ZA 101.03 Introduction to Ventilation Standards

25 minutes

Estimated duration to complete this Learning Segment

Zehnder Academy Learning Path

This segment is part of the training for:

Zehnder America Certified Comfosystems **SPECIFIER**

Zehnder America Certified Comfosystems **INSTALLER**

Zehnder America Authorized Comfosystems **TECHNICIAN**

Zehnder America Authorized Comfosystems **DEALER**

Zehnder America Authorized Comfosystems **DISTRIBUTOR**

Knowledge Level:

Introductory

Recommended prerequisites:

- ZA101.01 IAQ Basics
- ZA101.02 Basic Principles of Ventilation

LEARNING OBJECTIVE(S)

By the end of this course, participants will be able to...

1. Become conversant with ventilation flow rate terminology
2. Identify the key factors addressed by ventilation standards
3. Develop a basic familiarity with common codes and standards

Learning Objective 1

Become conversant with ventilation flow rate terminology

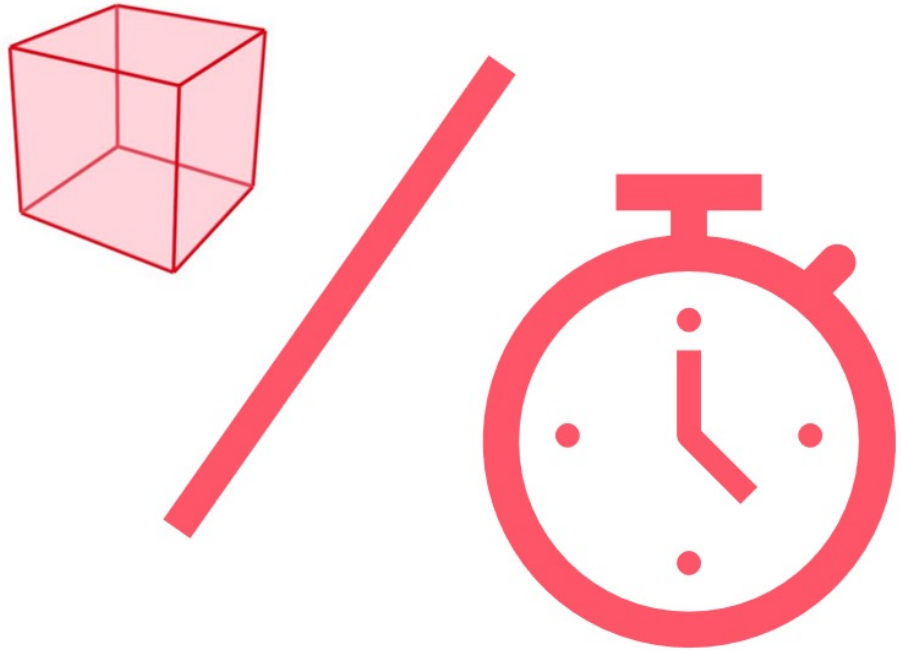
Ventilation Rate Units

The ventilation “rate” describes how much outdoor air (what volume) enters the building in a certain amount of time.

In North America…

- The common unit of volume is a cubic foot (a cube measuring 12” x 12” x 12”).
- The common unit of time is 1 minute.
- The resulting unit for ventilation rate is a cubic foot per minute (cfm).

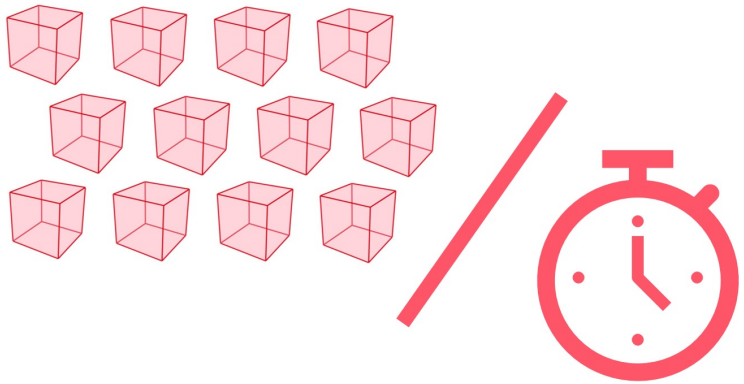
Note: Sometimes you may see flow rates in metric units...cubic meters per hour (m3h) or liters per second (L/s).



Ventilation Rate Units

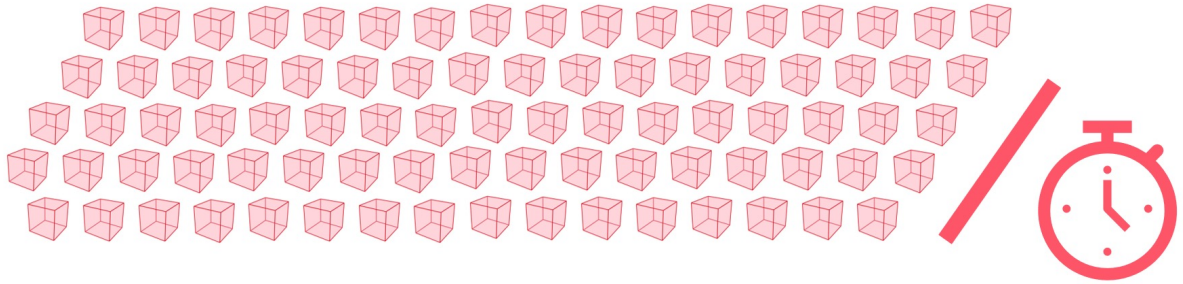
12 cfm

Perhaps the ventilation rate for a single room



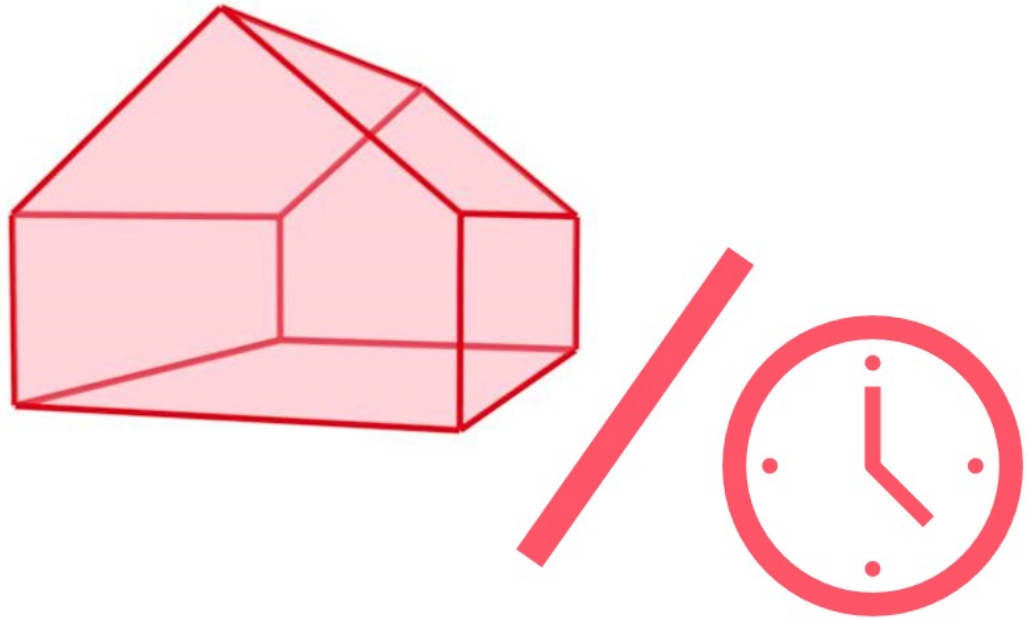
84 cfm

Perhaps the ventilation rate for an entire small house



Flow Rate and “Air Changes”

Another way to describe flow rate is to talk about how many complete air changes a space will have in an hour at a continuous flow. “Air changes per hour” is abbreviated as “ACH”.

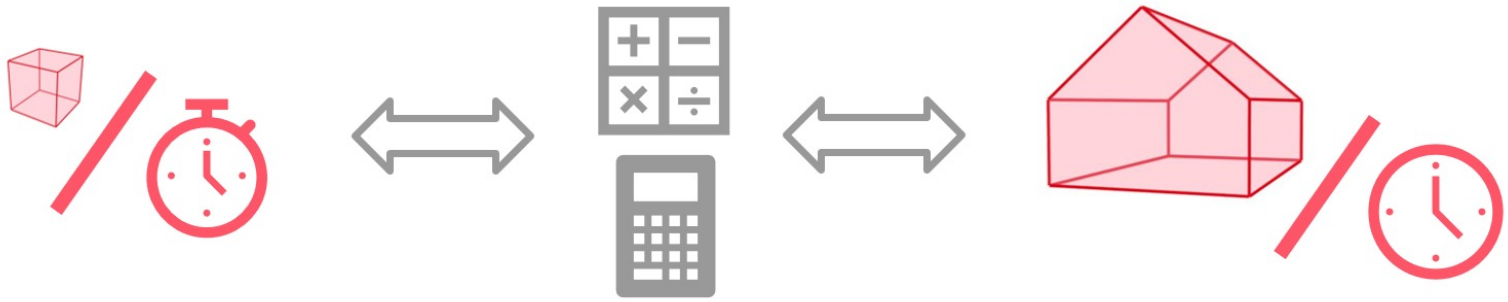


Let’s say the space being discussed is the whole house. In that case using “ACH” to describe the flow rate is kind of like saying “cubic houses per hour” instead of “cubic feet per minute”.

Calculating ACH

Air changes per hour (ACH) can be calculated as long as the flow rate (in cfm) and the total volume of the house are known. The volume of the house is its length x width x height (in feet).

(These calculations are fairly simple, but they will be covered in a later Learning Segment.)



Knowledge Check

Learning Objective 1:

Become conversant with ventilation flow rate terminology

Ventilation rate is the measure of…

A. The length x width x height of a building.
B. The total number of fans and blowers in a building.
C. The amount of outdoor air entering the building in a certain amount of time.
D. the total of all duct diameters x duct lengths in a building.

Knowledge Check

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Learning Objective 2

Identify the key factors addressed by ventilation standards

Three Key Factors

Ventilation standards and codes are designed to specify the right amount of ventilation to dilute indoor pollutants. Three sources of pollutants are considered by these standards…

- The building in general
- The occupants themselves
- Spaces with concentrated pollutants

Ventilation for the Building

Since the building and its furnishings are a major source of indoor pollutants, every ventilation standard and code considers the size of the building in its calculations for the airflow requirements.

This is commonly specified as a certain number of cubic feet per minute (cfm) per square foot of living space (or per 100 square feet).

It may also be specified as a minimum rate of air changes per hour (ACH) for the whole building.

Ventilation for the Occupants

The occupants and their activities are also a major source of indoor pollutants, so every ventilation standard and code also factors the number of occupants into the ventilation requirement.

A certain number of cubic feet per minute (cfm) will be required for each occupant.

Of course, the number of occupants may change over time for any house, so the typical solution is to count the number of bedrooms and add (1) to arrive at the number of occupants.

Ventilation for the Concentrated Pollutants

Although the entire building may be a source of pollutants, and the occupants may be anywhere in the building, ventilation standards and codes recognize that there are certain spaces in a house where pollutants are typically concentrated.

These spaces are bathrooms and kitchens.

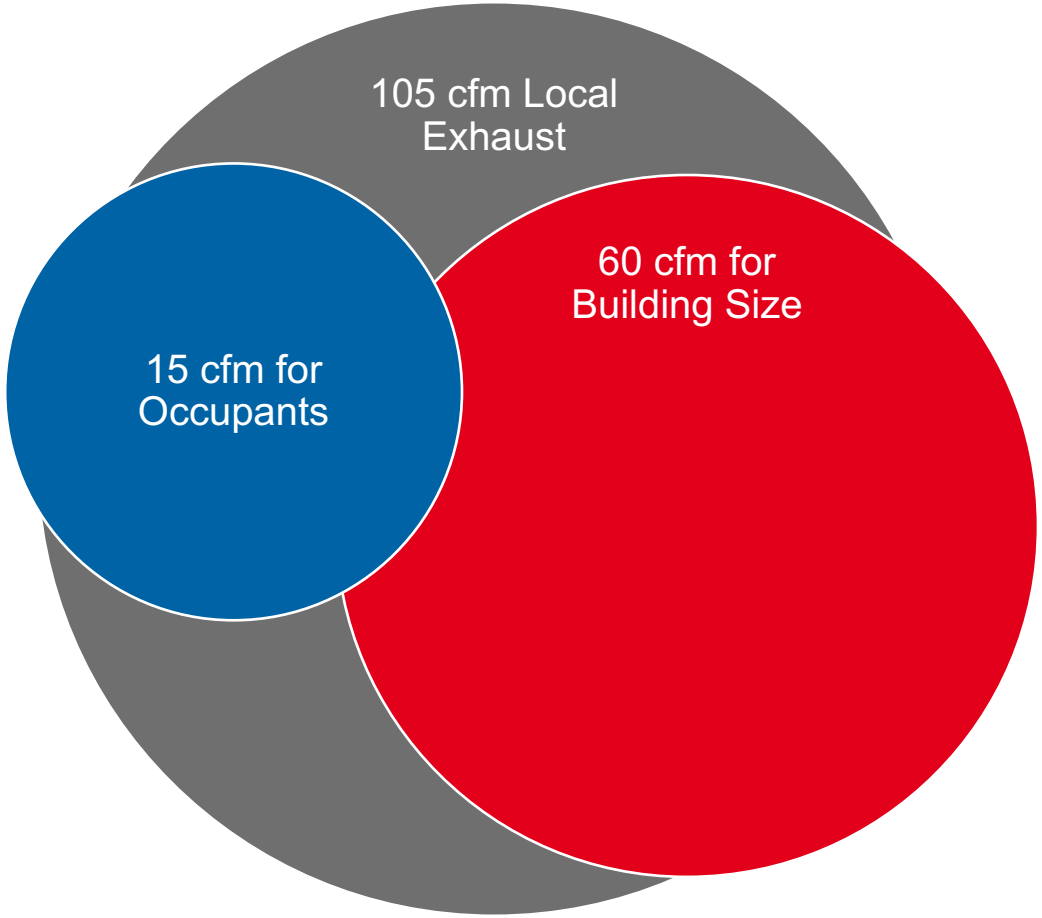
“Point source exhaust” is usually required in these spaces--in other words a fan dedicated to removing polluted air from that space and exhausting it directly outdoors.

Factoring the Requirements Together

When determining a total ventilation rate for a house, the minimum requirement for each of the three factors must be met.

Sometimes, it is possible that simply meeting one of the requirements may provide enough ventilation for the other two.

For example, it is common in homes with multiple bathrooms that the required bathroom exhaust fans provide enough air exchange to also meet the required ventilation rates for the size of the house and number of occupants.



Knowledge Check

Learning Objective 2:

Identify the key factors addressed by ventilation standards

Why are building size, number of occupants, and localized exhaust all important to ventilation standards?

A. Because there are usually more bathrooms than people in a house.

B. Because people produce more pollutants than the house does.

C. Because addressing all three addresses the sources of indoor air pollutants.

D. None of the above.

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Learning Objective 2:

Identify the key factors addressed by ventilation standards

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Learning Objective 3

Develop a basic familiarity with common codes and standards

Examples of Standards and Codes

As with every other aspect of the construction industry, ventilation codes may vary in different locales.

We shall look at three different examples that will provide a good idea of what you may find…

- ASHRAE Standard 62.2
- The International Mechanical Code
- Passive House Standard

ASHRAE 62.2 Standard

ASHRAE does not publish codes specifically. However, ASHRAE Standards are highly regarded in the industry and are often referenced directly in the codes.

ASHRAE 62.2 is the standard for “Ventilation and Acceptable Indoor Air Quality in Residential Buildings”.

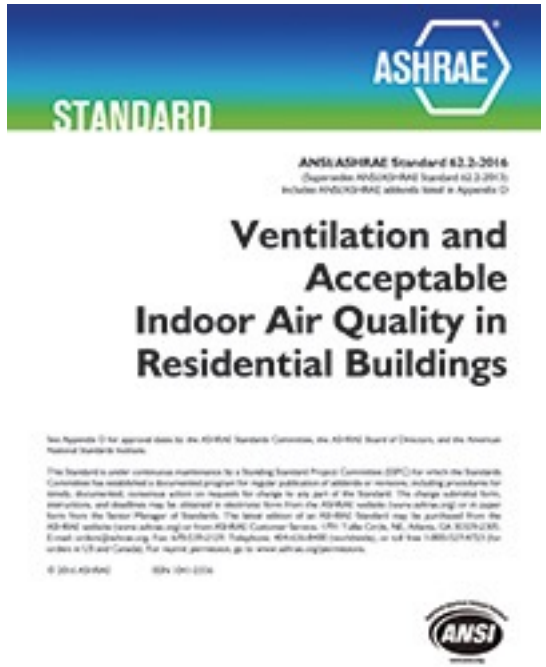
(62.1 is for commercial buildings)

ASHRAE System Requirements

62.2 says the “ventilation system shall consist of one or more supply or exhaust fans and associated ducts and controls.” This allows for various configurations of supply, exhaust and/or balanced mechanical ventilation systems.

62.2 allows local exhaust fans to be credited towards the total required ventilation rate.

Under certain circumstances, 62.2 allows for infiltration to be credited towards the total required ventilation rate. But a blower door test must be performed to determine if this is allowed.



ASHRAE Ventilation Formula

The 2016 version of 62.2 uses the following formula to specify the total ventilation rate...

$$Q_{tot} = 0.03A_{floor} + 7.5(N_{br} + 1)$$

Where:

Q_{tot} = total required ventilation rate, cfm

A_{floor} = dwelling-unit floor area, ft2

N_{br} = number of bedrooms (not to be less than 1)

Notice that the ASHRAE formula factors in both the building size and the number of occupants.

ASHRAE Ventilation Table

62.2 also provides an optional table to determine the total ventilation rate…

TABLE 4.1a (I-P) Ventilation Air Requirements, cfm

	Bedrooms				
Floor Area, ft^2	1	2	3	4	5
<500	30	38	45	53	60
501–1000	45	53	60	68	75
1001–1500	60	68	75	83	90
1501–2000	75	83	90	98	105
2001–2500	90	98	105	113	120
2501–3000	105	113	120	128	135
3001–3500	120	128	135	143	150
3501–4000	135	143	150	158	165
4001–4500	150	158	165	173	180
4501–5000	165	173	180	188	195

ASHRAE Local Exhaust

In addition to the total ventilation rate, 62.2 also has requirements for “local exhaust” in kitchens and bathrooms. This addresses the factor of concentrated pollutants.

There are different minimum rates depending on whether the exhaust is “demand-controlled” (intermittent) or “continuous” (24/7).

Kitchen

Demand-controlled (intermittent):

- Vented range hood: 100 cfm
- Other kitchen exhaust fans: 300 cfm

Continuous:

- 5 ACH, based on kitchen volume

Bathroom

Demand-controlled (intermittent):

- 50 cfm

Continuous:

- 20 cfm

Knowledge Check

ASHRAE 62.2 provides guidelines for…

A. ...calculating residential ventilation rates.

B. ...ventilating an inpatient hospital facility.

C. ...selecting the best heat recovery ventilator (HRV).

D. ...reducing the overall air changes per hour (ACH).

Knowledge Check

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International Mechanical Code

The International Mechanical Code (IMC) is prepared in 3-year cycles by the International Code Council. The IMC is widely adopted in almost all US states. In addition to covering plumbing, heating, air conditioning, and solar thermal practices, it also lays out requirements for ventilation systems.

The IMC covers both commercial and residential sectors, so it's always important to pay attention to what is being addressed by the section of the code you're looking at.

There are many details and contingencies that are covered by the IMC, but we shall consider the basics…

IMC Ventilation Formula

Section 403.3.2.1 of the IMC is titled “Outdoor Air for Dwelling Units”. It has a very similar formula as ASHRAE. In fact, the 2018 IMC uses the older 2013 ASHRAE formula where…

Q_{OA} = outdoor airflow rate, cfm

A_{floor} = floor area, ft2

N_{br} = number of bedrooms; not to be less than one

$$Q_{OA} = 0.01 A_{floor} + 7.5(N_{br} + 1)$$

Notice that the multiplier for the floor area is only ⅓ of the 2016 ASHRAE recommendation (0.01 in IMC instead of 0.03 in ASHRAE). This means that an IMC calculation may very well result in a lower total ventilation rate than an ASHRAE calculation.

IMC Targeted & Balanced

Although the 2021 IMC isn't yet adopted in most states, it does make an interesting exception to the requirement of the formula above.

This code provision highlights the effectiveness of balanced ventilation with a targeted air distribution system. We'll say more about this in future Learning Segments.

"The minimum mechanical ventilation rate determined in accordance with (the equation) shall be reduced by 30 percent provided that both of the following conditions apply:

2.1 A ducted system supplied ventilation air directly to each bedroom and to one or more of the following rooms:

2.1.1 Living room.

2.1.2 Dining room.

2.1.3 Kitchen.

2.2 The whole-house ventilation system is a balanced ventilation system."

IMC Local Exhaust

The IMC also follows ASHRAE very closely regarding local exhaust ventilation. Table 403.3.2.3 lists the following requirements…

Kitchens: 100 cfm intermittent or 25 cfm continuous

Bathrooms and toilet rooms: 50 cfm intermittent or 20 cfm continuous

Notice again that IMC follows ASHRAE very closely.

Also notice that continuous ventilation allows for a much lower flow rate than intermittent. This will help when we're designing balanced ventilation systems in future Learning Segments.

Knowledge Check

What is the minimum required bathroom exhaust ventilation rate in the IMC?

A. 50 cfm intermittent.
B. 20 cfm continuous.
C. Either A or B above.
D. None of the above (open a window).

Knowledge Check

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Passive House Standard

- A comprehensive building energy standard originally developed in Germany but growing in practice around the world
- Uses a rigorous system of calculations to optimize energy conservation, health and comfort
- Not a binding code in North America
- Referenced as an energy compliance path for an increasing number of state funding programs

2 main PH organizations in NA:

- PHI (int'l w/ HQ in Germany)
- Passive House Institute US (PHIUS)

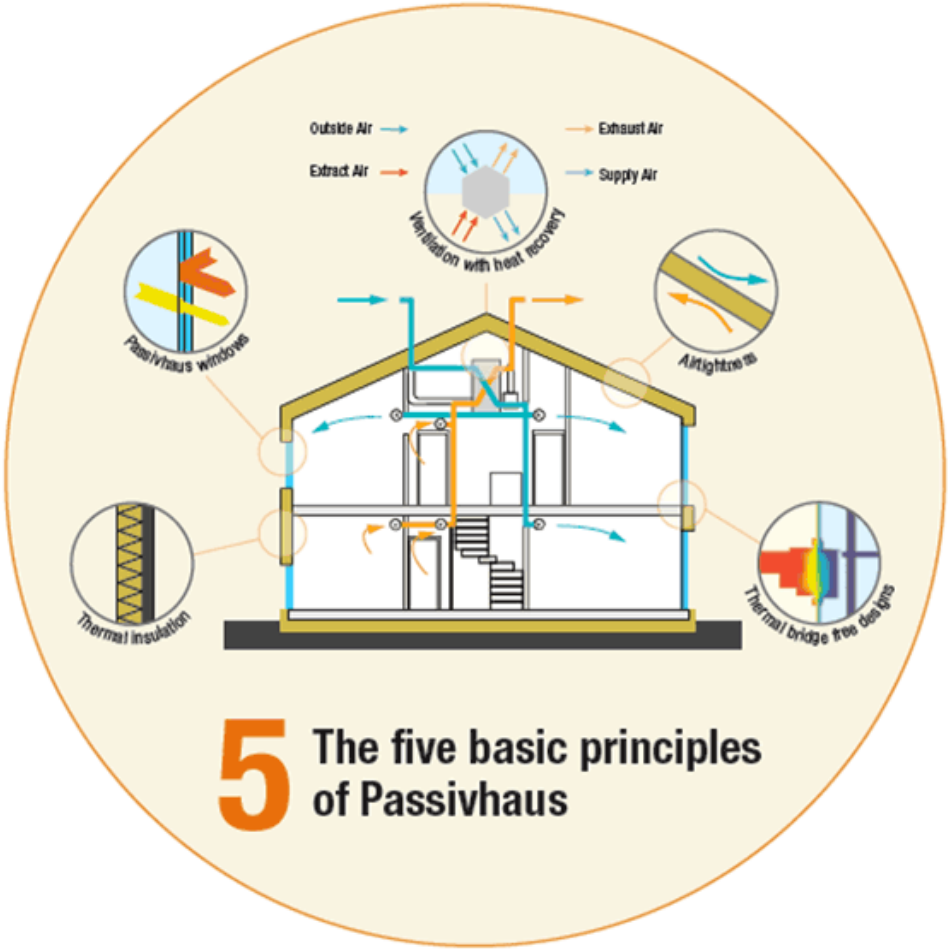
Passive House Institute

PHIUS
Passive House Institute US

Passive House Principles

The Passive House requirements are very detailed, but they emphasize five basic practices…

1. Provide a super-insulated building envelope to reduce heating and cooling loads
2. Provide a continuous air barrier all around the building to reduce infiltration
3. Provide high-performance windows suitable for the climate (often triple-glazed)
4. Minimize thermal bridges that conduct heat between the interior and exterior
5. Provide balanced ventilation with energy recovery for superior indoor air quality



Passive House Ventilation Requirements

For residential projects, Passive House has the following requirements…

1. 18 cfm of outdoor air supplied per person (with system on high speed)
2. Local exhaust ventilation (with the system on high speed)...
    a. 12 cfm for laundry rooms and half baths
    b. 24 cfm for full baths
    c. 35 cfm for kitchens
3. Overall air exchange rate in the building of 0.3 ACH in normal speed

The ventilation system must be balanced (equal supply and exhaust) at the minimum ventilation rate that will satisfy all the above requirements, and it must be done with a Heat Recovery Ventilator or Energy Recovery Ventilator (HRV/ERV) that meets specific performance standards for efficiency, health and comfort.

Knowledge Check

The ventilation requirements for Passive House are…

A. ...basically, the same as ASHRAE.

B. ...too strict to be practical.

C. ...only accomplished with an efficient HRV or ERV.

D. ...the exact same as the IMC.

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Thank you for taking this Learning Segment. We hope you found it informative.

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