

General Design Criteria and Mechanical System Requirements of the 2020 VT RBES

This summary covers most, but not all, of the RBES requirements falling under the scope of the Designer and/or Mechanical or HVAC contractor.

The following is a summary of **Chapter 3 – General Requirements** of the 2020 Vermont Residential Building Energy Standard (RBES), which covers General Requirements, Design Conditions, Mechanical Systems and Equipment, and Design Criteria for Residential Ventilation Systems. This summary also includes mechanical system requirements in Section R304 of **Chapter 4 – Residential Energy Efficiency**.

Section R302 – Design Conditions covers the design conditions and default values that can be used for calculating building design loads and installed materials requirements.

Section R303 – Materials, Systems and Equipment covers the general design criteria, basis for design, and material system installation requirements for residential buildings.

Sections R304 – Design Criteria for Residential Ventilation Systems through **Section R403 – Systems** cover the general scope, mandated and prescriptive compliance requirements for the Mechanical or HVAC trades.

This summary does not stand to replace nor cover all of the requirements for compliance with the 2020 RBES. The full language of the 2020 RBES should be referenced for compliance with the law and can be found @: https://publicservice.vermont.gov/energy_efficiency/rbes

Additional support is available through the Energy Code Assistance Center toll free at 855-887-0673.

SECTION R302 DESIGN CONDITIONS

R302.1 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.

R302.2 Climatic data.

The following design parameters in Table 302.2 shall be used for calculations required under this code.

TABLE 302.2
THERMAL DESIGN PARAMETERS

CONDITION	VALUE
Winter, Design Dry-Bulb	-11°F
Summer, Design Dry-Bulb	84°F
Summer, Design Wet Bulb	69°F
Degree Days Heating	7,665
Degree Days Cooling	489

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a. The outdoor design temperature is selected from the columns of 97- percent values for winter and 2-percent values for summer from tables in the ASHRAE *Handbook of Fundamentals*. Adjustments shall be permitted to reflect local climates which differ from the tabulated temperatures, or local weather experience determined by the code official or other authority having jurisdiction, where one exists.

b. The degree days heating (base 65°F) and cooling (base 65°F) are from the NOAA "Annual Degree Days to Selected Bases Derived from the 1971-2000 Normals" for Burlington International Airport.

Adjustments may be made only in the following cases:

1. Winter heating design temperatures for projects either:

i. Located at an elevation of 1,500 feet or higher, or

ii. Located in Caledonia, Essex or Orleans counties.

iii. Adjustments shall be made as listed in the National Climate Data Center for the specific weather station: <http://www.ncdc.noaa.gov/cdo-web/>.

2. As approved by the *code official or other authority having jurisdiction*.

SECTION R303 MATERIALS, SYSTEMS AND EQUIPMENT

R303.1 Identification. Materials, systems and equipment shall be identified in a manner that will allow a determination of compliance with the applicable provisions of this code.

- **R303.1.1 Building thermal envelope insulation.** An *R*-value identification mark shall be applied by the manufacturer to each piece of *building thermal envelope* insulation 12 inches (305 mm) or greater in width. Alternately, the insulation installers shall provide a certification listing the type, manufacturer and *R*-value of insulation installed in each element of the *building thermal envelope*. For blown or sprayed insulation (fiberglass and cellulose), the initial installed thickness, settled thickness, settled *R*-value, installed density, coverage area and number of bags installed shall be *listed* on the certification. For sprayed polyurethane foam (SPF) insulation, the installed thickness of the areas covered and *R*-value of installed thickness shall be *listed* on the certification. For insulated siding, the *R*-value shall be labeled on the product's package and shall be *listed* on the certification. The insulation installer shall sign, date and post the certification in a conspicuous location on the job site.
 - **R303.1.1.1 Blown or sprayed roof and ceiling insulation.** The thickness of blown-in or sprayed roof/ceiling insulation (fiberglass or cellulose) shall be written in inches (mm) on markers that are installed at least one for every 300 square feet (28 m²) throughout the attic space. The markers shall be affixed to the trusses or joists and marked with the minimum initial installed thickness with numbers not less than 1 inch (25 mm) in height. Each marker shall face the attic access opening. Spray polyurethane foam minimum thickness and installed *R*-value shall be *listed* on certification provided by the insulation installer.
- **R303.1.2 Insulation mark installation.** Insulating materials shall be installed such that the manufacturer's *R*-value mark is readily observable upon inspection.

R303.1.3 Fenestration product rating. *U*-factors of fenestration products (windows, doors and *skylights* shall be determined in accordance with NFRC 100.

Exception: Where required, garage door *U*-factors shall be determined in accordance with either NFRC 100 or ANSI/DASMA 105.

U-factors shall be determined by an accredited, independent laboratory, and labeled and certified by the manufacturer.

Products lacking such a labeled *U*-factor shall be assigned a default *U*-factor from Table R303.1.3(1) or R303.1.3(2). The *solar heat gain coefficient* (SHGC) and *visible transmittance* (VT) of glazed fenestration products windows, glazed doors and *skylights* shall be determined in accordance with NFRC 200 by an accredited, independent laboratory, and labeled and certified by the manufacturer. Products lacking such a labeled SHGC or VT shall be assigned a default SHGC or VT from Table R303.1.3(3).

**TABLE R303.1.3(1)
DEFAULT GLAZED WINDOW, GLASS DOOR AND SKYLIGHT *U*-FACTORS**

Frame Type	WINDOW AND GLASS DOOR		SKYLIGHT	
	Single pane	Double pane	Single	Double
Metal	1.20	0.80	2.00	1.30
Metal with Thermal Break	1.10	0.65	1.90	1.10
Nonmetal or Metal Clad	0.95	0.55	1.75	1.05
Glazed Block	0.60			

**TABLE R303.1.3(2)
DEFAULT OPAQUE DOOR *U*-FACTORS**

Door Type	Opaque <i>U</i> -Factor
Uninsulated Metal	1.20
Insulated Metal	0.60
Wood	0.50
Insulated, nonmetal edge, max 45% glazing, any glazing double pane	0.35

**TABLE R303.1.3(3)
DEFAULT GLAZED FENESTRATION SHGC AND VT**

	Single Glazed		Double Glazed		Glazed Block
	Clear	Tinted	Clear	Tinted	
SHGC	0.8	0.7	0.7	0.6	0.6
VT	0.6	0.3	0.6	0.3	0.6

R303.1.4 Insulation product rating. The thermal resistance, R -value, of insulation shall be determined in accordance with Part 460 of US-FTC CFR Title 16 in units of $\text{h} \cdot \text{ft}^2 \cdot ^\circ\text{F}/\text{Btu}$ at a mean temperature of 75°F (24°C).

R303.1.4.1 Insulated siding. The thermal resistance R -value, of insulated siding shall be determined in accordance with 2019 Vermont Residential Building Energy Standards 48 with ASTM C1363. Installation for testing shall be in accordance with the manufacturer's instructions.

R303.2 Installation. Materials, systems and equipment shall be installed in accordance with the manufacturer's instructions and the *International Building Code* or the *International Residential Code*, as applicable.

R303.2.1 Protection of exposed foundation insulation. Insulation applied to the exterior of *basement walls*, crawlspace walls and the perimeter of slab-on-grade floors shall have a rigid, opaque and weather-resistant protective covering to prevent the degradation of the insulation's thermal performance. The protective covering shall cover the exposed exterior insulation and extend not less than 6 inches (153 mm) below grade.

R303.3 Maintenance information. Maintenance instructions shall be furnished for equipment and systems that require preventive maintenance. Required regular maintenance actions shall be clearly stated and incorporated on a readily *accessible* label. The label shall include the title or publication number for the operation and maintenance manual for that particular model and type of product.

SECTION R304

DESIGN CRITERIA FOR RESIDENTIAL VENTILATION SYSTEMS

R304.1.1 Compliance. Compliance with Section 304 shall be achieved by meeting Section R304.2 through R304.11 or demonstrating compliance with one of the following alternatives:

- ASHRAE Standard 62.2-2016 (Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings)
- BSC Standard 01-2015 (Ventilation for New Low-Rise Residential Buildings)
- Passive house ventilation requirements (PHI or PHIUS)

Exception

Whole house balanced ventilation systems that are controlled using user-settable closed-loop feedback based on pollutant levels (e.g. carbon dioxide or volatile organic compounds) are not subject to run-time ventilation rate minimums in standards referenced above, or Section R304.6.1.1.

R304.2 Local ventilation. Ventilation fans in bathrooms containing a bathtub, shower, spa or similar bathing fixture and not included in the whole house ventilation system shall be sized to meet the net capacity rates as required in Table 304.2. Whole house ventilation fans serving both localized and whole house ventilation functions shall be sized to meet the net capacity rates as required by Section 304.6 and must meet all other requirements listed in Section 304.3, as applicable.

TABLE 304.2
MINIMUM REQUIRED LOCAL EXHAUST

Occupancy Classification	Mechanical Exhaust Capacity (CFM)
Bathrooms	50 cfm intermittent or 20 cfm continuous

R304.3 Whole house ventilation (MANDATORY). Every home and dwelling unit built to RBES shall be mechanically ventilated by a whole house ventilation system as defined in Chapter 2. The whole house ventilation system shall be one of two types: “exhaust only” or “balanced.”

R304.4 Whole house air circulation. Provisions shall be made to allow air flow to all finished living spaces by installation of distribution ducts, undercutting doors, installation of grilles, transoms or equivalent means. Door undercuts shall be at least 1/2 inch (12.7 mm) above the surface of the finished floor covering.

R304.5 Fan motor requirements. Fans installed for the purpose of providing whole house ventilation must meet the minimum requirements as specified in this section.

Exception: Fans installed exclusively for local ventilation purposes are exempt from meeting the fan motor requirements listed in Section R304.5.

R304.5.1 Fan durability. Whole house ventilation fan motors shall be rated for “continuous duty” and have manufacturer flow ratings as listed in HVI 911.

R304.5.2 Fan power consumption. Single-port whole house ventilation equipment shall not exceed 50 watts as listed by the manufacturer on the fan motor or as listed in accordance with HVI 911. Power used for lights, sensors, heaters, timers or night lights shall not be included in the determination of power consumption.

R304.5.3 Fan noise. Whole house ventilation equipment located less than 4 feet (1219 mm) from louvers, grilles or openings shall have a sound rating no greater than 1.5 sones as determined in accordance with HVI 911.

R304.5.4 Performance verification. 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.

R304.6 Net capacity requirements. Whole house ventilation system fans shall be installed according to the manufacturer’s installation instructions and shall have the manufacturer’s fan flow ratings as listed in accordance with HVI 911. Unless the whole house system is tested according to procedures in Section 304.6.1, the minimum continuous flow rate that the ventilation system must be capable of supplying during its operation shall be based on the rate per bedroom as specified in Table 304.6.

TABLE R304.6
PRESCRIPTIVE FAN CAPACITY REQUIREMENTS

Number of Bedrooms	Minimum Nominal Rated Total Fan Capacity *	Minimum Number of Fans to Meet Whole House Airflow Rates
1	50 cfm	1
2	75 cfm	1
3	100 cfm	1
4	125 cfm	All other systems – 2 or more, or centrally-ducted systems
5	150 cfm	All other systems – 2 or more, or centrally-ducted systems
Homes > 3,000sq.ft.	Cfm = 0.05 x sq.ft.	All other systems – 2 or more, or centrally-ducted systems

*represents total installed rated capacity of all fans designed for whole house ventilation

R304.6.1 Testing option. Testing may be done to verify that the whole house ventilation system satisfies the ventilation requirements of this section in accordance with Sections R304.1.1, R304.6.1.1 and R304.6.1.2.

R304.6.1.1 Minimum outdoor air. Automatic operation of the ventilation system shall not reduce the minimum continuous ventilation rate below 15 cfm of outdoor air per bedroom plus 15 cfm during occupancy.

Exception: Whole house approach in accordance using one of the compliance alternatives in Section R304.1.1.

R304.6.1.2 Performance verification. 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.

R304.7 Ventilation required during periods of occupancy. Ventilation shall be provided continuously or intermittently during the period that the building is occupied.

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.

Exception: Fans installed expressly for local ventilation purposes.

R304.8.1 Intermittent operation. Intermittently operated *whole house ventilation systems* shall be capable of being set remotely for continuous operation; or shall be provided with an automatic control capable of operating without the need for occupant intervention, such as a time switch or some other control device. Twist or crank-style timers are prohibited as control devices for *whole house ventilation systems*. Operation controlled solely by a humidity sensor (humidistat or dehumidistat) does not qualify.

R304.8.2 Continuous operation. Continuously operated *whole house ventilation systems* shall not be provided with local controls unless that control only operates the *whole house ventilation system* both intermittently at high speed and continuously at low speed.

R304.8.2.1 On/off switch for continuous operation. An on/off switch for continuously operated *whole house ventilation systems* shall be remotely installed and appropriately labeled.

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.

R304.10 Clothes dryer exhaust. Clothes dryers shall be exhausted in accordance with the manufacturer's instructions. Dryer exhaust systems shall be independent of all other systems and shall convey the moisture and any products of combustion to the outside of the building.

Exception: This section shall not apply to listed and labeled condensing (ductless) clothes dryers

R304.11 Makeup air required. Exhaust hood systems capable of exhausting in excess of 400 cubic feet per minute (0.19 m³/s) shall be provided with makeup air at a rate approximately equal to the exhaust air rate. Such makeup air systems shall be equipped with a means of closure and shall be automatically controlled to start and operate simultaneously with the exhaust system.

SECTION R305 COMBUSTION SAFETY (MANDATORY)

R305.1 General. The provisions of this section shall govern the requirements for combustion and dilution air for fuel-burning appliances in every new home built to RBES, whenever a new heating system is installed, or whenever alteration, renovation or repair work creates *unusually tight construction* as defined in NFPA 54 and NFPA 31.

R305.2 Unusually tight construction. For the purpose of applying the provisions of Section 305 to fuel gas, kerosene and oil-burning equipment, buildings constructed in compliance with the RBES shall be considered of unusually tight construction as defined in NFPA 54 and NFPA 31.

R305.3 Fuel gas, kerosene and oil-burning equipment. Every new home built to the RBES that contains Category I or II natural draft venting fuel-burning appliances shall be provided with combustion and dilution air as required by NFPA 54 for fuel-gas utilization equipment or NFPA 31 for oil-burning equipment. Direct vent appliances that do not draw combustion air from inside of the building are not required to be considered in the determination of the combustion and dilution air requirements.

Exception: Where all combustion devices in the home have a sealed combustion venting system, a mechanical draft venting system or are direct-vent appliances, then the combustion and dilution air requirements of this section do not apply.

R305.3.1 Crawl space and attic space. For the purposes of applying the provisions of Section 305, an opening to a naturally ventilated crawl space or attic space is not considered equivalent to an opening outdoors and is therefore prohibited for the purposes of supplying combustion and dilution air.

R305.3.2 Unvented room heaters. Unvented fuel-fired heaters, including room heaters and unvented fireplaces are prohibited.

R305.4 Solid fuel-burning appliances and fireplaces. All solid fuel-burning appliances and fireplaces shall meet the provisions of this section.

R305.4.1 Gasketed doors. All solid fuel-burning appliances and fireplaces shall have tight-fitting (defined as gasketed doors with compression closure or compression latch system) metal glass or ceramic doors.

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Exception: Any home certified to have passed the Appendix RA – Recommended Procedure for Worst-Case Testing of Atmospheric Venting Systems” is not required to have tight-fitting doors.

R305.4.2 Spillage testing. All chimney-vented equipment shall establish complete draft without spillage under “worst-case” conditions within two minutes. If any chimney-vented equipment fails this requirement, mechanically induced pressure relief shall be provided such that the requirement is met.

R305.4.3 Exterior air supply requirements. Solid fuel-burning appliances and fireplaces shall be equipped with an exterior air supply according to the provisions of Sections R305.4.3.1 through R305.4.3.7. Factory-built fireplaces, masonry fireplaces and solid fuel-burning appliances that list exterior air supply ducts as optional or required for proper installation are permitted to be installed with those exterior air supply ducts according to the manufacturer’s installation instructions in place of sections R305.4.3.1 through R305.4.3.7. This is not an exemption from the exterior air supply requirements.

R305.4.3.1 Combustion air shall not be taken from within the garage, attic, or basement.

R305.4.3.2 The exterior air inlet shall not terminate to the exterior higher than the firebox and the combustion air duct shall not rise vertically within 18 inches of the firebox.

Exception: Where woodstove or fireplace is installed below grade (in a basement), air intake is permitted to terminate above the firebox if the combustion air supply point is below the firebox and the combustion air intake point is greater than 15 inches (381 mm) below the top of the chimney.

R305.4.3.3 The exterior air intake must deliver combustion air to the firebox.

Exception: For older woodstoves and cookstoves where direct connection of combustion air is not possible, combustion air may be delivered within 24 inches (610 mm) of the stove’s air intake opening.

R305.4.3.4 The air inlet shall be screened with ¼ inch (6 mm) mesh.

R305.4.3.5 The air inlet shall be closable and designed to prevent debris from dropping into the air intake.

R305.4.3.6 The exterior air inlet shall be installed so as to remain free of obstruction from snow.

R305.4.3.7 Passageway. The combustion air passageway for unlisted exterior air supply ducts shall be a minimum of 6 square inches (3870 mm²) and not more than 55 square inches (0.035 m²). The passageway shall be non-combustible, masonry or 30 gauge (or thicker) metal, have 1 inch clearance to combustibles for the length of the combustion air intake. Combustion air systems for listed fireplaces shall be constructed according to the fireplace manufacturer’s instructions.

Section R403 Systems

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

R403.1.1 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). Adjustments to these settings for elderly, disabled or those with special needs is permissible.

The following exceptions are allowed as long as 5-wire connection to thermostat location is provided:

1. Radiant floor, wall, ceiling and/or beam system on dedicated zone
2. *Cold-climate heat pump* not designed for setbacks
3. Wifi or "smart" Internet-connected thermostats

R403.1.2 Heat pump supplementary heat

Heat pumps shall not have integrated supplementary electric-resistance heat other than that provided for frost control. See R404.2 for guidance on electric resistance heating equipment other than heat pumps.

R403.2 Hot water boiler outdoor temperature setback. Hot water boilers that supply heat to the *building* through one- or two-pipe heating systems shall have an outdoor setback control that lowers the boiler water temperature based on the outdoor temperature.

R403.3 Ducts. Ducts and air handlers for space conditioning shall be in accordance with Sections R403.3.1 through R403.3.5.

R403.3.1 Insulation (Prescriptive). All supply and return ducts shall be insulated to meet the same *R*-value requirement that applies to immediately proximal surfaces.

Exception: Ducts or portions thereof located completely inside the *building thermal envelope*.

R403.3.2 Sealing (Mandatory). Ducts, air handlers and filter boxes shall be sealed. Joints and seams shall comply with either the *International Mechanical Code* or *International Residential Code*, as applicable.

R403.3.2.1 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.

R403.3.3 Duct testing. Ducts shall be pressure tested to determine air leakage by one of the following methods:

1. Rough-in test: Total leakage shall be measured with a pressure differential of 0.1 inch w.g. (25 Pa) across the system, including the manufacturer's air handler enclosure if installed at the time of the test. All registers shall be taped or otherwise sealed during the test.
2. Postconstruction test: Total leakage shall be measured with a pressure differential of 0.1 inch w.g. (25 Pa) across the entire system, including the manufacturer's air handler enclosure. Registers shall be taped or otherwise sealed during the test.

Exceptions:

1. A structure where the ducts and air handlers are located entirely within the *building thermal envelope*.
3. Ducts serving heat or energy recovery ventilators that are not integrated with ducts serving heating or cooling systems.

A written report of the results of the test shall be signed by an individual certified as either a Building Performance Institute (BPI) Heating Professional or Air Conditioning/Heat Pump Professional, a Home Energy Rating System (HERS) Energy Rater or HERS Field Inspector or a Vermont Department of Public Service approved duct leakage tester, and provided to the *code official or other authority having jurisdiction, where one exists*, and to the *Department of Public Service* along with the RBES certificate upon completion of the construction project.

R403.3.4 Duct leakage (Prescriptive). The total leakage of the ducts, where measured in accordance with Section R403.3.3, shall be as follows:

1. Rough-in test: The total leakage shall be less than or equal to 3 cubic feet per minute (85 L/min) per 100 square feet (9.29 m²) of conditioned floor area.
2. Postconstruction test: Total leakage shall be less than or equal to 4 cubic feet per minute (113.3 L/min) per 100 square feet (9.29 m²) of conditioned floor area.

R403.3.5 Building cavities (Mandatory). *Building* framing cavities shall not be used as ducts or plenums.

R403.3.6 Ducts buried within ceiling insulation. Where supply and return air ducts are partially or completely buried in ceiling insulation, such ducts shall comply with all of the following:

1. The supply and return ducts shall have an insulation *R*-value not less than R-8.
2. At all points along each duct, the sum of the ceiling insulation *R*-value against and above the top of the duct, and against and below the bottom of the duct, shall be not less than R-40, excluding the *R*-value of the duct insulation.

R403.3.7 Ducts located in conditioned space. For ducts to be considered as inside a *conditioned space*, such ducts shall comply with either of the following:

1. The duct system shall be located completely within the continuous air barrier and within the building thermal envelope.
2. The ducts shall be buried within ceiling insulation in accordance with Section R403.3.6 and all of the following conditions shall exist:
 - 2.1. The air handler is located completely within the *continuous air barrier* and within the building thermal envelope.
 - 2.2. The duct leakage, as measured either by a rough-in test of the ducts or a post-construction total system leakage test to outside the building thermal envelope in accordance with Section R403.3.4, is less than or equal to 1.5 cubic feet per minute (42.5 L/min) per 100 square feet (9.29 m²) of conditioned floor area served by the duct system.
 - 2.3. The ceiling insulation *R*-value installed against and above the insulated duct is greater than or equal to the proposed ceiling insulation *R*-value, less the *R*-value of the insulation on the duct.

R403.4 Mechanical system piping insulation (Mandatory). Mechanical system piping designed to carry fluids above 105°F (41°C) or below 55°F (13°C) shall be located within the building thermal envelope and insulated to a minimum of R-3.

R403.4.1 Protection of piping insulation. Piping insulation exposed to weather shall be protected from damage, including that caused by sunlight, moisture, equipment maintenance and wind, and shall provide shielding from solar radiation that can cause degradation of the material. Adhesive tape shall not be permitted.

R403.5 Service hot water systems. Energy conservation measures for service hot water systems shall be in accordance with Sections R403.5.1 and R403.5.4.

R403.5.1 Heated water circulation and temperature maintenance systems (Mandatory). Heated water circulation systems shall be in accordance with Section R403.5.1.1. Heat trace temperature maintenance systems shall be in accordance with Section R403.5.1.2. Automatic controls, temperature sensors and pumps shall be *accessible*. Manual controls shall be readily *accessible*.

R403.5.1.1 Circulation systems. Heated water circulation systems shall be provided with a circulation pump. The system return pipe shall be a dedicated return pipe or a cold water supply pipe. Gravity and thermosyphon circulation systems shall be prohibited. Controls for circulating hot water system pumps shall start the pump based on the identification of a demand for hot water within the occupancy. The controls shall automatically turn off the pump when the water in the circulation loop is at the desired temperature and when there is no demand for hot water.

R403.5.1.2 Heat trace systems. Electric heat trace systems shall comply with IEEE 515.1 or UL 515. Controls for such systems shall automatically adjust the energy input to the heat tracing to maintain the desired water temperature in the piping in accordance with the times when heated water is used in the occupancy.

R403.5.2 Demand recirculation systems. A water distribution system having one or more recirculation pumps that pump water from a heated water supply pipe back to the heated water source through a cold water supply pipe shall be a *demand recirculation water system*. Pumps shall have controls that comply with both of the following:

1. The controls shall start the pump upon receiving a signal from the action of a user of a fixture or appliance, sensing the presence of a user of a fixture or sensing the flow of hot or tempered water to a fixture fitting or appliance.
2. The controls shall limit the temperature of the water entering the cold water piping to 104°F (40°C).

R403.5.3 Hot water pipe insulation (Prescriptive). Insulation for hot water pipe with a minimum thermal resistance, *R*-value, of R-3 shall be applied to the following:

1. Piping $\frac{3}{4}$ inch (19.1 mm) and larger in nominal diameter.
2. Piping serving more than one dwelling unit.
3. Piping located outside the *conditioned space*.
4. Piping from the water heater to a distribution manifold.
5. Piping located under a floor slab.
6. Buried piping.
7. Supply and return piping in recirculation systems other than demand recirculation systems.

R403.5.4 Drain water heat recovery units. Where installed, drain water heat recovery units shall comply with CSA B55.2. Drain water heat recovery units shall be tested in accordance with CSA B55.1. Potable water-side pressure loss of drain water heat recovery units shall be less than 3 psi (20.7 kPa) for individual units connected to one or two showers. Potable water-side pressure loss of drain water heat recovery units shall be less than 2 psi (13.8 kPa) for individual units connected to three or more showers.

R403.6 Mechanical ventilation (Mandatory). The *building* shall be provided with ventilation that meets the requirements of the *International Residential Code* 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 Whole-house mechanical ventilation system fan efficacy. Mechanical ventilation system fans shall meet the efficacy requirements of Table R403.6.1. Where an air handler that is integral to tested and *listed* HVAC equipment is used to provide whole house mechanical ventilation, the air handler shall be powered by an electronically commutated motor.

TABLE R403.6.1
WHOLE HOUSE MECHANICAL VENTILATION SYSTEM FAN EFFICACY

Fan Location	Air Flow Rate Minimum (CFM)	Minimum Efficacy (CFM/Watt)	Air Flow Rate Maximum (CFM)
HRV or ERV	Any	1.2 cfm/watt	Any
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.

R403.7 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 for Climate Zone 6.

R403.8 Systems serving multiple dwelling units (Mandatory). Systems serving multiple dwelling units shall comply with Sections C403 and C404 of the 2019 *Vermont Commercial Building Energy Standards* (CBES) in lieu of Section R403.

R403.9 Snow melt and ice system controls (Mandatory). Snow- and ice-melting systems, supplied through energy service to the building, shall include automatic controls capable of shutting off the system when the pavement temperature is above 45°F (10°C) and precipitation is falling, and an automatic or manual control that will allow shutoff when the outdoor temperature is above 40°F (4.8°C).

R403.10 Pools and permanent spa energy consumption (Mandatory). The energy consumption of pools and permanent spas shall be in accordance with Sections R403.10.1 through R403.10.4.

R403.10.1 Residential pools and permanent residential spas. Residential swimming pools and residential permanent spas that are accessory to detached one- and two-family dwellings and townhouses three stories or less in height above grade plane and that are available only to the household and its guests shall be in accordance with APSP-15.

R403.10.2 Heaters. The heaters shall be controlled by a readily *accessible* on-off switch that is an integral part of the heater mounted on the exterior of the heater, or external to and within 3 feet (914 mm) of the heater. Operation of such switch shall not change the setting of the heater thermostat. Such switches shall be in addition to a circuit breaker for the power to the heater. Gas-fired heaters shall not be equipped with continuously burning ignition pilots.

R403.10.3 Time switches. Time switches or other control methods that can automatically turn off and on according to a preset schedule shall be installed for heaters and pump motors. Heaters and pump motors that have built-in time switches shall be in compliance with this section.

For more information contact the Energy Code Assistance Center @ 855-887-0673

Exceptions:

1. Where public health standards require 24-hour pump operation.
2. Pumps that operate solar- and waste-heat-recovery pool heating systems.

R403.10.4 Covers. Outdoor heated pools and outdoor permanent spas shall be provided with an insulated vapor-retardant cover of at least R-12 or other *approved* vapor-retardant means.

Exception: Where more than 75 percent of the energy for heating, computed over an operation season, is from site-recovered energy, such as from a heat pump or solar energy source, covers or other vapor-retardant means shall not be required.

R403.11 Portable spas (Mandatory). The energy consumption of electric-powered portable spas shall be controlled by the requirements of APSP 14.