Heat Recovery Ventilation in Colder Climates - Code Compliance Brief

Overview:

The intent of this brief is to provide code-related information about heat recovery ventilation to help ensure that what is proposed regarding the heat recovery ventilator ‘product’ itself as well as ventilation measures can be verified as being in compliance with the code. Providing consistent information to document compliance with codes and standards to all relevant parties responsible for verifying with those codes and standards (e.g., code officials, builders, contractors, designers, etc.) is expected to result in increased compliance and more timely, less challenging and more uniform plan review and field inspections.

Many building scientists advocated for mechanical ventilation as part of building designs long before 2012 International Energy Conservation Code (IECC). However, there disagreements as to the level of envelope tightness that should trigger mechanical ventilation to alleviate health and safety concerns. The 2012 and 2015 IECC and other provisions in the International Residential Code (IRC)/International Mechanical Code include air leakage requirements. The 2012/2015 IECC does not specifically require whole-house mechanical ventilation, but it references the ventilation requirements of the 2012/2015 IRC or International Mechanical Code as a mandatory provision.

Heat-recovery ventilators (HRV) provide a controlled way of ventilating a home while minimizing energy loss by using conditioned exhaust air to warm fresh incoming air. Some small wall or window-mounted models are available, but the most prevalent systems are central, whole-house ventilation approaches that share the furnace duct system or have their own duct system. HRVs are recommended for cold-dry climates. They are most cost effective in climates with extreme winters where fuel costs are high.

The energy used to condition ventilation air is completely lost through exhaust air in exhaust-based ventilation systems. Heat recovery ventilation increases energy efficiency of ventilation systems by recovering a portion of energy lost to the exhaust air stream to condition incoming ventilation air. It also provides for a balanced ventilation system to avoid induced infiltration/exfiltration and minimize potential down-drafting problems. A large majority of projects constructed since 2010 in cold/very cold regions under Building America’s program have included heat recovery ventilation.[1]

The next section of this brief lists the applicable code requirements and details helpful for Plan Review. The Field Inspection section provides details of inspecting HRVs. Finally, see the Technical Validation/Reference Materials section for resources on technical validation, best practices, and measure guidelines.

The lists and provisions provided below in each section are intended to target the main code sections and provisions. There may be other references, code sections, standards, testing methods, etc., that affect the technology or other assemblies or functions of the building.


Plan Review:

This section lists current code sections in the 2015 IRC and IECC, and the language (underscored and struck-through) from a code change proposal being considered for the 2018 IECC. The language underscored and struck-through could change during the final code hearings that occur in late October 2016. Additional information on the code proposal and hearings can be found at http://www.iccsafe.org/codes-tech-support/codes/code-development-process/20152017-code-development-group-b/ [2]. This Code Compliance Brief will be updated accordingly after the hearings and final online Governmental Consensus voting period in November 2016.

2015 IRC, Section R104 Duties and Powers of the Building Official

2015 IECC/IRC, Section R104.1, General. The building official has authority to render interpretations of this code and to adopt policies, and procedures in order to clarify the application of its provisions. Such interpretations, policies, and procedures shall be in conformance with the intent and purpose of this code.
R102.1/R104.1, Alternative Materials, Design and Method of Construction and Equipment. The provisions of this code are not intended to prevent the installation of any material or prohibit any design or method of construction not specifically prescribed in the 2015 IECC/IRC, provided that any such alternative has been approved. The building official is permitted to approve an alternative material, design, or method of construction where the building official finds that the proposed design is satisfactory and complies with the intent of the provisions of this code, and the material, method, or work offered is for the purpose intended, not less than the equivalent of that prescribed in the code. Compliance with the specific performance-based provisions of the International Codes is an alternative to the specific requirements of this code.

R104.11.1, Tests. Whenever there is insufficient evidence of compliance with the provisions of this code, or evidence that a material or method does not conform to the requirements of this code, or in order to substantiate claims for alternative materials or methods, the building official has authority to require tests as evidence of compliance to be made at no expense to the jurisdiction. Test methods shall be as specified in this code or by other recognized test standards. In the absence of recognized and accepted test methods, the building official shall approve the testing procedures. Tests shall be performed by an approved agency. Reports of such tests shall be retained by the building official for the period required for retention of public records.

2015 IECC/IRC, Section R103.3/R106.3, Examination of Documents. The code official/building official must examine or cause to be examined construction documents for code compliance.

Construction Documentation. Review the construction documents for details describing the HRV system design and installation.

2015 IECC/IRC, Section R103.2/N1101.5, Information on Construction Documents. Construction documents should include:

- Confirm equipment type, size, and efficiency
- Equipment system and controls
- Location and installation specifications
- Confirmation that a mechanical ventilation system provides the appropriate ventilation rate (cfm)
- Confirmation that local exhaust systems for kitchens and bathrooms have been planned for appropriately
- Heating and cooling system design per Air Conditioning Contractors of America (ACCA) Manual S
- Heating and cooling load calculations per ACCA Manual J.

Section R302.1/N1101.9, Interior Design Conditions. The interior design temperatures used for heating and cooling load calculations shall be a maximum of 72°F (22°C) for heating and minimum of 75°F (24°C) for cooling.

IRC, Section R303.4, Mechanical Ventilation. Where the air infiltration rate of a dwelling unit is less than five 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 N1102.4.1.2, the dwelling unit shall be provided with whole-house ventilation in accordance with Section M1507.3.

Section N1102.4.1.2 is the extraction of the Air Leakage testing requirements in the IECC, Section R402.4. ICC duplicated the exact language from the IECC residential provisions into the IRC, Chapter 11, Energy Efficiency.

IRC/IECC, Section R402.4.1.2/N1102.4.1.2, Testing. The building dwelling or dwelling unit shall be tested and verified as having an air leakage rate not exceeding 5 ACH in climate zones 1 and 2 and 3 ACH in climate zones 3 through 8. Testing shall be conducted in accordance with ASTM E 79 or ASTM E 1827 and reported at a pressure of 0.2 inches water column (50 Pascals). Where required by the code official, testing shall be conducted by a third party. A written report of the results of the test shall be signed by the party conducting the test and provided to the code official.

IRC, Section R303.9, Required Heating. Where the winter design temperature in Table R301.2(1) is below 60°F, every dwelling unit should be provided with heating facilities capable of maintaining a room temperature of not less than 68°F at a point of 3 feet above the floor and 2 feet from exterior walls in habitable rooms at the design temperature. The installation of one or more portable space heaters should not be used to achieve compliance with this section.

Section R403/N1103 Systems

R403.1/N1103.1, Controls (mandatory). At least one thermostat shall be provided for each separate heating and cooling system.

R403.1.1/N1103.1.1, Programmable Thermostat. The thermostat controlling the primary heating or cooling system of the 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 by the manufacturer 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).
- **R403.3.2.1/N1103.3.2.1, Sealed Air Handler.** Air handlers shall have a manufacturer’s designation for an air leakage of no more than 2% of the design air flow rate when tested in accordance with ASHRAE 193.

- **R403.6/N1103.6, Mechanical Ventilation (mandatory).** The building shall be provided with ventilation that meets the requirements of Section M1507 of the IRC or International Mechanical Code, as applicable, 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.

  - **R403.6.1/N1103.6.1, Whole-House Mechanical Ventilation System Fan Efficacy.** Mechanical ventilation system fans shall meet the efficacy requirements of Table 403.6.1/N1103.6.1

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

- **R403.7 Heat Recovery Ventilation.** In climate zones 6, 7, and 8, buildings shall be provided with a heat recovery ventilation system. The system shall be balanced to provide a sensible heat recovery efficiency of not less than 65 percent determined in accordance with CSA 439 at 0 °C (32 °F) and at a system net airflow equal to or greater than the design whole-house mechanical ventilation rate.


There is a code proposal for the 2018 IECC/IRC to update the Mechanical Ventilation System Fan Efficiency table. The values in the table below are based on the published 2015 IECC/IRC.

**Table R403.6.1/N1103.6.1**

**Mechanical Ventilation System Fan Efficacy**

<table>
<thead>
<tr>
<th>Fan Location</th>
<th>Air Flow Rate Minimum (CFM)</th>
<th>Minimum Efficacy (CFM/Watt)</th>
<th>Air Flow Rate Maximum (CFM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Range hoods</td>
<td>Any</td>
<td>2.8 cfm/watt</td>
<td>Any</td>
</tr>
<tr>
<td>In-line fan</td>
<td>Any</td>
<td>2.8 cfm/watt</td>
<td>Any</td>
</tr>
<tr>
<td>Bathroom, utility room</td>
<td>10</td>
<td>1.4 cfm/watt</td>
<td>&lt; 90</td>
</tr>
<tr>
<td>Bathroom, utility room</td>
<td>90</td>
<td>2.8 cfm/watt</td>
<td>Any</td>
</tr>
</tbody>
</table>

**IRC, Section M1507.3, Whole-House Mechanical Ventilation System.** Whole-house mechanical ventilation systems should be designed in accordance with Sections M1507.3.1 through M1507.3.3.

  - **M1507.3.1, System Design.** The whole-house ventilation system should 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 should be considered as providing supply ventilation.

  - **M1507.3.2, System Controls.** The whole-house mechanical ventilation system should be provided with controls that enable manual override.

  - **M1507.3.3, Mechanical Ventilation Rate.** The whole-house mechanical ventilation system should 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% 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).

**Table M1507.3.3(1) Continuous Whole-House Mechanical Ventilation System Airflow Rate Requirements**

<table>
<thead>
<tr>
<th>Dwelling Unit Floor Area (ft^2)</th>
<th>Number of Bedrooms</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0-1</td>
</tr>
<tr>
<td>&lt; 1,500</td>
<td>30</td>
</tr>
<tr>
<td>1,501-3,000</td>
<td>45</td>
</tr>
</tbody>
</table>
### Table M1507.3.3(2) Intermittent Whole-House Mechanical Ventilation Rate Factors\(^a,b\)

<table>
<thead>
<tr>
<th>Dwelling Unit Floor Area (ft(^2))</th>
<th>Number of Bedrooms</th>
</tr>
</thead>
<tbody>
<tr>
<td>3,001-4,500</td>
<td>0-1  2-3  4-6  6-7  &gt;7</td>
</tr>
<tr>
<td>4,501-6,000</td>
<td>60  75  90  105  120</td>
</tr>
<tr>
<td>6,001-7,500</td>
<td>75  90  105  120  135</td>
</tr>
<tr>
<td>&gt;7,500</td>
<td>105 120 135 150 165</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Run-Time % in Each 4-Hour Segment</th>
<th>25%</th>
<th>33%</th>
<th>50%</th>
<th>66%</th>
<th>75%</th>
<th>100%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Factor(^a)</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1.5</td>
<td>1.3</td>
<td>1.0</td>
</tr>
</tbody>
</table>

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

b. Extrapolation beyond the table is prohibited.

---

**IECC/IRC, Section R403.7/N1103.7. Equipment Sizing and Efficiency Rating (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. New or replacement heating and cooling equipment shall have an efficiency rating equal to or greater than the minimum required by federal law for the geographic location where the equipment is installed.

There is a code proposal for the 2018 IECC/IRC to update the Specifications for the Standard Reference and Proposed Designs Table. The values in the table below are based on the published 2015 IECC/IRC.

- **Section R405/N1105, Simulated Performance Alternative (performance)**

### Excerpts from Table R405.5.2(1)/N1105.5.2(1) Specifications for the Standard Reference and Proposed Designs

<table>
<thead>
<tr>
<th>Building Component</th>
<th>Standard Reference Design</th>
<th>Proposed Design</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heating Systems(^a,b)</td>
<td>As proposed for other than electric heating without a heat pump, where the proposed design utilizes electric heating without a heat pump, the standard reference design shall be an air source heat pump meeting the requirements of Section C403 of the IECC-Commercial Provisions. Capacity: sized in accordance with Section R403.7.</td>
<td>As proposed</td>
</tr>
<tr>
<td>Cooling Systems(^a,c)</td>
<td>As proposed Capacity: sized in accordance with Section R403.7.</td>
<td>As proposed</td>
</tr>
<tr>
<td><em>Thermal Distribution Systems</em></td>
<td><em>Duct insulation: from Section R403.3.1</em> <em>A thermal distribution system efficiency (DSE) of 0.88 shall be applied to both the heating and cooling system efficiencies for all systems other than tested duct systems. For tested duct systems, the leakage rate shall be 4 cfm (113.3 L/min) per 100ft(^2) (9.29m(^2)) of conditioned floor area at a pressure differential of 0.1 inches w.g. (25 Pa).</em></td>
<td><em>As tested or as specified in Table R405.5.2(2) if not tested. Duct insulation shall be as proposed.</em></td>
</tr>
<tr>
<td>Thermostat</td>
<td>Type: Manual, cooling temperature setpoint = 75(^\circ)F; Heating temperature setpoint = 72(^\circ)F</td>
<td>Same as standard reference.</td>
</tr>
</tbody>
</table>

a. For a proposed design with multiple heating, cooling, or water heating systems using different fuel types, the applicable standard reference design system capacities and fuel types shall be weighted in accordance with their respective loads as calculated by accepted engineering practice for each equipment and fuel type present.

b. For a proposed design without a proposed heating system, a heating system with the prevailing federal minimum efficiency shall be assumed for both the standard reference design and proposed design.

c. For a proposed design home without a proposed cooling system, an electric air conditioner with the prevailing federal minimum efficiency shall be assumed for both the standard reference design and the proposed design.
Excerpts from Table R405.5.2(2)/N1105.5.2(2) Default Distribution System Efficiencies for Proposed Designs

<table>
<thead>
<tr>
<th>Distribution System Configuration and Condition</th>
<th>Forced Air Systems</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distribution system components located in unconditioned space</td>
<td>-</td>
</tr>
<tr>
<td>Untested distribution systems entirely located in conditioned space(^b)</td>
<td>0.88</td>
</tr>
<tr>
<td>&quot;Ductless&quot; systems(^c)</td>
<td>1</td>
</tr>
</tbody>
</table>

a. Default values given by this table are for untested distribution systems, which must still meet minimum requirements for duct system insulation.

b. Entire system in conditioned space shall mean that no component of the distribution system, including the air handler unit, is located outside of the conditioned space.

\(^c\) Ductless systems shall be allowed to have forced airflow across a coil but shall not have any ducted airflow external to the manufacturer's air-handler enclosure.

2015 IECC/IRC, Section R501.1.1/N1107.1.1 Alterations - General. Alterations to an existing building or portion thereof should comply with Section R502/N1108, R503/N1109 or R504/N1110. Unaltered portions of the existing building are not required to comply.

- **R503.1/N1109.1, General.** Alterations to any building or structure should comply with the requirements of the code for new construction. Alterations should be such that the existing building or structure is no less conforming to the provisions of this code than the existing building or structure was prior to the alteration. Alterations should not create an unsafe or hazardous condition or overload existing building systems. Alterations should be such that the existing building or structure uses no more energy than the existing building or structure prior to the alteration.

- **R503.2/N1103.2 Change in space conditioning.** Any non-conditioned or low-energy space that is altered to become conditioned space should be required to be in full compliance with this code. (This means not only the altered assembly is brought into compliance but the entire space or building would need to be brought into compliance.)

Exception

Where the simulated performance option in Section R405/N1105 is used to comply with this section, the annual energy cost of the proposed design is permitted to be 110% of the annual energy cost otherwise allowed by Section R405.3/N1105.3.

- **R503.1.2/N1109.1.2, Heating and Cooling Systems.** New heating, cooling, and duct systems that are part of the alteration shall comply with Sections R403.1, R403.2, R403.3, and R403.6 (N1103.1, N1103.2, N1103.3, and N1103.6).

Section R502/N1108, Additions

- **R502.1.1.2/N1108.1.1.2, Heating and Cooling Systems.** New heating, cooling, and duct systems that are part of the addition shall comply with Sections R403.1, R403.2, R403.3, R403.5, and R403.6 (N1103.1, N1103.2, N1103.3, N1103.5, and N1103.6).

Air Sealing/Air Leakage Control

2015 IECC/IRC, R402.4./N1102.4, Air Leakage Section R402, Building Thermal Envelope.

- **R402.4.1/N1102.4.1, Building Thermal Envelope.** The sealing methods between dissimilar materials should allow for differential expansion and contraction.

- **R402.4.1.1/N1102.4.1.1, Installation.** Components listed in the Air Barrier and Insulation Installation Table should be installed in accordance with the manufacturer's instructions and the criteria listed as the applicable method of construction. Below are the General Requirements and components from the table that are applicable to sealing and insulating unvented attics.

- Excerpts from Table R402.4.1.1/N1102.4.1.1, Air Barrier and Insulation Installation
  - Shafts, penetrations. Duct shafts, utility penetrations, and flue shafts opening to exterior or unconditioned space shall be sealed.
  - HVAC register boots. HVAC register boots that penetrate the building thermal envelope shall be sealed to the subfloor or drywall. (This provision only applies to ducted units.)

Field Inspection:

Per the 2015 IECC, Section R104, Inspections, construction or work for which a permit is required is subject to inspection. Construction or work is to remain accessible and exposed for inspection purposes until approved. Required inspections include footings and the foundation, framing and rough-in work, plumbing rough-in, mechanical rough-in, and final inspection.
R104.2.4, Mechanical Rough-In Inspection. Inspections at mechanical rough-in shall verify compliance as required by the code and approved plans and specifications as to installed HVAC equipment type and size, required controls, system insulation and corresponding R-value, system air leakage control, programmable thermostats, dampers, whole-house ventilation, and minimum fan efficiency.

Per the 2015 IRC, Section R109, Inspections, the wording is somewhat different in that for onsite construction, from time to time the building official, upon notification from the permit holder or his agent, can make or cause to be made any necessary inspections. Further details are provided for inspections regarding foundation, plumbing, mechanical, gas and electrical, floodplain, frame and masonry, and final inspection. Any additional inspections are at the discretion of the building official.

This section provides details for inspecting to the specific provisions for heat recovery ventilation where one or more specific type of inspection per the IECC or IRC may be necessary to confirm compliance. Verifying code compliance for HRVs would typically be at the mechanical rough-in and final inspection. Inspections should provide verification in the following areas:

- The HRV is properly labeled, located and mounted, and connections are made per approved construction documents.
- A mechanical ventilation system that provides the appropriate ventilation rate (cfm) is installed.
- Appropriate programmable thermostats and supplemental heat controls are installed per the approved construction document.
- Shaft, penetrations, and any HVAC register boots are sealed properly.

Technical Validation(s):

This section provides additional related information and references to materials that are applicable to the provision.

  Author(s): ICC
  Organization(s): ICC
  Publication Date: May 2014
  This code establishes a baseline for energy efficiency by setting performance standards for the building envelope (defined as the boundary that separates heated/cooled air from unconditioned, outside air), mechanical systems, lighting systems, and service water heating systems in homes and commercial businesses.

  Author(s): ICC
  Organization(s): ICC
  Publication Date: May 2014
  This code for residential buildings creates minimum regulations for one- and two-family dwellings of three stories or less. It brings together all building, plumbing, mechanical, fuel gas, energy, and electrical provisions for one- and two-family residences.


  [http://www.energystar.gov/ia/home_improvement/home_contractors/qispec.pdf](http://www.energystar.gov/ia/home_improvement/home_contractors/qispec.pdf)


Related BASC Guides: