Energy Code Assistance Center

Efficiency Vermont

# BALANCED WHOLE-HOUSE VENTILATION DESIGN and INSTALLATION CRITERIA – Best Practice Ventilation Design

In reference to 2020 RBES R403.6 – R403.6.1 and Section R304
Design Criteria for Residential Ventilation Systems – Whole-House Balanced Ventilation System option.

The 2020 VT RBES requires per Section R304.3 Whole-House Ventilation. R304 allows for both exhaust-only and balanced systems, both prescriptively per Table R304.6 OR through compliance with ASHRAE Standard 62.2-2016, BSC Standard 01-2015, or Passive House (PH) Ventilation requirements.

This document outlines the best practices and/or requirements for design and installation of balanced (HRV/ERV) Whole-House ventilation systems. This document does not stand to replace the full rule requirements of Sections R403.6-R403.6.1 and Section R304 but covers the basic requirements and practice for the design and installation of balanced ventilation systems.

The main difference between an HRV and an ERV is that an HRV transfers sensible heat (i.e. temperature) from exhaust air to incoming air, while ERVs transfer both sensible heat and latent heat (i.e. temperature plus the energy trapped in the air's moisture). Certain manufacturers, building consultants, and installers have opinions on which type of system is best for cold climates, but there is no universally accepted solution for homes in Vermont. Some units have the capability to swap an HRV and ERV core if you later decide that you'd like the other type of system.

A useful tool for calculating required mechanical ventilation rate is available at:
https://www.redcalc.com/ashrae-62-2-2016/

## RBES R304.9 | INSTALLATION REQUIREMENTS

Ventilation equipment shall be installed according to the manufacturer's instructions and in accordance with Sections R304.9.1 through R304.9.8.

**R304.9.1 Fan housings.** Fan housings for single-port exhaust only systems must be sealed to the ceiling or wall.

**R304.9.2 Inlet grills.** Inlet grills for multiport exhaust ventilation systems or balanced whole house ventilation systems must be sealed to the ceiling or wall.

**R304.9.3 Ducts.** Smooth wall ducts (e.g. metal or composite) must be used for all duct runs longer than 8 feet (2438 mm). Ducts shall be insulated when installed in an unheated location or outside the building thermal envelope.

**R304.9.4 Fasteners.** Mechanical fasteners must be used to connect all ducts to the fan(s) without impeding the operation of the fan or any internal backdraft damper.

**R304.9.5 Joints and connections.** All joints, seams and connections shall be securely fastened and sealed with welds, gaskets, o-rings, mastics (adhesives), mastic embedded fabric systems or approved tapes.

**R304.9.6 Noise abatement.** Remote whole house ventilation fans shall be acoustically isolated from the structural elements of the building and from attached ducts using at least 1 foot (305 mm), but not more than 2 feet (610 mm) of insulated flexible duct.

**R304.9.7 Intake openings.** Mechanical and gravity outside air intake openings for balanced whole house systems, integrated supply systems or heat recovery ventilating systems that are installed in accordance with Section 304 shall be located a minimum of 10 feet (3048 mm) from any hazardous or noxious contaminant, such as vents, chimneys, plumbing vents, fuel fills and vents, streets, alleys, parking lots and loading docks, except as otherwise specified in this code.

The bottom of the intake termination shall be located at least 12 inches (305 mm) above the normally expected snow accumulation level.

**R304.9.8 Outside opening protection.** Air exhaust and in take openings located in exterior walls shall be protected with corrosion- resistant screens, louvers or grilles having a minimum opening size of ¼ inch (6.4 mm) and a maximum opening size of ½ inch (12.7 mm), in any dimension. Openings shall be protected against local weather conditions.

**R304.8 Controls.** Whole house ventilation systems (balanced or exhaust-only ventilation) shall be capable of being set remotely for continuous operation or shall be provided with an automatic control for intermittent operation. All whole house ventilation controls shall be readily accessible.

Total system measured capacity meets Vermont RBES Prescriptive table, ASHRAE 62.2-2016, BSC Standard 01-2015, or PH Ventilation requirements

**Per RBES Table R403.6.1:** HRV or ERV must have minimum fan efficacy of 1.2 cfm/watt

**Per RBES Table 304.2:** Bathrooms meet minimum spot ventilation requirements of 50cfm for intermittent use, or 20cfm continuous use

Additional Information. The list below represents best practices but not requirements:

- HRV/ERV is installed in a location that allows for easy filter maintenance.
- At a minimum, fresh air is delivered to main living space and each bedroom.
- Install a condensate drain if the HRV/ERV requires it
- If the HRV/ERV uses heating/cooling ductwork, interlock it with the heating/cooling air handler
- Provide homeowner with HRV/ERV manual and an explanation of why the system is there, how it works, and maintenance requirements.

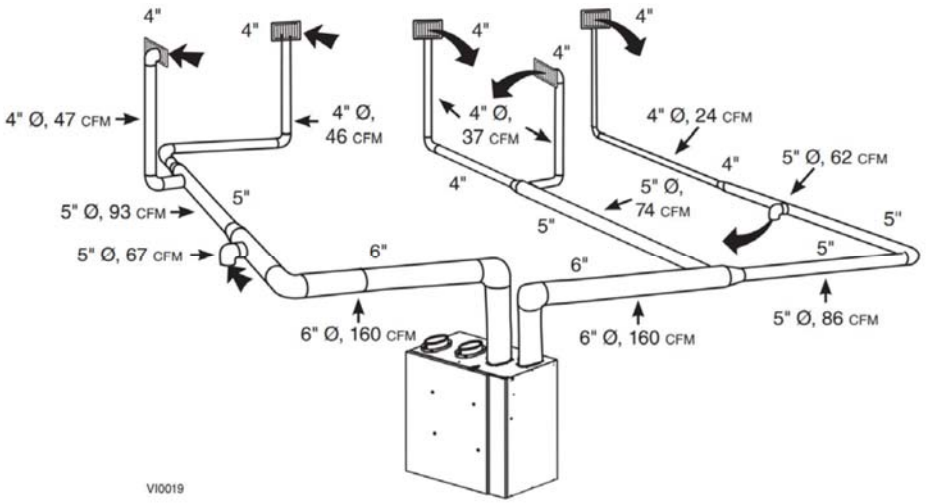
Good targets for delivered ventilation flows (at low speed) are as follows:

- Living room – 20-30 cfm supply
- Bedrooms – 15-20 cfm supply
- Kitchen – 30 cfm exhaust (a grease filter may be required)
- Bathrooms – 20 cfm exhaust

Design ducts using a guideline such as ACCA Manual D – this helps ensure that proper flow rates are achieved in the various locations served by the system.

- Keep duct runs short and straight
- Use smooth round ducts
- Seal joints
- Supply air should not be located near a room entry door; if there is a return in the same room, make it opposite the supply
- Place a balancing damper in trunk and/or branch lines or use adjustable diffusers for tuning flows.
- Commission the system, including testing and balancing the flows.
- Outside intake and exhaust terminations are minimum 10' apart, away from sources of pollution (e.g. laundry or boiler/furnace vent), and above expected snow depth.
- Per RBES R304.5.4: In-field measurements of exhaust fan flows shall be conducted using a manufactured flow- measuring device in accordance with the manufacturer's instructions. Acceptable devices include a calibrated orifice combined with a digital manometer or a flow hood. All measuring devices shall be accurate to within 10 percent of measured flow.

## Standard / Stand-Alone System Duct Schematic




## HRV/ERV Integration with Forced-Air Delivery Systems-following sections

Best practice design is dedicated ductwork for ventilation. Ventilation flows are typically much lower than what's delivered through furnace ducts, so using furnace ducts can result in poor control over ventilation air flows. Use dedicated ventilation ductwork as shown in Figure 1 whenever possible rather than tying into heating or cooling ducts. When that's not possible, at least try to provide dedicated ductwork for the exhaust side of the ventilation system. If using the heating/cooling ducts, follow manufacturer recommendations and interlock the HRV/ERV with the heating/cooling air handler.

# INTEGRATED SYSTEM DESIGN RECOMMENDATIONS

**If ventilation is integrated into a furnace:**

- Adhere to manufacturer guidelines (below – Venmar and Renewaire).

- Per RBES R403.6.1: Where an air handler that is integral to tested or listed HVAC equipment is used to provide whole house mechanical ventilation, the air handler shall be powered by an electronically commutated motor (ECM).

**Ventilator and air handler**

- Operating continuously provides best air quality and is the simplest installation. But H/ERV must be able to operate at a low enough flow to avoid overventilation and air handler energy is significant with this operation strategy. With ECMs good duct design will minimize fan energy.

- Operating intermittently requires motorized dampers that open only when the ventilator is on. Note that the air handler must be controlled by the ventilator so it is always on when the ventilator is on.

- Most air handlers with an ECM have a ventilation mode or other very low speed that can be used when the ventilator is operating but there is no call for space conditioning. Air handler wattage at this speed varies depending on ductwork. Select air handler carefully to ensure the system can support integrated ventilation with minimal energy penalty.

Local exhaust in bathrooms and kitchen must be provided by dedicated exhaust fans when H/ERV exhaust air is co-ducted with a furnace/AC. There is no way to verify ventilation flows without dedicated exhaust ductwork.

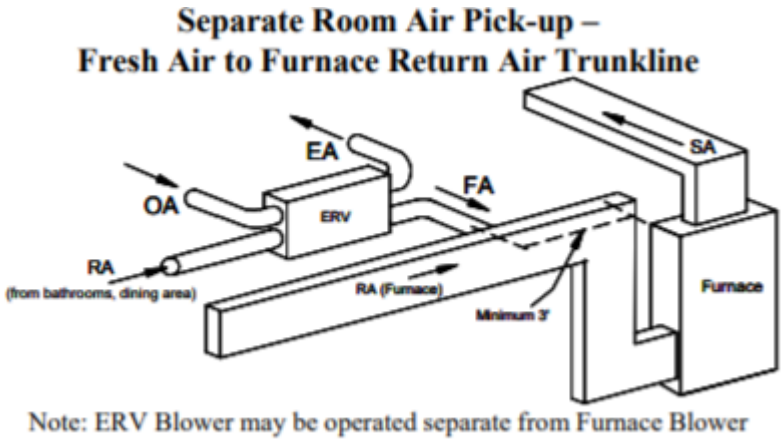
Are all of the HRV controls located in the mechanical room? If so, the ability to turn on the system with ease outside of the normal cycle is eliminated. Sophisticated thermostats such as Nest, Ecobee or Honeywell Prestige IAQ allow operation of the ventilation system through the thermostat. Otherwise, a simple boost control in the living space may do the trick.

# MANUFACTURER INTEGRATION RECOMMENDATIONS

**Method 1: "Return" (MOST COMMON)** | Fresh air leaving H/ERV is injected into the return side of the furnace ductwork. Return air to H/ERV is via dedicated ductwork.

**Recommendations:**

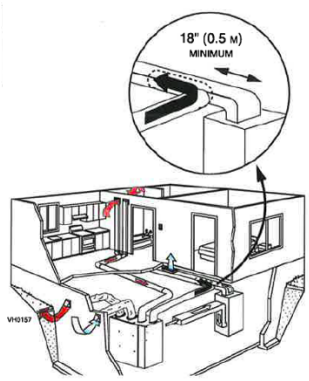
- Entry point into return ductwork is min. 10' upstream from furnace return (Venmar) (RenewAire and Panasonic show 3' upstream of horizontal run)
- Recommended but not essential that furnace blower synchronized with H/ERV (All except Panasonic, which is vague and seems to imply it's required)




**Method 2: "Supply"** | Fresh air leaving H/ERV is injected into supply side of the furnace ductwork. Return air to H/ERV is via dedicated ductwork.

**Recommendations:**

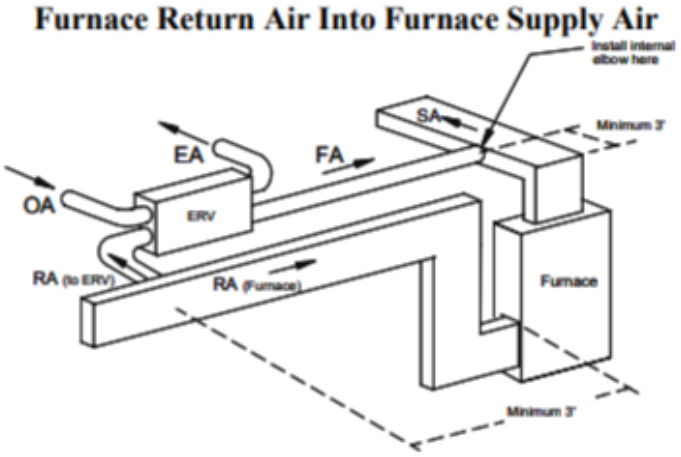
- Entry point into supply ductwork is min. 18" downstream from furnace supply (Venmar)
- Recommended but not essential that furnace blower synchronized with H/ERV (Venmar)




**Method 3: "Return-supply"** | Fresh air leaving H/ERV is injected into supply side of the furnace ductwork AND exhaust air returning to H/ERV is drawn out from return side of furnace.

**Recommendations:**

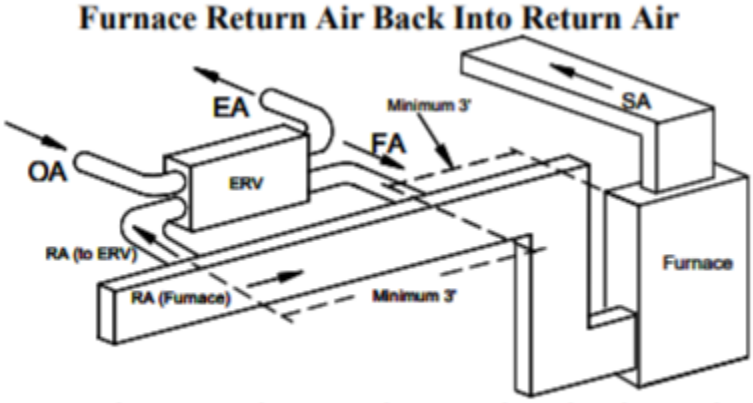
- Entry point into return ductwork is min. 10' upstream from furnace return (Venmar) (RenewAire shows 3' upstream of horizontal run)
- Entry point into supply ductwork is min. 18" downstream from furnace supply (Venmar) (RenewAire shows 3' downstream of horizontal run)
- Recommended but not essential that furnace blower synchronized with H/ERV (Venmar, RenewAire)




**Method 4: "Return-return"** | Fresh air leaving H/ERV is injected into return side of the furnace ductwork AND exhaust air returning to H/ERV is drawn out from return side of furnace at a point at least 3' upstream of the fresh air injection.

**Recommendations:**

- Entry point into return ductwork (for supply from H/ERV) is min. 10' upstream from furnace return (Venmar) (3' horizontal RenewAire, Panasonic)
- Entry point into return ductwork (for return to H/ERV) is min. 3' upstream from the fresh air injection (Venmar, RenewAire) (40" Panasonic)
- Essential that furnace blower synchronized with H/ERV (Venmar, RenewAire, Lifebreath, Panasonic)




Note: The Furnace Blower must be operated any time the ERV is operated. Use furnace fan "on" continuous low speed or optional FM control to cycle furnace fan on with ERV