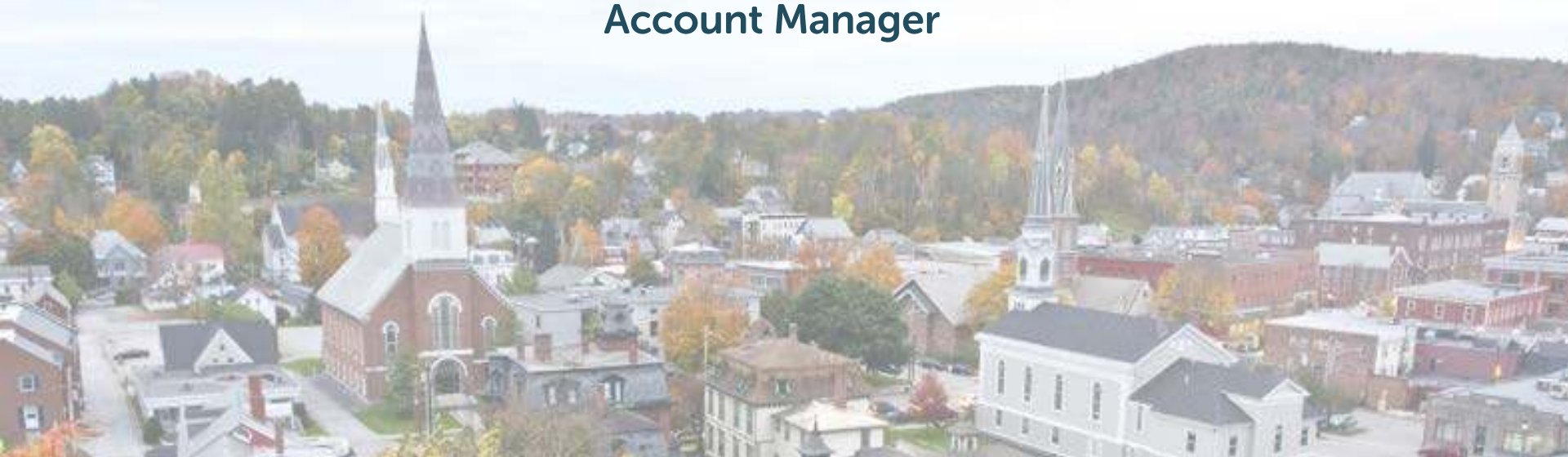




DATE: AUGUST 26, 2020

Prescriptive Compliance with the 2020 Vermont RBES

Steve Spatz
Residential Energy Consultant /
Account Manager



2020 VT Residential Building Energy Standard - RBES

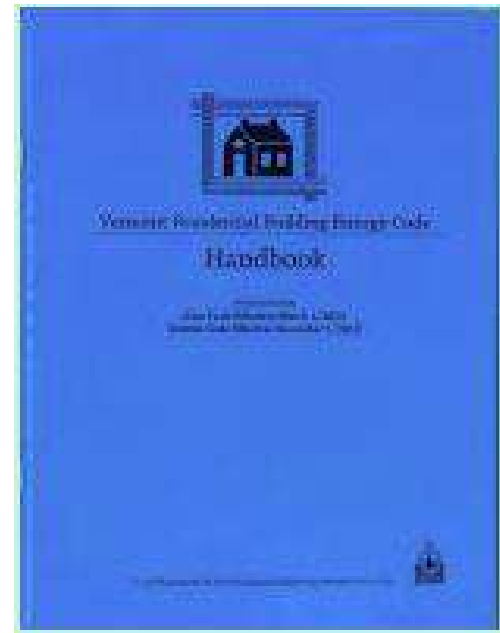
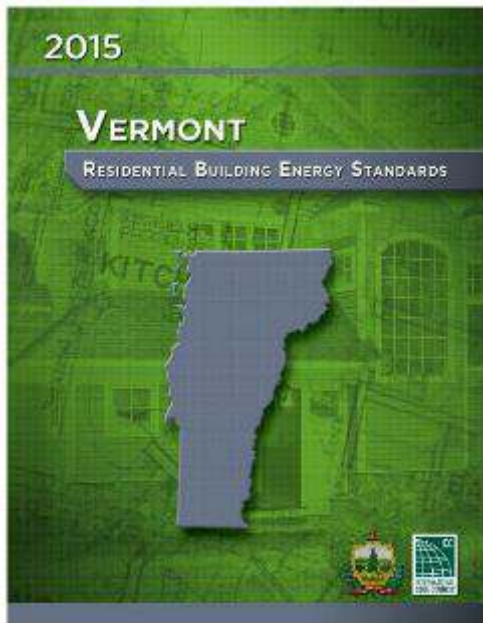


- Law enacted RBES in Legislation:
 - Act 20 of 1997
- Typically, a three-year code revision cycle with public review process
- Based on the International Energy Conservation Code (IECC) *with Vermont-specific additions and exemptions*
- As of September 1, 2020 the 2020 RBES will apply to all projects commencing or permitted on or after this date
- Current (2015) code applies to all projects beginning on or after March 1, 2015 through to August 31, 2020

Major Changes for 2020

- New insulation requirements and packages
 - Packages plus points
 - Requirements vary with house size
- More options for ventilation
- Blower door testing required
- Electric resistance heat mostly prohibited / clarifications in use
- Minimum electric vehicle charging infrastructure / Stretch & MF
- Solar ready required for Stretch Code

The full RBES code and the RBES Handbook



There is a distinct difference between the Full RBES Code Book and the RBES Handbook

- The full RBES Code contains ALL of the applicable code requirements of compliance for all residential construction as defined in the Code and outlined in this training.
- The Handbook/Guidebook is a summary *guide* highlighting some of the key requirements and methods for compliance with the full RBES Code.
- The Handbook/Guidebook should NOT be used as a substitute nor replacement of the full RBES Code.
 - The full content of the RBES Code should always be referenced for compliance with the law

Using the RBES rule book and the RBES Handbook

- The full enforceable content of the law is contained in the 2020 RBES Code Publication and is available and accessible through the International Code Council (ICC):
 - <https://codes.iccsafe.org/>
- The 2020 RBES Handbook is a publication created in partnership by the Vermont Department of Public Service and the Energy Code Assistance Center and is available through the Department of Public Service:
 - <https://publicservice.vermont.gov/content/efficiency>

Efficiency Vermont's role?



We are not the code police..



For additional support and any questions regarding the application of the Residential Building Energy Standard:

- Energy Code Assistance Center
20 Winooski Falls Way, 5th Floor
Winooski, Vermont 05404
855-887-0673
- Vermont Public Service Department
Efficiency and Energy Resources Division
112 State Street Montpelier VT 05620-2601
802-828-2811

Which buildings must comply?

- New construction, low-rise residential
 - One and two family dwellings
 - Multifamily housing three stories or less
 - Does not include commercial buildings
 - But does include residential part of mixed-use
- Existing low-rise residential buildings
 - Additions
 - Only the addition needs to conform
 - Renovations and alterations have their own requirements defined in the Code (Chapter 5 – Existing Homes)
- All projects that require Act 250 permits are required to meet Stretch Code
- Stretch Code is also required in certain jurisdictions in VT that have adopted it

Exempt Buildings – Definitions under Section R101.5.2

- Low energy use Buildings
- Unconditioned Buildings
- Mobile Homes
- Hunting Camps
- Summer Camps
- Yurts
- Owner-Built Homes

Owner-Built Homes definition

- Residential construction by an owner, if **all** of the following conditions apply:
 - The owner of the residential construction is the builder, as defined by 30 V.S.A 51.(a)(1), and:
 - The residential construction is used as a dwelling by the owner, and:
 - The owner in fact directs the details of construction with regard to the installation of materials not in compliance with the RBES, and:
 - The owner discloses in writing to a prospective buyer, before entering into a binding purchase agreement, with respect to the nature and extent of any non-compliance with the RBES

Existing Buildings: Additions, alterations, repairs, and change of occupancy or use

– Chapter 5 Sections 501-505.2

- Applies to additions, alterations, renovations or repairs to an existing building, building system, or portion thereof
 - Must comply if:
 - Change of unconditioned to conditioned space
 - Insulation projects
 - Replacement windows
 - Exempt:
 - Unaltered portions of building
 - Storm windows and glass-only (not window) replacement
 - Existing walls, ceiling, or floor cavities if they are already full of insulation
 - Reroofing, unless roof cavity is exposed and cavity is empty/not full
 - Replacement of less than 50% of light fixtures
 - Replacement of bulb and ballast in existing fixtures

Liability

- Homeowner may take civil action against person certifying building
- Damages may include increased energy costs and costs to bring the building into compliance (as well as court, attorneys' fees)
- Claims must be filed within six years
- More and more lenders and title attorneys are requiring RBES certificates in order to close loans/mortgages

RBES Process



Builders/Homeowners have multiple options for complying with the RBES : RBES Handbook



Builder/homeowner follows the guidelines for building to the Energy Code



Builder fills out the RBES certificate and files copies with the municipality and the Public Service Department



Builder posts copy of the compliance certificate in the home



Code certificates can be found at:
publicservice.vermont.gov/topics/energy_efficiency/rbes

R401.3 Certificate of Compliance (Mandatory)

A certification may be issued and signed by a builder, a licensed professional engineer, a licensed architect or an accredited home energy rating organization. If certification is not issued by a licensed professional engineer, a licensed architect or an accredited home energy rating organization, it shall be issued by the builder. Any certification shall certify that residential construction meets the RBES.

The person certifying shall provide a copy of the certificate to the Department of Public Service and shall assure that a certificate is recorded and indexed in the town land records.

A builder may contract with a licensed professional engineer, a licensed architect or an accredited home energy rating organization to issue certification and to indemnify the builder from any liability to the owner of the residential construction caused by noncompliance with the RBES.

The Certificate

2020 Vermont Residential Building Energy Standards (RBES) Certificate			
<p>This certificate is for projects started on or after September 1, 2020. <i>Before completing this form, refer to the instructions in Chapter 8 of the Residential Energy Code Handbook (5th edition).</i> <i>For additions, alterations, renovations or repairs, only fill out applicable portions of certificate.</i></p>			
Property Address (Street, City, ZIP Code)		Applicable Code: <input type="checkbox"/> Base <input type="checkbox"/> Stretch Project Description: <input type="checkbox"/> Single family <input type="checkbox"/> Renovation / alteration * <input type="checkbox"/> Multi-family <input type="checkbox"/> Addition * <input type="checkbox"/> Log home <input type="checkbox"/> Repair *	
Construction START Date	Construction FINISH Date	Act 250 (Y/N)	Act 250 Permit #
#Units	#Stories	#Conditioned Sq. Ft.	#Bedrooms
* Existing Home Project Description:			
Foundation: <input type="checkbox"/> Basement <input type="checkbox"/> Slab On Grade <input type="checkbox"/> Crawl Space <input type="checkbox"/> Other:			
<div> <div> Compliance Method MUST select Option 1, Option 2, or Option 3 </div> <div> Option 1: Package-Plus Points BASE / STRETCH (circle one) Package # _____ Points required: _____ Points achieved: _____ </div> <div> <i>Ref. RBES for full requirements of each point option (Base requires 4-10pts / Stretch 6-12pts, see Handbook Tables 5-2 and 5-5)</i> </div> </div>			
<div> <div> <input type="checkbox"/> Envelope: Slab, R-10 under all (1pt) <input type="checkbox"/> Envelope: Walls-Upgrade, R20+12 (2pts) <input type="checkbox"/> Envelope: Walls-High-R, R-40 (2pts) <input type="checkbox"/> Envelope: Ceiling, R-60 flat / 60 sloped (1pt) <input type="checkbox"/> Envelope: Windows 0.27 (1pt, Base only) <input type="checkbox"/> Envelope: Windows 0.22 (2pts) <input type="checkbox"/> Pre-drywall blower door (1pt) result <input type="checkbox"/> ENERGY STAR heating and cooling (1pt) <input type="checkbox"/> Advanced heating and cooling (3pts) </div> <div> <input type="checkbox"/> ACH50 ≤ 2.0 and qualifying HRV/ERV (3pts for Base OR 1pt for Stretch) <input type="checkbox"/> ACH50 ≤ 1.0 and qualifying HRV/ERV (4pts) <input type="checkbox"/> ENERGY STAR DHW (1pt) <input type="checkbox"/> ENERGY STAR electric DHW (2pts) <input type="checkbox"/> Low flow fixtures (1pt) <input type="checkbox"/> Drain water heat recovery (1pt) <input type="checkbox"/> User-demand hot water recirculation (1pt) <input type="checkbox"/> Water certification (2pts) List cert. type _____ </div> <div> <input type="checkbox"/> Solar ready (1pt, Base only) <input type="checkbox"/> On-site generation (1-4pts) _____ kW _____ pts <input type="checkbox"/> Low flow water (2pts) <input type="checkbox"/> Building energy monitoring (1pt) <input type="checkbox"/> Level 2 EV-ready (1pt) <input type="checkbox"/> 6 kWh battery backup (1pt) *See RBES for MF exception </div> </div>			
<div> <div> Option 2: REScheck software _____ (cannot be used for Stretch Code) UA result _____ </div> <div> Option 3: HERSERI _____ HERS Result (Overall) _____ HERS without Renewables _____ REMRate Version # _____ <input type="checkbox"/> IAF incorporated into model Approved Rater Name: _____ (Maximum HERS: 61 Base, 54 Stretch) </div> </div>			
Thermal Envelope Basement: R-_____ Basement / Crawl Space Walls _____ Basement Insulation Depth (ft) _____ U-_____ Basement Windows <input type="checkbox"/> NFRC <input type="checkbox"/> Default Slab: R-_____ Unheated Slab (Under) _____ R-_____ Heated Slab (Under) _____ R-_____ Perimeter Slab Edge _____ Wall/Ceiling: R-_____ Above-Grade Walls _____ R-_____ Flat Ceilings _____ Area (sq ft) _____ R-_____ Sloped Ceilings _____ Area (sq ft) _____ Other: R-_____ Floors over Unheated Spaces _____ R-_____ Attic Access Hatch / Door _____ NA _____ Fenestration U-_____ Windows <input type="checkbox"/> NFRC <input type="checkbox"/> Default U-_____ Doors <input type="checkbox"/> NFRC <input type="checkbox"/> Default U-_____ Skylights <input type="checkbox"/> NFRC <input type="checkbox"/> Default			
Air Sealing / Blower Door Test _____ ACH50 _____ Date of test _____ (must report either ACH50 or CFM50/sq ft of building shell (6 sides) Air Leakage Tester Name: _____ or CFM50/sq ft for Base Code) Both measurements are required for Stretch Code			
Ventilation System (must select one) <input type="checkbox"/> Balanced, SRE _____ % Flow verification: <input type="checkbox"/> Rated, OR <input type="checkbox"/> Measured → _____ Exhaust air flow (total cfm) _____ Supply air flow (total cfm) _____ <input type="checkbox"/> Exhaust-Only Flow verification: <input type="checkbox"/> Rated, OR <input type="checkbox"/> Measured → _____ Exhaust air flow (total cfm)			
Combustion Safety (verify all) <input type="checkbox"/> Exterior (outdoor) air supply is provided for solid fuel-burning appliances and fireplaces. OR <input type="checkbox"/> NA (no solid fuel burning appliance or fireplace in home) <input type="checkbox"/> Solid fuel burning appliances and fireplaces have gasketed doors with compression closure. OR <input type="checkbox"/> NA (no solid fuel burning appliance or fireplace in home) <input type="checkbox"/> Spillage testing conducted on combustion equipment not directly-vented. OR <input type="checkbox"/> NA (no equipment, or all equipment directly-vented)			
Mechanical System (must complete all) Design Load Calculation Method: <input type="checkbox"/> ACCA Manual J, OR <input type="checkbox"/> Other Approved Method (List) _____ Calculation details: (Ref. RBES R302 for design temperature exceptions) _____ Winter design temp, outdoor dry-bulb (VT range -11 to 1°F) _____ Summer design temp, outdoor dry-bulb (typ. max. 84°F), OR <input type="checkbox"/> No cooling _____ Winter design temp, indoor (max 72°F) _____ Summer design temp, indoor (min. 75°F), OR <input type="checkbox"/> No cooling _____ Heating design load, Btu/hr _____ Cooling design load, Btu/hr, OR <input type="checkbox"/> No cooling _____ Primary heating system size, Btu/hr _____ Primary cooling system size, Btu/hr, OR <input type="checkbox"/> No cooling _____ HSPF or COP or AFUE (circle which) _____ SEER or COP (circle which), OR <input type="checkbox"/> No cooling <input type="checkbox"/> Programmable thermostat, OR <input type="checkbox"/> Exempt; list reason _____			
Ducts <input type="checkbox"/> Ducts located completely within conditioned space, OR <input type="checkbox"/> NA (no ducts) _____ Duct airtightness test result (CFM @ 25 Pa) Test performed at: <input type="checkbox"/> Rough-in (max 3 CFM per 100 sq ft of cond. floor area), OR <input type="checkbox"/> Post-construction (max 4 CFM per 100 sq ft of cond. floor area)			
Other Requirements Mandatory (Base and Stretch): <input type="checkbox"/> Mechanical system piping, min. R-3 <input type="checkbox"/> Multi-family: EV charging requirement is met: _____ #spaces <input type="checkbox"/> 90% of lamps high efficacy <input type="checkbox"/> Automatic or gravity dampers for vent. system intake and exhaust Mandatory (Stretch Code Only): <input type="checkbox"/> Single-family: Solar ready <input type="checkbox"/> Single-family: One Level 1 EV-charging space Where applicable: <input type="checkbox"/> Circulating service hot water piping, R-3 <input type="checkbox"/> Pools: All requirements per R403.10 are met <input type="checkbox"/> Automatic controls for snowmelt systems			
I certify to _____ (Owner) that the above information is correct and that the premises listed have been constructed in accordance with the Vermont Residential Building Standards (RBES) created under 30 V.S.A. § 51. Signature: _____ Date: _____ Printed Name: _____ Company: _____ Phone: _____			
<small>30 V.S.A. § 51 requires this certificate label to be permanently affixed to the inside electrical service panel or heating or cooling equipment or nearby in a visible location. Copies of the certificate (and Home Energy Rating Certificate if Option 3 is used) also must be provided to 1) the Dept. of Public Services, 112 State St., Montpelier, VT 05602; and 2) the town clerk of the town where the property is located. NOTE: Noncompliance with RBES may result in action for damages under 30 V.S.A. § 51. This label does not specify all 2020 RBES requirements. QUESTIONS? CALL the Energy Code Assistance Center at 855-887-0673 or the VT PUBLIC SERVICE DEPARTMENT at 802-829-2811.</small>			

- Provides:
 - Details about the house
 - Builder's word that house meets code
- Fill out & file
 - Post in house, file with town, copy to state

2020 Vermont Residential Building Energy Standards (RBES) Certificate

This certificate is for projects started on or after September 1, 2020.
 Before completing this form, refer to the instructions in Chapter 8 of the Residential Energy Code Handbook (5th edition).
 For additions, alterations, renovations or repairs, only fill out applicable portions of certificate.

Property Address (Street, City, ZIP Code) _____

Construction START Date _____

Construction FINISH Date _____

Act 250 (Y/N): _____

Act 250 Permit # _____

#Units _____

#Stories _____

#Sq. Ft. _____

#Bedrooms _____

Applicable Code: ☐ Base ☐ Stretch

Project Description

☐ Single family

☐ Renovation / alteration *

☐ Multi-family

☐ Addition *

☐ Log home

☐ Repair *

* Existing Home Project Description: _____

Foundation: ☐ Basement ☐ Slab On Grade ☐ Crawl Space ☐ Other: _____

Compliance Method

☐ Option 1: Package-Plus-Points

Ref. RBES for full requirements of each point option

☐ Option 2: REScheck™ software (Base only)

(MUST select Option 1, Option 2, or Option 3)

BASE / STRETCH (circle one)
 Package # _____

Points required: _____ (Base requires 4-10pts / Stretch 6-12pts,
 Points achieved: _____ see Tables R402.1.2.2 and R407.2.1.2)

☐ HRV/ERV installed (mandatory)
 _____ Tested ACH50 (must be under 2.0)
 _____ UA (from REScheck™)

☐ Envelope: Slab, R-10 under all (1pt)

☐ ACH50 ≤ 2.0 and qualifying HRV/ERV (3pts for Base OR 1pt for Stretch)

☐ Envelope: Walls-Upgraded, R20+12 (2pts)

☐ ACH50 ≤ 1.0 and qualifying HRV/ERV (4pts) ☐ Solar ready (1pt, Base only¹)

☐ Envelope: Walls-High-R, R-40 (3pts)

☐ ENERGY STAR DHW (1pt)

☐ On-site generation (1-4pts)

☐ Envelope: Ceiling, R-80 flat / 60 sloped (1pt)

☐ ENERGY STAR electric DHW (2pts)

_____ kW _____ pts

☐ Envelope: Windows 0.27 (1pt, Base only)

☐ Low flow fixtures (1pt)

☐ Solar hot water (2pts)

☐ Envelope: Windows 0.22 (2pts)

☐ Drain water heat recovery (1pt)

☐ Building energy monitoring (1pt)

☐ Pre-drywall blower door (1pt), result _____

☐ User-demand hot water recirculation (1pt)

☐ Level 2 EV-ready (1pt)

☐ ENERGY STAR heating and cooling (1pt)

☐ Water certification (2pts)

☐ 6 kWh battery backup (1pt)

☐ Advanced heating and cooling (3pts)

List cert. type _____

¹See RBES for MF exception

☐ Option 3: HERS/ERI

_____ HERS Result (Overall)
 _____ HERS without Renewables
 _____ REM/Rate Version #
 _____ IAF incorporated into model

Approved Rater Name: _____

(Maximum HERS: 61 Base, 54 Stretch)

Thermal Envelope

Basement: R-_____ Basement / Crawl Space Walls _____ Basement Insulation Depth (ft) U-_____ Basement Windows ☐ NFRC ☐ Default

Slab: R-_____ Unheated Slab (Under) R-_____ Heated Slab (Under) R-_____ Perimeter Slab Edge

Wall/Ceiling: R-_____ Above-Grade Walls R-_____ Flat Ceilings _____ Area (sq ft) R-_____ Sloped Ceilings _____ Area (sq ft)

Other: R-_____ Floors over Unheated Spaces R-_____ Attic Access Hatch / Door ☐ NA

Fenestration U-_____ Windows ☐ NFRC ☐ Default U-_____ Doors ☐ NFRC ☐ Default U-_____ Skylights ☐ NFRC ☐ Default

Air Sealing / Blower Door Test

(must report either ACH50

or CFM50/sq ft for Base Code)

_____ ACH50 (Building volume used: _____ cu ft)

_____ CFM50/sq ft of building shell (6 sides; Thermal shell area used: _____ sq ft)

Both measurements are required for Stretch Code

Blower Door Result _____ CFM50

Date of Test _____

Air Leakage Tester Name: _____

Ventilation System

(must select one)

☐ Balanced, SRE _____ %

Flow verification: ☐ Rated, OR

☐ Measured →

_____ Exhaust air flow (total cfm)

_____ Supply air flow (total cfm)

☐ Exhaust-Only

Flow verification: ☐ Rated, OR

☐ Measured →

_____ Exhaust air flow (total cfm)

Combustion Safety (verify all) ☐ Exterior (outdoor) air supply is provided for solid fuel-burning appliances and fireplaces, OR ☐ NA (no solid fuel burning appliance or fireplace in home)
☐ Solid fuel burning appliances and fireplaces have gasketed doors with compression closure, OR ☐ NA (no solid fuel burning appliance or fireplace in home)
☐ Spillage testing conducted on combustion equipment not directly-vented, OR ☐ NA (no equipment, or all equipment directly-vented)

Mechanical System (must complete all) Design Load Calculation Method: ☐ ACCA Manual J, OR ☐ Other Approved Method (List) _____
Calculation details: (Ref. RBES R302 for design temperature exceptions)
_____ Winter design temp, outdoor dry-bulb (VT range: -11 to 1°F) _____ Summer design temp, outdoor dry-bulb (typ. max. 84°F), OR ☐ No cooling
_____ Winter design temp, indoor (max 72°F) _____ Summer design temp, indoor (min. 75°F), OR ☐ No cooling
_____ Heating design load, Btu/hr _____ Cooling design load, Btu/hr, OR ☐ No cooling
_____ Primary heating system size, Btu/hr _____ Primary cooling system size, Btu/hr, OR ☐ No cooling
_____ HSPF or COP or AFUE (circle which) _____ SEER or COP (circle which), OR ☐ No cooling
☐ Programmable thermostat, OR ☐ Exempt; list reason _____

Ducts ☐ Ducts located completely within conditioned space, OR ☐ NA (no ducts)
_____ Duct tightness result (CFM @ 25 Pa)
Test performed at ☐ Rough-in (max 3 CFM per 100 sq ft of cond. floor area), OR ☐ Post-construction (max 4 CFM per 100 sq ft of cond. floor area)

Other Requirements Mandatory (Base and Stretch): ☐ Mechanical system piping, min. R-3 ☐ Multi-family: EV charging requirement is met: _____ # spaces
☐ 90% of lamps high efficacy ☐ Automatic or gravity dampers for vent. system intake and exhaust
Mandatory (Stretch Code Only): ☐ Single-family: Solar ready ☐ Single-family: One Level 1 EV-charging space
Where applicable: ☐ Circulating service hot water piping, R-3 ☐ Pools: All requirements per R403.10 are met ☐ Automatic controls for snow-melt systems

I certify to _____ (Owner) that the above information is correct and that the premises listed **have been constructed in accordance with the Vermont Residential Building Standards (RBES) created under 30 V.S.A. § 51.**

Signature: _____ Date: _____

Company: _____ Printed Name: _____

30 V.S.A. § 51 requires this certificate label to be permanently affixed to the inside electrical service panel or heating or cooling equipment or nearby in a visible location. Copies of the certificate and REScheck Compliance Certificate or Home Energy Rating Certificate (if Option 2 or 3 used) also must be provided to 1) the Dept. of Public Service, 112 State St., Montpelier, VT 05602, and 2) the town clerk of the town where the property is located. NOTE: Noncompliance with RBES may result in action for damages under 30 V.S.A. § 51. This label does not specify all 2020 RBES requirements. **QUESTIONS? CALL THE VT PUBLIC SERVICE DEPARTMENT at 802-828-2811 or the Energy Code Assistance Center at 855-887-0673.**

Real Estate Transactions

- Lack of code certificate does not cloud title
 - So sale can go through
- Lack of certificate may raise questions of value
- Some banks won't issue mortgage without certificate

General Requirements



Arrangement and Format of the 2020 RBES

- The 2020 RBES, like other codes published by ICC, is arranged and organized to follow sequential steps that generally occur during a plan review or inspection. The 2020 RBES is divided into six different parts:

Chapters	Subjects
1-2	Scope, Administration and Definitions
3	General Requirements
4	Residential Energy Efficiency
5	Existing Buildings
6	Referenced Standards

Chapter 1 – Scope and Administration

- This chapter contains provisions for the application, enforcement and administration of subsequent requirements of the code. In addition to establishing the scope of the code, Chapter 1 identifies which buildings and structures come under its purview.

Chapter 2 -Definitions

- Chapter 2 – **Section R202** should be referenced for definitions of applicable materials, systems, assemblies, design conditions, and equipment as they are referenced and apply to the full rule of the code

Chapter 3 General Requirements

- Sections R302 – R305 Summary
 - Chapter 3 details design conditions and parameters of residential construction for:
 - Building load design conditions
 - Materials, systems, and equipment
 - Includes insulation and fenestration identification and default values
 - Design criteria for whole-house ventilation systems
 - Combustion Safety

Chapter 4 – Residential Energy Efficiency

- Chapter 4 contains the energy-efficiency-related requirements for the design and construction of residential buildings regulated under this code. This Chapter contains the bulk of the information for construction in compliance with the RBES and is the focus of this training

Chapter 5 – Existing Homes

- Chapter 5 contains the technical energy efficiency requirements for existing buildings. Chapter 5 addresses the maintenance of buildings for compliance with the code as well as how additions, alterations, repairs and changes of occupancy need to be addressed from the standpoint of energy efficiency. Specific provisions are provided for historic buildings.
- A separate training has been created for Existing Homes requirements

Chapter 6 – Referenced Standards

- Chapter 6 contains a comprehensive list of all federal, trade, license, and industry applicable standards that are referenced in the code. These standards are part of the code to the extent of the reference of the standard. Compliance with the referenced standards is necessary for compliance with the RBES code

Prescriptive Compliance for New Construction *and* *Additions*

- Sections R402.1.1-R404.3

Compliance methods

- Prescriptive Method
 - Significant Changes from 2015 RBES
- Software Method / ResCheck
- Home Energy Rating / HERS Rating

Prescriptive/Rx Packages

- Advantages
 - Pathway many builders end up following for compliance, often by no design of their own..
 - Simple
 - Minimal calculations
 - The 2020 RBES is built upon the performance requirements of the Rx path
- Drawbacks
 - Least flexible, may limit some home designs
 - Some higher component values that may not be practical for cavity-fill only wall package option

The two packages for minimum R-value performance from 2015 no longer exists in the 2020 RBES.

R402.1.4 U-factor alternative. An assembly with a *U*-factor equal to or less than that specified in Table R402.1.4 shall be permitted as an alternative to the *R*-value in Table R402.1.2.

R402.1.5 Total UA alternative. If the total *building thermal envelope* UA (sum of *U*-factor times assembly area) is less than or equal to the total UA resulting from using the *U*-factors in Table R402.1.4 (multiplied by the same assembly area as in the proposed building), the building shall be considered in compliance with Table R402.1.2. The UA calculation shall be done using a method consistent with the ASHRAE *Handbook of Fundamentals* and shall include the thermal bridging effects of framing materials. The SHGC requirements shall be met in addition to UA compliance.

R402.2 Specific insulation requirements (Prescriptive). In addition to the requirements of Section R402.1, insulation shall meet the specific requirements of Sections R402.2.1 through R402.2.13.

Table 402.1.4 defines the reference conditions for a code compliant home in Vermont. The specific *U*-factors are not necessarily required as long as the home can demonstrate equivalent or lower energy use as compared to the same home built with these components installed. This equivalency can be demonstrated by selecting one of the packages in Table 402.1.2, selecting an alternative package in the 2015 RBES Handbook, using *REScheck*TM software to demonstrate equivalency, or obtaining a Home Energy Rating System (HERS) rating that meets Section 406.

TABLE R402.1.2
INSULATION AND FENESTRATION REQUIREMENTS BY COMPONENT^a

PACKAGE # ⁱ	FENESTRATION <i>U</i> -FACTOR ^b	SKYLIGHT ^b <i>U</i> -FACTOR	CEILING ^h <i>R</i> -VALUE	WOOD FRAME WALL ⁱ <i>R</i> -VALUE	MASS WALL ^g <i>R</i> -VALUE	FLOOR <i>R</i> -VALUE	BASEMENT ^c & CRAWL SPACE WALL <i>R</i> -VALUE	SLAB ^d <i>R</i> -VALUE & DEPTH	HEATED SLAB ^d <i>R</i> -VALUE
1	0.32	0.55	49	13 + 10	15/20	30 ^e	15 continuous or 20 cavity	15, 4 ft	15, edge and under
2	0.28	0.55	49	25	15/20	30 ^e	15 continuous or 20 cavity	15, 4 ft	15, edge and under

For SI: 1 foot = 304.8 mm.

Table R402.1.2.1 – Insulation Requirements by Component for Base Packages

Component ^a	Package 1 Standard	Package 2 SIPS	Package 3 Thick Wall	Package 4 Cavity Only	Package 5 Log Homes
Ceiling	R-49 ^f	R-28 cont.	R-49 ^f	R-60 ^g attic / R-49 ^f slope	Construct log home to ICC 400-2017 “Standard on the Design and Construction of Log Structures” OR Table R402.1.6 in RBES code language
Wood Frame Walls	R-20+5 ^e OR 13+10 ^e	R-21 cont.	R-20+12 ^e	R-20 cavity	
Common Wall Insulation	R-10	R-10	R-10	R-10	
Floor	R-30	R-30	R-30	R-38	
Basement/Crawl Space Wall ^c	R-15 (continuous) OR 20 (cavity) OR R-13+5	R-15 (continuous) OR 20 (cavity) OR R-13+5	R-20 (continuous) OR R-13+10 ^e	R-20 (continuous) OR R-13+10 ^e	
Slab Edge ^d	R-15, 4 ft OR R-10 perimeter + R-7.5 under entire rest of slab	R-15, 4 ft OR R-10 perimeter + R-7.5 under entire rest of slab	R-10, 4 ft	R-15, 4 ft OR R-10 perimeter + R-7.5 under entire rest of slab	
Heated Slab ^d	R-15 (edge and under)	R-15 (edge and under)	R-15 (edge and under)	R-15 (edge and under)	
Fenestration ^b (Window and Door)	U-0.30 max.	U-0.30 max.	U-0.30 max.	U-0.28 max.	
Skylight ^b	U-0.55 max.	U-0.55 max.	U-0.55 max.	U-0.55 max.	
Air Leakage ⁱ	≤3.0 ACH50 ^h tested	≤3.0 ACH50 ^h tested	≤3.0 ACH50 ^h tested	≤3.0 ACH50 ^h tested	
Duct Leakage	Inside thermal boundary	Inside thermal boundary	4 CFM25 per 100 sq. ft. of CFA ⁱ	Inside thermal boundary	
Percent High Efficacy Lamps ⁱ	90%	90%	90%	100%	

Package Plus Points – Table R402.1.2.2

Requires prescriptive package requirements be met AND # of points earned based on building sq. footage

REQUIRED POINTS BY BUILDING SIZE FOR BASE CODE

Building/Dwelling Size	Required Points
Multifamily < 2000 square feet	4 points
<2000 square feet	5 points
2000 to 4000 square feet	7 points
>4000 square feet	10 points

Points

- Building size for the above points table is determined by the finished conditioned floor area per dwelling unit within the building thermal envelope, including unfinished basements and storage/utility spaces.
- Multifamily dwelling unit size is based on the average dwelling size for the building.

Table R402.1.2.3 - Available Points by Component

Component		Description	Points
Envelope	Slab	R-10 below entire slab	1
	Walls - Upgraded	AG walls R-20+12 (or U-factor maximum 0.033 wall assembly) (Exception: not available for base package 3) OR ^b	2
	Walls – High-R	AG walls \geq R-40(cavity + continuous) (or U-factor maximum 0.025 wall assembly)	3
	Ceiling	R-80 attic / R-60 slopes	1
	Windows	Average U-factor \leq 0.27 OR ^b	1
		Average U-factor \leq 0.22	2
Air Leakage and Ventilation	Pre-Drywall	ACH50 is tested with blower door after full insulation/primary air barrier completion but before insulation is fully enclosed/covered OR ^b	1
	Tight	ACH50 \leq 2.0 and balanced ventilation with ECM ^e fans and \geq 70% SRE ^d for HRV ^c , \geq 65% SRE ^d for ERV ^c OR ^b	3
	Very Tight	ACH50 \leq 1.0 and balanced ventilation with ECM ^e fans and \geq 80% SRE ^d for HRV ^c , \geq 75% SRE ^d for ERV ^c	4
Heating and Cooling ^a	Basic	ENERGY STAR basic: (1) Gas/propane furnace \geq 95 AFUE, Oil furnace \geq 85 AFUE, (2) Gas/Propane Boiler \geq 90 AFUE, Oil Boiler \geq 87 AFUE, (3) Heat pump HSPF \geq 9.0; PLUS any AC is SEER \geq 14.5 OR ^b	1
	Advanced	Whole building heat/cool is (1) NEEP-listed heat pump combination ⁱ , (2) GSHP ⁱ , closed loop and COP \geq 3.3, (3) ATWHP ^f COP \geq 2.5 and 120F design temp, (4) Advanced wood heating system	3

Table 402.1.2.3 cont.d

Component		Description	Points
Water	Basic	ENERGY STAR basic: Fossil fuel [EF 0.67 for ≤ 55 gal; EF 0.77 for > 55 gal] OR ^b	1
	Advanced	ENERGY STAR advanced: Electric [EF or UEF ≥ 2.00 for ≤ 55 gal; EF ≥ 2.20 for > 55 gal]	2
	Low Flow	All showerheads ≤ 1.75 gpm ^a , all lav. faucets ≤ 1.0 gpm ^a , and all toilets ≤ 1.28 gpf ^h OR ^b	1
	Certified	Certified water efficient design per WERS, WaterSense, or RESNETH2O	2
	Drain Heat Recovery	Drain water heat recovery system on primary showers and tubs	1
	User-Demand	Controlled hot water recirculation system with user-demand via push-button for furthest fixtures	1
Renewables	Solar Ready	Home is Solar Ready per R407.5, OR ^b	1
	On-Site Generation	Solar Photovoltaic (PV) (or other on-site renewable energy system), 1 point per 1.5 kW per housing unit of renewable generation on site	1 per 1.5 kW, max. 4
	Solar Hot Water	Solar hot water system designed to meet at least 50% of annual hot water load	2
Other Measures	Monitoring	Install whole-building energy monitoring system, min. 5 circuits and homeowner access to data	1
	EV Ready	Level 2 electric vehicle charger-ready per 407.4R407.3	1
	Battery	Min. 6 kWh grid-connected dispatchable demand-response-enabled battery backup	1

Stretch Code

- Stretch Code is a more stringent requirement of the RBES code with a separate prescriptive package and points requirement.
- Stretch Code compliance is required for any project that requires an ACT 250 permit, and in those jurisdictions within the state that have adopted Stretch Code as a local requirement
 - Towns that have adopted Stretch Code provisions:
 - South Burlington
 - Williston* While not adopting Stretch Code, residential subdivisions require meeting a more stringent performance package than RBES base code
 - Hartford is planning on adopting Stretch code
- Section R407 covers the additional requirements of Stretch Code applicable projects

Stretch Code – Prescriptive package

-Table R407.2.1.1

Component ^a	Package 1 Standard	Package 2 SIPS	Package 3 Thick Wall
Ceiling R-Value	R-60 ^g attic / R-49 ^f slope	R-36 cont.	R-49 ^f
Wood Frame Wall R-Value	R-20+5 ^e OR 13+10 ^e	R-21 cont.	R-20+12 ^e
Common Wall Insulation	R-10	R-10	R-10
Floor R-Value	R-30	R-30	R-30
Basement/Crawl Space Wall ^c R-Value	R-20 (continuous) OR R-13+10 ^e	R-20 (continuous) OR R-13+10 ^e	R-20 (continuous) OR R-13+10 ^e
Slab Edge ^d	R-15, 4ft OR R-10 perimeter + R-7.5 under entire rest of slab	R-15, 4 ft OR R-10 perimeter + R-7.5 under entire rest of slab	R-15, 4ft OR R-10 perimeter + R-7.5 under entire rest of slab
Heated Slab ^d	R-15 (edge and under)	R-15 (edge and under)	R-15 (edge and under)
Fenestration ^b (Window and Door)	U-0.28 max.	U-0.28 max.	U-0.30 max.
Skylight ^b	U-0.55 max.	U-0.55 max.	U-0.55 max.
Air Leakage ⁱ	≤3.0 ACH50 ^h tested	≤3.0 ACH50 ^h tested	≤3.0 ACH50 ^h tested
Ventilation	Balanced; ECM ^l fan plus ≥70% SRE ^k for HRV ^j , ≥65% SRE for ERV ^j	Balanced; ECM ^l fan plus ≥70% SRE ^k for HRV ^j , ≥65% SRE for ERV ^j	Balanced; ECM ^l fan plus ≥70% SRE ^k for HRV ^j , ≥65% SRE for ERV ^j
Duct Leakage	Inside thermal boundary	Inside thermal boundary	Inside thermal boundary
Percent High Efficacy Lamps ⁱ	90%	90%	90%

Required points by building size for Stretch Code

Building/Dwelling Size	Required Points
Multifamily < 2000 square feet average unit size	6 points
<2000 square feet	7 points
2000 to 4000 square feet	9 points
>4000 square feet	12 points

Table R407.2.1.3 – Available Points by Component Stretch Code

Component		Description	Points
Envelope	Slab	R-10 below entire slab	1
	Walls: Upgraded	Above grade walls R-20+12 (or U-factor maximum 0.033 wall assembly ^a) (Not available for stretch package 3) OR^b	2
	Walls: High-R	Above grade walls \geq R-40 (cavity and continuous) (or U-factor maximum 0.025 wall assembly ^a)	3
	Ceiling	R-80 attic flat / R-60 sloped, vaulted and cathedral	1
	Windows	Average U-factor \leq 0.22	2
Air Leakage and Ventilation	Pre-Drywall	ACH50 is tested with blower door after full insulation/primary air barrier completion but before insulation is fully enclosed/covered	1
	Tight	ACH50 \leq 2.0 and balanced ventilation with ECM ^c fans and \geq 70% SRE ^d for HRV ^e \geq 65% SRE ^d for ERV ^e OR^b	1
	Very Tight	ACH50 \leq 1.0 and balanced ventilation with ECM ^c fans and \geq 80% SRE ^d for HRV ^e \geq 75% SRE ^d for ERV ^e	4
Heating and Cooling ^f	Basic	ENERGY STAR [®] basic: (1) Gas/propane furnace \geq 95 AFUE, Oil furnace \geq 85 AFUE, (2) Gas/Propane Boiler \geq 90 AFUE, Oil Boiler \geq 87 AFUE, (3) Heat pump HSPF \geq 9.0; and any AC is SEER \geq 14.5 OR^b	1
	Advanced	Whole building heat/cool is (1) NEEP-listed heat pump combination ^g , (2) GSHP ^h closed loop and COP \geq 3.3, (3) AWHP ⁱ COP \geq 2.5 and max. 120°F distribution design temperature, (4) Advanced wood heating system	3

Table R407.2.1.3 cont'd.

Water	Basic	ENERGY STAR® basic: Fossil fuel [EF 0.67 for ≤ 55 gal; EF 0.77 for > 55 gal] <u>OR^b</u>	1
	Advanced	ENERGY STAR® advanced: Electric [EF or UEF ≥ 2.00 for ≤ 55 gal; EF ≥ 2.20 for > 55 gal]	2
	Low Flow	All showerheads ≤ 1.75 <u>gpm</u> , all lavatory faucets ≤ 1.0 <u>gpm</u> , and all toilets ≤ 1.28 <u>gpf^k</u> <u>OR^b</u>	1
	<u>Certified^l</u>	Certified water efficient design per WERS, <u>WaterSense</u> , or RESNET HERS _{H2O}	2
	Drain Heat Recovery	Drain water heat recovery system on <u>primary showers</u> and tubs	1
	User-Demand	Controlled hot water recirculation system with user-demand via push-button for furthest <u>fixtures^m</u>	1
Renewables	Solar Ready	Home is Solar Ready per R407.5, <u>OR^b</u>	1
	On-Site Generation	Solar Photovoltaic (PV) (or other on-site renewable energy system), 1 point per 1.5 kW per housing unit of renewable generation <u>on site</u>	Max 4
	Solar Hot Water	Solar hot water system designed to meet at least 50% of annual hot water load	2
Other Measures	Monitoring	Install whole-building energy monitoring system, min. 5 circuits and homeowner access to <u>dataⁿ</u>	1
	EV Ready	Level 2 electric vehicle charger-ready per R407.4 ^o	1
	Battery	Min. 6 kWh grid-connected dispatchable demand-response-enabled battery backup	1

Stretch Code Continued

- All Base Code requirements shall be met in addition to the requirements in Stretch Code **Section R407** in order to be in compliance with the Stretch Code.
- **R407.2 Compliance.**
 - Compliance for Stretch Code shall be documented through **Section R407.2.1** Package Plus Points Approach or **Section R407.2.2** ERI-based (HERS Rating) compliance for Stretch Code.
 - ResCheck is NOT and allowable compliance option for Stretch Code
- Stretch Code projects are also require compliance with **Section R407.5 – Solar Ready Zone for Stretch Code**

Back to Base Code Prescriptive Requirements





Alternatives to Prescriptive Package Compliance

- There are options to comply with RBES (Base Code) prescriptively without meeting the full component requirements listed in the Prescriptive package **Table R402.1.2.1**
 - **R402.1.4 U-Factor Alternative** : An *assembly* with a *u-factor* equal to or less than that specified in **Table R402.1.4** shall be permitted as an alternative to the *R-values* in **Table R402.1.2.1**. The building must still comply with the points required based on building sq. footage defined in **Table R402.1.2.2** and the points by component in **Table R402.1.2.3**

U-Factor alternative compliance without points requirement

- An assembly with a U-factor equal to or less than that specified in Table R402.1.4 shall be permitted as an alternative compliance method with no Table R402.1.2.3 point required, provided that:
 - a. Airtightness is less than or equal to 2.0 ACH/50 tested, and
 - b. Ventilation system is balanced (HRV/ERV) with ECM fan motor plus greater than or equal to 70% SRE for an HRV or greater than or equal to 65% SRE for an ERV

R-Value vs. U-Factor/Value?

- R-Value is the inverse of U-value and vice-versa
- $1/\text{R-Value} = \text{U-Value}$
- $1/\text{U-Value} = \text{R-Value}$
 - $R20 = .05 \text{ U-value}$
 - $R49 = .02 \text{ U-value}$
- When calculating u-value the full assembly needs to be calculated, not just the value of the material in the framing cavity. The equivalent R/U-value of framing and % thereof in an assembly sq. footage needs to be factored into the full u-value computation. So a U-.05 insulation wall cavity (R20) does not equate to a U-.05 wall *assembly*.
- Bottom line: try to meet the prescriptive values completely in Table R402.1.2.1

Table R402.1.4 Equivalent U-values

- Component *Assembly* values:

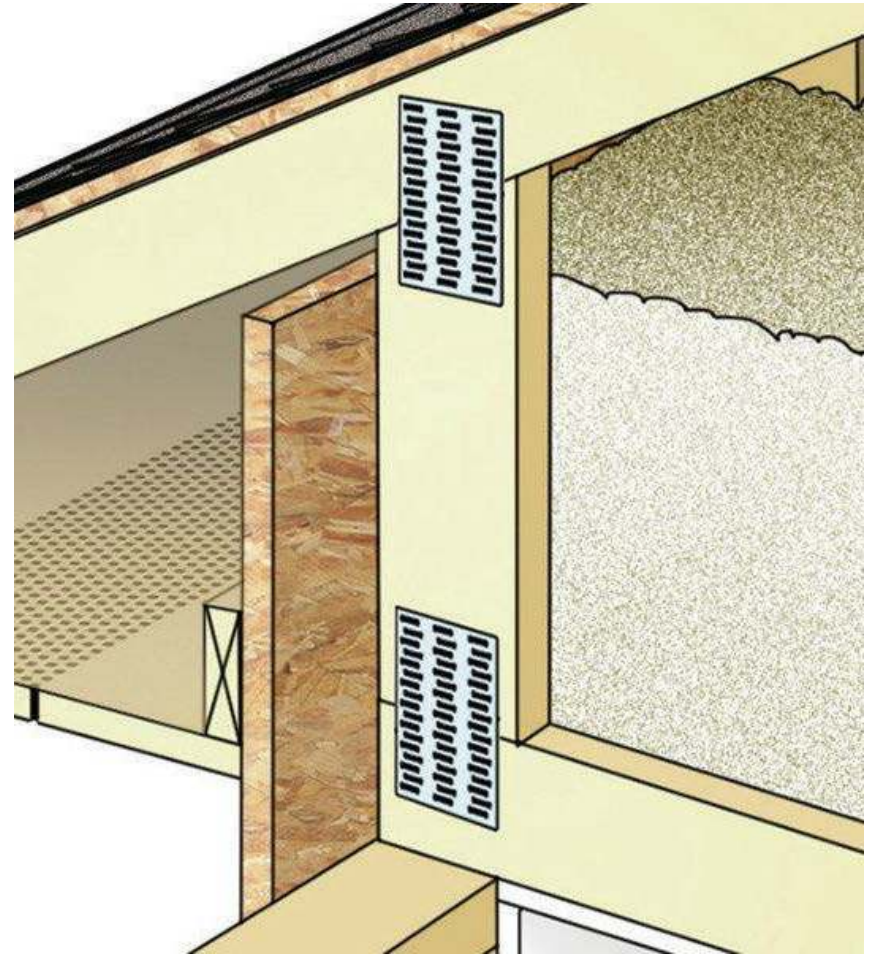
FENESTRATION U- FACTOR	SKYLIGHT U-FACTOR	CEILING U- FACTOR	FRAME WALL U- FACTOR	MASS WALL U- FACTOR _b	FLOOR U- FACTOR	BASEMENT WALL U- FACTOR	CRAWL SPACE WALL U-FACTOR	SLAB & UNHEATED SLAB U- FACTOR & DEPTH
0.27	0.55	0.022	0.044	0.060	0.030	0.035	0.035	0.066, 4 ft

Other notable alternatives/exceptions

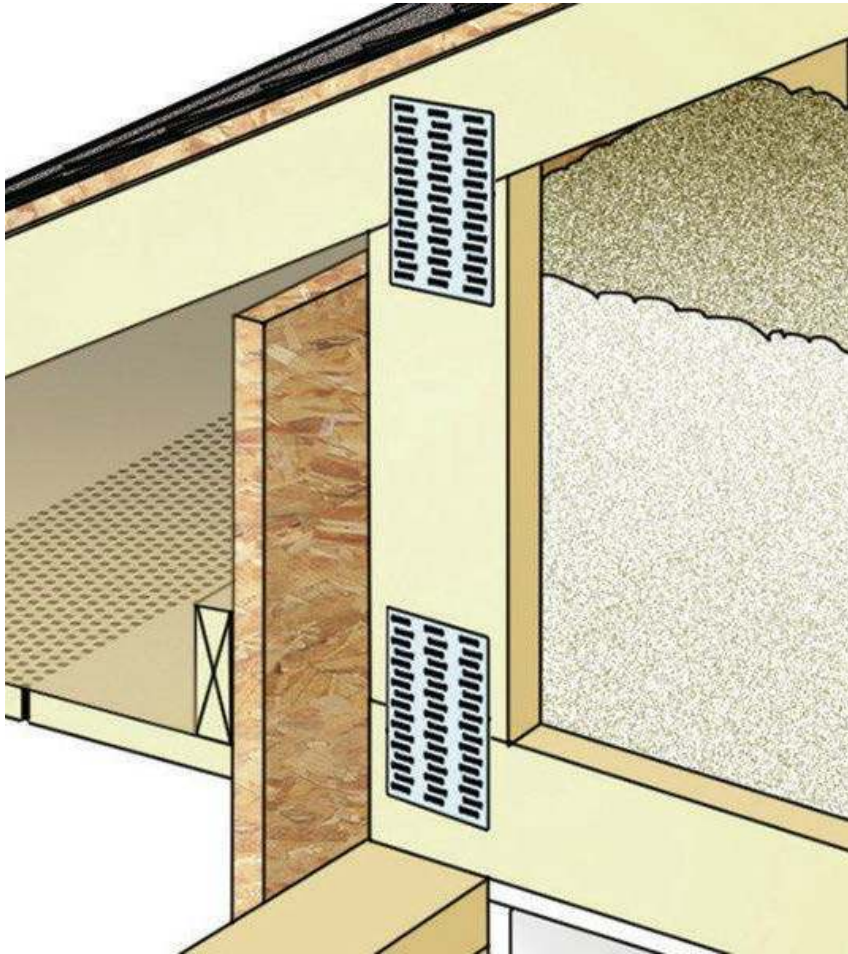


R38 for R49

- Installing R38 over 100% of the ceiling area requiring insulation shall be deemed to satisfy the requirement for R49 wherever the full height of uncompressed R38 insulation extends over the top plate at the eaves.



R49 for R60



- Installing R49 over 100% of the ceiling area requiring insulation shall be deemed to satisfy the requirement for R60 wherever the full height of uncompressed R49 insulation extends over the top plate at the eaves.

Alternatives/exceptions cont.d

- R402.2.2-Ceilings without attic spaces

Where the design/construction of a roof/ceiling assembly does not allow sufficient space for the required R-value (R49) the minimum required insulation for such assemblies shall be R30.

Insulation shall extend of top of wall plates to the outer edge of such plates and shall not be compressed. This reduction of insulation from the requirements of Section R402.1.2 shall be limited to 500sq.ft. or 20% of the total insulated ceiling area, whichever is less

Section R402.2 – Specific Insulation Requirements

-Performance
requirements in addition
to requirements of Section
R402.1

Sections R402.2.1- R402.2.15

- These following slides cover the most relevant building systems and performance/installation requirements for these systems/assemblies as required for Prescriptive Compliance
- This is not a fully inclusive list of all potential building systems in Section R402.2, but a summary of the most common assembly types and their specific performance requirements for general residential construction

R402.2.2.1 –

Unvented attic assemblies

Unvented assemblies (ceiling joist cavity) shall be permitted if the following conditions are met:

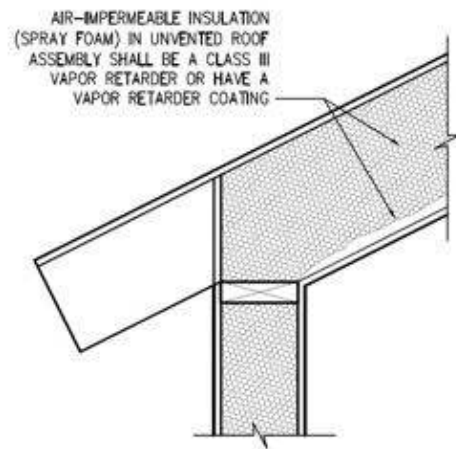
- The unvented attic space is completely contained within the building thermal envelope.
- No interior vapor retarders (Class I or II) are installed on the ceiling side (attic floor) of the unvented attic assembly.
- Where wood shingles or shakes are used, a minimum 1/4 inch (6 mm) vented air space separates the shingles or shakes and the roofing underlayment above the structural sheathing.
- Any air-impermeable (e.g., spray foam) insulation shall be a Class II vapor retarder, or shall have a vapor retarder coating or covering in direct contact with the underside of the insulation. **Don't use open-cell**

R402.2.2.1 –

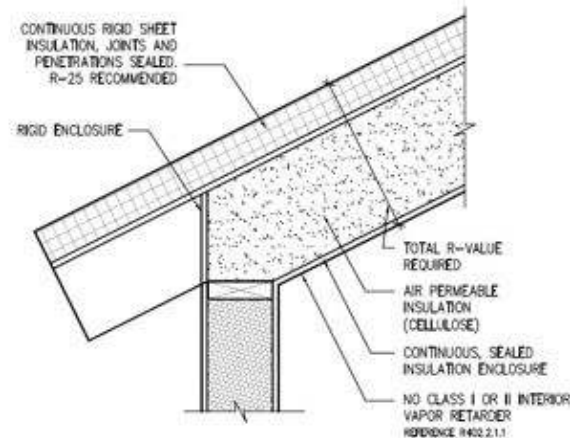
Unvented assemblies cont.d

- Either Item 5.1, 5.2 or 5.3 shall be met, depending on the air permeability of the insulation directly under the structural roof sheathing.
 - **5.1 Air-impermeable (e.g., spray foam) insulation only.** Insulation shall be applied in direct contact with the underside of the structural roof sheathing.
 - **5.2 Air-permeable (e.g., fiberglass or cellulose) insulation only.** In addition to the air-permeable insulation installed directly below the structural sheathing, rigid board sheet insulation shall be installed directly above the structural roof sheathing for condensation control.
 - **5.3 Air-impermeable and air-permeable insulation.** The air-impermeable (e.g., spray foam) insulation shall be applied in direct contact with the underside of the structural roof sheathing for condensation control. The air-permeable (e.g., fiberglass or cellulose) insulation shall be installed directly under the air-impermeable (e.g., spray foam) insulation. **Flash & Fill**

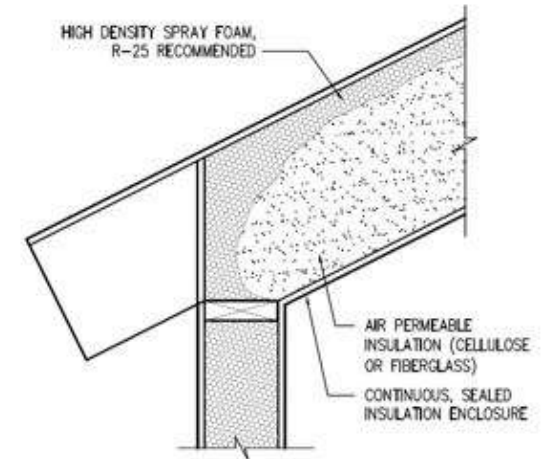
Examples of unvented roof assemblies



SPRAY FOAM

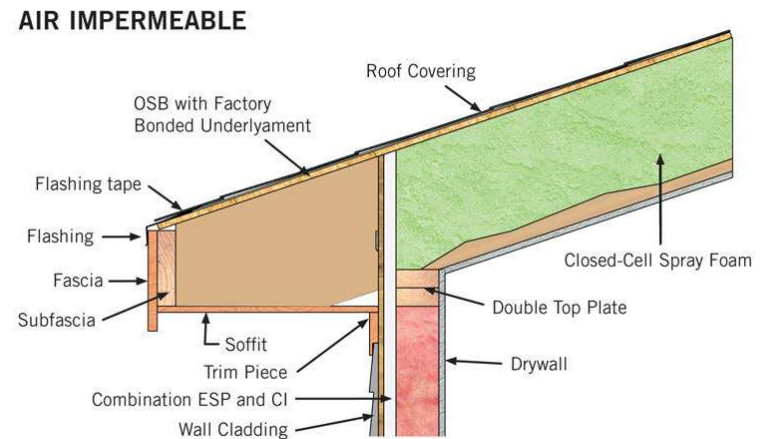


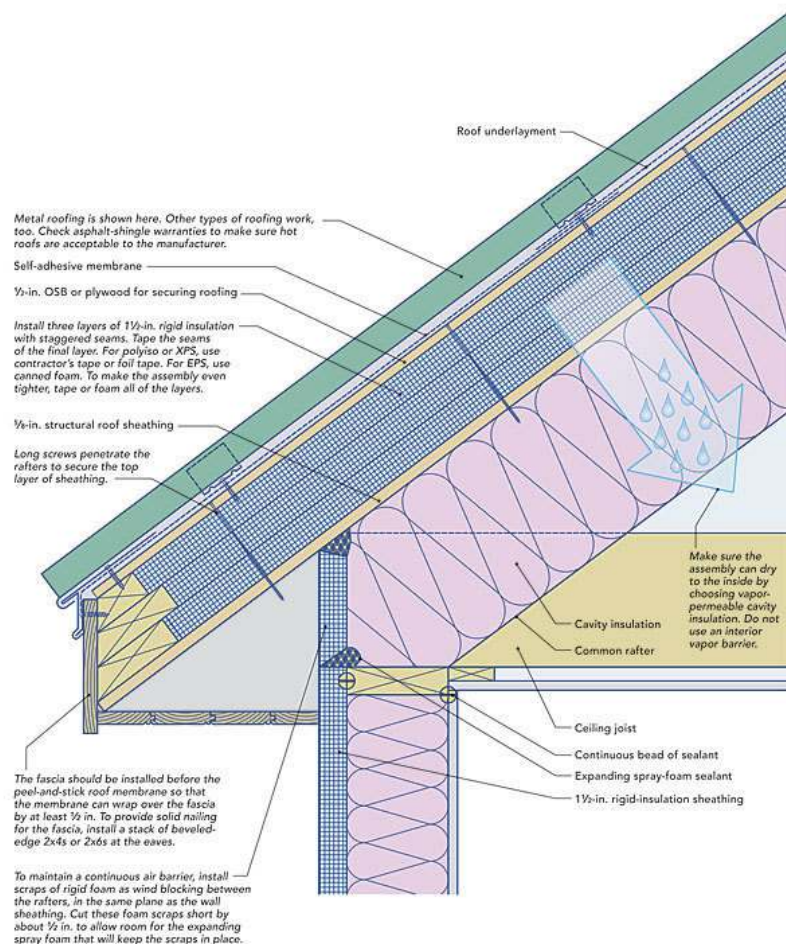
EXTERIOR RIGID



FLASH AND BATT

- 5.1 Air-impermeable (e.g., spray foam) insulation only. Insulation shall be applied in direct contact with the underside of the structural roof sheathing.





- 5.2 Air-permeable (e.g., fiberglass or cellulose) insulation only. In addition to the air-permeable insulation installed directly below the structural sheathing, rigid board sheet insulation shall be installed directly above the structural roof sheathing for condensation control.

- **5.3 Air-impermeable and air-permeable insulation.**
The air-impermeable (e.g., spray foam) insulation shall be applied in direct contact with the underside of the structural roof sheathing for condensation control. The air-permeable (e.g., fiberglass or cellulose) insulation shall be installed directly under the air-impermeable (e.g., spray foam) insulation. **Flash & Fill**



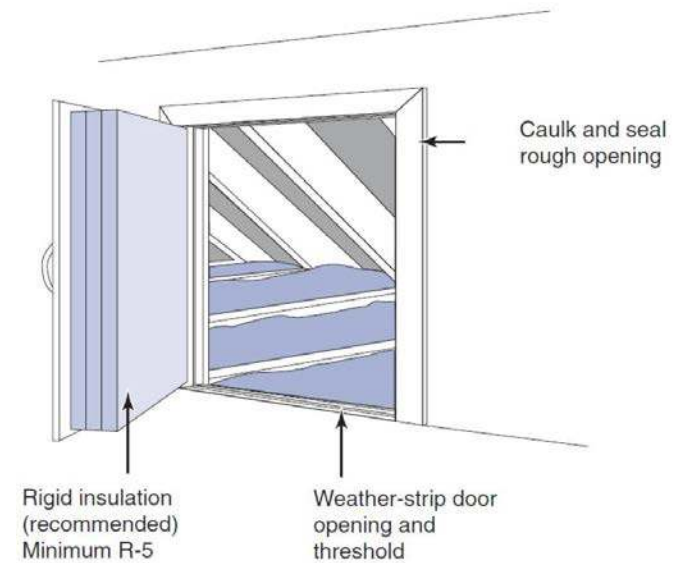
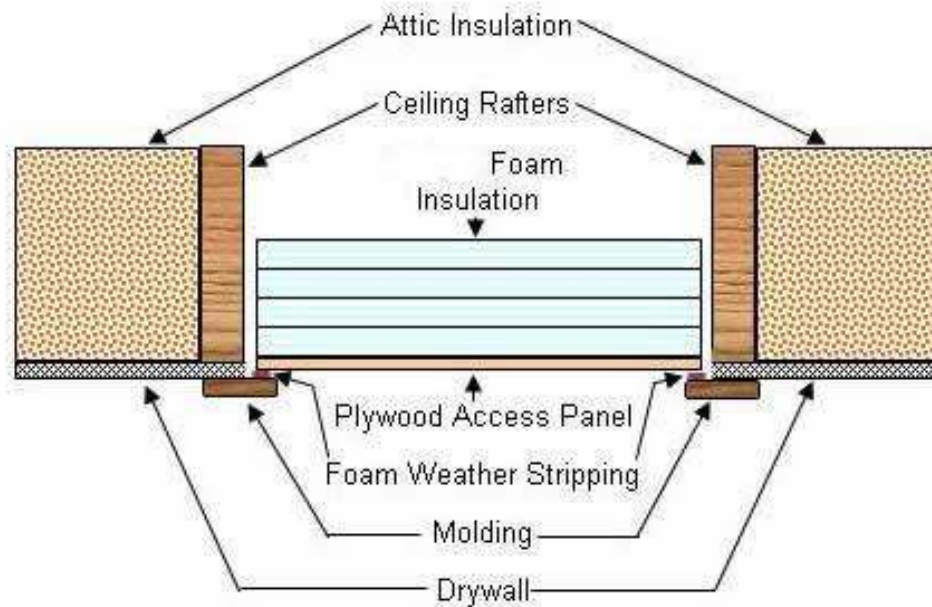
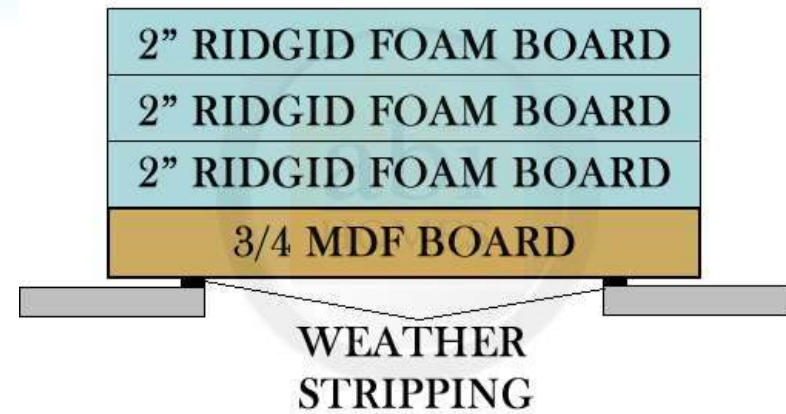
R402.2.3

- **R402.2.3 Eave Baffles**
 - For air-permeable insulation in vented attics a baffle shall be installed adjacent to soffit and eave vents. Baffles shall maintain an opening equal or greater than the net free area of the vent. The baffles shall extend over the top of the insulation. The baffle shall be permitted to be any solid material



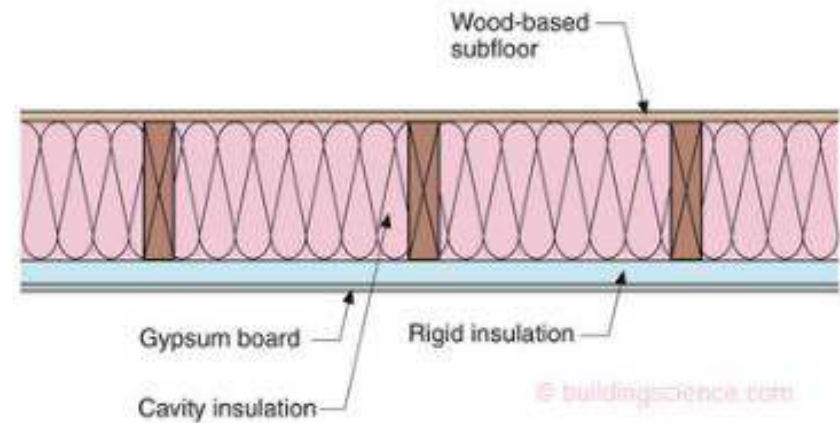
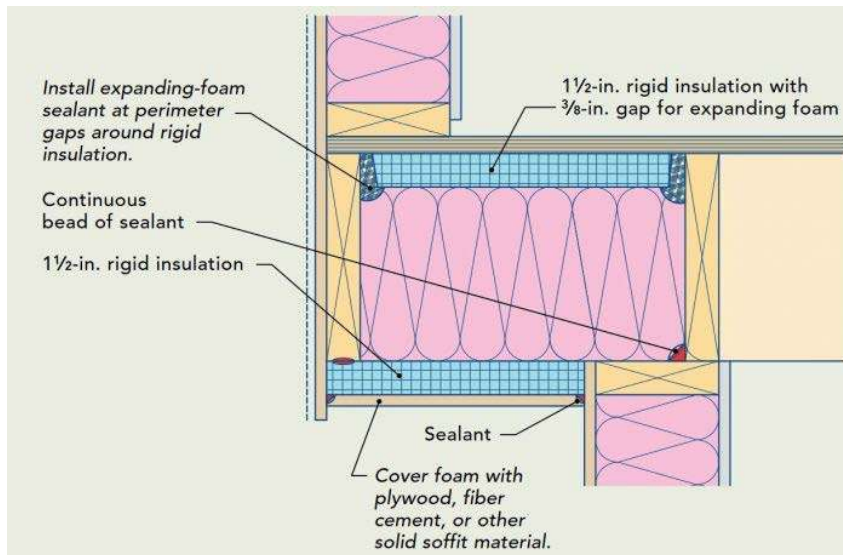
R402.2.4

- R402.2.4 (attic/crawl space) Access Hatches and Doors
 - Access hatches from conditioned spaces to unconditioned spaces shall be weather-stripped and insulated to a level equivalent to the insulation on the surrounding surfaces. A wood-framed or equivalent baffles or retainer is required to be provided when loose-fill insulation is installed.
 - Exception: Vertical doors that provide access from conditioned to unconditioned spaces shall be permitted to meet the max. U-value of .28 or .30 depending on the prescriptive package table requirement being used



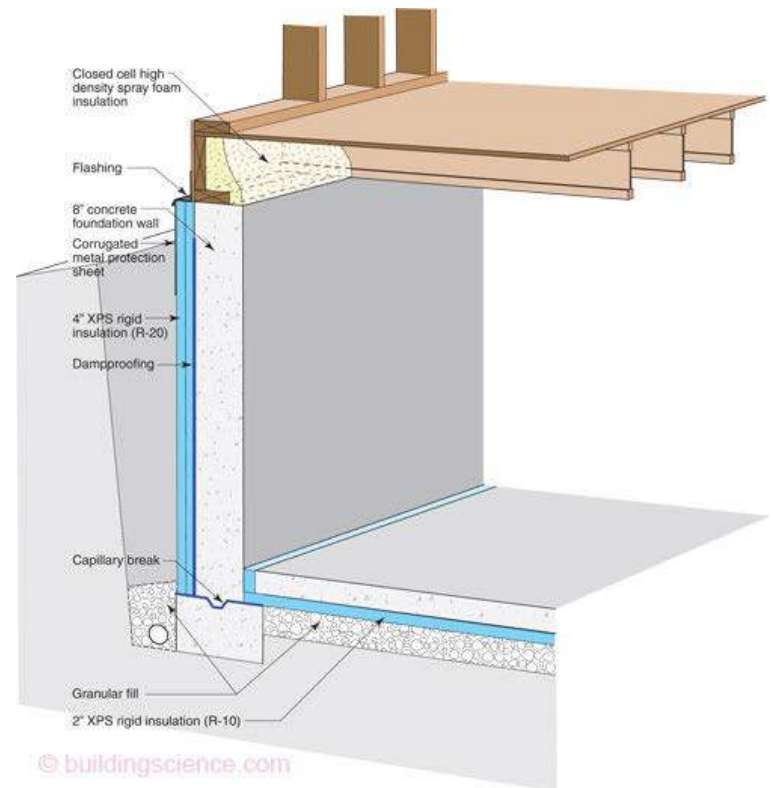
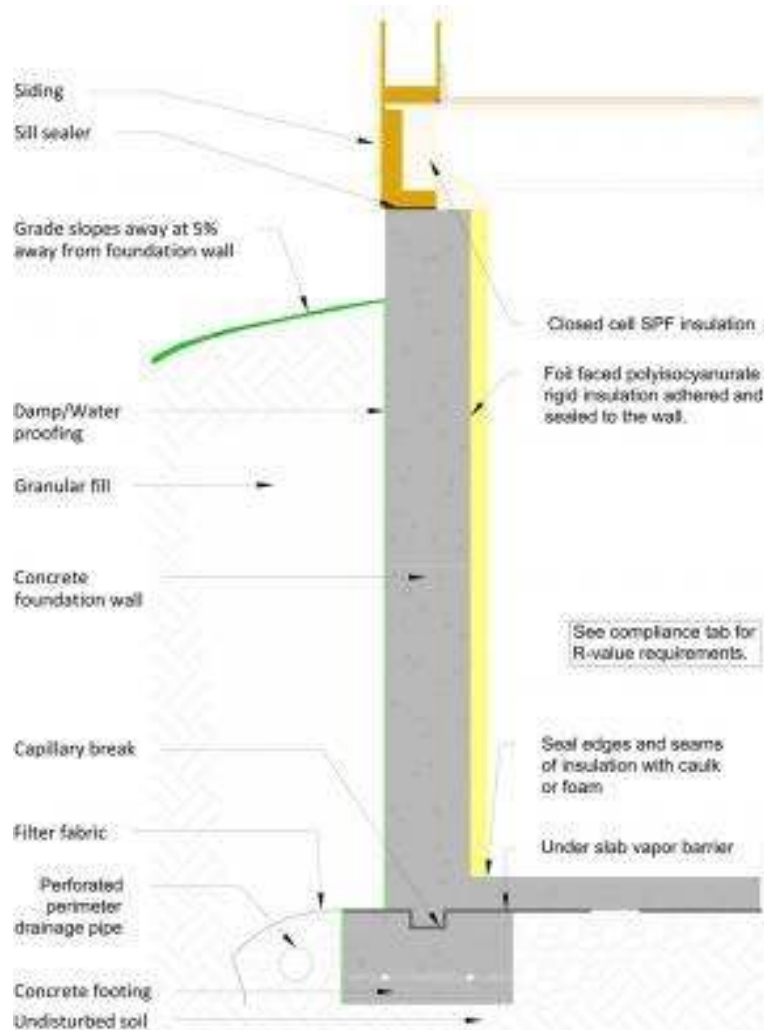
R402.2.8 Floors

Floor framing cavity insulation shall be installed to maintain permanent contact with the underside of the subfloor decking

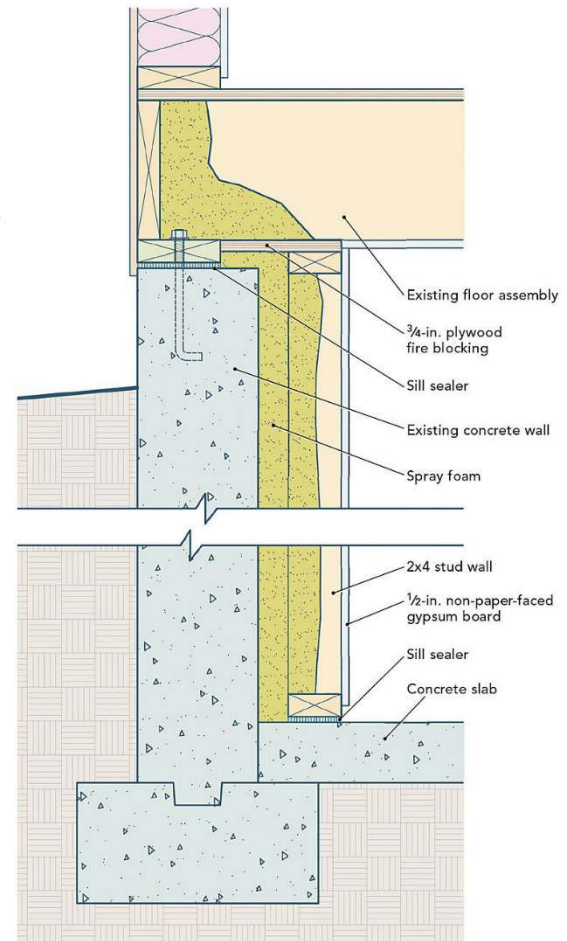
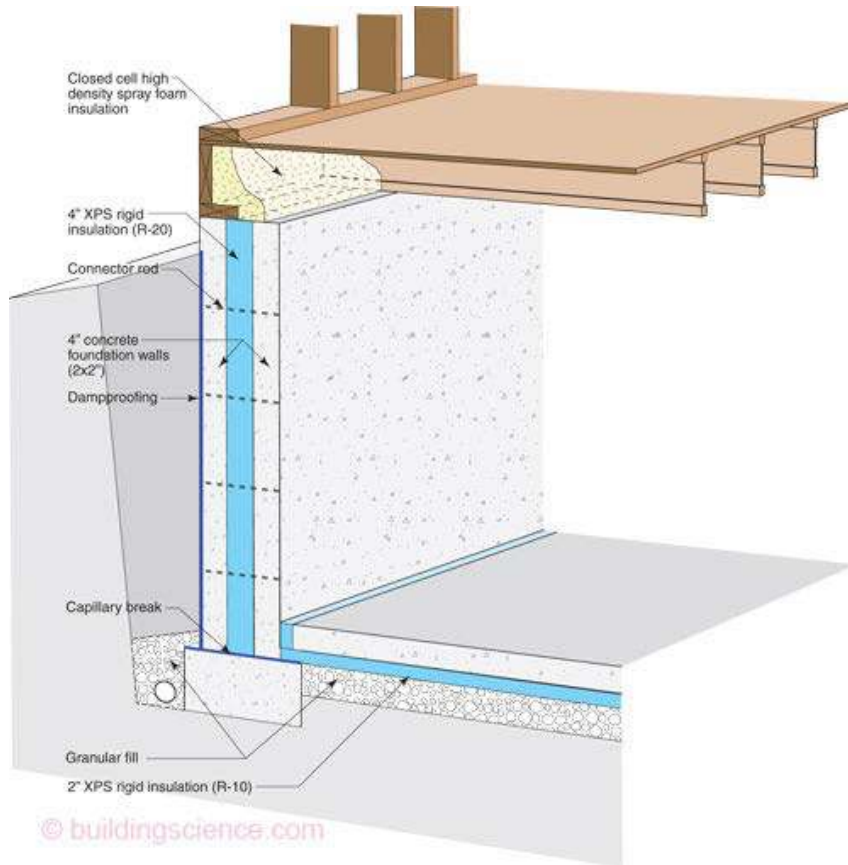


R402.2.9 Basement Walls

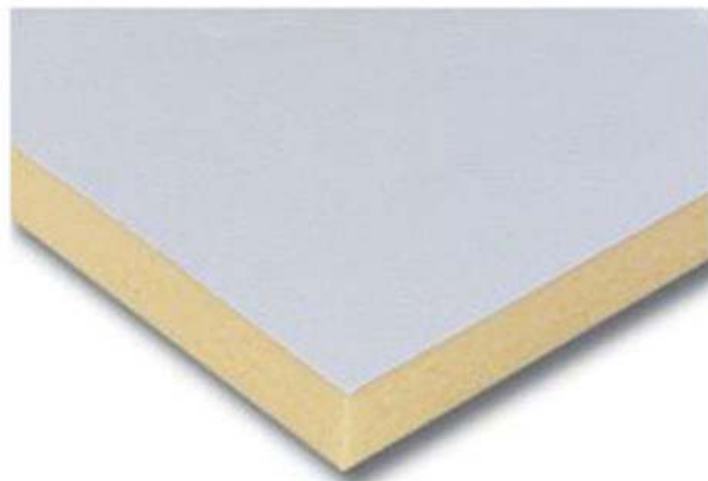
Walls associated with conditioned basements shall be insulated from the top of the basement wall down to 10ft. below grade or to the basement floor, whichever is less. Walls associated with unconditioned basements shall meet this requirement unless the floor overhead is insulated (R30/38)



R402.2.9 cont.d



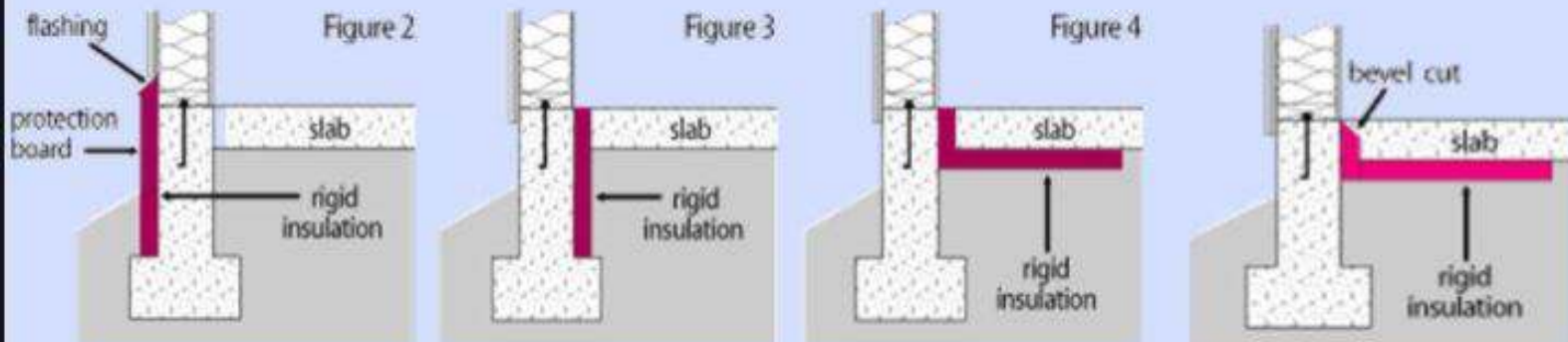
Exposed foams need to have a fire ignition barrier



R402.2.10 Slab-On-Grade Floors

Slab on grade floors with a floor surface less than 12 inches below grade shall be insulated in accordance with Table R402.1.2 (R15,4ft. OR R10 perimeter+R7.5 under rest of slab)

- Downward from top of slab a minimum of ~~2'~~ 4'
- Insulation can be vertical or extend horizontally under the slab or out from the building (must be under 10 inches of soil),
- Can be angled at edge of slab



R402.2.11 Crawl Space Walls

As an alternative to insulating floors over crawl spaces, crawl space walls shall be permitted to be insulated when the crawl space is not vented to the outside. Crawl space wall insulation shall be permanently fastened to the wall and extend downward from the floor to the finished grade level and then at least an additional 24 inches. Exposed earth in unvented crawl space foundations shall be covered with a continuous Class I vapor retarder in accordance with the *International Building Code* or *International Residential Code*, as applicable.



R402.2.15 – Wood-Frame Walls

Condensation & Moisture Mitigation

- **R402.2.15 Frame walls**
 - Efforts must be made to protect insulated cavities from airborne water vapor and condensation. Air sealing the interior face of the assembly, controlled mechanical ventilation (targeting 30% relative humidity during the winter season), exterior continuous insulation and proper consideration of the vapor permeance of materials are all design elements that can contribute to this protection.
- **R402.2.15.1 Vapor Retarders**
 - Class I or II vapor retarders shall be installed on the interior side of frame walls.
 - Exceptions:
 - Basement/Concrete foundation walls
 - Below grade portion of any wall
 - Construction where moisture or freezing will not damage materials
- **R402.2.15.2 Low Permeability Insulating Sheathing**
 - Where a Class II vapor retarder is used on the interior side of frame walls, in combination with a low permeability insulating sheathing installed as continuous insulation on the exterior side of frame walls, the Class II vapor retarder shall have a vapor permeance greater than 1 perm. Use of a Class I interior vapor retarder in frame walls with a Class I vapor retarder on the exterior side shall require an engineered approved design.

R402.2.15 – Wood Frame Walls

Cont.d

- R402.2.15.3 Class III vapor retarders.
 - Class III vapor retarders on the interior side of frame walls shall be permitted where any one of the following conditions is met:
 - 1. Vented cladding over the following sheathing types:
 - a. fiberboard;
 - b. gypsum;
 - c. plywood (CDX or comparable); or
 - d. solid wood
 - Insulated sheathing with *R*-value 7.5 minimum over 2 x 4 wall.
 - Insulated sheathing with *R*-value 11.25 minimum over 2 x 6 wall.

Vapor Retarder Classifications

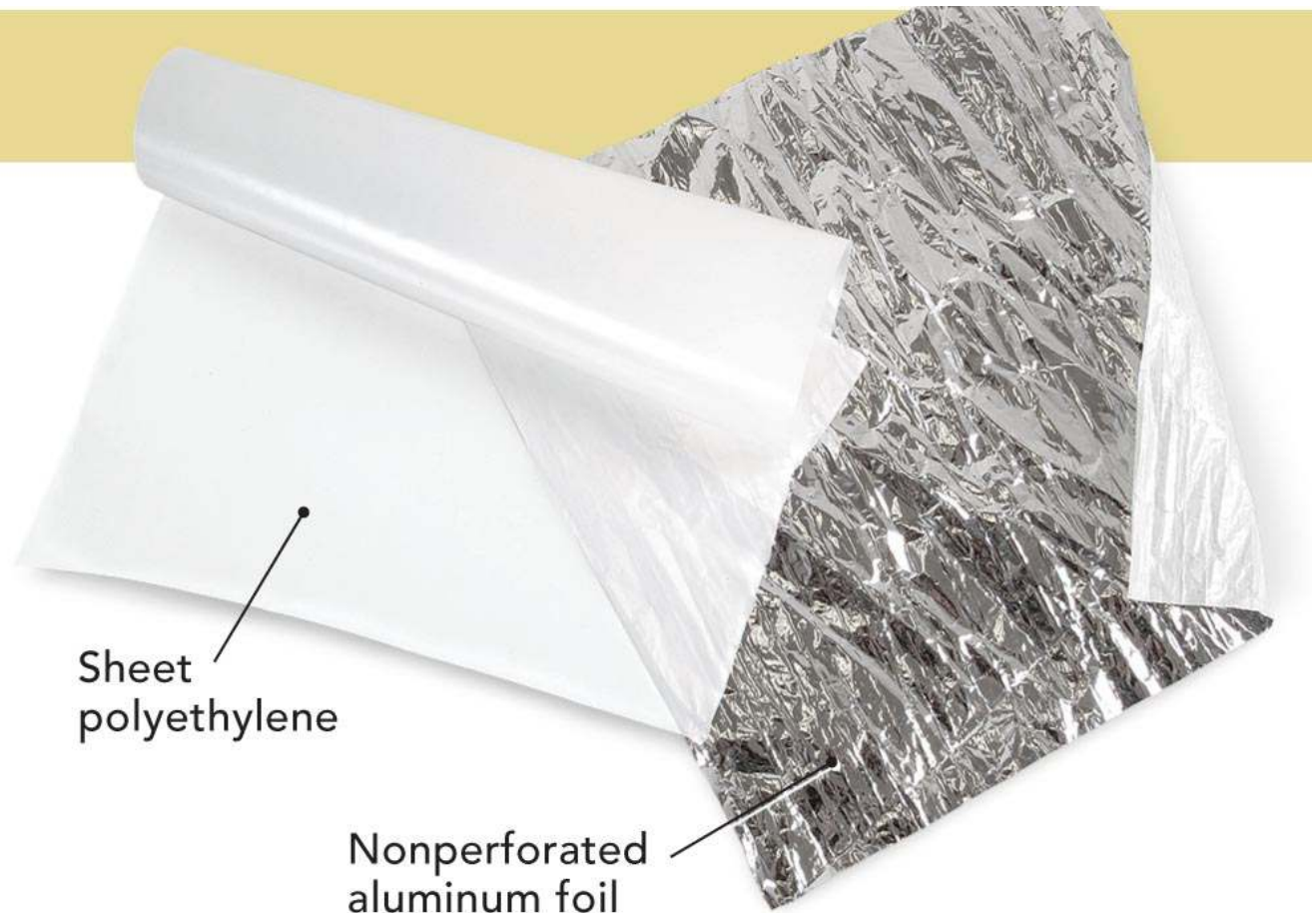
Class	Definition	Examples
I	0.1 perm or less	Sheet polyethylene, sheet metal, non-perforated aluminum foil
II	Greater than 0.1 perm to less than 1.0 perm	Kraft-faced fiberglass batts or low-perm paint
III	Greater than 1.0 perm to less than 10 perm	Latex or enamel paint

What does this all mean?

- Don't create a vapor-barrier-sandwich
 - There needs to be a pathway for moisture that will (and it does) accumulate in wall or enclose cavity ceiling to dry to the outside, inside, or both ways.
 - I'll argue that walls that can dry both ways may be the safest if you are using vapor permeable insulation materials.

Class I

At times referred to as a vapor barrier, a class-I vapor retarder has a permeance level of 0.1 perm or less and is considered impermeable.

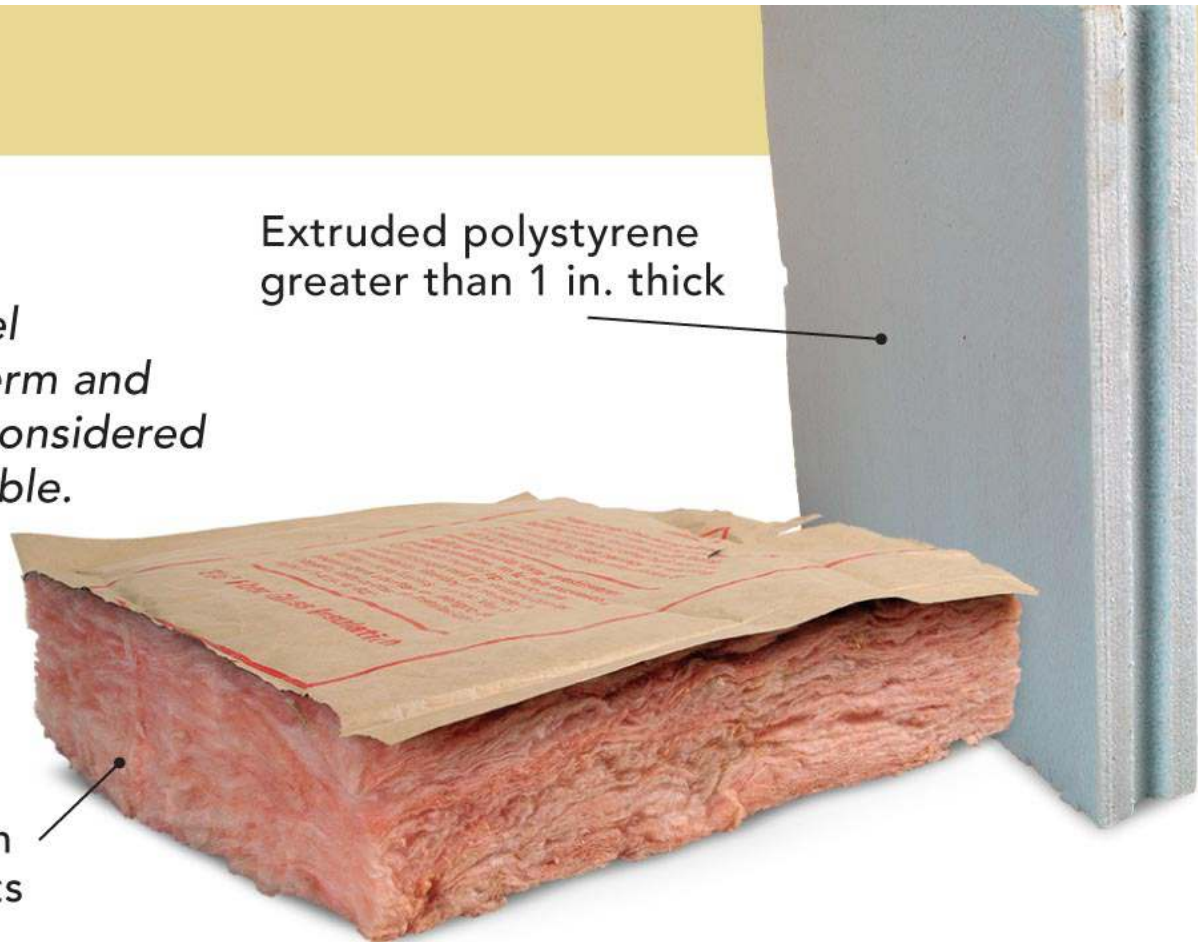


Class II

A class-II vapor retarder has a permeance level between 0.1 perm and 1 perm and is considered semi-impermeable.

Extruded polystyrene greater than 1 in. thick

Kraft facing on fiberglass batts



Class III

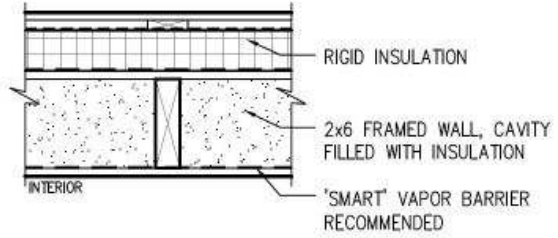
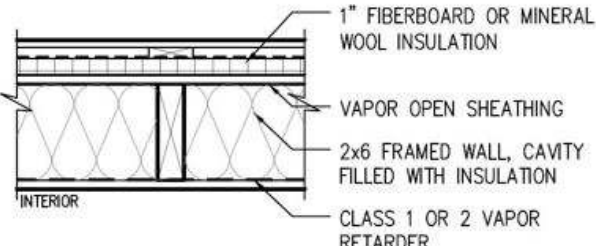
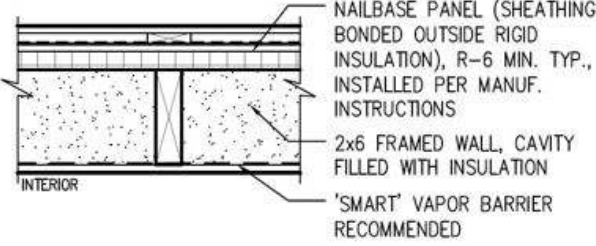
A class-III vapor retarder has a permeance level between 1 perm and 10 perms and is considered semi-permeable.



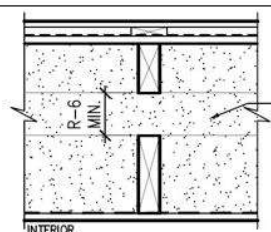
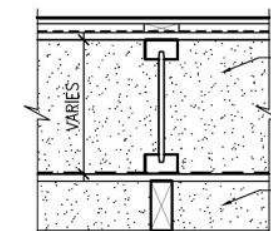
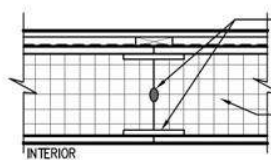
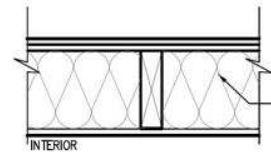
Vapor-Variable Membranes – vapor closed in winter / vapor open in summer



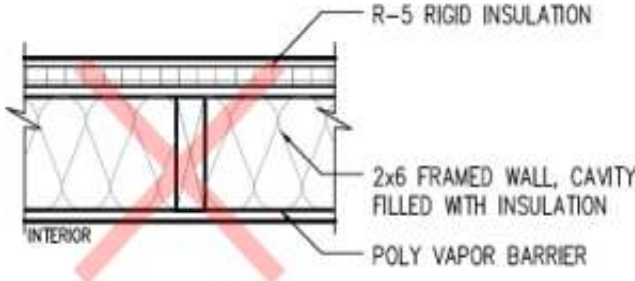
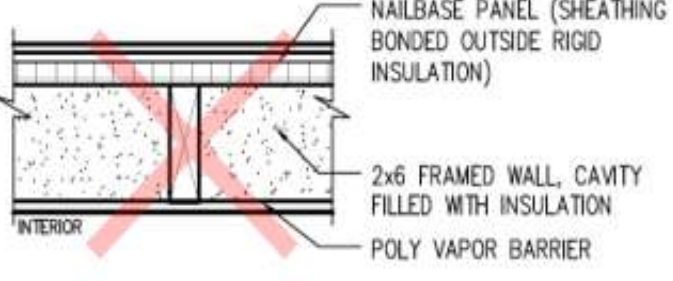
Prescriptive Compliant Wall Assembly Details

 <p>RIGID INSULATION</p> <p>2x6 FRAMED WALL, CAVITY FILLED WITH INSULATION</p> <p>'SMART' VAPOR BARRIER RECOMMENDED</p> <p>INTERIOR</p>	<p>EXTERIOR RIGID INSULATION</p> <ul style="list-style-type: none"> - Relies on <u>sufficient</u> insulation outboard of the sheathing to keep it above the dewpoint in winter; conservative building science suggests targeting minimum 50% of wall's total R-value outside the sheathing - Smart vapor retarder on the inside slows outward vapor drive yet allows inward drying; poly on interior can make this wall riskier - If exterior rigid is fibrous (e.g. fiberboard), wall can dry outwards depending on properties of exterior layers
 <p>1" FIBERBOARD OR MINERAL WOOL INSULATION</p> <p>VAPOR OPEN SHEATHING</p> <p>2x6 FRAMED WALL, CAVITY FILLED WITH INSULATION</p> <p>CLASS 1 OR 2 VAPOR RETARDER</p> <p>INTERIOR</p>	<p>THIN EXTERIOR RIGID INSULATION – VAPOR OPEN</p> <ul style="list-style-type: none"> - Sheathing spends time below dewpoint in winter, but with proper design, it can dry to both sides while resisting outward moisture drive in winter - Poly on interior limits ability of inward drying, and may increase risk
 <p>NAILBASE PANEL (SHEATHING BONDED OUTSIDE RIGID INSULATION), R-6 MIN. TYP., INSTALLED PER MANUF. INSTRUCTIONS</p> <p>2x6 FRAMED WALL, CAVITY FILLED WITH INSULATION</p> <p>'SMART' VAPOR BARRIER RECOMMENDED</p> <p>INTERIOR</p>	<p>NAILBASE PANEL</p> <ul style="list-style-type: none"> - Sheathing may spend time below dewpoint in winter, but likely first condensing surface is the foam; with proper design and attention to detail, it resists outward moisture drive in winter - Smart vapor retarder on the inside slows outward vapor drive yet allows inward drying; poly on interior limits ability of inward drying, and may increase risk - Limited drying potential, so good taping is important to limit air/vapor passing through

Prescriptive Compliant Wall Assembly Details

 <p>ENTIRE FRAMED CAVITY FILLED WITH INSULATION, R-6 MIN. BETWEEN FRAMING</p> <p>INTERIOR</p>	<p>DOUBLE STUD</p> <ul style="list-style-type: none"> - Depending on detailing, wall can dry in one or both directions - Fibrous insulation adds moisture buffering capability - Poly on interior limits ability of inward drying, and may increase risk
 <p>VARIES</p> <p>EXTERIOR I-JOIST OR LARSEN TRUSS, CAVITY FILLED WITH FIBROUS INSULATION, TYPICAL 50% TOTAL R-VALUE OF WALL</p> <p>2x INNER BEARING WALL. OPTIONAL: FILL WITH INSULATION OR LEAVE EMPTY FOR SERVICE CAVITY</p> <p>INTERIOR</p>	<p>TJI OR LARSEN TRUSS</p> <ul style="list-style-type: none"> - Relies on <u>sufficient</u> insulation outboard of the sheathing to keep it above the dewpoint in winter; conservative building science suggests targeting min. 50% of wall's total R-value outside the sheathing - Depending on detailing, wall can dry in one or both directions - Poly on interior limits ability of inward drying, and may increase risk
 <p>SEALANT, SPLINE, INSTALLED PER MANUFACTURER'S INSTRUCTIONS</p> <p>STRUCTURAL INSULATED PANEL (SIPs)</p> <p>INTERIOR</p>	<p>SIP</p> <ul style="list-style-type: none"> - If detailed correctly, resists moisture movement and there are no internal condensing surfaces - Panel joints must be detailed correctly to avoid failure; note that timber frames may move over time, breaking essential seals, so taped seams (both interior and exterior) <i>in addition to</i> sealed joints recommended
 <p>2x6 FRAMED WALL, CAVITY FILLED WITH INSULATION</p> <p>INTERIOR</p>	<p>STANDARD 2X6</p> <ul style="list-style-type: none"> - Sheathing spends time below dewpoint in winter, but can dry to the exterior (and interior, if smart vapor retarder used rather than poly)

At-Risk Wall Assemblies

 <p>R-5 RIGID INSULATION</p> <p>2x6 FRAMED WALL, CAVITY FILLED WITH INSULATION</p> <p>POLY VAPOR BARRIER</p> <p>INTERIOR</p>	<p>Thin Exterior Rigid Insulation without Drying</p> <ul style="list-style-type: none">➤ Insulation isn't thick enough to prevent the sheathing from spending time below the dewpoint in winter➤ Poly prevents drying inwards and most foamboard limits drying outward; if any moisture finds its way into this wall, it cannot dry quickly or easily➤ Also considered a "vapor barrier sandwich"
 <p>NAILBASE PANEL (SHEATHING BONDED OUTSIDE RIGID INSULATION)</p> <p>2x6 FRAMED WALL, CAVITY FILLED WITH INSULATION</p> <p>POLY VAPOR BARRIER</p> <p>INTERIOR</p>	<p>Nailbase Panel with Poly</p> <ul style="list-style-type: none">➤ Insulation isn't thick enough to prevent the foam/sheathing from spending time below the dewpoint in winter➤ Poly prevents drying inwards and foam layer prevents limits outward; if any moisture finds its way into this wall, it cannot dry quickly or easily➤ Also considered a "vapor barrier sandwich"

Section R402.3 – Fenestration (window/glazing) Summary

- In addition to the u-value requirements in **Table 402.1.2.1** fenestration shall comply with the following guidelines:
 - **R402.3.1 U-Factor**
 - An area weighted average of fenestration products shall be permitted to satisfy the U-factor requirements
 - **R402.3.3 Glazed Fenestration Exemption**
 - Up to 15sq.ft. of glazed fenestration per dwelling shall be exempt from the U-Factor and SHGC requirements of Section R402.1.2. This exemption shall not apply to the U-Factor alternative approach in Section R402.1.4 and the Total UA alternative in Section R402.1.5
 - **R402.3.4 Door Exemption**
 - Up to 24sq.ft. of exterior door assembly is exempt from the U-Factor requirement in Section R402.1.4 with the same restrictions as fenestrations noted above in R402.3.3
 - **R402.5 max Fenestration U-Factor and SHGC**
 - The area-weighted average maximum fenestration *U*-factor permitted using tradeoffs from Section R402.1.5 or R405 shall be 0.30 for vertical fenestration, and 0.55 for skylights.

Section R402.4

Air Leakage

R402.4.1 – R402.4.4.5

- **Table R402.4.1.1** covers the primary and mandatory air leakage pathways that need to be addressed within the building envelope and specific criteria to assemblies and materials used to create a durable and continuous air barrier.

Table R402.4.1.1 – Air Barrier and Insulation Installation

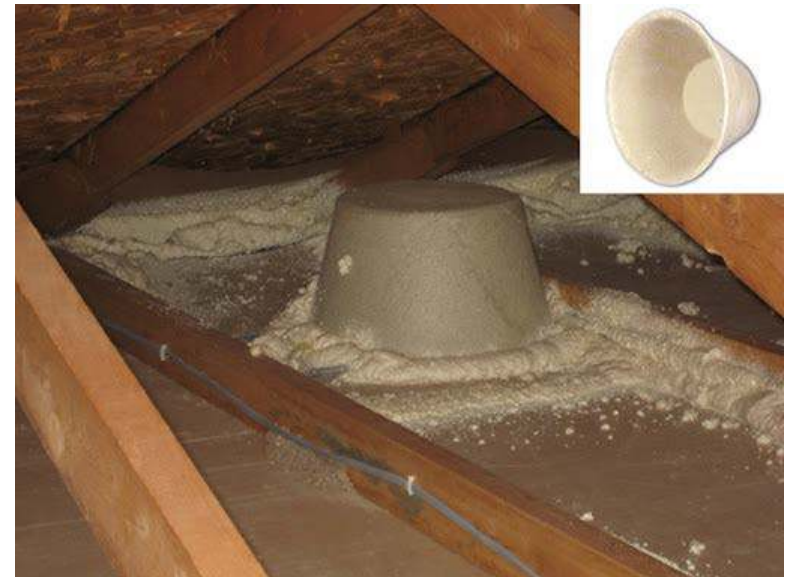
- Table R402.4.1.1 details the requirements for alignment of building air barrier details *with* insulation measures.
- Generally, insulation materials cannot be used also as an air barrier material
 - Exceptions are made for spray foam insulation installed to minimum thicknesses with appropriate vapor mitigation installed as a part of the measure.
- In summary:
 - A continuous, durable air barrier shall be installed in the building envelope. The exterior thermal envelope contains a continuous, durable air barrier. Breaks or joints in the air barrier shall be sealed.
 - An air barrier is defined as any durable solid (non-porous) material that completely blocks air flow between *conditioned space* and *unconditioned space*

Other notable requirements in Table R402.4.1.1

- Floor framing cavity insulation shall be installed to maintain permanent contact with the underside of subfloor decking, or floor framing cavity insulation shall be permitted to be in contact with the top side of sheathing, or with continuous insulation installed on the underside of floor framing and extending from the bottom to the top of all perimeter floor framing members.
- Exposed earth in unvented crawl spaces shall be covered with a Class I vapor retarder with overlapping joints taped. Where provided instead of floor insulation, vapor barrier shall be permanently attached to the crawlspace walls.
- Air sealing shall be provided between the garage and *conditioned spaces*.

Recessed light fixtures and other appliances (speakers, exhaust fans, light shafts, etc.) installed in the building thermal envelope shall be ICAT (Insulation Contact and Air Tight) rated, airtight labeled (or "Washington State Approved") and sealed with a gasket or caulk between the housing and the interior wall or ceiling cover.

Fixtures and appliances shall maintain required clearances of not less than 1/2" from combustible material and not less than 3" from insulation material, or as required by manufacturer's installation requirements



Exterior walls adjacent to showers and tubs shall have a rigid durable, air barrier separating the exterior wall from the shower and tubs and be insulated.



Examples of whole-building air sealing via (a) interior-side air barrier and (b) exterior-side air barrier

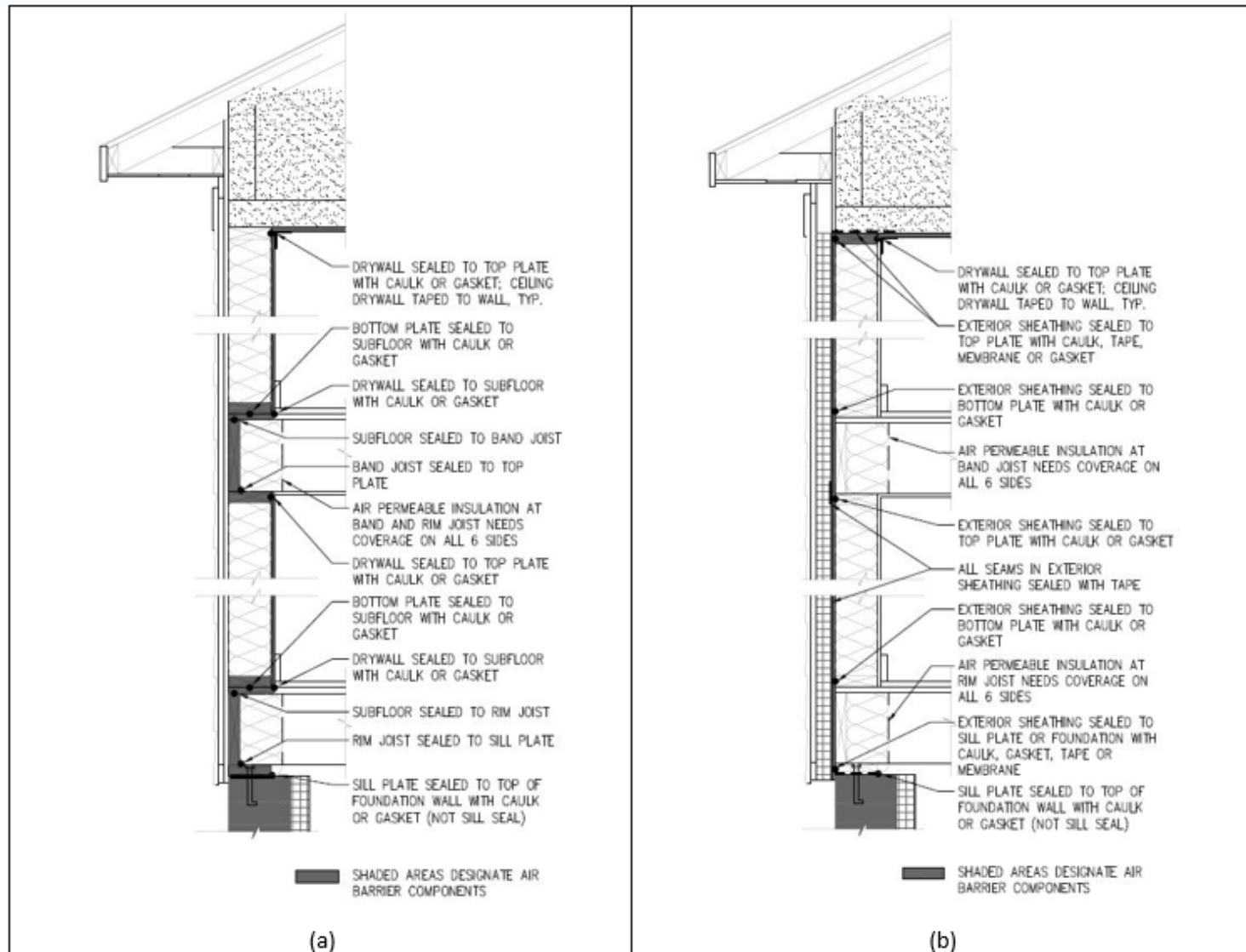
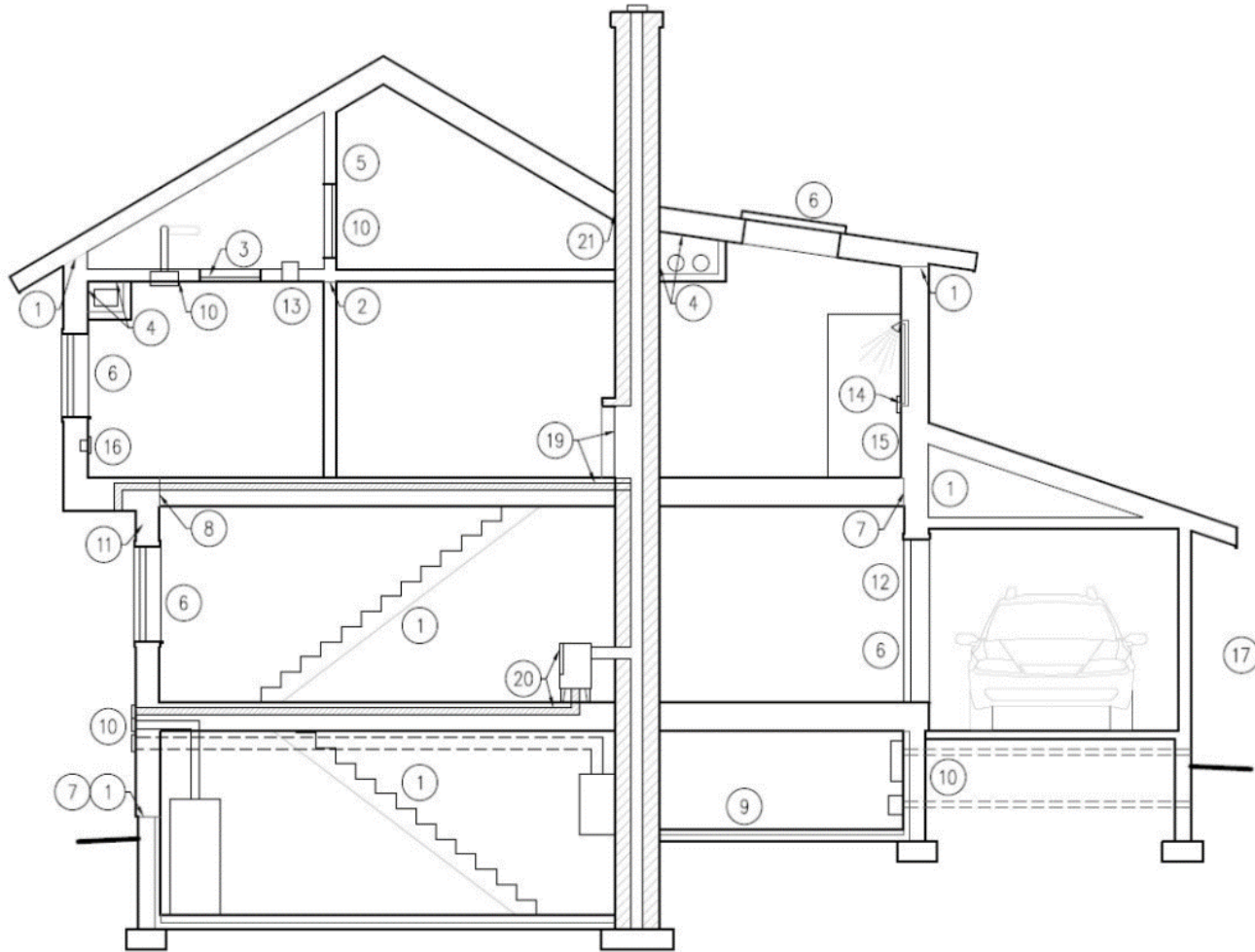


Table R402.4.1.1 – Air sealing checklist corresponding details



Section R402.4.1.2 – Air Leakage Testing

- The *building* or dwelling unit shall be tested and verified as having an air leakage rate not exceeding three (3) air changes per hour 3 ACH/50.
- This testing requirement applies to all new construction and to additions
- Testing shall be conducted in accordance with RESNET/ICC 380, ASTM E779 or ASTM E1827 and reported at a pressure of 50 Pascals.
- Testing and verification shall be conducted by:
 - An applicable Building Performance Institute (BPI) Professional,
 - Home Energy Rating System (HERS) Energy Rater,
 - HERS Field Inspector,
 - A Vermont Department of Public Service approved air leakage tester.
- A written report of the results of the test shall be signed by the party conducting the test. Testing shall be performed at any time after creation of all intentional/operational penetrations of the *building thermal envelope*

Section 402.4.2 – Fireplaces

- New wood-burning fireplaces shall have tight-fitting doors and outdoor combustion air. Where using tight-fitting doors on factory-built fireplaces *listed* and *labeled* in accordance with UL 127, the doors shall be tested and *listed* for the fireplace. Where using tight-fitting doors on masonry fireplaces, the doors shall be listed and labeled in accordance with UL 907.
- Full detail on requirements for solid-fuel (wood/pellet) burning appliances and fireplaces can be found in **Chapter 3 - Section R305.4 / Subsections R305.4.1 – R305.4.3.7**

Another item to note from Section R305 – Combustion Safety

- Any home built to be compliant with the 2020 RBES shall be considered of *unusually tight construction*, as defined by NFPA 54 and NFPA 31.
- Basically this means that any fuel-burning combustion appliances within the building need to be direct-vented (closed combustion) or have outdoor combustion air provided directly to the combustion appliance
- Further detail and the full compliance language can be found in **Section R305 – Combustion Safety**

Section R403 – Systems

- **Section R403** primarily deals with the application and requirements of mechanical systems installed in residential buildings. Items covered include:
 - Controls / thermostats
 - Supplementary heat (disallowed) in heat pump systems other than for defrost
 - Ducts: design/ installation/ testing
 - Mechanical and DHW piping, including circulation systems
 - Mechanical ventilation
 - Equipment sizing – **Manual S and Manual J or equivalent load calculations required for sizing heating and cooling equipment**
 - Snow melt systems
 - Pools and spas

Section R404 – Electrical Power and Lighting Systems

- R404.1 Lighting Equipment
 - Not less than 90 percent of the lamps (or “bulbs”) in permanently installed lighting fixtures shall be high-efficacy lamps. Where multiple replaceable lamps are connected to a permanently installed lighting fixture, the number of lamps is to be used in calculating the percentage.

Section R404 – Continued

- R404.2 Electric Resistance Heating Equipment
 - Heat pumps having supplementary electric resistance heat shall be certified *cold-climate heat pumps* only and shall have controls that, except during defrost, prevent supplementary electric heat operation where the heat pump compressor can meet the heating load.
 - Building heating with electric resistance heating equipment is prohibited.

Section R404.2 – Continued

Exceptions for use of electric resistance heating equipment:

- Replacement of existing electrical resistance units.
- Limited areas where other heating sources are cost prohibitive or impractical (e.g., a small interior space such as a bathroom or stairwell, which is distant from the distribution system).
- Buildings with Cold-Climate Heat Pump(s) as the primary heating system, provided:
 - a. The supplemental electric resistance heat is controlled to prevent it from operating at an outside air temperature of 5°F or higher; and
 - b. The building has a tested air tightness of ≤ 2.0 ACH50.
- 4. Multifamily buildings with heating loads ≤ 6.0 Btu/hour/square foot at design temperature.
- *Buildings served by the Burlington Electric Department (BED) must also receive approval from BED before installing electric resistance heating equipment.

Section R404.3 – Electric Vehicle Charging

- Multi-family developments of 10 units or more shall provide level 1 or level 2 electrical charging stations according to **Table R404.3**
 - If level 1 service is provided, the required EV Charging Parking Spaces shall also be “Level 2 ready” as defined in Section R407.4.
- Single-family residential projects needing to meet Stretch Code are required to have one level 1 parking space with accessible socket

Mechanical Ventilation Requirements

Chapter 3

Section R304

Design Criteria for Residential Ventilation Systems

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 - Definitions**.
- The whole house ventilation system shall be one of two types: “exhaust only” or “balanced.”

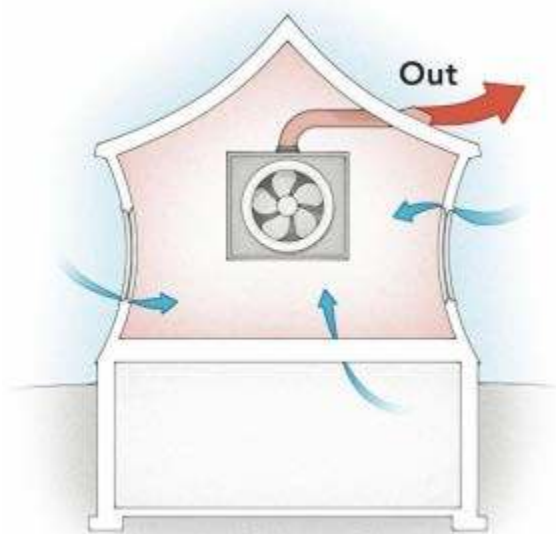
R304.1.1 Compliance

- Compliance with **Section 304** can be achieved Prescriptively by meeting the minimum requirements for fan selection provided in **Table R304.6** and complying with **Sections R304.2** through **R304.11**
- As an alternative to meeting the requirements of **Section R304** by way of the Prescriptive approach, compliance may be demonstrated 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)

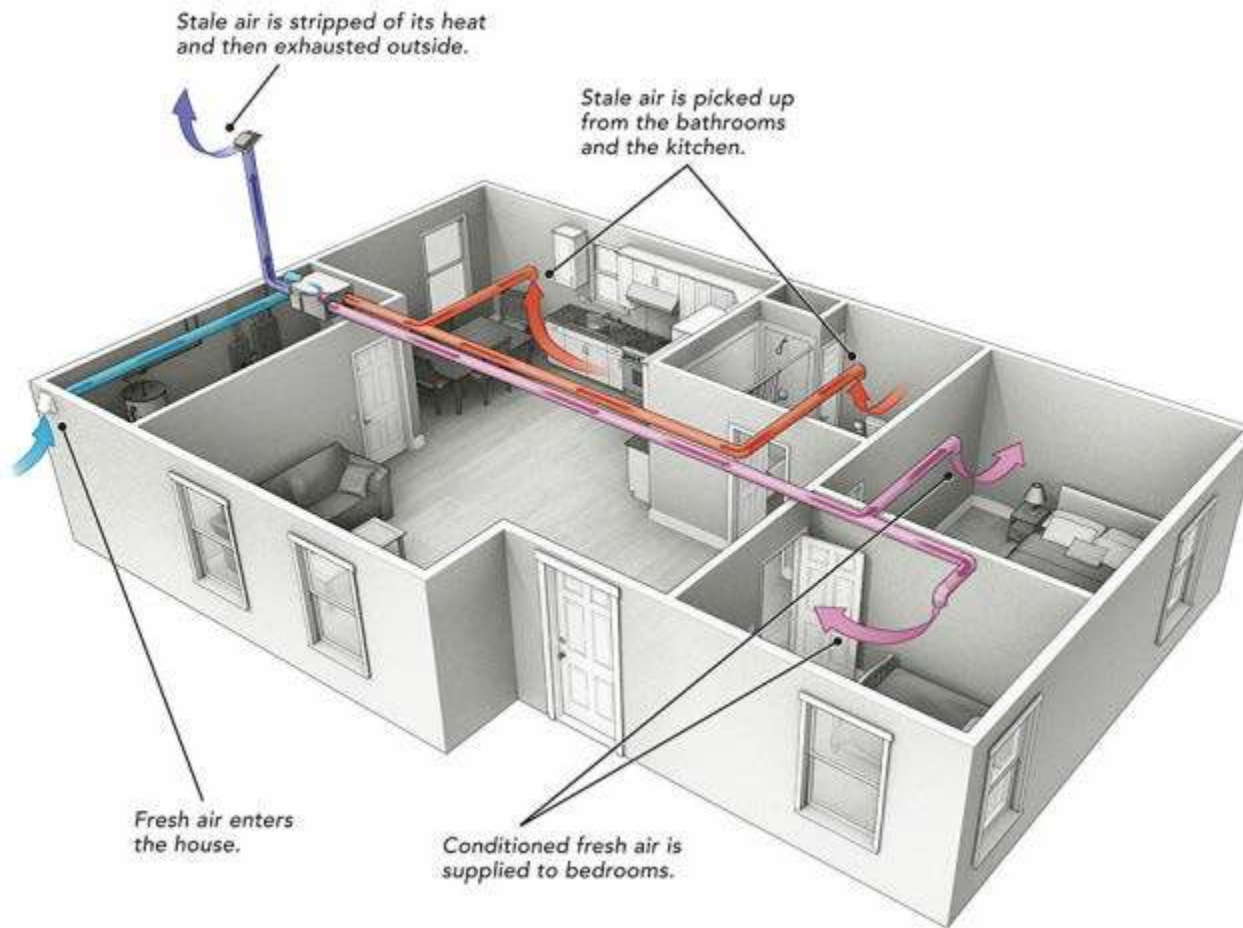
Table R304.6 – Prescriptive Fan Capacity Requirements

Number of Bedrooms	Minimum Rated Capacity (CFM)	Minimum Number of Fans
1	50	1
2	75	1
3	100	1
4	125	Centrally ducted systems: 1, All other systems: 2 or more
5	150	Centrally ducted systems: 1, All other systems: 2 or more
Homes over 3000 sq. ft.	0.05 x sq. ft. of conditioned space	Centrally ducted systems: 1, All other systems: 2 or more

Exhaust Only Ventilation



Balanced Ventilation



Local Ventilation Requirement

- Section R304.2

- 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**

Table 304.2 – Local Ventilation Requirements

TABLE 304.2
MINIMUM REQUIRED LOCAL EXHAUST

OCCUPANCY CLASSIFICATION	MECHANICAL EXHAUST CAPACITY (CFM)
Bathrooms	50 cfm intermittent or 20 cfm continuous

HRV and ERV details

- Base Code
 - HRV or ERV not required for Packages Plus Points
 - HRV or ERV required for
 - U-factor alternative path
 - RES*check* path
- Stretch Code
 - HRV or ERV required
- Where HRV or ERV is required, it must have
 - ECM fan(s)
 - HRV: min. 70% SRE (sensible recovery efficiency) at HVI-listed flow
 - ERV: min. 65% SRE at HVI-listed flow

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.
- **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.

Whole-house Mechanical Ventilation Requirement Summary

- Automatically operated mechanical ventilation is required for every building to manage indoor air quality and moisture. **Not an on/off switch in the bathroom for use after the morning constitutional or shower**
- Not installing a whole-house system can leave you exposed to a lot of potential liability
- The ventilation *system* is an assembly of ventilation equipment (fan / ERV or HRV) and the duct system that delivers the air
- A poorly thought out and installed duct system will lead to poor ventilation and a motivation for the owner to turn off the equipment = problems down the road

Condensation Good.



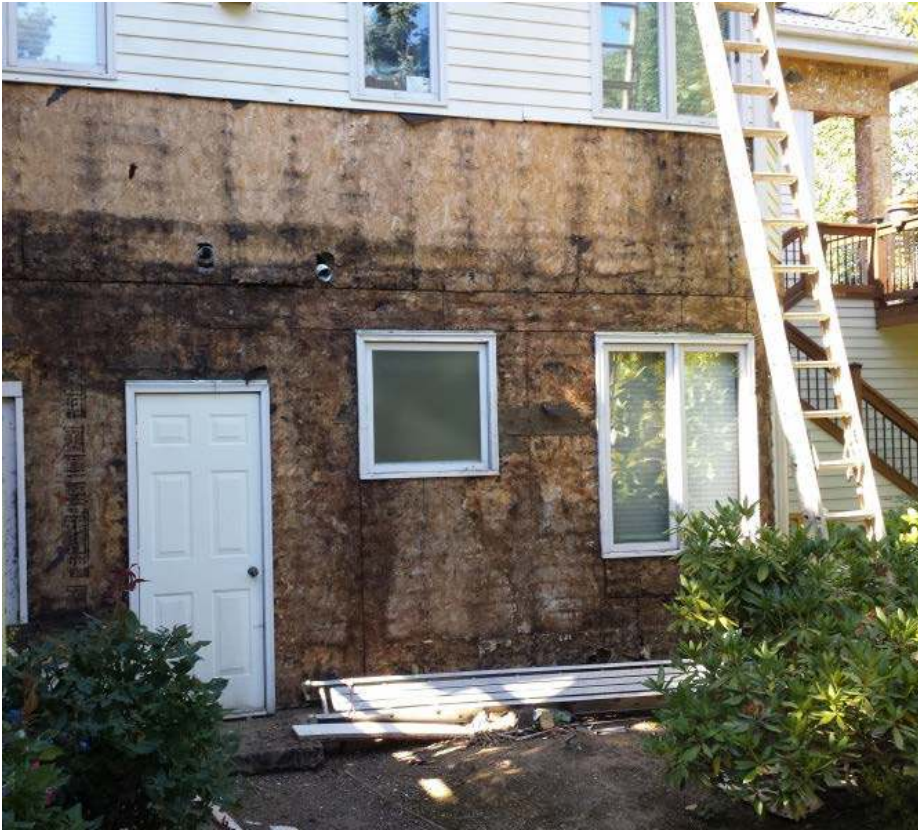
Condensation Bad



Condensation Real Bad..



Wet funk comes in many flavors



Section R304 – Additional Mechanical Requirements

- **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 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.

- Who's got your back?

Efficiency
Vermont



For additional support and any questions regarding the application of the Residential Building Energy Standard:

- Energy Code Assistance Center
20 Winooski Falls Way, 5th Floor
Winooski, Vermont 05404
855-887-0673
- Vermont Public Service Department
Efficiency and Energy Resources Division
112 State Street Montpelier VT 05620-2601
802-828-2811

Thank you!

Steve Spatz

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