2012 IMC, IRC & IECC HVAC Ventilation Code review & Modern Systems

Presented For:
Office of Education & Data management
Career Development

By:

Roger Stolting from EDOS Manufacturers' Reps

April 2015

Material & Data Sources for Presentation

- 2003 IRC & IMC Tenth Printing, IECC Seventh Printing Publications
- 2009 IRC Fifth Printing Publication
- 2012 IRC & IMC Second Printing, IECC Second Printing Publications
- Honeywell International
- Rehau Unlimited Polymer Solutions
- Photos from Collective Websites & General Resources

The New Era of Heating & Air Conditioning

Green Technologies

One Type of System Does Not Fit All Applications

Common Considerations:

- What is it? Residential, Commercial, Institutional, Industrial, Agricultural.
- What's the Application? New Construction, Remodeling, System addition/upgrade, Equipment Replacement
- What is the end user looking for/expect
- What's the Budget?
- Are there Tax Incentives/Rebate?
- Qualifications of Contractor(s)

Qualified Designers & Contractors

- Just because they are a Licensed Contractor doesn't mean they are not over their heads
- Specific training on products is essential for good outcomes
- System controls are typically key to most efficient & effective operation. This is often a battleground between the Home Automation & the HVAC Contractor.
- One size fits all & bigger is better usually has poor results
- Attention to detail usually pays off well

2012 IRC N1103.6 (R403.6) Equipment sizing (Mandatory).

Heating and cooling equipment shall be sized in accordance with ACCA Manual S based on building loads calculated in accordance with ACCA Manual J or other *approved* heating and cooling calculation methodologies.

ACCA Manual S sets equipment sizing limits

Table 1. Manual S equipment selection sizing limitations.

Equipment	Sizing Limitations	Reference (section)
Furnaces	100–140% of total heating load	2-2
boilers	100–140% of total heating load	2-2
air conditioners	115% of total cooling load*	3-4
heat pumps	115%[1] or 125%[2] of total cooling load*	4-4
supplemental heat (heat pumps)		
electric	based on equipment balance point	4-8
dual fuel	100–140% of total heating load	6-8
emergency heat (heat pumps)	based on local codes	4-9

1. Heat pumps in a cooling dominant climate are allowed to be 115% of the cooling level.
2. Heat pumps in a heating dominant climate are allowed to be 125% of the cooling level.
*The size of the cooling equipment must be based on the same temperature and humidity conditions that were used to calculate the Manual J loads.

AHRI Versus OEM Expanded Performance Data

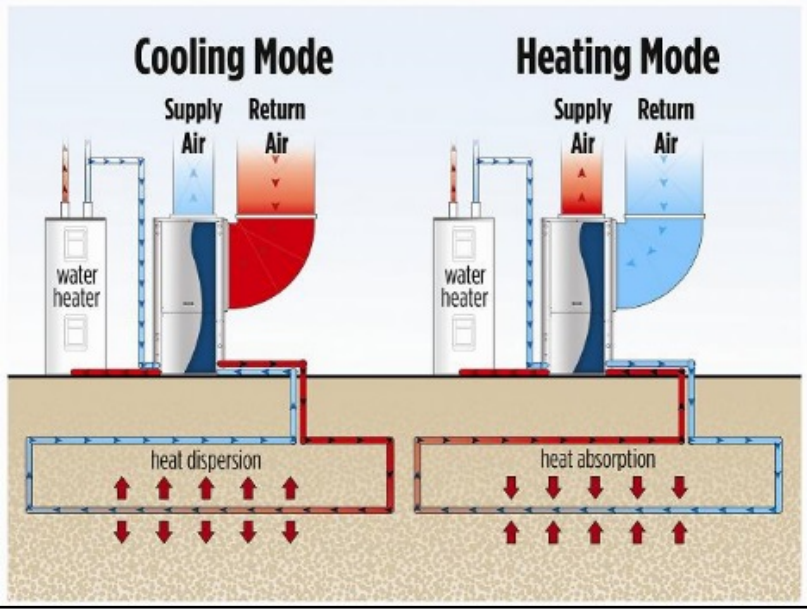
Manufacturers of heating and cooling equipment are responsible for testing and certifying the performance of their products. The Air Conditioning, Heating and Refrigeration Institute (AHRI) produces standards for rating such equipment, but data published in **AHRI product directories should not be used** because the test conditions simulate a very small geographic area in the U.S. As such, **AHRI directories should only be used to compare equipment efficiency ratings** —OEM expanded performance data **should** be used to select properly sized equipment

Ultra High Efficiency & Modern Systems

“Geothermal”

Ground Source Heat Pumps

Geothermal Heat Pump Systems

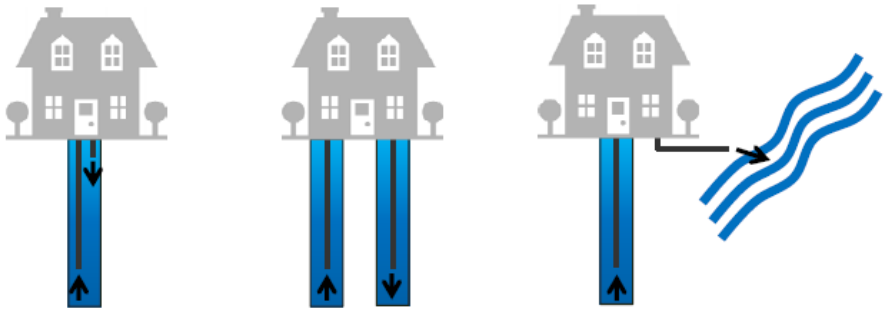


Geothermal Ground Loop Heat Exchangers

1. THE ROLE OF THE GROUND HEAT EXCHANGER

a) OPEN LOOP GEOTHERMAL SYSTEMS

- Open loop geothermal systems pump groundwater directly through the heat pump
- These systems are highly regulated, allowed only where conditions dictate
- There are three main types of open loop systems:
  1. Single well ("standing water column")
  2. Dual well ("reinjection well")
  3. Pump and Dump



Single Well | Dual Well | Pump and Dump

Common Older Type Systems still in use

THE ROLE OF THE GROUND HEAT EXCHANGER

b) CLOSED LOOP GEOTHERMAL SYSTEMS

- Closed loop geothermal systems pump fluid through underground piping (the "ground loop" or "ground heat exchanger") connected to a heat pump
- There are three main types of closed loop systems:
  1. Vertical Borehole
  2. Horizontal Field Loop
  3. Pond Loop

Vertical Borehole/s | Horizontal Field Loop | Pond Loop

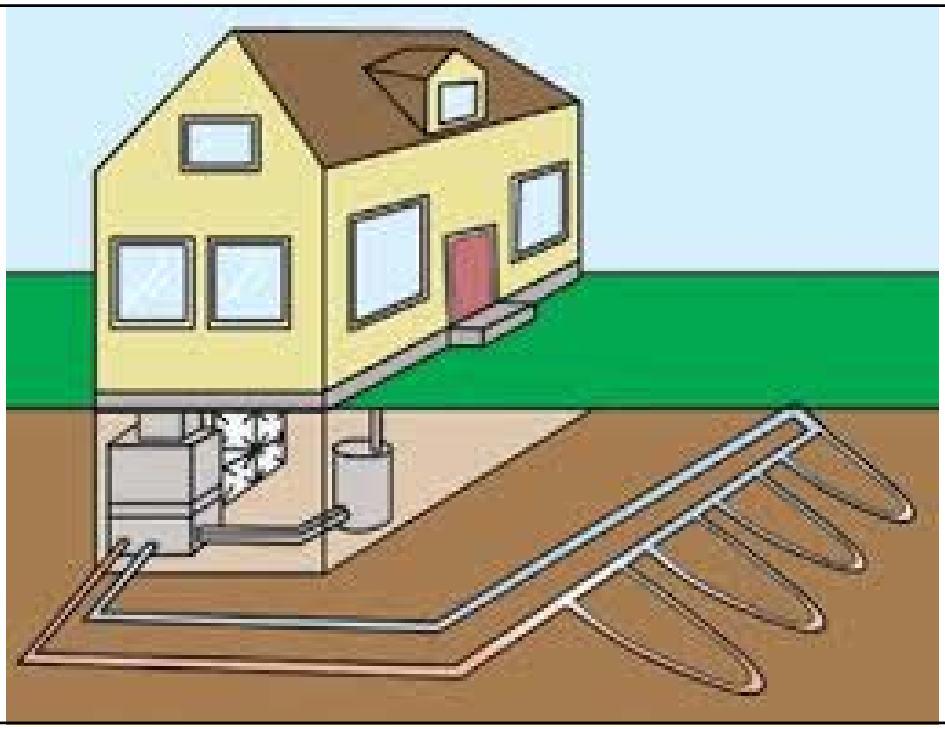
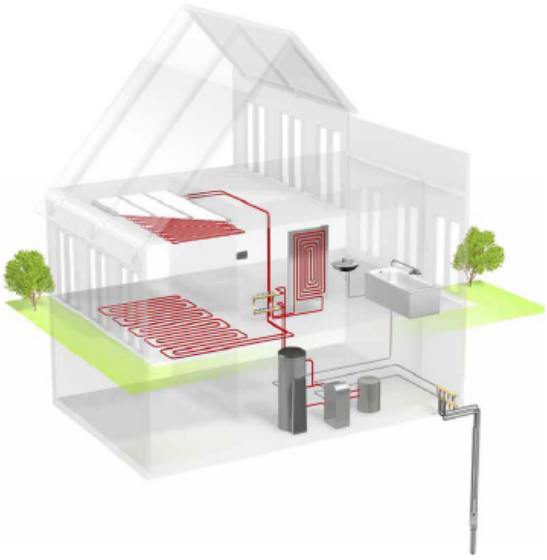


Image courtesy of:
http://www.tva.gov/commercial/images/geothermal_diagram.jpg

Geothermal Heat Pumps & Radiant

Integration with GSHP

- A ground source heat pump is usually a perfect match of water temperatures with radiant distribution for heating and cooling
- 115°F output temperature works well for most radiant heating systems
- Most heat pumps will operate at a higher efficiency (deliver a better COP) when used with low-temperature radiant heating distribution
  - The lower the better



"Radiant"

The King in Heating Comfort & Efficiency

Advantages of radiant Floor Heating

The six primary benefits of RFH:

a) Adaptability
b) Architectural freedom
c) Thermal comfort
d) Control
e) Efficiency
f) Safety

- An element of "Green" design

RESIDENTIAL APPLICATIONS

- Basements
- Slab-on-grade pours
- **Suspended floor overpour**
- Garages
- Apartments

COMMERCIAL APPLICATIONS

- Hotels
- Offices
- Restaurants
- Warehouses
- **Car Dealerships and Garages**
- Museums

INDUSTRIAL APPLICATIONS

- Fire Stations
- Bus Stations
- Warehouses
- Garages
- Factories
- **Aircraft Hangars**

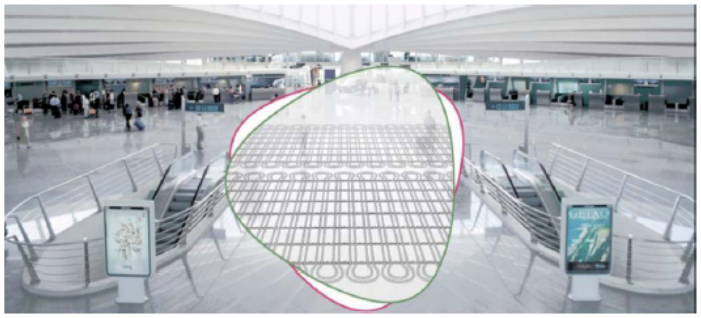
Radiant Heating

Radiant Heating

Radiant Cooling Systems

- Typically designed in conjunction with radiant heating, radiant cooling systems circulate chilled water through the same network of pipes where warm water circulates during the heating season
- This network of pipes can turn the floors, walls and ceilings of a conditioned space into cooled surfaces that evenly absorb heat energy
- Radiant cooling works best in a tightly sealed building that integrates radiant with a downsized forced-air system to meet the building's fresh air requirements

Example:
Bilbao International Airport, northern Spain



Benefits of Radiant Cooling Systems

Hybrid radiant/forced-air cooling systems are ideally suited to a broad range of commercial applications and achieve best results when combined with other energy efficient solutions in tight building structures

Five primary benefits :

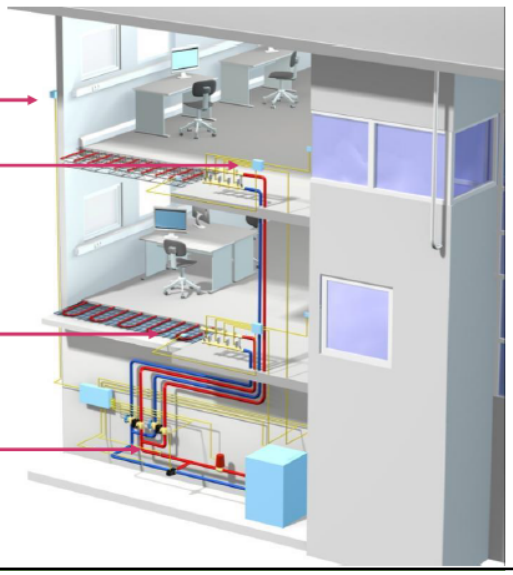
a) Adaptability
b) Architectural freedom
c) Thermal comfort
d) Control
e) Efficiency

Example:
YWCA Elm Centre, Toronto, ON LEED® Silver

Use Controls for Comfort, Efficiency & to <u>Avoid</u> Condensation

Typical elements:

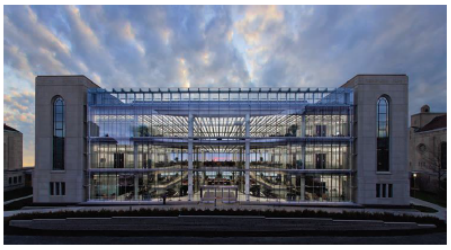
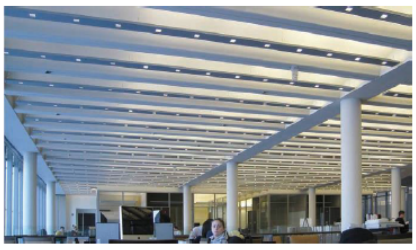
- Outdoor temperature sensor on the northern side of the building, not exposed to direct sunlight
- Humidity and temperature sensor(s) in each zone to monitor dew points and set points
- Floor temperature sensor in the upper level of the thermal mass
- Supply and return fluid temperature sensors in the piping network



FEASIBLE APPLICATIONS OF RADIANT HEATING AND COOLING

RADIANT CEILING EXAMPLE APPLIED IN A UNIVERSITY LIBRARY – LEED® SILVER
LIBRARY AT LOYOLA UNIVERSITY CHICAGO, ILLINOIS



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Hybrid HVAC systems utilizing radiant heating and cooling can help to reduce operating costs when compared with 100% AHU systems

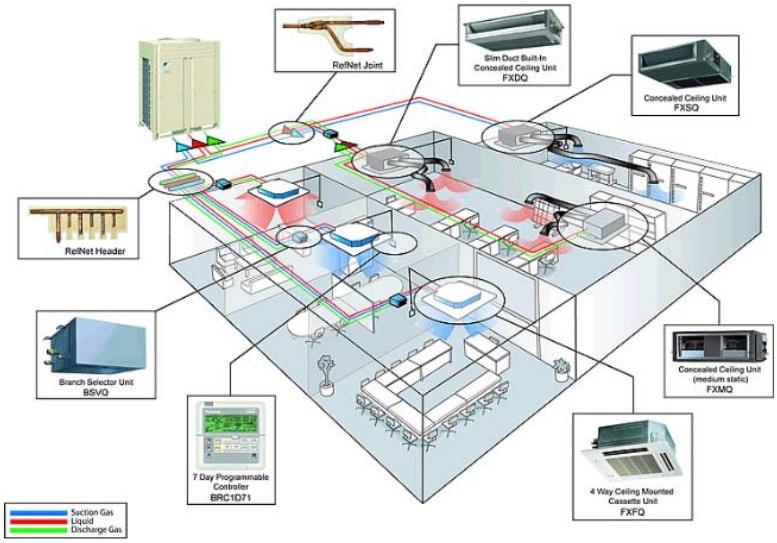
1. Radiant cooling allows a higher space set-point temperature, while still maintaining the same level of cooling comfort compared to a traditional air handling unit (AHU)
   - Loads can be reduced
2. The superior heat transfer properties of water compared to air allows the hydronic portion of the system to efficiently distribute energy to conditioned spaces
   - A 60 watt circulator can deliver the same energy as a 1,500 watt air distribution fan; a 90% reduction
3. Operating with moderate supply water temperatures allows the integration of renewable systems such as geothermal heat pumps at maximum efficiencies
   - Radiant cooling systems typically work with fluid temperatures of 60°F to 63°F, resulting in higher EER ratings in cooling mode

- In addition, the reduction in required maintenance of the radiant system compared to the 100% air system helps to augment operating cost savings
  - No filters, belts, pulleys

Mini-Split & Variable Refrigerant Flow (VRF) Systems

Becoming a Big Piece of Both New Construction and the Retrofit Market

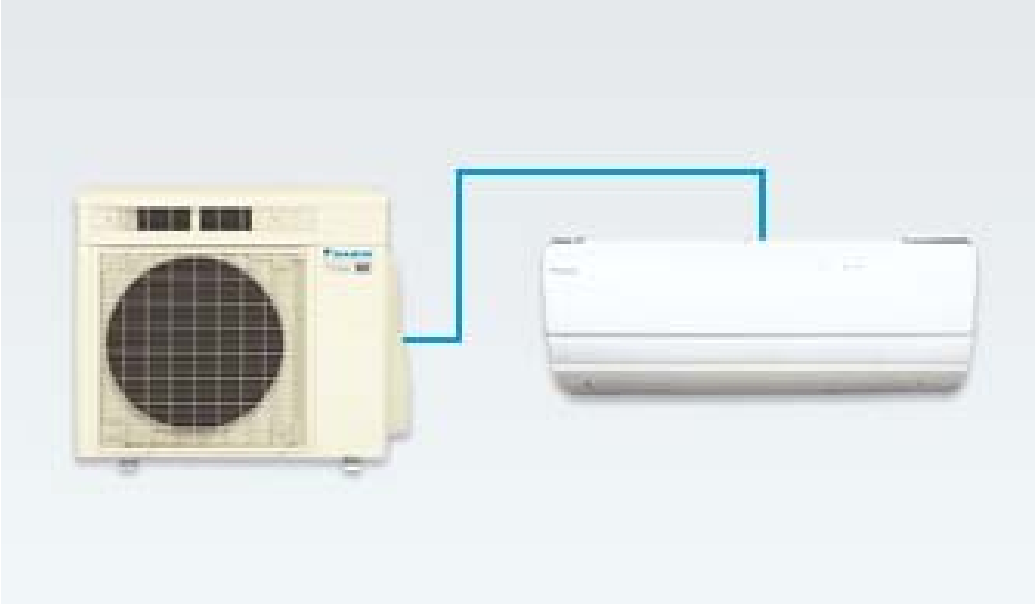
Variable Refrigerant Flow (VRF) Systems



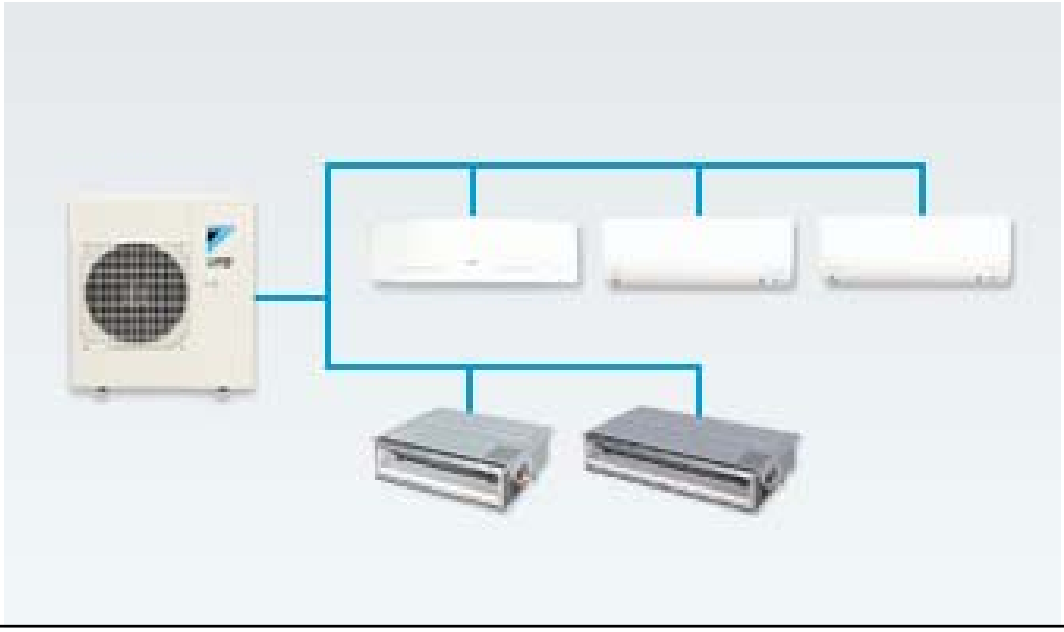
Variable Refrigerant Flow (VRF) systems have commissioning requirements that are very unique to these highly specialized systems. An example are Daikin's Variable Refrigerant Volume (VRV) systems.

Ductless Min-Split Systems

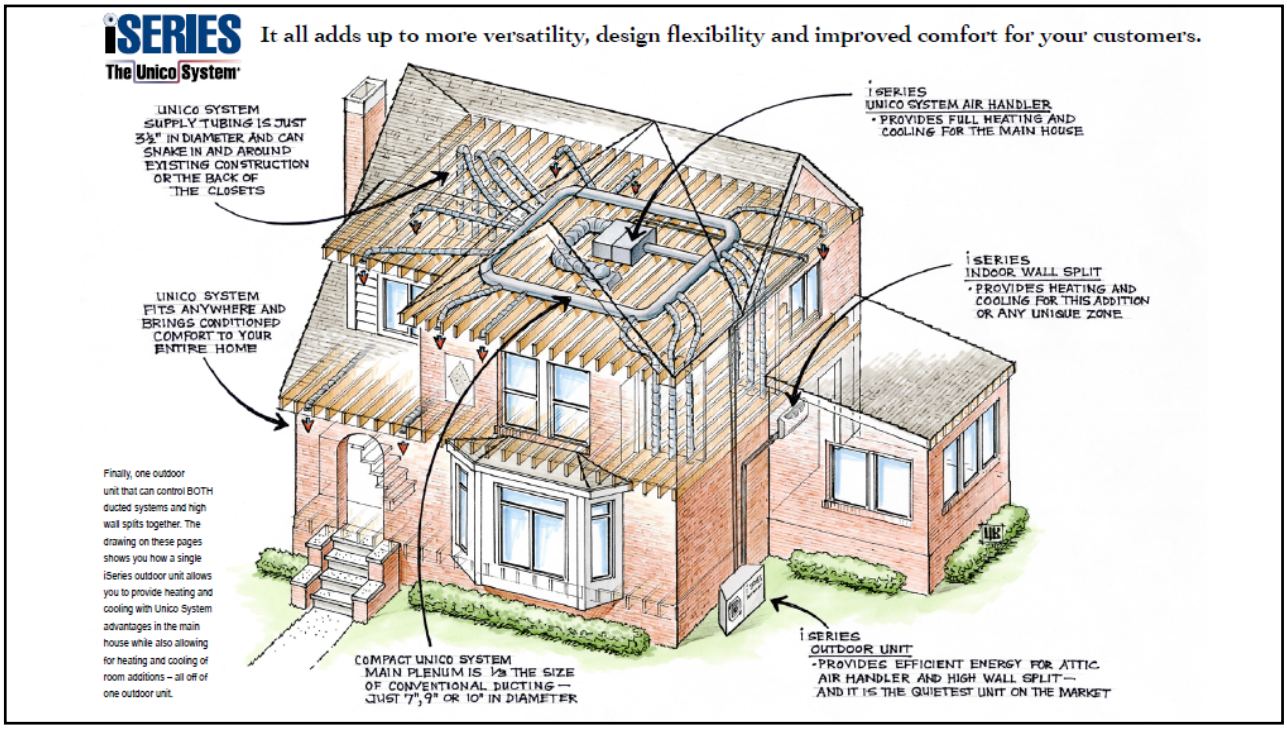
Single Head Min-Split



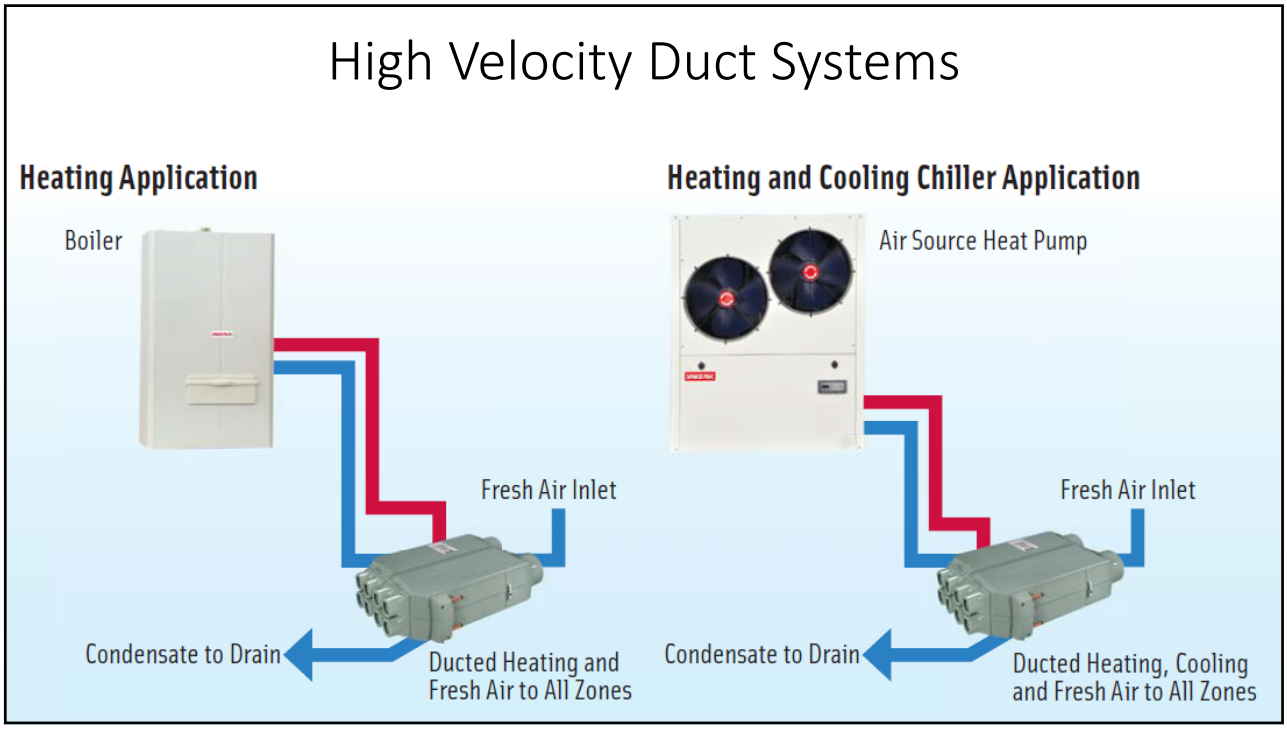
Multi-Head Min-Split

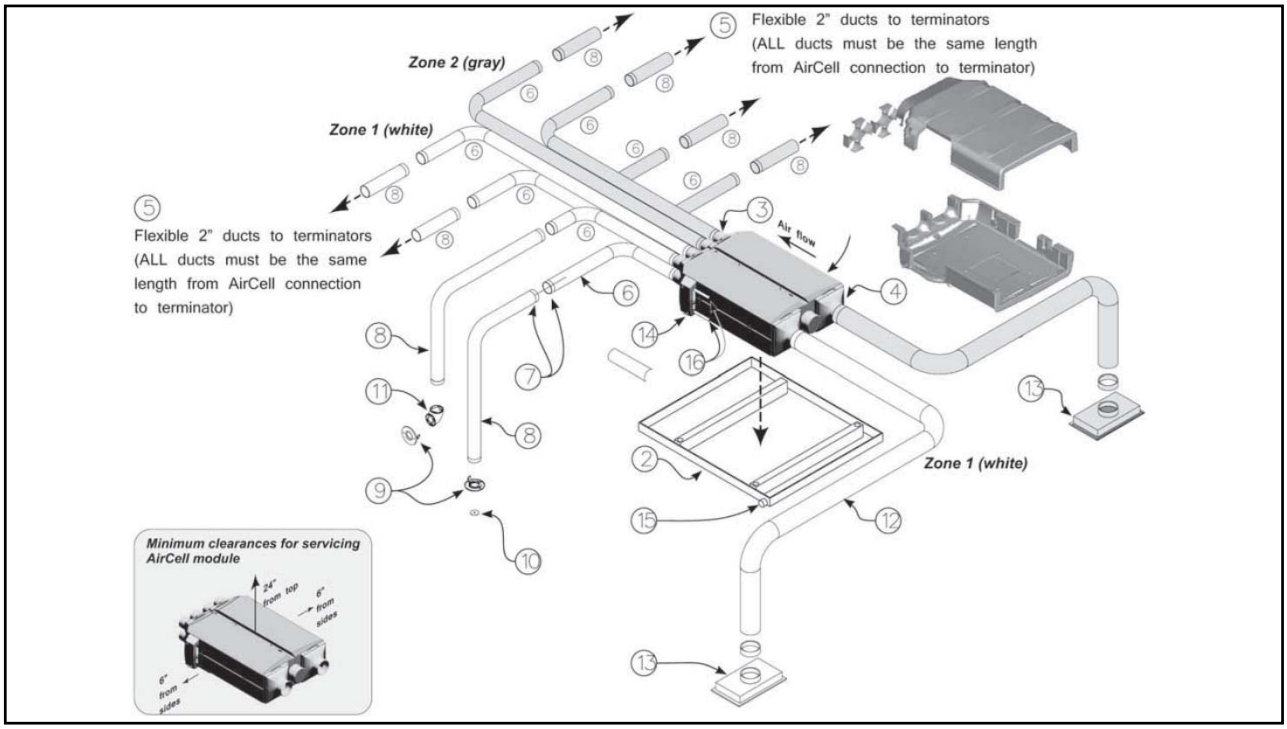


High Velocity Duct Systems



High Velocity Duct Systems





Remote HVAC System Access

The Largest Growing Sector of Controls

is

Internet & Smart Device

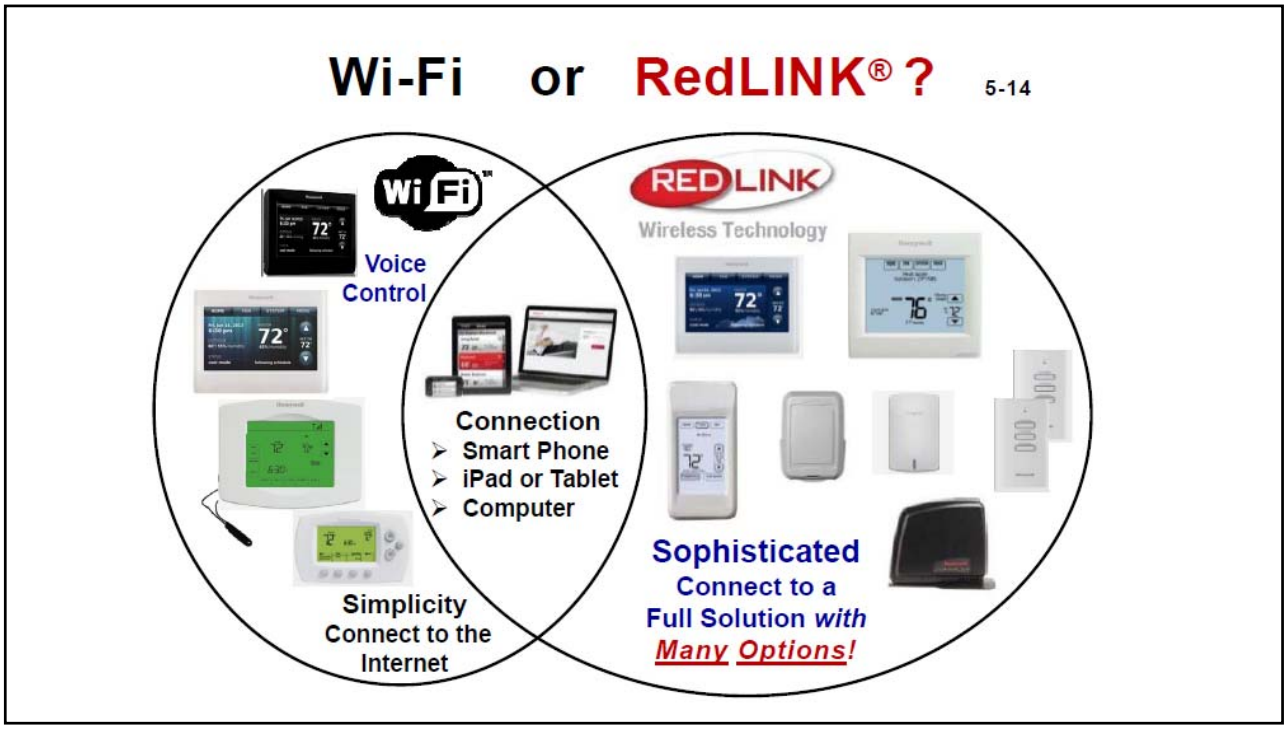
Connectability

The World is Getting Connected!!!

Honeywell

And this provides a huge opportunity that we all need to embrace!

Samples of Internet Controllable Thermostats



NEACA III

Major Water Heater Changes

NAECA Efficiency Requirements

- National Appliance Energy Conservation Act (NAECA)
  - Effective April 16, 2015
  - Incremental EF increase for < 55 gal gas and electric storage
  - Condensing and HPWH technologies required for > 55 gal
- New test procedure proposed for residential and commercial
  - Load based efficiency test; point-of-use, low, medium and high use categories (10 gal, 38 gal, 55 gal and 84 gal per day)
  - Applies to commercial heaters used for residential applications

Product class	Standard level	
Residential water heaters		
Gas-fired Storage	For tanks with Rated Storage Volume ≤ 55 gallons: EF = 0.675-(0.0015 x Rated Storage Volume in gallons)	For tanks with Rated Storage Volume > 55 gallons: EF = 0.8012-(0.00078 x Rated Storage Volume in gallons)
Electric Storage	For tanks with Rated Storage Volume ≤ 55 gallons: EF = 0.9951-(0.0003 x Rated Storage Volume in gallons)	For tanks with Rated Storage Volume > 55 gallons: EF = 2.057-(0.0113 x Rated Storage Volume in gallons)

NAECA III Efficiency Standards

Gas Models

Capacity (gals)	Current min. EF	*NEW min E.F.*
30	0.61	0.63
40	0.59	0.62
50	0.58	0.60
60	**0.56**	**0.75**
75	**0.53**	**0.74**
100	**0.48**	**0.72**

Electric Models

Capacity (gals)	Current min. EF	*New min. EF*
30	0.93	0.95
40	0.92	0.95
50	0.90	0.95
65	**0.88**	**1.98**
80	**0.86**	**1.97**
120	**0.81**	**1.92**

Note: Solar, TT , Pt of Use electric models and gas water heaters less than 20 gal capacity are exempted

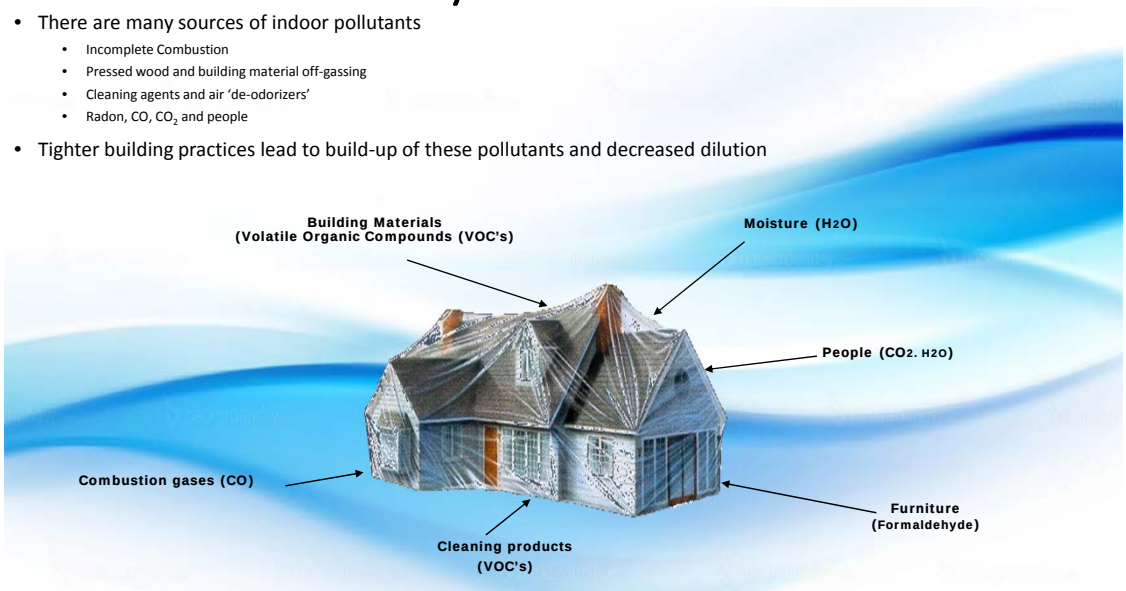
NEACA III Will Drive More Technology




Ventilation
&
Code Review

Why Ventilate?

- There are many sources of indoor pollutants
  - Incomplete Combustion
  - Pressed wood and building material off-gassing
  - Cleaning agents and air 'de-odorizers'
  - Radon, CO, CO_2 and people
- Tighter building practices lead to build-up of these pollutants and decreased dilution



CHAPTER 4

INTERNATIONAL MECHANICAL CODE "VENTILATION"

SECTION 401
From 2012 IMC

GENERAL REQUIREMENTS

401.1 Scope.

- This chapter shall govern the ventilation of spaces within a building intended to be occupied. (same)

- Mechanical exhaust systems, including exhaust systems serving clothes dryers and cooking appliances; hazardous exhaust systems; dust, stock and refuse conveyor systems; subslab soil exhaust systems; smoke control systems; energy recovery ventilation systems and other systems specified in Section 502 shall comply with Chapter 5. **New**

401.2 Ventilation required.

- Every occupied space shall be ventilated by natural means in accordance with Section 402 or by mechanical means in accordance with Section 403. (Same as 2003 IMC)
- Where the air infiltration rate in a dwelling unit is less than 5 air changes per hour when tested with a blower door at a pressure of 0.2-inch water column (50 Pa) in accordance with Section 402.4.1.2 of the International Energy Conservation Code, the dwelling unit shall be ventilated by mechanical means in accordance with Section 403.

  (Added Language from 2003 IMC)

401.3 When required.

Ventilation shall be provided during the periods that the room or space is occupied.

Same as 2003 IMC

Specific Thermostats & Special Controllers can be Configured to Meet this Requirement





401.4 Intake opening location.

1. Intake openings shall be located a minimum of **10 feet (3048 mm) from lot lines or buildings on the same lot.**
2. Mechanical and gravity outdoor air intake openings shall be located not less than **10 feet horizontally** from any hazardous or noxious contaminant source, such as vents, streets, alleys, parking lots and loading docks, except as specified in Item 3 or Section 501.2.1. Outdoor air intake openings **shall be permitted to be located less than 10 feet (3048 mm) horizontally from streets, alleys, parking lots and loading docks provided that the openings are located not less than 25 feet (7620 mm) vertically above such locations.** Where openings front on a street or public way, the distance shall be measured from the closest edge of the street or public way.
3. Intake openings shall be located not **less than 3 feet (914 mm) below contaminant sources where such sources are located within 10 feet** (3048 mm) of the opening.
4. Intake openings on structures **in flood hazard areas shall be at or above the elevation required by Section 1612** of the *International Building Code* for utilities and attendant equipment.

OLD 2003 IMC: Outdoor air exhaust and intake openings shall be located a minimum of 10 feet (3048 mm) from lot lines or buildings on the same lot. Where openings front on a street or public way, the distance shall be measured to the centerline of the street or public way. **Exception:** Group R-3.

401.5 Intake opening protection.

Air intake openings that terminate outdoors shall be protected with corrosion-resistant screens, louvers or grilles. Openings in louvers, grilles and screens shall be sized in accordance with Table 401.5, and shall be protected against local weather conditions. Louvers that protect air intake openings in structures located in hurricane-prone regions, as defined in the *International Building Code,* shall comply with AMCA 550. Outdoor air intake openings located in exterior walls shall meet the provisions for exterior wall opening protectives in accordance with the *International Building Code.*

Very Similar to 2003 IMC, exhaust verbage removed, hurricane language & AMCA 550 Added

TABLE 401.5 OPENING SIZES IN LOUVERS, GRILLES AND SCREENS PROTECTING AIR INTAKE OPENINGS

OUTDOOR OPENING TYPE	MINIMUM AND MAXIMUM OPENING SIZES IN LOUVERS, GRILLES AND SCREENS MEASURED IN ANY DIRECTION
Intake openings in residential occupancies	Not < $^1/_4$ inch and not > $^1/_2$ inch
Intake openings in other than residential occupancies	> $^1/_4$ inch and not > 1 inch

2003 IMC Exhaust Language Removed

401.6 Contaminant sources.

Stationary local sources producing airborne particulates, heat, odors, fumes, spray, vapors, smoke or gases in such quantities as to be irritating or injurious to health shall be provided with an exhaust system in accordance with Chapter 5 or a means of collection and removal of the contaminants. Such exhaust shall discharge directly to an *approved* location at the exterior of the building.

2003 IMC same language

SECTION 402

NATURAL VENTILATION

[B] 402.1 Natural ventilation.

Natural ventilation of an occupied space shall be through windows, doors, louvers or other openings to the outdoors. The operating mechanism for such openings shall be provided with ready access so that the openings are readily controllable by the building occupants.

2003 IMC Same language, no Change

[B] 402.2 Ventilation area required.

The minimum openable area to the outdoors shall be 4 percent of the floor area being ventilated.

2003 IMC Same Language, no Change

[B] 402.3 Adjoining spaces.

- Where rooms and spaces without openings to the outdoors are ventilated through an adjoining room, the opening to the adjoining rooms shall be unobstructed and shall have an area not less than 8 percent of the floor area of the interior room or space, but not less than 25 square feet (2.3 m^2). The minimum openable area to the outdoors shall be based on the total floor area being ventilated.
- **Exception:** Exterior openings required for ventilation shall be permitted to open into a thermally isolated sunroom addition or patio cover, provided that the openable area between the sunroom addition or patio cover and the interior room has an area of not less than 8 percent of the floor area of the interior room or space, but not less than 20 square feet (1.86 m^2). The minimum openable area to the outdoors shall be based on the total floor area being ventilated.

- 2003 IMC Same Language, no Change

[B] 402.4 Openings below grade.

Where openings below grade provide required *natural ventilation,* the outside horizontal clear space measured perpendicular to the opening shall be one and one-half times the depth of the opening. The depth of the opening shall be measured from the average adjoining ground level to the bottom of the opening.

2003 IMC same language, no Change

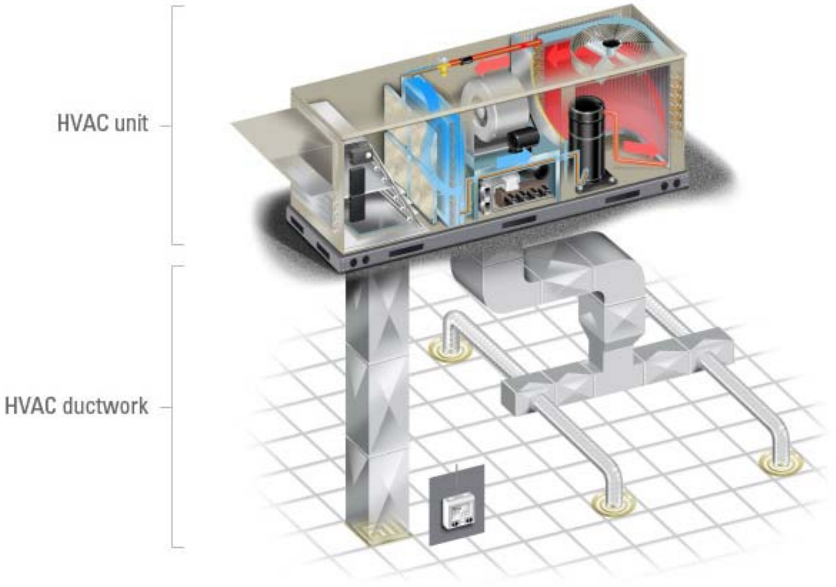
SECTION 403
MECHANICAL VENTILATION

403.1 Ventilation system.

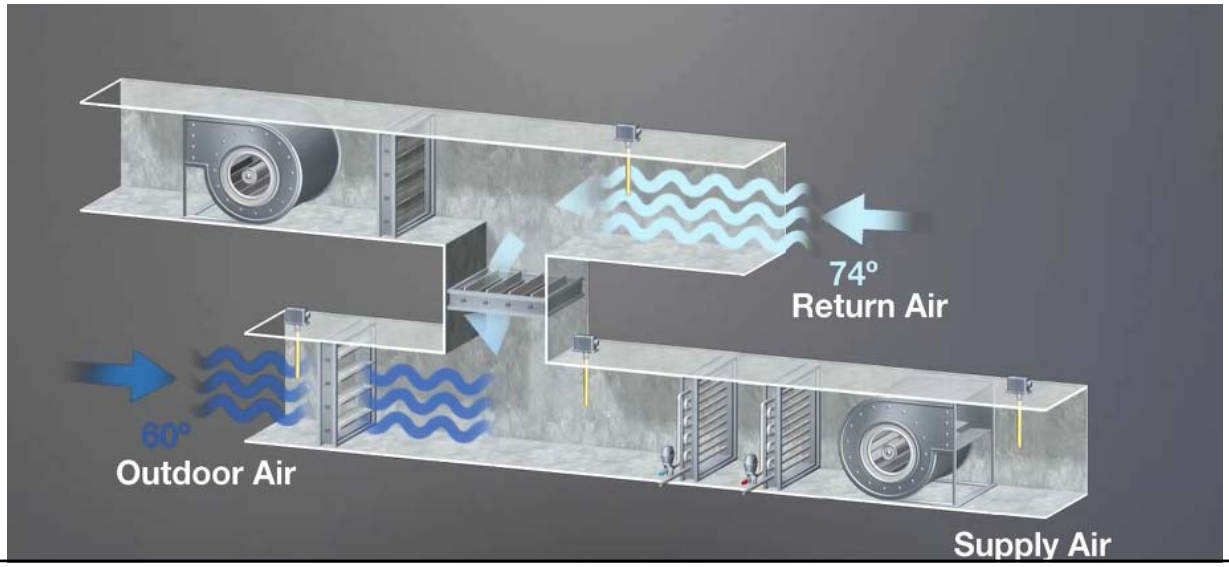
Mechanical ventilation shall be provided by a method of supply air and return or *exhaust air.* The amount of supply air shall be approximately equal to the amount of return and *exhaust air.* The system shall not be prohibited from producing negative or positive pressure. The system to convey *ventilation air* shall be designed and installed in accordance with Chapter 6

Same language as 2003 IMC

Ventilation Though a Rooftop Unit



Ventilation for Equipment Located in Conditioned Space



403.2 Outdoor air required.

- The minimum outdoor airflow rate shall be determined in accordance with Section 403.3. *Ventilation supply systems shall be designed to deliver the required rate of outdoor airflow to the breathing zone within each occupiable space. Blue Italicized is new*
- **Exception:** Where the *registered design professional* demonstrates that an engineered ventilation system design will prevent the maximum concentration of contaminants from exceeding that obtainable by the rate of outdoor air ventilation determined in accordance with Section 403.3, the minimum required rate of outdoor air shall be reduced in accordance with such engineered system design. Added language

Continued……

403.2.1 Recirculation of air.

The outdoor air required by Section 403.3 shall not be recirculated. Air in excess of that required by Section 403.3 shall not be prohibited from being recirculated as a component of supply air to building spaces, except that: Same

1. Ventilation air shall not be recirculated from **one *dwelling* to another or to dissimilar occupancies.** Same
2. Supply air to a swimming pool and associated deck areas shall not be recirculated **unless such air is dehumidified** to maintain the relative humidity of the area at 60 percent or less. Air from this area **shall not** be recirculated to other spaces *where **more than 10 percent** of the resulting supply airstream consists of air recirculated from these spaces. Italicized blue has been added*

Continued…..

3. Where mechanical exhaust is required by *Note b* in Table 403.3, recirculation of air from such spaces shall be prohibited. All air supplied to such spaces shall be exhausted, including any air in excess of that required by Table 403.3. Blue italicized has been added
4. Where mechanical exhaust is required by Note g in Table 403.3, mechanical exhaust is required and recirculation is prohibited where more than 10 percent of the resulting supply airstream consists of air recirculated from these spaces. New Paragraph

403.2.2 Transfer air.

Except where recirculation from such spaces is prohibited by Table 403.3, **air transferred from occupiable spaces is not prohibited** from serving as *makeup air* for required exhaust systems in such spaces as kitchens, baths, toilet rooms, elevators and smoking lounges. The amount of transfer air and *exhaust air* shall be sufficient to provide the flow rates as specified in Section 403.3. The required outdoor airflow rates specified in Table 403.3 shall be introduced directly into such spaces or into the occupied spaces from which air is transferred or a combination of both. Same

403.3 Outdoor airflow rate.

- Ventilation systems shall be designed to have the capacity to supply the minimum outdoor airflow rate determined in accordance with this section. The occupant load utilized for design of the ventilation system shall not be less than the number determined from the estimated maximum occupant load rate indicated in Table 403.3. Ventilation rates for occupancies not represented in Table 403.3 shall be those for a listed *occupancy* classification that is most similar in terms of occupant density, activities and building construction; or shall be determined by an *approved* engineering analysis. The ventilation system shall be designed to supply the required rate of *ventilation air* continuously during the period the building is occupied, except as otherwise stated in other provisions of the code.
- Same Language

Continued……

Continued….

- With the exception of smoking lounges, the ventilation rates in Table 403.3 are based on the absence of smoking in occupiable spaces. Where smoking is anticipated in a space other than a smoking lounge, the ventilation system serving the space shall be designed to provide ventilation over and above that required by Table 403.3 in accordance with accepted engineering practice. Add Paragraph

- **Exception:** The occupant load is not required to be determined based on the estimated maximum occupant load rate indicated in Table 403.3 where *approved* statistical data document the accuracy of an alternate anticipated occupant density. Same

TABLE 403.3 MINIMUM VENTILATION RATES

Added Tables & Classifications

OCCUPANCY CLASSIFICATION	OCCUPANT DENSITY #/1000 FT^{2a}	PEOPLE OUTDOOR AIRFLOW RATE IN BREATHING ZONE, R_p CFM/PERSON	AREA OUTDOOR AIRFLOW RATE IN BREATHING ZONE, R_a CFM/FT^{2a}	EXHAUST AIRFLOW RATE CFM/FT^{2a}
Correctional facilities				
Cells				
without plumbing fixtures	25	5	0.12	—
with plumbing fixtures[g]	25	5	0.12	1.0
Dining halls (see food and beverage service)	—	—	—	—
Guard stations	15	5	0.06	—
Day room	30	5	0.06	—
Booking/waiting	50	7.5	0.06	—
Dry cleaners, laundries				
Coin-operated dry cleaner	20	15	—	—
Coin-operated laundries	20	7.5	0.06	—
Commercial dry cleaner	30	30	—	—
Commercial laundry	10	25	—	—
Storage, pick up	30	7.5	0.12	—

OCCUPANCY CLASSIFICATION	OCCUPANT DENSITY #/1000 FT^{2a}	PEOPLE OUTDOOR AIRFLOW RATE IN BREATHING ZONE, R_p CFM/PERSON	AREA OUTDOOR AIRFLOW RATE IN BREATHING ZONE, R_a CFM/FT^{2a}	EXHAUST AIRFLOW RATE CFM/FT^{2a}
Education				
Auditoriums	150	5	0.06	—
Corridors (see public spaces)	—	—	—	—
Media center	25	10	0.12	—
Sports locker rooms[g]	—	—	—	0.5
Music/theater/dance	35	10	0.06	—
Smoking lounges[b]	70	60		—
Day care (through age 4)	25	10	0.18	—
Classrooms (ages 5-8)	25	10	0.12	—
Classrooms (age 9 plus)	35	10	0.12	—
Lecture classroom	65	7.5	0.06	—
Lecture hall (fixed seats)	150	7.5	0.06	—
Art classroom[g]	20	10	0.18	0.7
Science laboratories[g]	25	10	0.18	1.0
Wood/metal shops[g]	20	10	0.18	0.5
Computer lab	25	10	0.12	—
Multiuse assembly	100	7.5	0.06	—
Locker/dressing rooms[g]	—	—	—	0.25
Food and beverage service				
Bars, cocktail lounges	100	7.5	0.18	—
Cafeteria, fast food	100	7.5	0.18	—
Dining rooms	70	7.5	0.18	—
Kitchens (cooking)[b]	—	—	—	0.7

OCCUPANCY CLASSIFICATION	OCCUPANT DENSITY #/1000 FT^{2a}	PEOPLE OUTDOOR AIRFLOW RATE IN BREATHING ZONE, R_p CFM/PERSON	AREA OUTDOOR AIRFLOW RATE IN BREATHING ZONE, R_a CFM/FT^{2a}	EXHAUST AIRFLOW RATE CFM/FT^{2a}
Hospitals, nursing and convalescent homes				
Autopsy rooms[b]	—	—	—	0.5
Medical procedure rooms	20	15	—	—
Operating rooms	20	30	—	—
Patient rooms	10	25	—	—
Physical therapy	20	15	—	—
Recovery and ICU	20	15	—	—

OCCUPANCY CLASSIFICATION	OCCUPANT DENSITY #/1000 FT^{2a}	PEOPLE OUTDOOR AIRFLOW RATE IN BREATHING ZONE, R_p CFM/PERSON	AREA OUTDOOR AIRFLOW RATE IN BREATHING ZONE, R_a CFM/FT^{2a}	EXHAUST AIRFLOW RATE CFM/FT^{2a}
Hotels, motels, resorts and dormitories				
Multipurpose assembly		5	0.06	—
Bathrooms/toilet—private[g]		—	—	25/50[f]
Bedroom/living room		5	0.06	—
Conference/meeting		5	0.06	—
Dormitory sleeping areas		5	0.06	—
Gambling casinos		7.5	0.18	—
Lobbies/prefunction		7.5	0.06	—
Offices				
Conference rooms	50	5	0.06	—
Office spaces	5	5	0.06	—
Reception areas	30	5	0.06	—
Telephone/data entry	60	5	0.06	—
Main entry lobbies	10	5	0.06	—
Private dwellings, single and multiple				
Garages, common for multiple units[b]	—	—	—	0.75
Garages, separate for each dwelling[b]	—	—	—	100 cfm per car
Kitchens[b]	—	—	—	25/100[f]
Living areas[c]	Based upon number of bedrooms. First bedroom, 2; each additional bedroom, 1	0.35 ACH but not less than 15 cfm/person	—	—
Toilet rooms and bathrooms[g]	—	—	—	20/50[f]

OCCUPANCY CLASSIFICATION	OCCUPANT DENSITY #/1000 FT^{2a}	PEOPLE OUTDOOR AIRFLOW RATE IN BREATHING ZONE, R_p CFM/PERSON	AREA OUTDOOR AIRFLOW RATE IN BREATHING ZONE, R_a CFM/FT^{2a}	EXHAUST AIRFLOW RATE CFM/FT^{2a}
Public spaces				
Corridors	—	—	0.06	—
Elevator car	—	—	—	1.0
Shower room (per shower head)[g]	—	—	—	50/20[f]
Smoking lounges[b]	70	60	—	—
Toilet rooms — public[g]	—	—	—	50/70[e]
Places of religious worship	120	5	0.06	—
Courtrooms	70	5	0.06	—
Legislative chambers	50	5	0.06	—
Libraries	10	5	0.12	—
Museums (children's)	40	7.5	0.12	—
Museums/galleries	40	7.5	0.06	—
Retail stores, sales floors and showroom floors				
Sales (except as below)	15	7.5	0.12	—
Dressing rooms	—	—	—	0.25
Mall common areas	40	7.5	0.06	—
Shipping and receiving	—	—	0.12	—
Smoking lounges[b]	70	60	—	—
Storage rooms	—	—	0.12	—
Warehouses (see storage)	—	—	—	—

OCCUPANCY CLASSIFICATION	OCCUPANT DENSITY #/1000 FT^{2a}	PEOPLE OUTDOOR AIRFLOW RATE IN BREATHING ZONE, R_p CFM/PERSON	AREA OUTDOOR AIRFLOW RATE IN BREATHING ZONE, R_a CFM/FT^{2a}	EXHAUST AIRFLOW RATE CFM/FT^{2a}
Specialty shops				
Automotive motor-fuel dispensing stations[b]	—	—	—	1.5
Barber	25	7.5	0.06	0.5
Beauty salons[b]	25	20	0.12	0.6
Nail salons [b, h]	25	20	0.12	0.6
Embalming room[b]	—	—	—	2.0
Pet shops (animal areas)[b]	10	7.5	0.18	0.9
Supermarkets	8	7.5	0.06	—
Sports and amusement				
Disco/dance floors	100	20	0.06	—
Bowling alleys (seating areas)	40	10	0.12	—
Game arcades	20	7.5	0.18	—
Ice arenas without combustion engines	—	—	0.30	0.5
Gym, stadium, arena (play area)	—	—	0.30	—
Spectator areas	150	7.5	0.06	—
Swimming pools (pool and deck area)	—	—	0.48	—
Health club/aerobics room	40	20	0.06	—
Health club/weight room	10	20	0.06	—

OCCUPANCY CLASSIFICATION	OCCUPANT DENSITY #/1000 FT^{2a}	PEOPLE OUTDOOR AIRFLOW RATE IN BREATHING ZONE, R_p CFM/PERSON	AREA OUTDOOR AIRFLOW RATE IN BREATHING ZONE, R_a CFM/FT^{2a}	EXHAUST AIRFLOW RATE CFM/FT^{2a}
Storage				
Repair garages, enclosed parking garages[b,d]	—	—	—	0.75
Warehouses	—	—	0.06	—
Theaters				
Auditoriums (see education)	—	—	—	—
Lobbies	150	5	0.06	—
Stages, studios	70	10	0.06	—
Ticket booths	60	5	0.06	—
Transportation				
Platforms	100	7.5	0.06	—
Transportation waiting	100	7.5	0.06	—
Workrooms				
Bank vaults/safe deposit	5	5	0.06	—
Darkrooms	—	—	—	1.0
Copy, printing rooms	4	5	0.06	0.5
Meat processing[c]	10	15	—	—
Pharmacy (prep. area)	10	5	0.18	—
Photo studios	10	5	0.12	—
Computer (without printing)	4	5	0.06	—

Chart Notes

For SI: 1 cubic foot per minute = 0.0004719 m^3/s, 1 ton = 908 kg, 1 cubic foot per minute per square foot = 0.00508 $m^3/(s \bullet m^2)$, °C = [(°F) -32]/1.8, 1 square foot = 0.0929 m^2.

a. Based upon *net occupiable floor area.*

b. Mechanical exhaust required and the recirculation of air from such spaces is prohibited (see Section 403.2.1, Item 3).

c. Spaces unheated or maintained below 50°F are not covered by these requirements unless the occupancy is continuous.

d. Ventilation systems in enclosed parking garages shall comply with Section 404.

e. Rates are per water closet or urinal. The higher rate shall be provided where the exhaust system is designed to operate intermittently. The lower rate shall be permitted only where the exhaust system is designed to operate continuously while occupied.

f. Rates are per room unless otherwise indicated. The higher rate shall be provided where the exhaust system is designed to operate intermittently. The lower rate shall be permitted only where the exhaust system is designed to operate continuously while occupied.

g. Mechanical exhaust is required and recirculation is prohibited except that recirculation shall be permitted where the resulting supply airstream consists of not more than 10 percent air recirculated from these spaces (see Section 403.2.1, Items 2 and 4).

h. For nail salons, each nail station shall be provided with a *source capture system* capable of exhausting not less than 50 cfm per station.

403.3.1 Zone outdoor airflow.

The minimum outdoor airflow required to be supplied to each zone shall be determined as a function of *occupancy* classification and space air distribution effectiveness in accordance with Sections 403.3.1.1 through 403.3.1.3. New language & Title

403.3.1.1 Breathing zone outdoor airflow. New

The outdoor airflow rate required in the *breathing zone* (V_{bz}) of the *occupiable space* or spaces in a zone shall be determined in accordance with Equation 4-1.

$$V_{bz} = R_p P_z + R_a A_z \qquad \textbf{(Equation 4-1)}$$

where:

A_z = Zone floor area: the *net occupiable floor area* of the space or spaces in the zone.
P_z = Zone population: the number of people in the space or spaces in the zone.
R_p = People outdoor air rate: the outdoor airflow rate required per person from Table 403.3.
R_a = Area outdoor air rate: the outdoor airflow rate required per unit area from Table 403.3.

403.3.1.2 Zone air distribution effectiveness.

The zone air distribution effectiveness (E_z) shall be determined using Table 403.3.1.2.

New

TABLE 403.3.1.2
ZONE AIR DISTRIBUTION EFFECTIVENESS a,b,c,d,e

New

Air Distribution Configuration	E_z
Ceiling or floor supply of cool air	1.0[f]
Ceiling or floor supply of warm air and floor return	1.0
Ceiling supply of warm air and ceiling return	0.8[g]
Floor supply of warm air and ceiling return	0.7
Makeup air drawn in on the opposite side of the room from the exhaust and/or return	0.8
Makeup air drawn in near to the exhaust and/or return location	0.5

Notes for Table 403.3.1.2

For SI: 1 foot = 304.8 mm, 1 foot per minute = 0.00506 m/s,
°C = [(°F) – 32]/1.8.

a. "Cool air" is air cooler than space temperature.

b. "Warm air" is air warmer than space temperature.

c. "Ceiling" includes any point above the breathing zone.

d. "Floor" includes any point below the breathing zone.

e. "Makeup air" is air supplied or transferred to a zone to replace air removed from the zone by exhaust or return systems.

f. Zone air distribution effectiveness of 1.2 shall be permitted for systems with a floor supply of cool air and ceiling return, provided that low-velocity displacement ventilation achieves unidirectional flow and thermal stratification.

g. Zone air distribution effectiveness of 1.0 shall be permitted for systems with a ceiling supply of warm air, provided that supply air temperature is less than 15°F above space temperature and provided that the 150 foot-per-minute supply air jet reaches to within $4^1/_2$ feet of floor level.

403.3.1.3 Zone outdoor airflow.

New

- The zone outdoor airflow rate (V_{oz}), shall be determined in accordance with Equation 4-2.

$$V_{oz} = \frac{V_{bz}}{E_z}$$

(Equation 4-2)

403.3.2 System outdoor airflow.

New

The outdoor air required to be supplied by each ventilation system shall be determined in accordance with Sections 403.3.2.1 through 403.3.2.3 as a function of system type and zone outdoor airflow rates.

403.3.2.1 Single zone systems.

New

Where one air handler supplies a mixture of outdoor air and recirculated return air to only one zone, the system outdoor air intake flow rate (V_{ot}) shall be determined in accordance with Equation 4-3.

$$V_{ot} = V_{oz}$$

(Equation 4-3)

403.3.2.2 100-percent outdoor air systems.

New

Where one air handler supplies only outdoor air to one or more zones, the system outdoor air intake flow rate (V_{ot}) shall be determined using Equation 4-4.

$$V_{ot} = \Sigma_{all\ zones} V_{oz}$$ **(Equation 4-4)**

403.3.2.3 Multiple zone recirculating systems.

New

Where one air handler supplies a mixture of outdoor air and recirculated return air to more than one zone, the system outdoor air intake flow rate (V_{ot}) shall be determined in accordance with Sections 403.3.2.3.1 through 403.3.2.3.4.

403.3.2.3.1 Primary outdoor air fraction.

New

The primary outdoor air fraction (Z_p) shall be determined for each zone in accordance with Equation 4-5.

$$Z_p = \frac{V_{oz}}{V_{pz}} \qquad \textbf{(Equation 4-5)}$$

where:

V_{pz} =Primary airflow: The airflow rate supplied to the zone from the air-handling unit at which the outdoor air intake is located. It includes outdoor intake air and recirculated air from that air-handling unit but does not include air transferred or air recirculated to the zone by other means. For design purposes, V_{pz} shall be the zone design primary airflow rate, except for zones with variable air volume supply and V_{pz} shall be the lowest expected primary airflow rate to the zone when it is fully occupied.

403.3.2.3.2 System ventilation efficiency.

New

The system ventilation efficiency (E_v) shall be determined using Table 403.3.2.3.2 or Appendix A of ASHRAE 62.1.

TABLE 403.3.2.3.2 SYSTEM VENTILATION EFFICIENCY [a,b]

Max (Z_p)	E_v
≤ 0.15	1
≤ 0.25	0.9
≤ 0.35	0.8
≤ 0.45	0.7
≤ 0.55	0.6
≤ 0.65	0.5
≤ 0.75	0.4
> 0.75	0.3

a. *Max* (Z_p) is the largest value of Z_p calculated using Equation 4-5 among all the zones served by the system.

b. Interpolating between table values shall be permitted.

403.3.2.3.3 Uncorrected outdoor air intake.

New

The uncorrected outdoor air intake flow rate (V_{ou}) shall be determined in accordance with Equation 4-6.

$$V_{ou} = D\Sigma_{all\ zones} R_p P_z + \Sigma_{all\ zones} R_a A_z \qquad \textbf{(Equation 4-6)}$$

where:
D =Occupant diversity: the ratio of the system population to the sum of the zone populations, determined in accordance with Equation 4-7.

$$D = \frac{P_s}{\Sigma_{all\ zones} P_z} \qquad \textbf{(Equation 4-7)}$$

where:

P_s =System population: The total number of occupants in the area served by the system. For design purposes, P_s shall be the maximum number of occupants expected to be concurrently in all zones served by the system.

403.3.2.3.4 Outdoor air intake flow rate.

New

The outdoor air intake flow rate (V_{ot}) shall be determined in accordance with Equation 4-8.

$$V_{ot} = \frac{V_{ou}}{E_v}$$

(Equation 4-8)

403.4 Exhaust ventilation.

New

Exhaust airflow rate shall be provided in accordance with the requirements in Table 403.3. Exhaust *makeup air* shall be permitted to be any combination of outdoor air, recirculated air and transfer air, except as limited in accordance with Section 403.2.

403.5 System operation.

The minimum flow rate of outdoor air that the ventilation system must be capable of supplying during its operation shall be permitted to be based on the rate per person indicated in Table 403.3 and the actual number of occupants present.

Different Section # same language

403.6 Variable air volume system control.

Variable air volume air distribution systems, other than those designed to supply only 100-percent outdoor air, shall be provided with controls to regulate the flow of outdoor air. Such control system shall be designed to maintain the flow rate of outdoor air at a rate of not less than that required by Section 403.3 over the entire range of supply air operating rates.

Same

403.7 Balancing.

The *ventilation air* distribution system shall be provided with means to adjust the system to achieve at least the minimum ventilation airflow rate as required by Sections 403.3 and 403.4. Ventilation systems shall be balanced by an *approved* method. Such balancing shall verify that the ventilation system is capable of supplying and exhausting the airflow rates required by Sections 403.3 and 403.4.

Similar Verbiage, added language for earlier sections

Instruments Needed to Verify Requirements are Met

SECTION 404

“ENCLOSED PARKING GARAGES”

404.1 Enclosed parking garages.

Mechanical ventilation systems for enclosed parking garages shall be permitted to operate intermittently in accordance with Item 1, Item 2 or both.

1. The system shall be arranged to operate automatically upon detection of vehicle operation or the presence of occupants by approved automatic detection devices.
2. The system shall be arranged to operate automatically by means of carbon monoxide detectors applied in conjunction with nitrogen dioxide detectors. Such detectors shall be installed in accordance with their manufacturers’ recommendations.

New Language & control parameters

404.2 Minimum ventilation.

Automatic operation of the system shall not reduce the ventilation airflow rate below 0.05 cfm per square foot (0.00025 $m^3/s \bullet m^2$) of the floor area and the system shall be capable of producing a ventilation airflow rate of 0.75 cfm per square foot (0.0038 $m^3/s \bullet m^2$) of floor area.

Same Language, slight change in formula

404.3 Occupied spaces accessory to public garages.

Connecting offices, waiting rooms, ticket booths and similar uses that are accessory to a public garage shall be maintained at a positive pressure and shall be provided with ventilation in accordance with Section 403.3.

Same

SECTION 405

SYSTEMS CONTROL

405.1 General.

Mechanical ventilation systems shall be provided with manual or automatic controls that will operate such systems whenever the spaces are occupied. Air-conditioning systems that supply required *ventilation air* shall be provided with controls designed to automatically maintain the required outdoor air supply rate during occupancy.

Same

SECTION 406

VENTILATION OF UNINHABITED SPACES

406.1 General.

Uninhabited spaces, such as crawl spaces and attics, shall be provided with *natural ventilation* openings as required by the *International Building Code* or shall be provided with a mechanical exhaust and supply air system. The mechanical exhaust rate shall be not less than 0.02 cfm per square foot (0.00001 $m^3/s \cdot m^2$) of horizontal area and shall be automatically controlled to operate when the relative humidity in the space served exceeds 60 percent.

Same

SECTION 508

COMMERCIAL KITCHEN MAKEUP AIR

508.1 Makeup air.

Makeup air shall be supplied during the operation of commercial kitchen exhaust systems that are provided for *commercial cooking appliances.* The amount of *makeup air* supplied to the building from all sources shall be approximately equal to the amount of *exhaust air* for all exhaust systems for the building. The *makeup air* shall not reduce the effectiveness of the exhaust system. *Makeup air* shall be provided by gravity or mechanical means or both. Mechanical *makeup air* systems shall be automatically controlled to start and operate simultaneously with the exhaust system. *Makeup air* intake opening locations shall comply with Section 401.4.

Same language

508.1.1 Makeup air temperature.

The temperature differential between *makeup air* and the air in the conditioned space shall not exceed 10°F (6°C) except where the added heating and cooling loads of the *makeup air* do not exceed the capacity of the HVAC system.

Slight change in language

SECTION 514

ENERGY RECOVERY VENTILATION SYSTEMS

514.1 General.

- Energy recovery ventilation systems shall be installed in accordance with this section. Where required for purposes of energy conservation, energy recovery ventilation systems shall also comply with the *International Energy Conservation Code.* Ducted heat recovery ventilators shall be listed and labeled in accordance with UL 1812. Nonducted heat recovery ventilators shall be listed and labeled in accordance with UL 1815.

  Same

514.2 Prohibited applications.

Energy recovery ventilation systems shall not be used in the following systems:

1. Hazardous exhaust systems covered in Section 510.
2. Dust, stock and refuse systems that convey explosive or flammable vapors, fumes or dust.
3. Smoke control systems covered in Section 513.
4. Commercial kitchen exhaust systems serving Type I and Type II hoods.
5. Clothes dryer exhaust systems covered in Section 504.

Same

514.3 Access.

A means of access shall be provided to the heat exchanger and other components of the system as required for service, maintenance, repair or replacement.

Same

514.4 Recirculated air.

Air conveyed within energy recovery systems shall not be considered as recirculated air where the energy recovery ventilation system is constructed to limit cross-leakage between air streams to less than 10 percent of the total airflow design capacity.

Added Section

Short Break

2012 International Energy Conservation Code

Commercial Energy Efficiency

Not in 2003 IECC

C403.2.4.1.1 Heat pump supplementary heat.

Heat pumps having supplementary electric resistance heat shall have controls that, except during defrost, prevent supplementary heat operation where the heat pump can meet the heating load.

Same

C403.2.4.3.2 Automatic setback and shutdown capabilities.

Automatic time clock or programmable controls shall be capable of starting and stopping the system for **seven different daily schedules per week** and retaining their programming and time setting during a loss of power for at least 10 hours. Additionally, the controls shall have a manual override that allows temporary operation of the system for up to 2 hours; a manually operated timer capable of being adjusted to operate the system for up to 2 hours; or an occupancy sensor.

C403.2.4.4 Shutoff damper controls.

Both outdoor air supply and exhaust ducts shall be equipped with motorized dampers that will automatically shut when the systems or spaces served are not in use.

Exceptions:

1. Gravity dampers shall be permitted in buildings less than three stories in height.
2. Gravity dampers shall be permitted for buildings of any height located in Climate Zones 1, 2 and 3. Not Connecticut
3. Gravity dampers shall be permitted for outside air intake or exhaust airflows of 300 cfm (0.14 m3/s) or less.

Commercial Conventional & Heatpump Thermostats with Lockout & Ventilation Abilities






C403.2.5.1 Demand controlled ventilation.

Demand control ventilation (DCV) shall be provided for spaces larger than 500 square feet (50 m^2) and with an average occupant load of 25 people per 1000 square feet (93 m^2) of floor area (as established in Table 403.3 of the *International Mechanical Code*) and served by systems with one or more of the following:

1. An air-side economizer;
2. Automatic modulating control of the outdoor air damper; or
3. A design outdoor airflow greater than 3,000 cfm (1400 L/s).

Continued…..

C403.2.5.1 Demand controlled ventilation.

Exception: Demand control ventilation is not required for systems and spaces as follows:

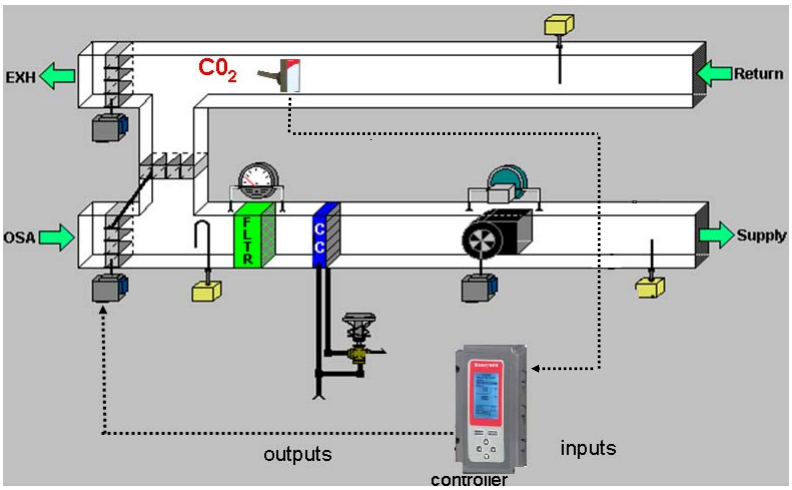
1. Systems with energy recovery complying with Section C403.2.6.
2. Multiple-zone systems without direct digital control of individual zones communicating with a central control panel.
3. System with a design outdoor airflow less than 1,200 cfm (600 L/s).
4. Spaces where the supply airflow rate minus any makeup or outgoing transfer air requirement is less than 1,200 cfm (600 L/s).
5. Ventilation provided for process loads only.

Carbon Dioxide Sensors

Honeywell

Carbon Dioxide ($C0_2$) Applications

- **Return air override of minimum position**



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CO2 - Applications

Honeywell

- **Typical Applications**
  - **Demand control ventilation**
    - Regulate the quantity of ventilation provided in response to changes in occupancy



New models (C7262A)

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CO_2 Sensor- Key Features

Honeywell

- **Field Selectable voltage or current output (0/2-10vdc or 4-20mA)**
- **CO2/Temp sensor is available**
- **Wall or Duct Models available**
- **Models with or without display are available**
- **Selectable SPST relay output**
- **Range : 0 to 2000 ppm**

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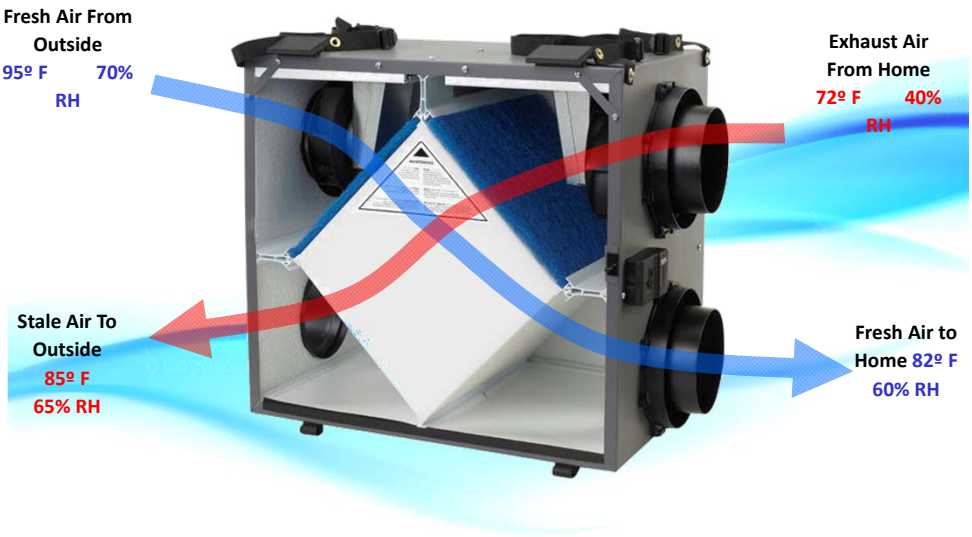
Demand Ventilation Benefits

- Ventilation is only brought in when needed
- Can be made to override minimum code requirements and provide additional ventilation/outside air when extreme conditions take place
- Typically a very fast payback on investment due to energy saving

C403.2.6 Energy recovery ventilation systems.

Where the supply airflow rate of a fan system exceeds the values specified in Table C403.2.6, the system shall include an energy recovery system. The energy recovery system shall have the capability to provide a change in the enthalpy of the outdoor air supply of not less than 50 percent of the difference between the outdoor air and return air enthalpies, at design conditions. Where an air economizer is required, the energy recovery system shall include a bypass or controls which permit operation of the economizer as required by Section C403.4.

Example of How an ERV Works



ERVs Transfer Both Sensible & Latent Heat

Exception:

An energy recovery ventilation system shall not be required in any of the following conditions:

1. Where energy recovery systems are prohibited by the International Mechanical Code.
2. Laboratory fume hood systems that include at least one of the following features:

2.1. Variable-air-volume hood exhaust and room supply systems capable of reducing exhaust and makeup air volume to 50 percent or less of design values.

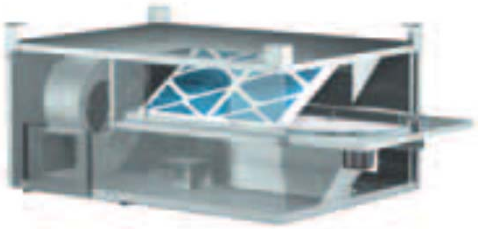
2.2. Direct makeup (auxiliary) air supply equal to at least 75 percent of the exhaust rate, heated no warmer than 2°F (1.1°C) above room setpoint, cooled to no cooler than 3°F (1.7°C) below room setpoint, no humidification added, and no simultaneous heating and cooling used for dehumidification control.

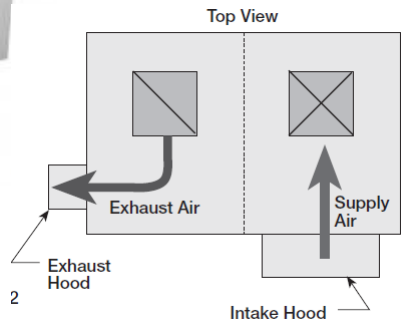
3. Systems serving spaces that are heated to less than 60°F (15.5°C) and are not cooled.
4. Where more than 60 percent of the outdoor heating energy is provided from site-recovered or site solar energy.
5. Heating energy recovery in Climate Zones 1 and 2.
6. Cooling energy recovery in Climate Zones 3C, 4C, 5B, 5C, 6B, 7 and 8.
7. Systems requiring dehumidification that employ energy recovery in series with the cooling coil.
8. Where the largest source of air exhausted at a single location at the building exterior is less than 75 percent of the design outdoor air flow rate.
9. Systems expected to operate less than 20 hours per week at the outdoor air percentage covered by Table C403.2.6.

TABLE C403.2.6 ENERGY RECOVERY REQUIREMENT

CLIMATE ZONE	PERCENT (%) OUTDOOR AIR AT FULL DESIGN AIRFLOW RATE					
	≥ 30% and < 40%	≥ 40% and < 50%	≥ 50% and < 60%	≥ 60% and < 70%	≥ 70% and < 80%	≥ 80%
	DESIGN SUPPLY FAN AIRFLOW RATE (cfm)					
3B, 3C, 4B, 4C, 5B	NR	NR	NR	NR	≥ 5000	≥ 5000
1B, 2B, 5C	NR	NR	≥ 26000	≥ 12000	≥ 5000	≥ 4000
6B	≥ 11000	≥ 5500	≥ 4500	≥ 3500	≥ 2500	≥ 1500
1A, 2A, 3A, 4A, 5A, 6A	≥ 5500	≥ 4500	≥ 3500	≥ 2000	≥ 1000	> 0
7, 8	≥ 2500	≥ 1000	> 0	> 0	> 0	> 0

Commercial Energy Recovery Ventilators





Economizers

C403.3 Simple HVAC systems and equipment (Prescriptive).

This section applies to buildings served by unitary or packaged HVAC equipment listed in Tables C403.2.3(1) through C403.2.3(8), each serving one *zone* and controlled by a single thermostat in the *zone* served. It also applies to two-pipe heating systems serving one or more *zones*, where no cooling system is installed.

C403.3.1 Economizers.

Each cooling system that has a fan shall include either an air or water economizer meeting the requirements of Sections C403.3.1.1 through C403.3.1.1.4.

Exception: Economizers are not required for the systems listed below.

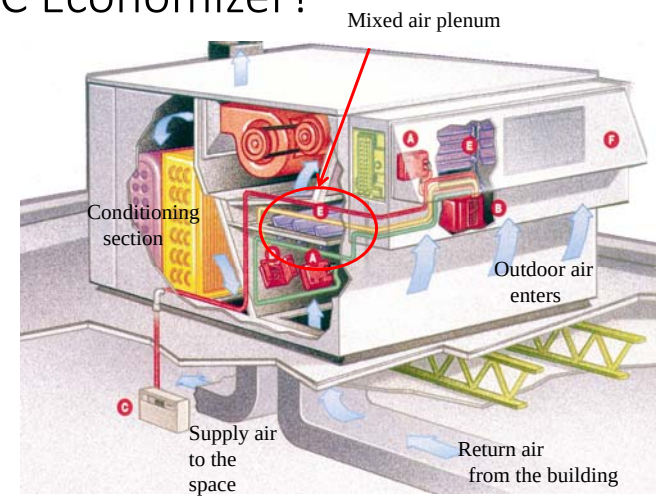
1. Individual fan-cooling units with a supply capacity less than the minimum listed in Table C403.3.1(1).
2. Where more than 25 percent of the air designed to be supplied by the system is to spaces that are designed to be humidified above 35°F (1.7 °C) dew-point temperature to satisfy process needs.
3. Systems that serve *residential* spaces where the system capacity is less than five times the requirement listed in Table C403.3.1(1).
4. Systems expected to operate less than 20 hours per week.
5. Where the use of *outdoor air* for cooling will affect supermarket open refrigerated casework systems.
6. Where the cooling *efficiency* meets or exceeds the *efficiency* requirements in Table C403.3.1(2).

TABLE C403.3.1(1) ECONOMIZER REQUIREMENTS

CLIMATE ZONES	ECONOMIZER REQUIREMENT
1A, 1B	No requirement
2A, 2B, 3A, 3B, 3C, 4A, 4B, 4C, 5A, 5B, 5C, 6A, 6B, 7, 8	Economizers on all cooling systems ≥ 33,000 Btu/h[a]

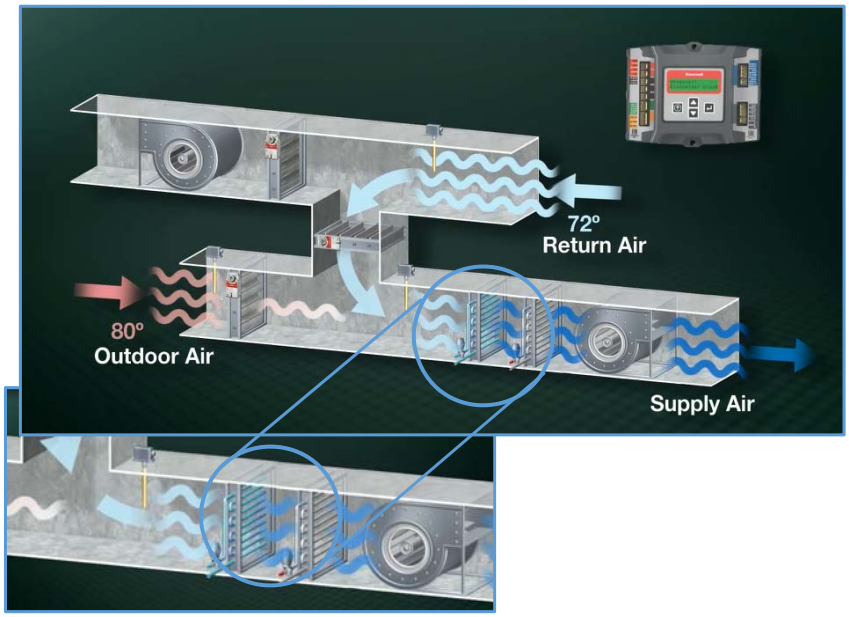
What is an Airside HVAC Economizer?

- A OA and RA Sensors
- B Damper Actuator
- C 2-stage Room Thermostat or controller
- D Mixed Air Sensor
- E Modulating Dampers OA and RA
- F OA Hood



Need 2-stage thermostat for integrated economizing

Built up Economizer



Impact of Energy Issues on Economizers

Economizers Yesterday

- **Save money by utilizing free outside air instead of mechanical equipment**
- **Provide ventilation with demand control ventilation**
- **No direct feedback of operation or fault detection**

Controllers today

- **More complex control requirements for additional energy savings**
- **Simplified diagnostics and verifiable operation**
- **Traceable operation and maintenance**
- **Meet CA title 24, ASHRAE and ICC codes and standards**

64% Installed Rooftop Economizers Do Not Work!

Economizer Controllers

Honeywell

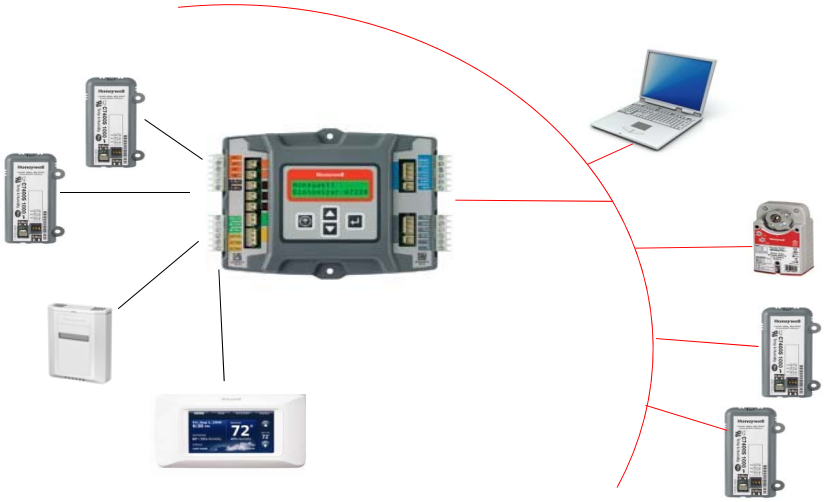
Honeywell.com

W7220 JADE™ Economizer Controller

- **LCD Display eliminates guessing**
- **Programmable setpoints**
- **System Checkout**
- **Demand Control Ventilation**
- **Rugged Push Buttons**
- **Correction Offset for Drifting Humidity Sensors**
- **Simplified Wiring**
- **Alarm(s) for Failed Component(s)**
- **Communicates with Sensors/Actuator**

Another Modern Economizer Control

Control Flexability



2012 IRC Code

Information Effecting HVAC

Chapter 11

Energy Efficiency

SECTION N1101

GENERAL

N1101.8 (R103.2) Information on construction documents.

- **Construction documents shall be drawn to scale upon suitable material. Electronic media documents are permitted to be submitted when approved by the building official. Construction documents shall be of sufficient clarity to indicate the location, nature and extent of the work proposed, and show in sufficient detail pertinent data and features of the building, systems and equipment as herein governed.** Details shall include, but are not limited to, as applicable, insulation materials and their R-values; fenestration U-factors and SHGCs; area-weighted U-factor and SHGC calculations; **mechanical system design criteria; mechanical and service water heating system and equipment types, sizes and efficiencies; economizer description; equipment and systems controls; fan motor horsepower (hp) and controls; duct sealing, duct and pipe insulation and location;** lighting fixture schedule with wattage and control narrative; **and air sealing details.**
- **New Requirement**

N1101.16 (R401.3) Certificate (Mandatory).

A permanent certificate shall be completed and posted on or in the electrical distribution panel by the builder or registered design professional. The certificate shall not cover or obstruct the visibility of the circuit directory label, service disconnect label or other required labels. **The certificate shall list the predominant *R*-values of insulation installed in or on** ceiling/roof, walls, foundation (slab, *basement wall,* crawl space wall and/or floor) and **ducts outside conditioned spaces;** *U*-factors for fenestration and the solar heat gain coefficient (SHGC) of fenestration, and the **results from any required duct system and building envelope air leakage testing done on the building.** Where there is more than one value for each component, the certificate shall list the value covering the largest area. **The certificate shall list the types and efficiencies of heating, cooling and service water heating equipment. Where a gas-fired unvented room heater, electric furnace, or baseboard electric heater is installed in the residence, the certificate shall list "gas-fired unvented room heater," "electric furnace" or "baseboard electric heater," as appropriate.** An efficiency shall not be *listed* for gas-fired unvented room heaters, electric furnaces or electric baseboard heaters.

Is also required in 2009 IRC

SECTION N1102

BUILDING THERMAL ENVELOPE

N1102.4 (R402.4) Air leakage (Mandatory).

The building thermal envelope shall be constructed to limit air leakage in accordance with the requirements of Sections N1102.4.1 through N1102.4.4

Far stricter then 2003 & 2009 IRC requirements

TABLE N1102.4.1.1 (R402.4.1.1) AIR BARRIER AND INSULATION INSTALLATION

Examples:

- A continuous air barrier shall be installed in the building envelope.
  Exterior thermal envelope contains a continuous air barrier.
  Breaks or joints in the air barrier shall be sealed.
  Air-permeable insulation shall **not** be used as a sealing material.
- HVAC register boots that penetrate building thermal envelope shall be **sealed** to the subfloor or drywall.
- An air barrier shall be installed on fireplace walls. Fireplaces shall have **gasketed** doors.
- Not in 2003 IRC, much stricter language than 2009

N1102.4.1.2 (R402.4.1.2) Testing.

Edited to Show Climate Zone 5A Requirements

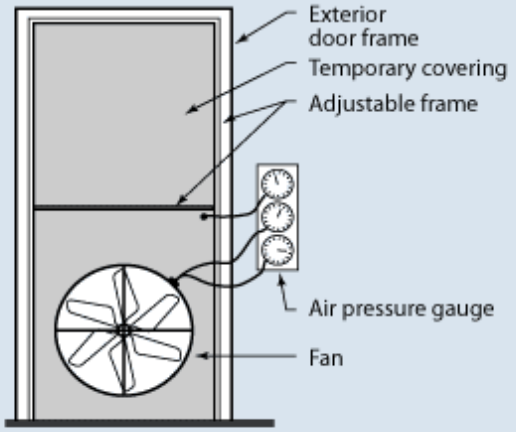
- The building or dwelling unit **shall be tested** and verified as having an air leakage rate of **not exceeding 3 air changes per hour** in Zone 5A. **Testing shall be conducted with a blower door** at a pressure of 0.2 inches w.g. (50 Pascals). Where required by the *building official,* testing shall be conducted by an *approved* third party. A written report of the results of the test shall be signed by the party conducting the test and provided to the *building official.* Testing shall be performed at any time after creation of all penetrations of the *building thermal envelope.*

- Not required with 2003 IRC, Choice of visual inspection or test in 2009

Blower Door testing

Diagnostic Tools

Testing the airtightness of a home using a special fan called a blower door can help to ensure that air sealing work is effective. Often, energy efficiency incentive programs, such as the DOE/ EPA ENERGY STAR Program, require a blower door test (usually performed in less than an hour) to confirm the tightness of the house.



N1102.4.2 (R402.4.2) Fireplaces.

- New wood-burning fireplaces shall have tight-fitting flue dampers and **outdoor combustion air.**

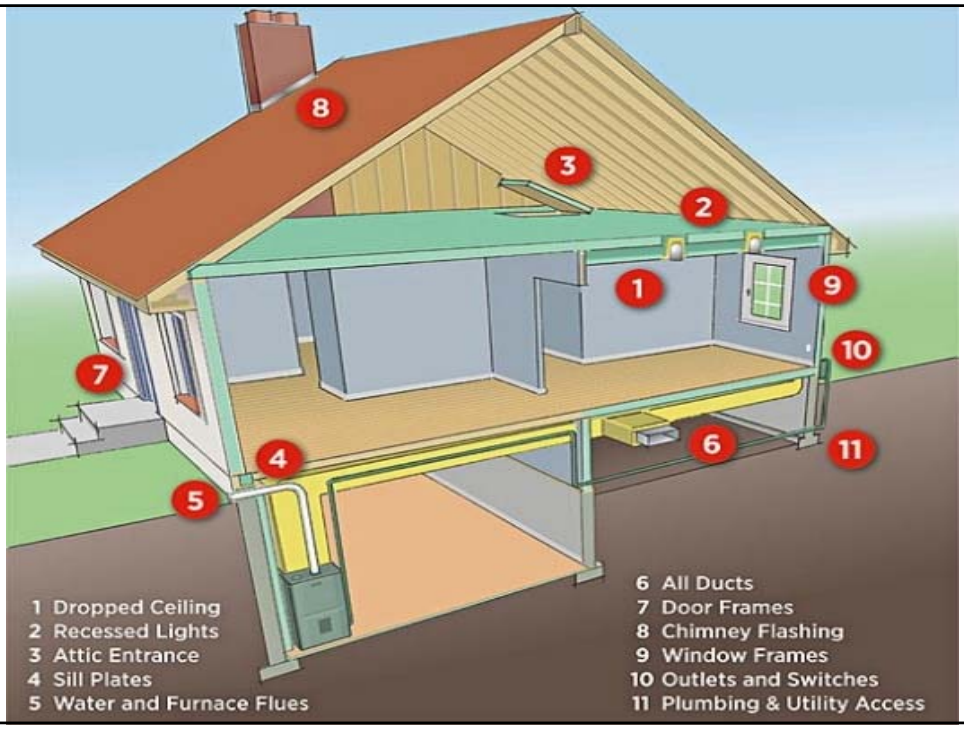
N1102.4.4 (R402.4.4) Recessed lighting.

- Recessed luminaires installed in the building thermal envelope shall be **sealed** to limit air leakage between conditioned and unconditioned spaces. All recessed luminaires shall be IC-rated and labeled as having an air leakage rate not more than 2.0 cfm (0.944 L/s) when tested in accordance with ASTM E 283 at a 1.57 psf (75 Pa) pressure differential. All recessed luminaires shall be **sealed with a gasket or caulk between the housing and the interior wall or ceiling covering.**
- Some Language similar regarding air leakage, no mention of gasket or chaulk in 2003 IRC for recessed lighting

2012 IRC Section N1102.1.10 Air leakage.

- All joints, seams, penetrations; site-built windows, doors, and skylights; openings between window and door assemblies and their respective jambs and framing; and other sources of air leakage (infiltration and exfiltration) through the building thermal envelope shall be caulked, gasketed, weatherstripped, wrapped, or otherwise sealed to limit uncontrolled air movement.

- Very little discussed with regard to air leakage or testing in 2003



SECTION N1103

SYSTEMS

N1103.1 (R403.1) Controls (Mandatory).

- N1103.1.1 (R403.1.1) Programmable thermostat.

Where the primary heating system is a forced-air furnace, at least one thermostat per dwelling unit shall be capable of controlling the heating and cooling system on a daily schedule to maintain different temperature set points at different times of the day. This thermostat shall include the capability to set back or temporarily operate the system to maintain zone temperatures down to 55°F (13°C) or up to 85°F (29°C). The thermostat shall initially be programmed with a heating temperature set point no higher than 70°F (21°C) and a cooling temperature set point no lower than 78°F (26°C). Programmable requirement is new

- N1103.1.2 (R403.1.2) Heat pump supplementary heat (Mandatory).

Heat pumps having supplementary electric-resistance heat shall have controls that, except during defrost, **prevent supplemental heat operation** when the heat pump compressor can meet the heating load. Was also in 2003 IRC code

To meet this requirement a thermostat with an outdoor temperature lock-out is typically used

N1103.2 (R403.2) Ducts.

- **N1103.2.2 (R403.2.2) Sealing (Mandatory).**

Ducts, air handlers, and **filter boxes shall be sealed**. Joints and seams shall comply with Section M1601.4.1 of this code. New added language

- **N1103.2.2.1 (R403.2.2.1) Sealed air handler.**

Air handlers shall have a manufacturer's designation for an air leakage of no more than 2 percent of the design air flow rate when tested in accordance with ASHRAE 193. New added Language

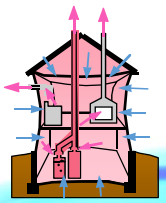
N1103.5 (R403.5) Mechanical ventilation (Mandatory).

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.

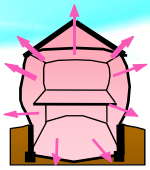
New Added language

Ways to Ventilate

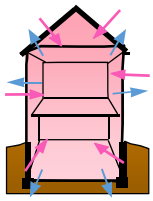
- **Exhaust Ventilation**
  - This is an inexpensive way to provide ventilation
  - You are not controlling the air coming into the house
  - Requires make-up air for combustion products



- **Supply Ventilation**
  - Preferable form of inexpensive ventilation in southern markets
  - Could cause problems with atmospheric exhaust appliances
  - Can also push humidified air into the wall space



- **Balanced Ventilation**
  - You are in control of the air
  - Typically more expensive to install but less expensive to operate



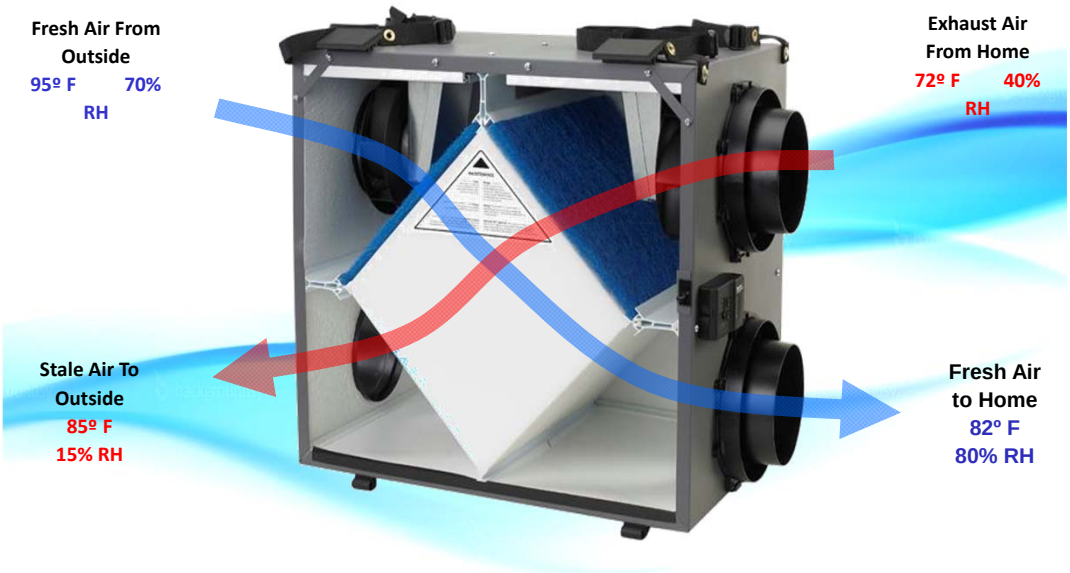
Type Ventilation Products

Exhaust Ventilation Using Exhaust Fans

Balanced Ventilation Systems

Supply Ventilation

How an HRV Works

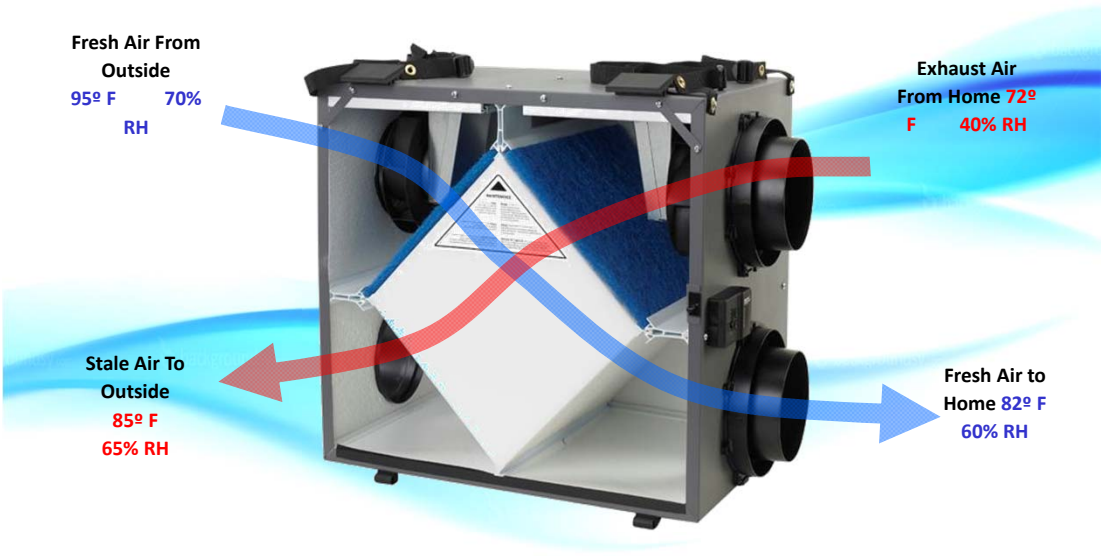


HRVs Transfer Only Sensible Heat

HRVs

- Supply fresh air into the home
- Exhaust stale air from the home
- HRV core **transfers heat**
- Sensible Effectiveness (Typically up to 70%)
- Core defrost via supply motor shut-off or opening a bypass or port

How an ERV Works



ERVs Transfer Both Sensible & Latent Heat

ERVs

- Supply fresh air into the home
- Exhaust stale air from the home
- ERV core transfers both heat and moisture
- Sensible Effectiveness (typically up to 69%) ERV's are most often not as efficient as HRV's with regard to sensible heat transfer
- Core defrost via supply motor shut-off

Multiple Ventilation Controls Options

All Above Controls Ventilate According to ASHRAE 62.2

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

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

TABLE N1103.5.1 (R403.5.1) MECHANICAL VENTILATION SYSTEM FAN EFFICACY

FAN LOCATION	AIR FLOW RATE MINIMUM (CFM)	MINIMUM EFFICACY (CFM/WATT)	AIR FLOW RATE MAXIMUM (CFM)
Range hoods	Any	2.8 cfm/watt	Any
In-line fan	Any	2.8 cfm/watt	Any
Bathroom, utility room	10	1.4 cfm/watt	< 90
Bathroom, utility room	90	2.8 cfm/watt	Any

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

N1103.6 (R403.6) Equipment sizing (Mandatory).

Heating and cooling equipment shall be sized in accordance with ACCA Manual S based on building loads calculated in accordance with ACCA Manual J or other *approved* heating and cooling calculation methodologies.

SECTION N1105

SIMULATED PERFORMANCE ALTERNATIVE (PERFORMANCE)

N1105.1 (R405.1) Scope.

- This section establishes criteria for compliance using simulated energy performance analysis. Such analysis shall include heating, cooling, and service water heating energy only.
- This Alternative does provide alternatives to earlier reviewed requirements
- This does not however give Builder/Contractor a way out of effeciencies, just trade offs.

SECTION M1507

MECHANICAL VENTILATION

M1507.3 Whole-house mechanical ventilation system.

Whole-house mechanical ventilation systems shall be designed in accordance with Sections M1507.3.1 through M1507.3.3.

M1507.3.1 System design.

- The whole-house ventilation system shall consist of one or more supply or exhaust fans, or a combination of such, and associated ducts and controls. Local exhaust or supply fans are permitted to serve as such a system. Outdoor air ducts connected to the return side of an air handler shall be considered to provide supply ventilation.

M1507.3.2 System controls.

- The whole-house mechanical ventilation system shall be provided with controls that **enable manual override.**

M1507.3.3 Mechanical ventilation rate.

- The whole-house mechanical ventilation system shall provide outdoor air at a continuous rate of not less than that determined in accordance with Table M1507.3.3(1).

- **Exception:** The whole-house mechanical ventilation system is permitted to operate intermittently where the system has controls that enable operation for not less than 25-percent of each 4-hour segment and the ventilation rate prescribed in Table M1507.3.3(1) is multiplied by the factor determined in accordance with Table M1507.3.3(2).

Ventilation Override Controls

Examples Programmable Ventilation Rate Controls





TABLE M1507.3.3(1) CONTINUOUS WHOLE-HOUSE MECHANICAL VENTILATION SYSTEM AIRFLOW RATE REQUIREMENTS

DWELLING UNIT FLOOR AREA (square feet)	NUMBER OF BEDROOMS				
	0 â€" 1	2 â€" 3	4 â€" 5	6 â€" 7	> 7
	Airflow in CFM				
< 1,500	30	45	60	75	90
1,501 â€" 3,000	45	60	75	90	105
3,001 â€" 4,500	60	75	90	105	120
4,501 â€" 6,000	75	90	105	120	135
6,001 â€" 7,500	90	105	120	135	150
> 7,500	105	120	135	150	165

For SI: 1 square foot = 0.0929 m^2, 1 cubic foot per minute = 0.0004719 m^3/s.

TABLE M1507.3.3(2) INTERMITTENT WHOLE-HOUSE MECHANICAL VENTILATION RATE FACTORS a, b

RUN-TIME PERCENTAGE IN EACH 4-HOUR SEGMENT	25%	33%	50%	66%	75%	100%
Factor[a]	4	3	2	1.5	1.3	1.0

a. For ventilation system run time values between those given, the factors are permitted to be determined by interpolation.

b. Extrapolation beyond the table is prohibited.

New Section

M1507.4 Local exhaust rates.

- *Local exhaust* systems shall be designed to have the capacity to exhaust the minimum air flow rate determined in accordance with Table M1507.4.

TABLE M1507.4 MINIMUM REQUIRED LOCAL EXHAUST RATES FOR ONE- AND TWO-FAMILY DWELLINGS

AREA TO BE EXHAUSTED	EXHAUST RATES
Kitchens	100 cfm intermittent or 25 cfm continuous
Bathrooms-Toilet Rooms	Mechanical exhaust capacity of 50 cfm intermittent or 20 cfm continuous

For SI: 1 cubic foot per minute = 0.0004719 m^3/s.

Same as 2003 IRC Requirments, Section 1506.3

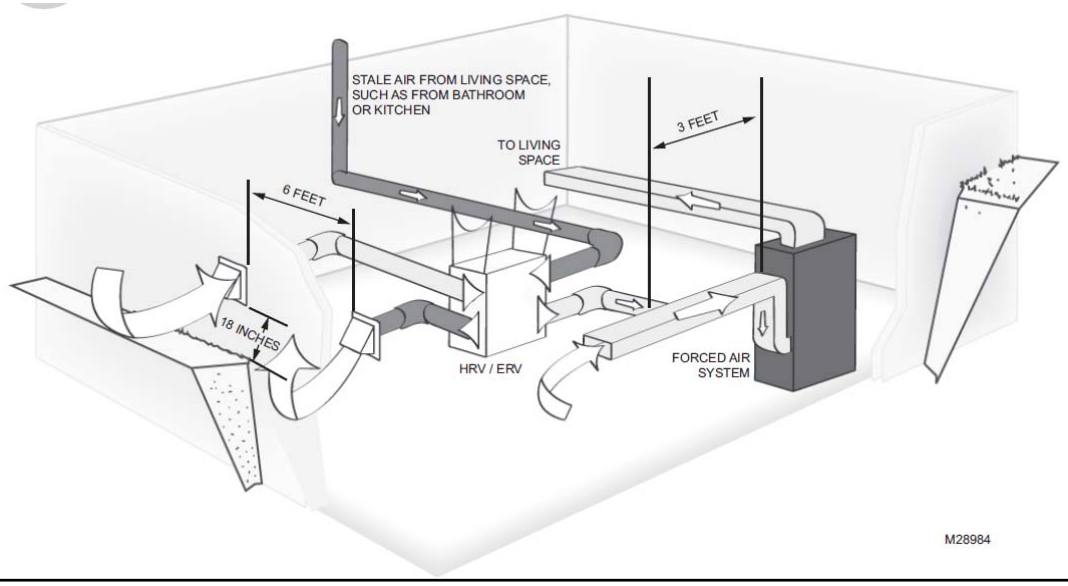
In Closing

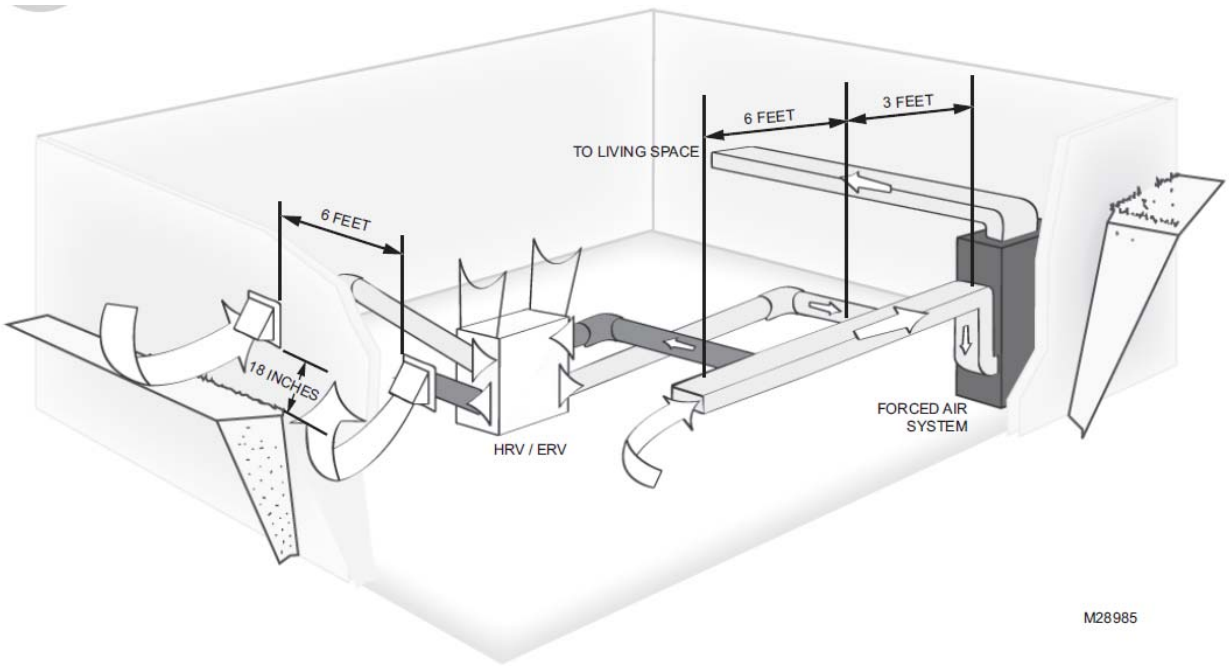
Residential ventilation

HRV's & ERV's often provide best solution to meet 2012 ICC codes with regard to residential applications

- Provides for simplified balanced ventilation required by code
- Also provides added energy efficiency over Exhaust/supply air built up systems
- Control strategies are simplified
- Actual balancing and verification of are much more straight forward
- Many more override & control solutions available at very little cost

Typical ERV or HRV Installation





Critical Considerations for ERV & HRV Functionality & Longevity

- Manufacturer's Installation requirements Followed.
- System balanced with instruments properly.
- Routine maintenance performed.

- There is many a blog & complaint regarding premature ventilator failure, vast majority is due to the above.