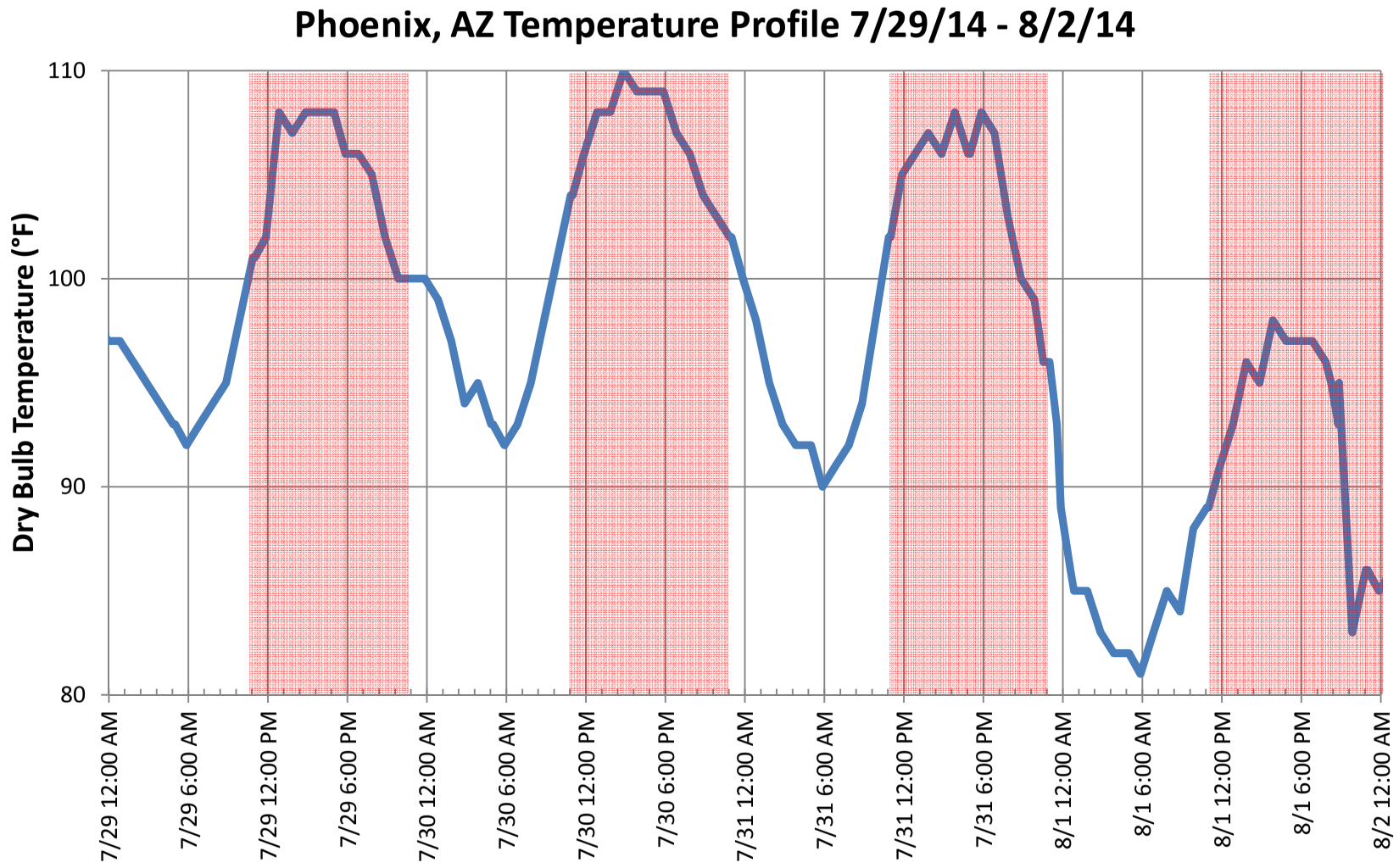

Not the ideal time to be bringing in outdoor air

Sensible Load Extremes – Deal With it!

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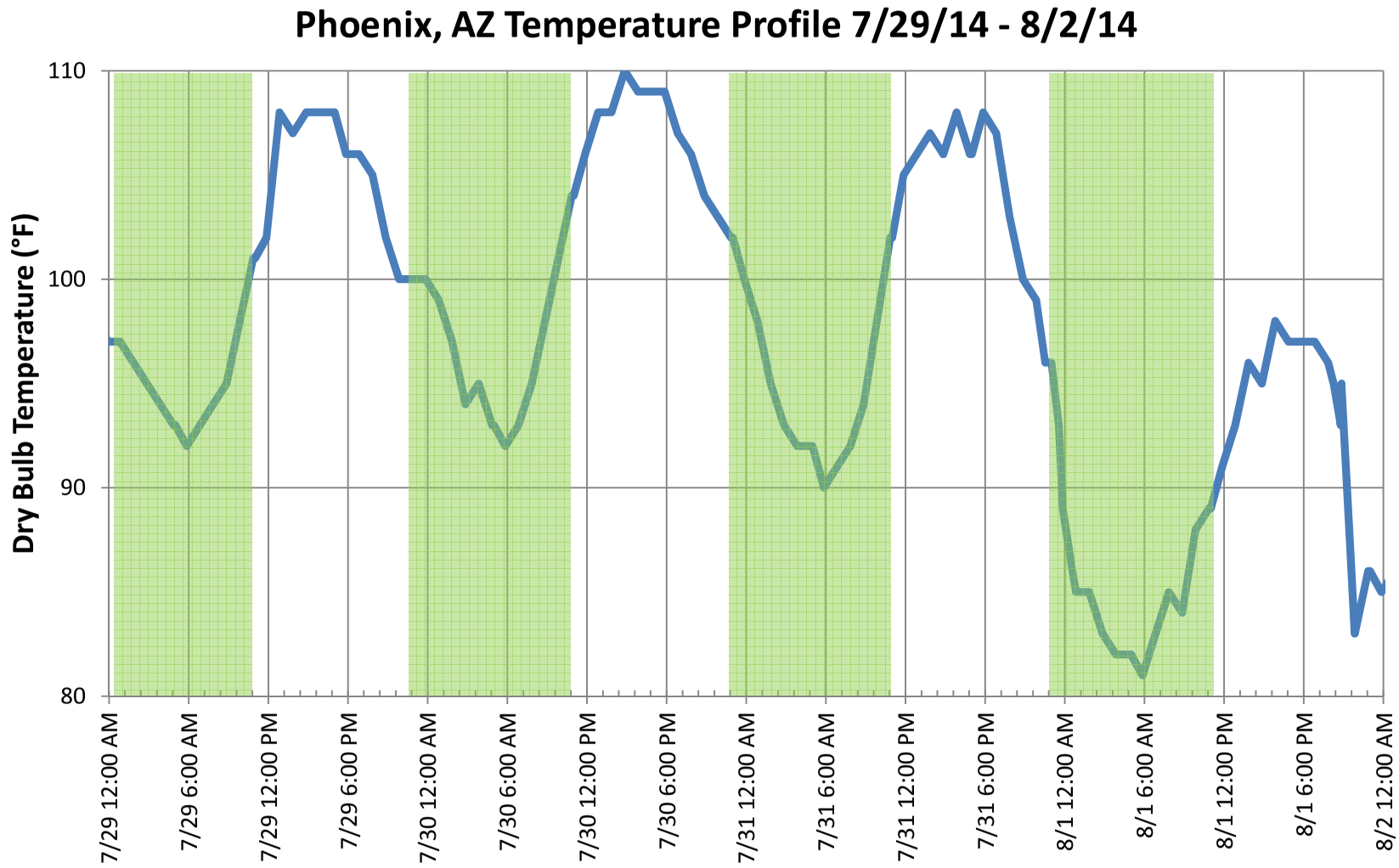

During extreme conditions, why not ventilate during "optimum" times?

Sensible Load Extremes – Deal With It

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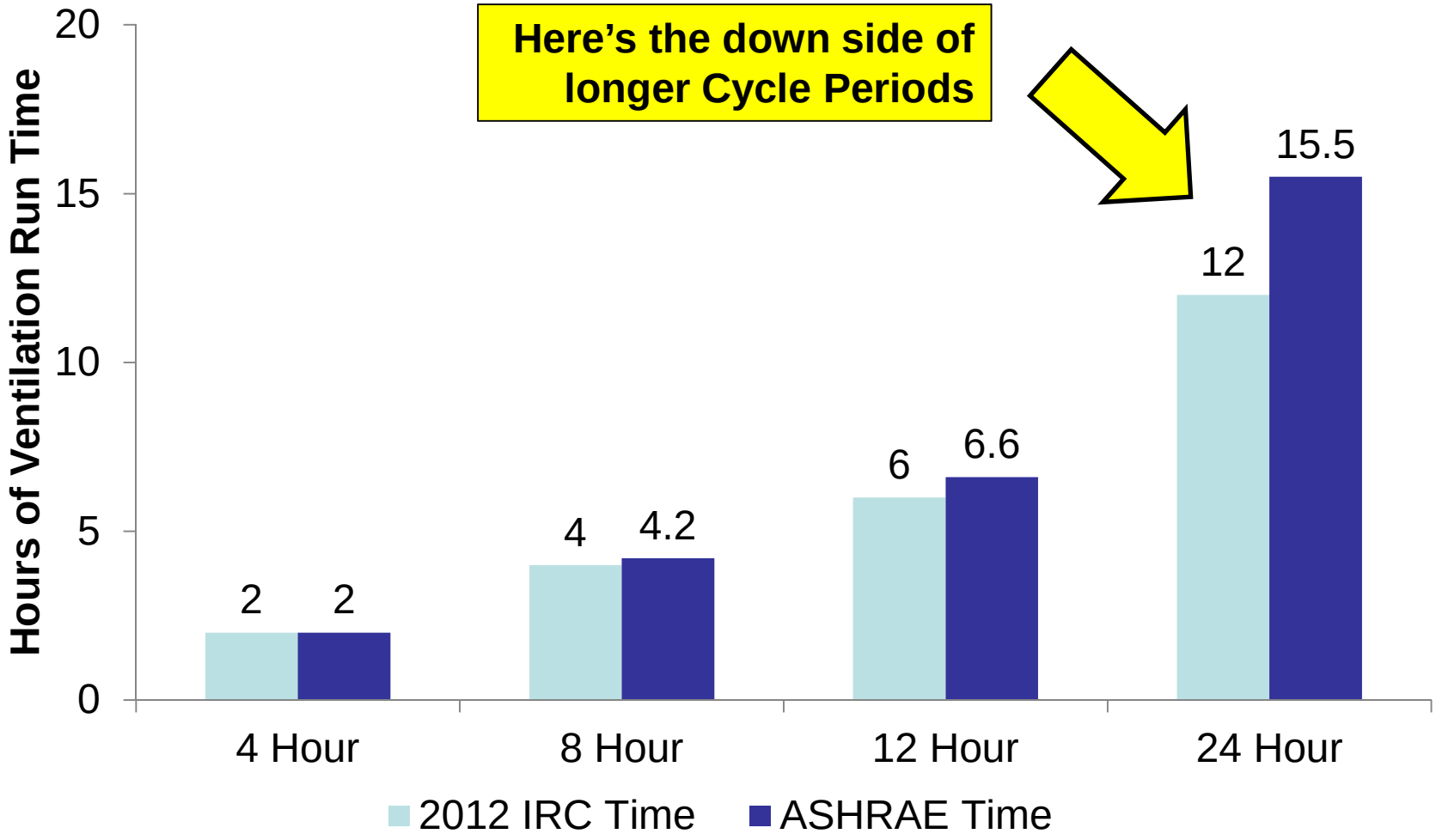
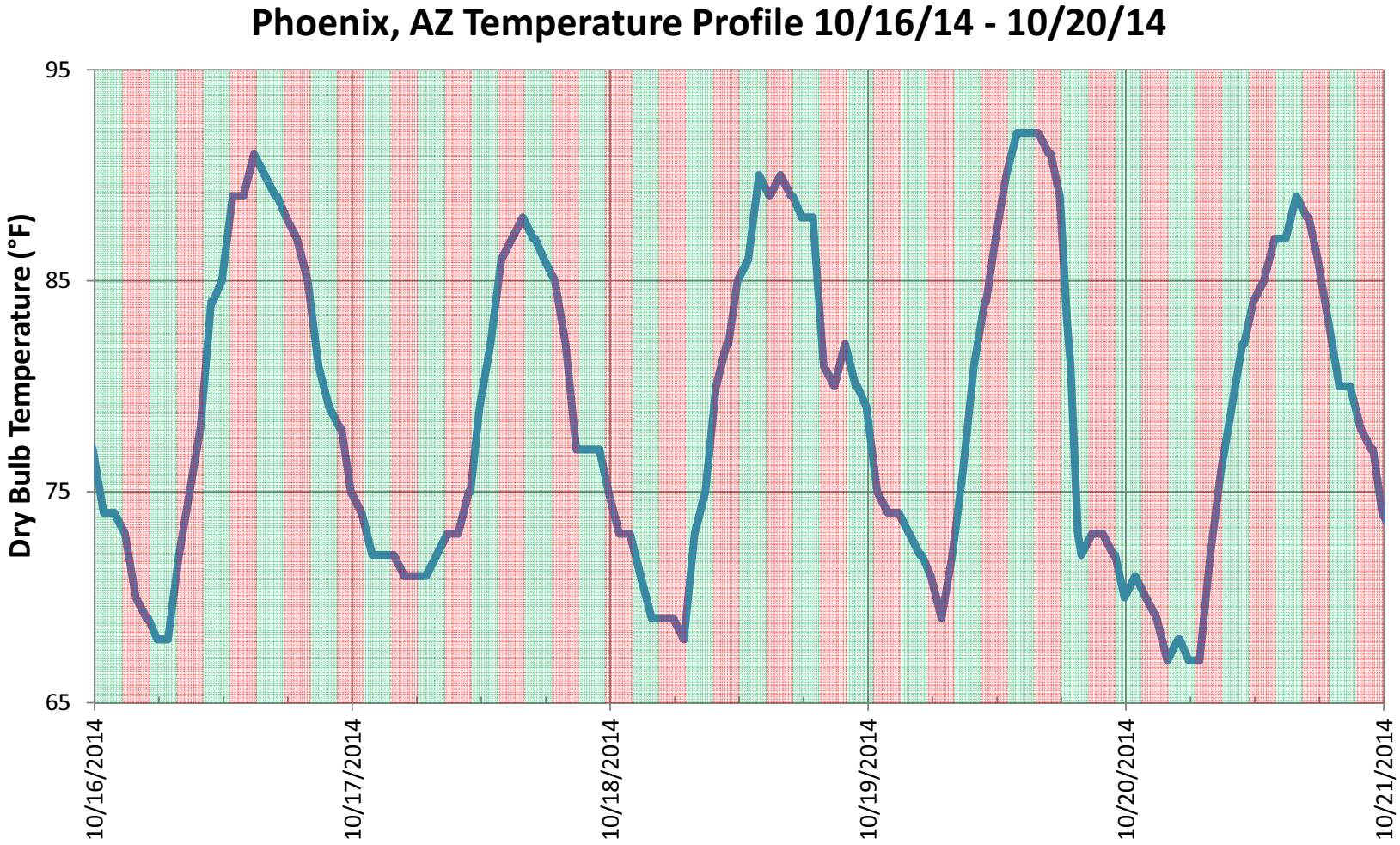
- Use ventilation controls that will implement a high temperature limit on ventilation, coupled with the ASHRAE allowable method for making up lost ventilation time later (with consideration to effectiveness)
  - Small annual energy savings
  - Improved comfort: Would ventilation air that is 10° cooler be less “noticeable” by the homeowner?
  - Lower the design load on the HVAC system from 660 BTUh to 1150 Btuh compared to design conditions; not much compared to the total load, but is this enough to be able to downsize the equipment?
- At additional installation/equipment cost, couple with energy recovery equipment for even greater savings

“Effect” of effectiveness



- 60 CFM continuous ventilation required
- 120 CFM fan installed

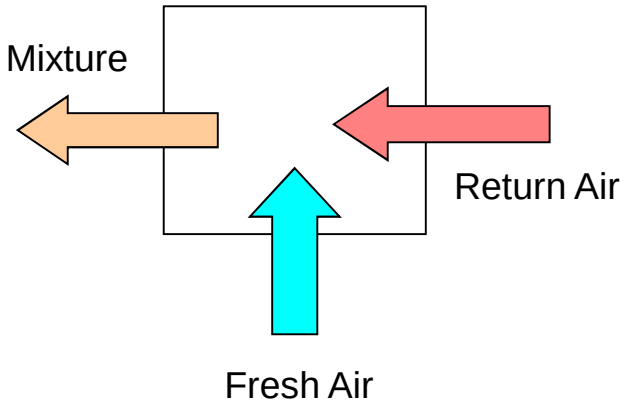
Ventilation Run Time – Deal With it!



Use intelligent controls that will return to a lower cycle time during moderate temperatures to minimize ventilation run time

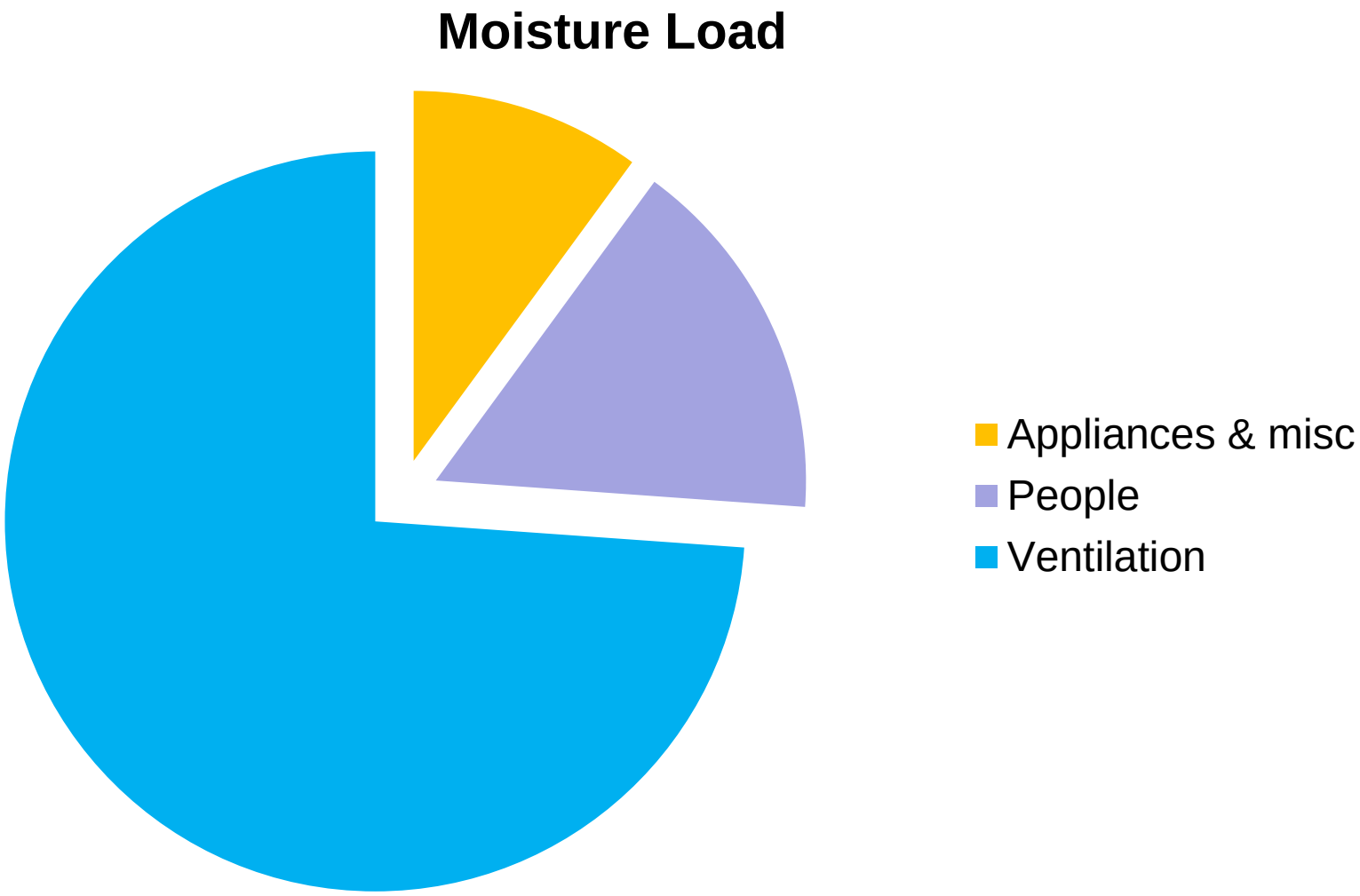
Air Temperature Extremes – Deal With It!

- In extreme hot/dry climates, concern is occupant discomfort from ventilation air
- In cold climates, concern is occupant discomfort, condensation on the outside of ducts (sheet metal in particular) and temperatures entering the furnace/air handler
- In hot/humid climates, concern is occupant discomfort and the potential for condensation in the ductwork or other cold surfaces due to moisture in the ventilation air



Air mixing is a solution

Moisture Load – Deal With It!



**Assumes indoor conditions of 76℉/50% RH; 75 CFM ve ntilation in home with 4 people in Orlando, FL*

What do you have to deal with if you live here?

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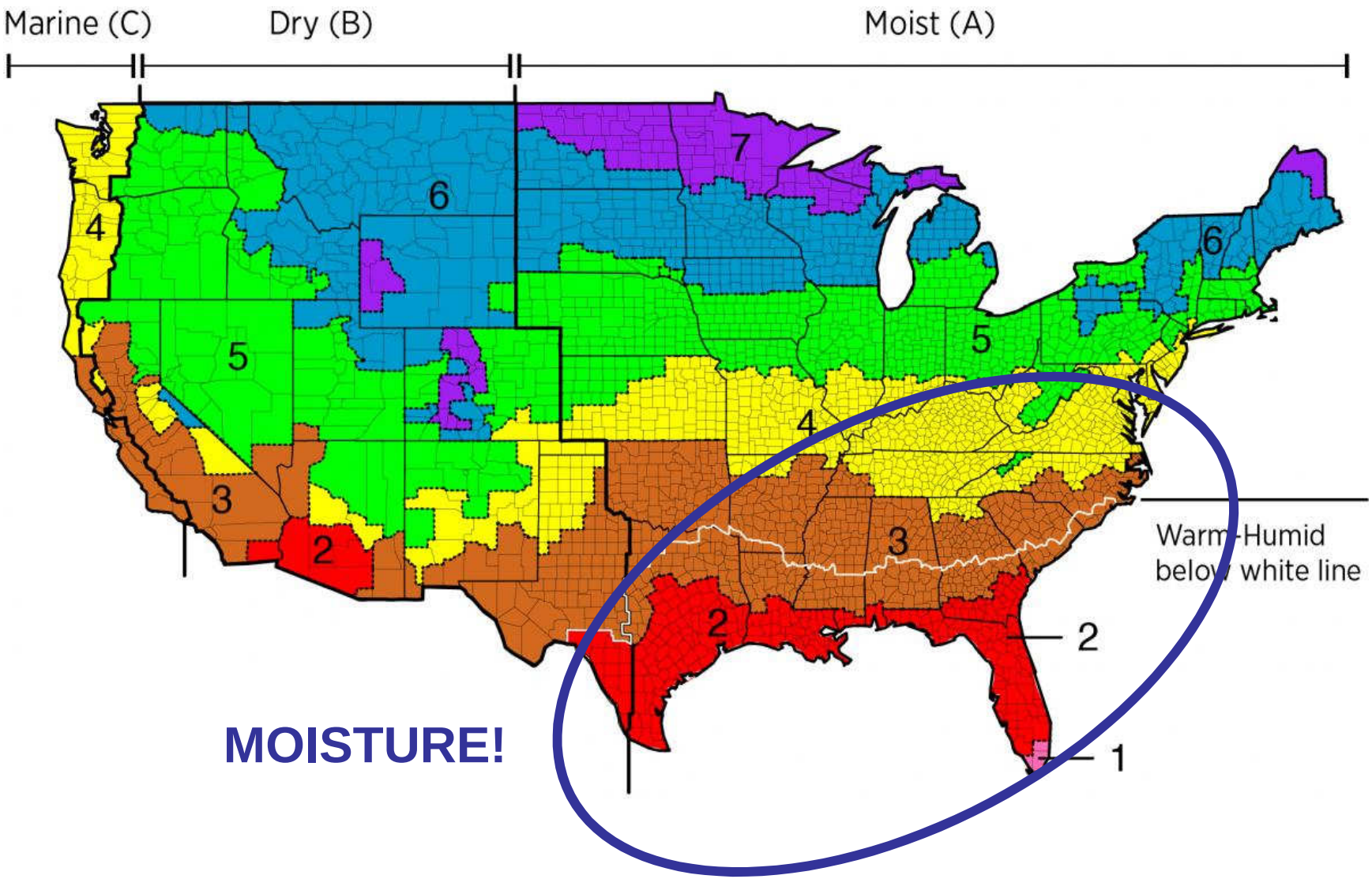

Moisture Comparison U.S. Regions

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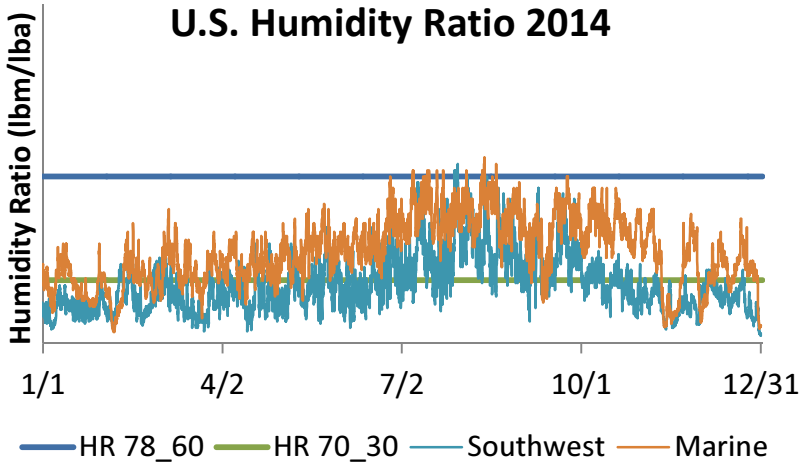
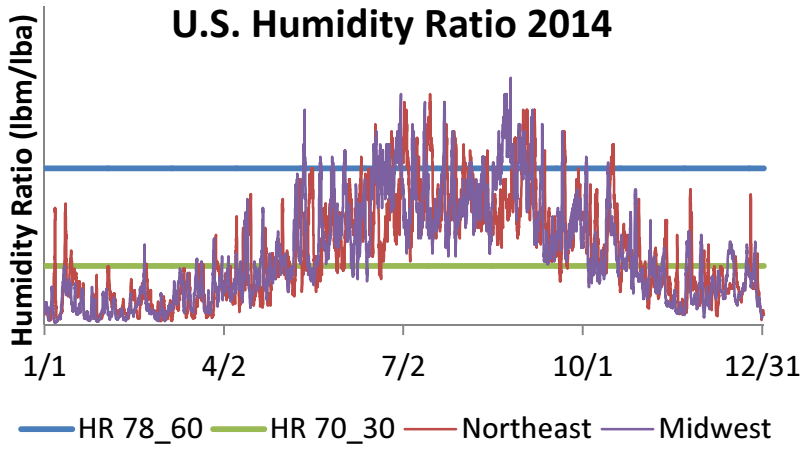
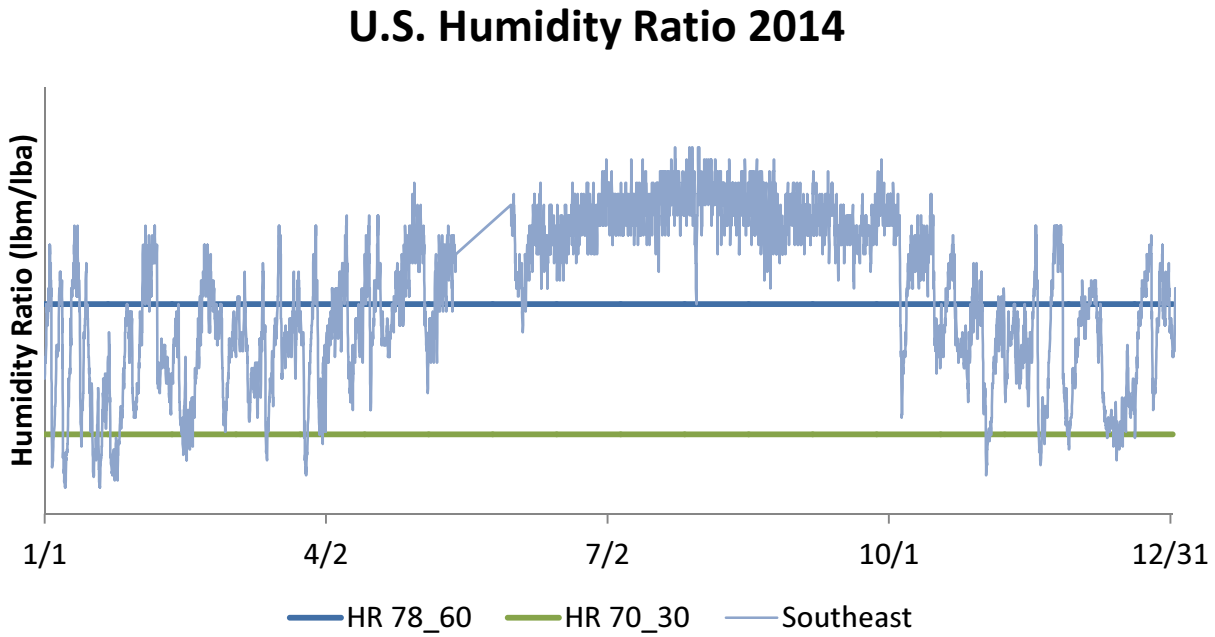
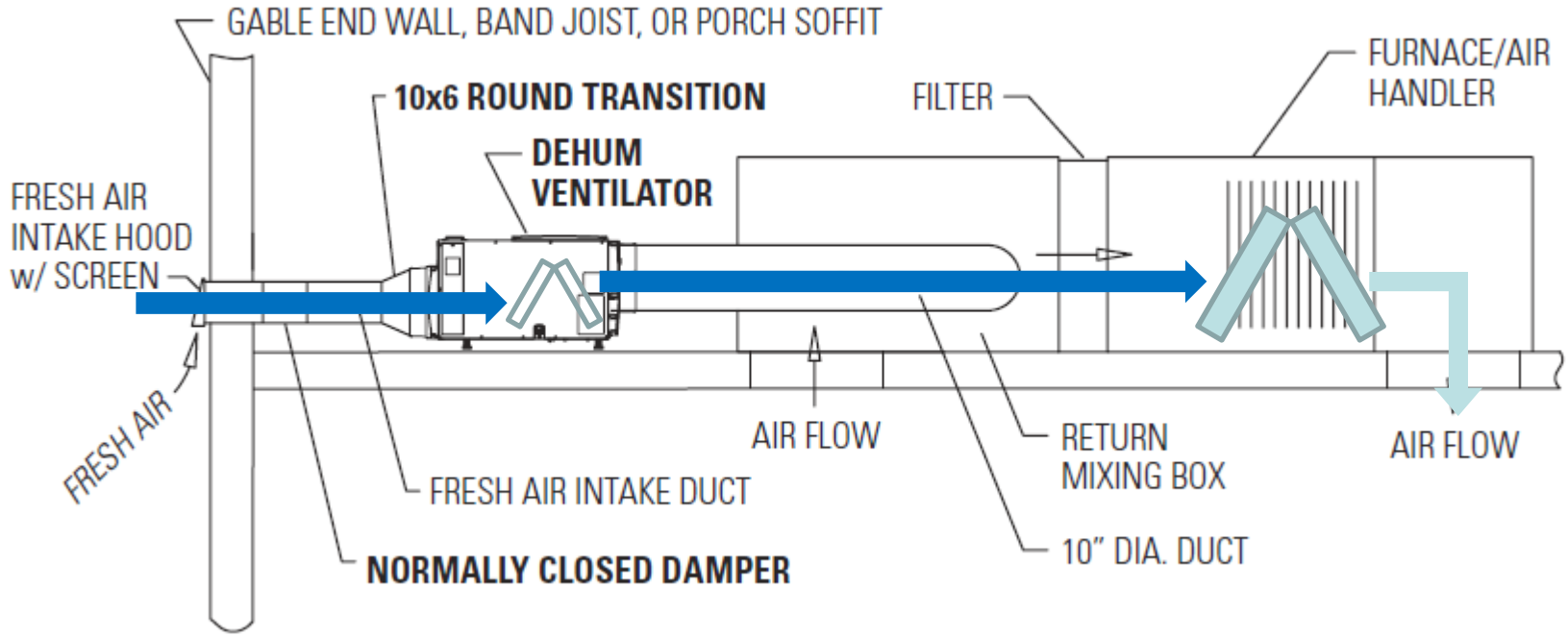






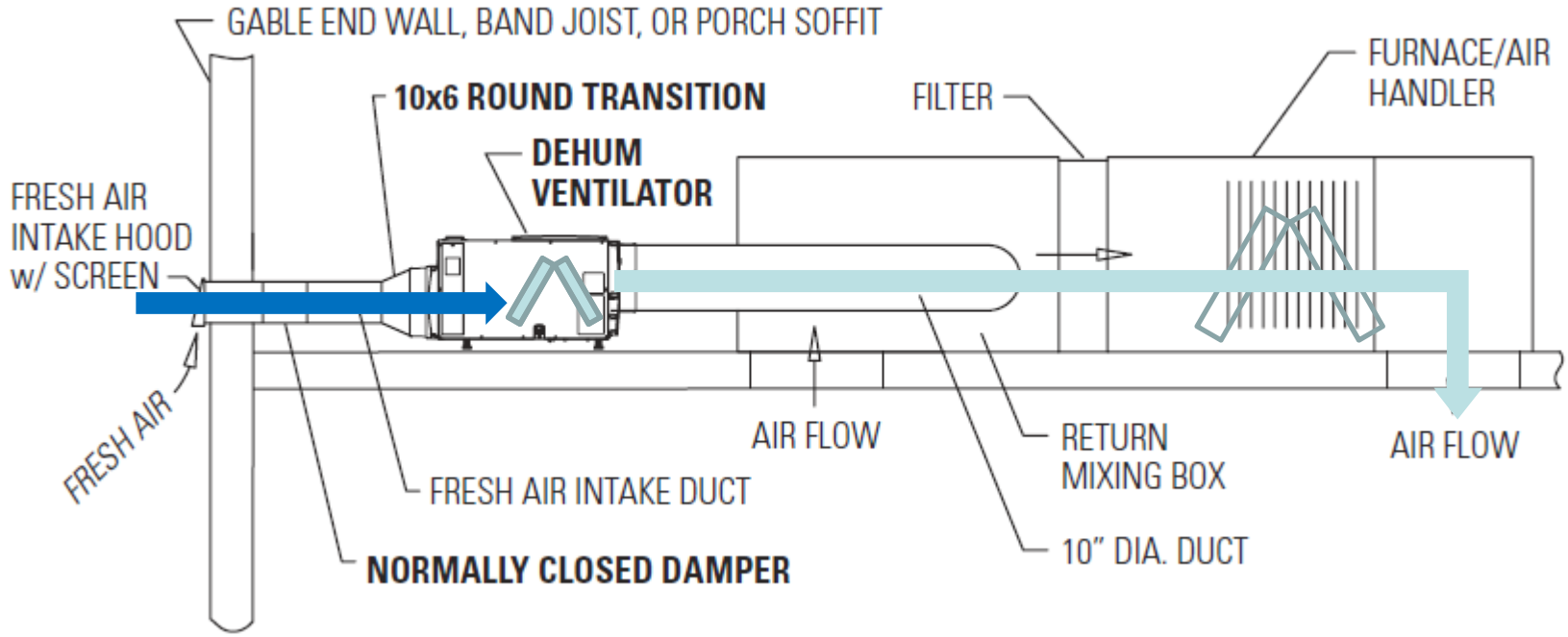
Moisture from ventilation – Deal With it!



In humid climates, remove the moisture from the ventilation air before it gets to the home:

1. Ventilate when the AC is running – air conditioners make excellent dehumidifiers…when they run

Moisture from ventilation – Deal With it!



In humid climates, remove the moisture from the ventilation air before it gets to the home:

1. Ventilate when the AC is running – air conditioners make excellent dehumidifiers…when they run
2. Use a ventilator with dehumidification capabilities to remove the moisture during those parts of the year where the sensible load is low (AC runs less), but the humidity is still high

Summary

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- Ventilation **is** coming, and it's just a good idea
  - Good indoor air quality is the primary driver for ventilation
  - 2012 IRC/IECC requires mechanical ventilation
  - Energy Star and EPA Indoor airPLUS homes require mechanical ventilation
- Ventilation Rate: ASHRAE 62.2-2010 = 2012 IRC/IECC
  - CFM Tables show minimum continuous required ventilation. Use the ASHRAE 62.2-2010 equation instead to minimize required ventilation.
  - When using a fan with more capacity than required, run it intermittently
  - Use the ASHRAE flexibility of up to 24 hour cycle periods to meet ventilation requirements while saving energy by running at optimum times
- Reduce the cost of the necessity
  - Ventilation is needed, but it has a cost
  - Run ventilation during optimum times of the day
  - Run ventilation to meet the requirements and not more
- Improve the comfort of ventilation as much as possible
  - Run ventilation when outdoor temperatures are not at the extremes & mix with room air for tempering
  - Bring in humid outdoor air when the AC is running, or dehumidify the fresh air before it reaches the house