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LEEP LOCAL ENERGY EFFICIENCY PARTNERSHIPS NET ZERO ENERGY Wall Assemblies

APPENDIX B: Selection Process for Exterior Insulation in Split-Walls

The following flowchart summarizes the process for designing durable split-insulated wood frame walls in Part 9 buildings with any type or thickness of exterior insulation. The pathway for this process is not necessarily sequential, since design decisions and product selection at any step could impact other aspects (e.g., R-values vs. thickness vs. permeance). The following steps can serve as checkpoints and should be referred to between each step.

1 Determine Target R-Value

Determine the target R-value based on the climate zone and the associated Heating Degree Days, as well as the performance-based energy requirements determined through energy modelling.

2 Calculate Effective R-Value

Calculate the effective R-Value of the proposed wall assembly based on the framing and exterior insulation type and thickness.

3 Select Exterior Insulation Based on Permeance

Check the permeance of the selected exterior insulation type and the resulting insulation ratio requirements.

4 Calculate Insulation Ratio

Determine the required amount of exterior insulation needed based on the ratio of the insulation outboard and inboard of the sheathing.

5 Check Other Design Criteria & Critical Barriers: Vapour, Airflow, Water, Cladding Attachment

Finalize the wall design and check that the vapour, water, and airflow control are appropriate, and consider other factors such as the cladding attachment.

Example Assemblies

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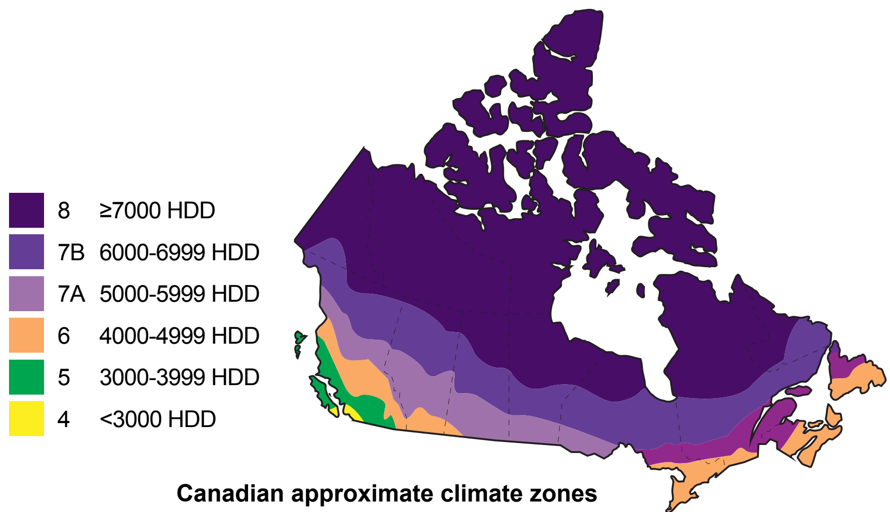
1 Determine Target R-Value

The National Building Code (NBC) sets the minimum required effective R-values in Subsection 9.36.2. Subsections 9.36.7. and 9.36.8. set out improved energy performance requirements (i.e., Tiered Energy Performance Compliance or “Tier Code”) which may use higher R-values. Requirements are separated into six climate zones in Canada based on Heating Degree Days (HDD). Provincial and city building codes typically provide similar framework, including the BC Energy Step Code and the Vancouver Building Bylaw.[1]



Canadian approximate climate zones based on NBC climatic information.

Code Minimum Effective R-values per Climate Zone

NBC Table 9.36.2.6.-A and -B set out the requirements for the minimum effective thermal resistance of above-ground opaque wall assemblies. The NBC Tiered Energy Performance Compliance sets out improved energy efficiency compliance pathways which may include higher wall R-value requirements.

	Zone 4	Zone 5	Zone 6	Zone 7A	Zone 7B	Zone 8
Code Minimum	R- 15.8	R- 17.5	R- 17.5	R- 17.5	R- 21.9	R- 21.9
Tier/Step Code	generally up to R-30 to R-40, potentially higher depending on building design and climate zone					

only two prescriptive R-values higher than what an insulated 2x6 wall can achieve

The R-value requirement can then be used to approximate the assembly configuration based on typical R-value ranges for split-insulated walls. Note that the accompanying wall assembly guides discussing exterior insulation were developed with as the assumed target of approximately R-35 effective.

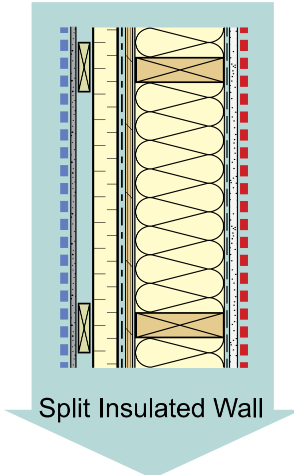
Table B-1 Typical Effective R-values of Split-Insulated Wall Assemblies

Thickness of Ext. Ins.	2x4 Framed Wall (w/ R-12 Batts)		2x6 Framed Wall (w/ R-19 Batts)	
	R-4 / inch Ext. Ins.	R-5 / inch Ext. Ins.	R-4 / inch Ext. Ins.	R-5 / inch Ext. Ins.
1"	15.4	16.4	20.3	21.3
2"	19.4	21.4	24.3	26.3
3"	23.4	26.4	28.3	31.3
4"	27.4	31.4	32.3	36.3
5"	31.4	36.4	36.3	41.3
6"	35.4	41.4	40.3	46.3

23% framing factor assumed, consistent with standard 16" o.c. framing practices

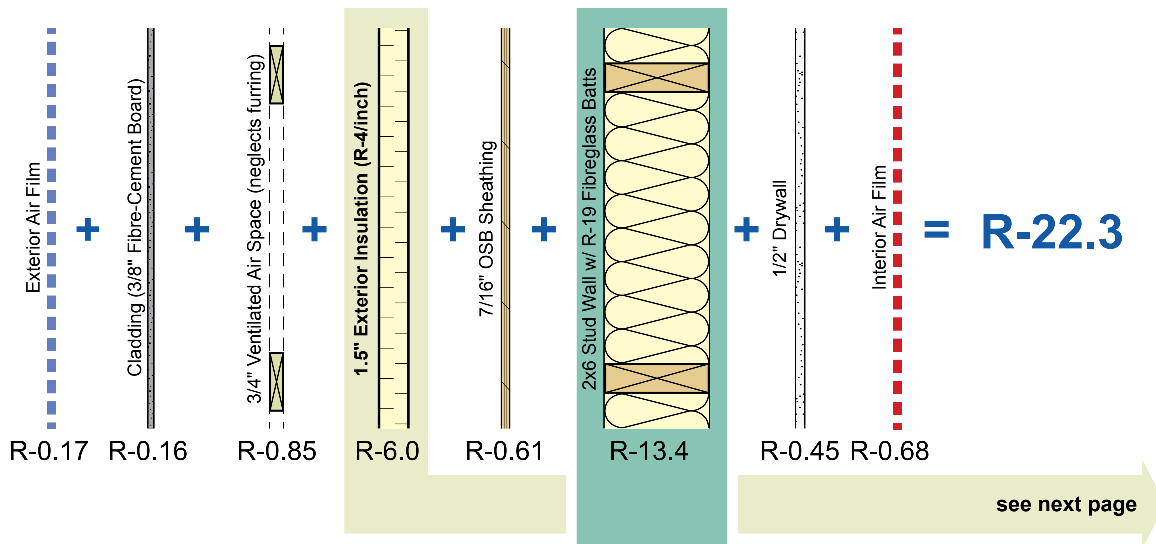
[1] *Refer the BC Energy Step Code Builder Guide published by BC Housing.*

2 Calculate Effective R-value



Once the minimum requirements are determined and the backup wall framing and insulation are approximated, the effective R-value of the wall can be calculated using the Isothermal-Planes and Parallel-Path Flow methods as outlined in NBC 9.36.2.4. The following diagram shows an example calculation of the effective R-value for a split-insulated wall assembly.

Isothermal Planes Method: Add the effective thermal resistance of all layers with continuous materials together



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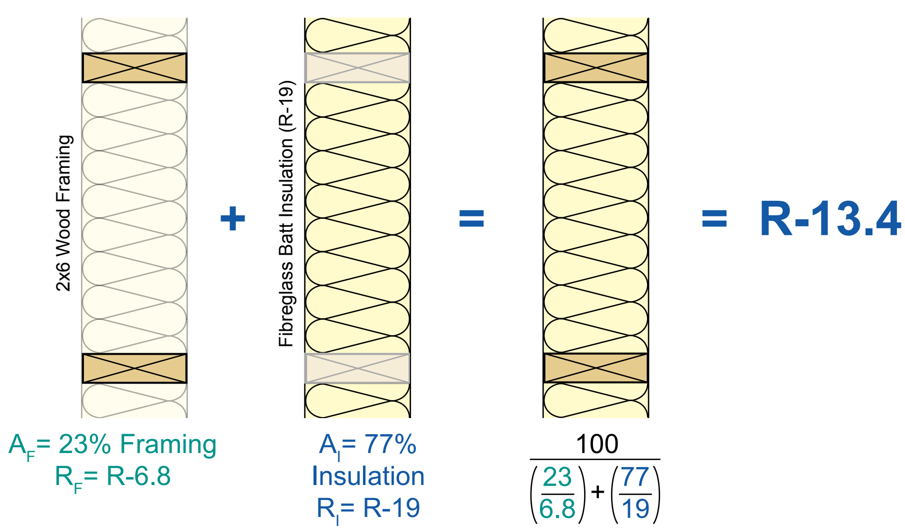
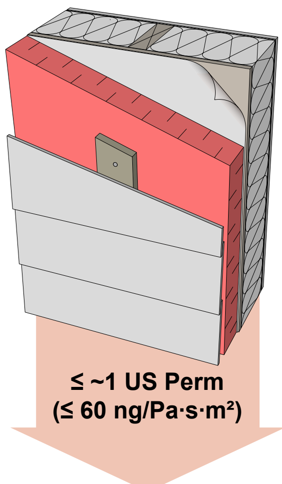
Parallel Paths Method: Calculate the combined thermal resistance of a section of wood framing and adjacent insulated cavity portion (i.e. area weighted U-value calculation)



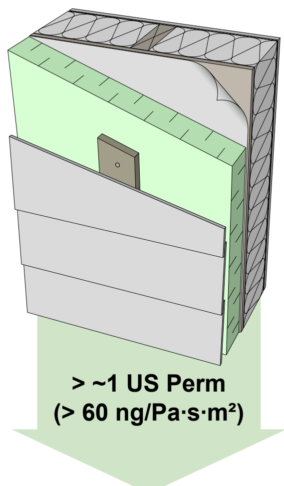
3 Select Exterior Insulation Based on Permeance

From a Code compliance perspective for moisture durability and condensation risk, there are two functional categories of exterior insulation: low permeance insulation, and permeable insulation. There are many insulation types, including those with "borderline" permeance that don't fit neatly into the functional categories. The selection of the insulation type and thickness, R-value, and its resulting permeance, determines several important design constraints for the wall assembly, starting with the **insulation ratio.**

Low Permeance Insulation



Permeable Insulation



Insulation with permeance close to 1 US perm must be carefully considered

Triggers Requirements for Placement/Ratio*:
An assembly with low permeance exterior insulation must comply with NBC Table 9.25.5.2. for minimum ratios and be designed to account for the constraints discussed later in this flowchart.

Exempt from Requirements for Placement/Ratio:
An assembly with permeable exterior insulation is not required to comply with NBC Table 9.25.5.2. Considerations for permeable exterior insulations are discussed later in this flowchart.

Table B-2 Approximate Dry Cup Permeance of Typical Exterior Insulation Types (US perms)

	1"	2"	3"	4"	5"	6"	7"	8"
XPS	0.9	0.4	0.3	0.2	0.2	0.1	0.1	0.1
Closed Cell Spray Foam	1.7	0.9	0.6	0.4	0.3	0.3	0.2	0.2
Polyiso with Fiberglass Facer	2.0	1.0	0.7	0.6	0.4	0.4	0.3	0.3
Polyiso with Foil Facer	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
EPS/GPS with Poly Facer	0.5	0.3	0.2	0.1	0.1	0.1	0.1	0.1
Unfaced EPS/GPS Type 2	3.5	1.8	1.2	0.9	0.7	0.6	0.5	0.4
Unfaced EPS/GPS Type 1	5.2	2.6	1.7	1.3	1.0	0.9	0.7	0.7
Wood Fiber Board	9.1	4.6	3.0	2.3	1.8	1.5	1.3	1.1
Hybrid Open Cell Spray Foam	20.5	10.3	6.8	5.1	4.1	3.4	2.9	2.6
Open Cell Spray Foam	60.2	30.1	20.1	15.1	12	10	8.6	7.5
Rigid Mineral Wool	88.8	49.5	29.6	22.2	17.8	14.8	12.7	11.1
Cellulose	92.3	46.1	30.8	23.1	18.5	15.4	13.2	11.5
Rigid Fiberglass	145	72.5	48.4	36.3	29	24.2	20.7	18.1

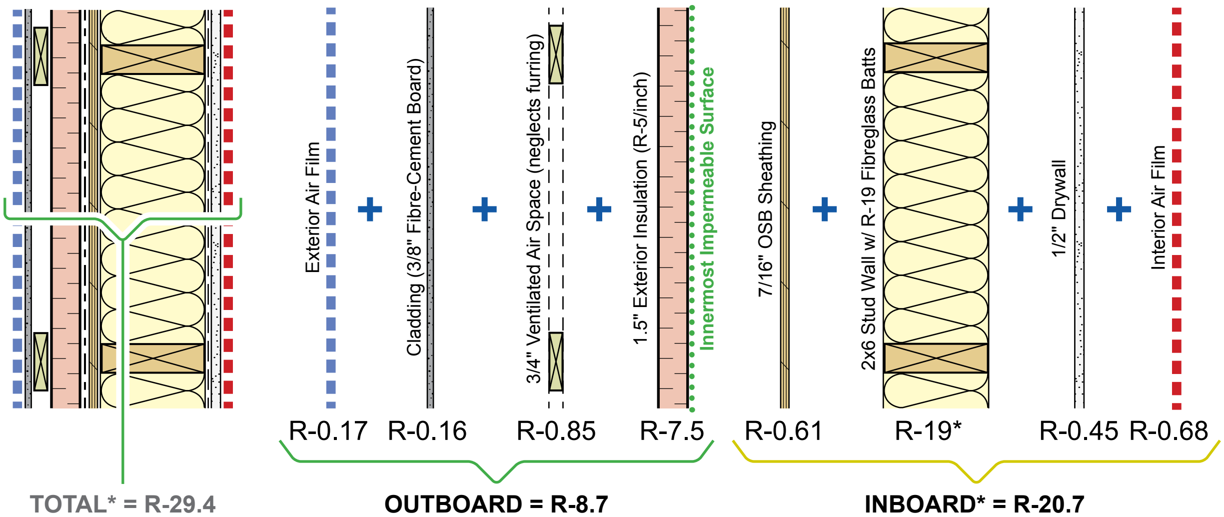
≤ ~1 US perm triggers ratio requirements*

**Code ratio requirements do not apply to exterior insulation that is at least R-4, at least 0.5 perms, and used in climates below 6000 HDD. These provisions are not discussed in this flowchart.*

4 Calculate Insulation Ratio

The Code requirement for the assembly insulation ratio is triggered when low permeance insulation is used. The Code-defined calculation is given as the ratio between the total thermal resistance (R-value) of all materials outboard of the innermost impermeable surface of the exterior insulation and the total thermal resistance of all materials inboard of that surface. **The higher the R-value of the exterior insulation, the higher the insulation ratio**.

Example Wall Assembly Ratio Calculation (excluding effects of framing per A-9.25.5.2.):



The ratio between the outboard R-value and the total R-value is shown below for reference.

$$\text{CODE INSULATION RATIO} = \frac{\text{OUTBOARD}}{\text{INBOARD}} = \frac{8.7}{20.7} = 0.42$$

$$\text{TOTAL INSULATION RATIO} = \frac{\text{OUTBOARD}}{\text{TOTAL}} = 0.30$$

Table B-3 Excerpt from NBC Table 9.25.5.2. Insulation Ratio Requirements

Heating Degree Days (HDD)	**Table 9.25.5.2. Minimum Ratio of Outboard to Inboard R-value for Low Permeance Exterior Insulation**	Corresponding Ratio of Outboard to Total R-value
Up to 4 999	0.2	0.17
5 000 to 5 999	0.3	0.23
6 000 to 6 999	0.35	0.26
7 000 to 7 999	0.4	0.29
8 000 to 8 999	0.5	0.33
9 000 to 9 999	0.55	0.35
10 000 to 10 999	0.6	0.38
11 000 to 11 999	0.65	0.39
12 000 or higher	0.75	0.43

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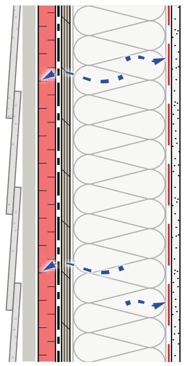
4 Insulation Ratio: Limitations of Code-Minimum Exterior Insulation Ratios (NBC 9.25.5.2.)

A wall assembly with low permeance exterior insulation must account for the following design constraints.

code-minimum

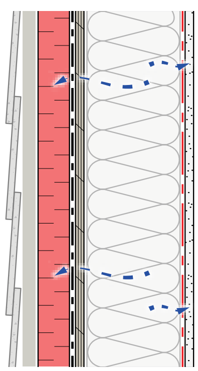


Code-Minimum Insulation Ratio

While a wall assembly with the code-minimum insulation ratio for low permeance exterior insulation can perform adequately, it has the following limitations (per NBC A-9.25.5.2.):

- The code-minimum ratios are intended to help avoid significant accumulation of moisture within the assembly during most of the heating season.
- However, the code-minimum ratios are based on maintaining a maximum average indoor relative humidity of 35% during the winter in colder climates.
- As discussed on the following page, it can be difficult to grantee this limitation is followed during the life of the building. Elevated indoor relative humidity conditions can result in high relative humidity conditions (at or above 80% RH) and condensation in the wall, which can lead to fungal growth and degradation.
- As such, code-minimum insulation ratios should be carefully considered. Increased ratios above code minimum are always beneficial.

better



Low Insulation Ratio

A wall assembly with a slightly increased ratio above code-minimum can more easily manage potential risks from higher indoor relative humidity:

- More exterior insulation means warmer interior layers, including the wall sheathing and framing. More exterior insulation is always beneficial.
- Having warmer interior layers reduces the risk of high relative humidity conditions and condensation in the wall especially during elevated indoor relative humidity conditions.
- Note that the wall is still considered as having a low ratio, so it still needs an interior vapour retarder.
- Using an interior variable vapour retarder membrane (i.e.,“smart vapour barrier”) or vapour barrier paint, instead of 6 mil poly, can help reduce the risk of trapping moisture in the assembly (see page B-8).

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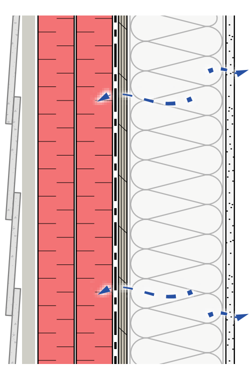


High Insulation Ratio

To further reduce the risks associated with low permeance exterior-insulation, even higher ratios can be used:

- High R-value exterior insulation keeps the wall structure and sheathing warm and removes the risk of condensation and high relative humidity conditions in the wall.
- When there is enough exterior insulation (i.e., the wall has a “high ratio”), an interior vapour retarder is not needed.
- Instead, the low permeance exterior insulation can serve as the vapour retarder alone.
- When there is no interior vapour retarder, the wall assembly permits inward drying and doesn't risk trapping moisture.

see next page

4 Insulation Ratio: Increased Exterior Insulation Ratio Beyond Code-Minimum

The following table provides recommended “low ratio” and “high ratio” insulation ratios for walls with low permeance exterior insulation.

While code-minimum ratios are acceptable for standard indoor relative humidity conditions, the recommended ratios provide confidence that a low ratio assembly will meet the intended long-term durability performance requirements when subject to higher indoor relative humidity conditions compared to what the Code assumes. See below for more information on higher indoor relative humidity conditions.

High ratios are given for walls without an interior vapour barrier, both for standard and for higher indoor relative humidity conditions, to prevent the temperature of the inside face of the insulation from falling below the dew point of the indoor heated air. These recommendations are based on industry research as well as dew point calculations for each climate zone (see References on page B-16). Note that Part 9 of the Code requires that wall assemblies either have a dedicated vapour retarder (which the low permeance exterior insulation provides) or be designed by a qualified design professional.

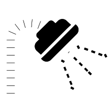
Table B-4 Recommended Ratios of Outboard to Total R-value to Keep the Sheathing Reliably Below 80% RH for Assemblies with Low Permeance Exterior Insulation ≤ ~1 US perm[1]

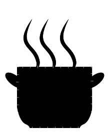
Climate Zone	Heating Degree Days (HDD)	**Low Ratio** Higher Indoor Relative Humidity Interior Vapour Retarder Required[2]	**High Ratio** Interior Vapour Retarder not Required[3]	
			Standard Indoor Relative Humidity	Higher Indoor Relative Humidity
4	<3 000	0.21	0.29	0.50
5	3 000–3 999	0.25	0.33	0.55
6	4 000–4 999	0.29	0.47	0.57
7A	5 000–5 999	0.33	0.57	0.63
7B	6 000–6 999	0.37	0.63	0.70
8[1]	7 000–7 999	0.41	0.75	0.80
	8 000–8 999	0.45		
	9 000–9 999	0.49		
	10 000–10 999	0.53		
	11 000–11 999	0.57		
	≥12 000	0.61		

[1] For wall assemblies in extreme climates, with borderline insulation ratios, or with borderline exterior insulation permeance, consult with a qualified design professional.

[2] Recommended ratios are based on assemblies with an interior variable vapour retarder membrane (i.e.,“smart vapour barrier”) or vapour barrier paint, with a permeance of not more than 60 $ng/Pa \cdot s \cdot m^2$ (dry cup).

[3] Part 9 of the Code requires that wall assemblies either have a dedicated vapour retarder (which the low permeance exterior insulation provides) or be designed by a qualified design professional.





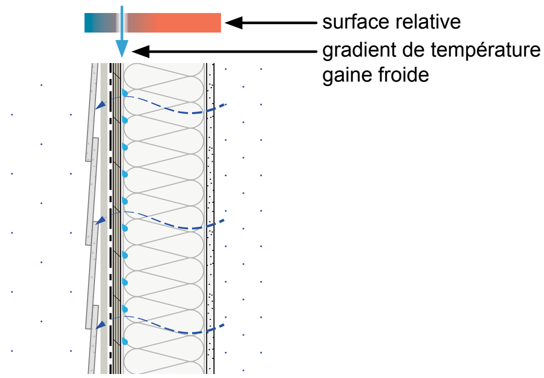
Higher Indoor Relative Humidity Conditions

In a smaller airtight home where many occupants regularly bathe and cook, or where humidifiers are regularly used, the average indoor relative humidity may be higher than a similarly occupied larger home or a home operating under standard conditions. As indicated in the table above, higher relative humidity conditions can be counteracted with higher insulation ratios.

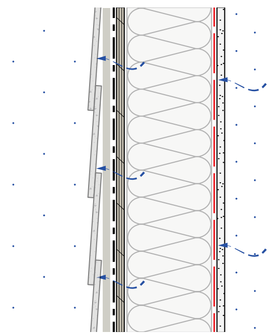
For the purpose of this guide, homes with higher indoor relative humidity conditions do not include high humidity loads such as indoor pools, hot tubs, and saunas. These cases require professional design under Part 5 of the Code.

4 Insulation Ratio: Why Does Low Permeance Insulation Ratio Matter Beyond Code Compliance?

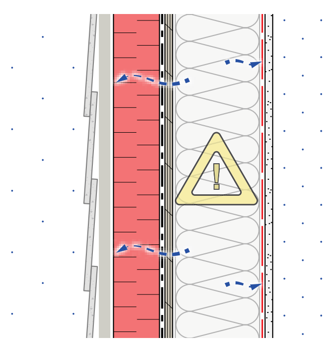
The presence of low permeance exterior insulation impacts the moisture durability of the wall assembly if the balance of the potential for wetting versus drying is not properly accounted for. The following figures show the impact of different exterior insulation levels and vapour control strategies.



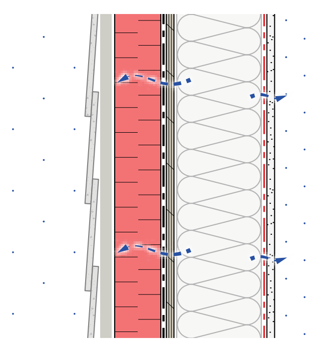
Wall without exterior insulation or interior vapour control (not Code compliant): Vapour is driven from interior to exterior during colder weather. A wall assembly without exterior insulation or interior vapour/airflow control is at risk of condensation on the cold surfaces below the dew point temperature (typically the interior surface of the sheathing).



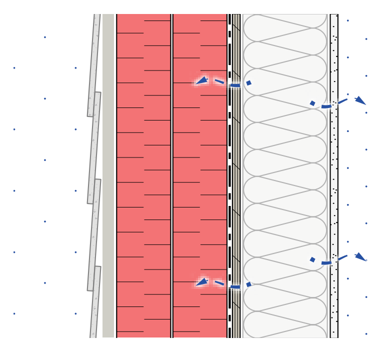
Wall with interior vapour control: A typical interior-insulated wall assembly uses interior vapour/airflow control to limit the outward vapour drive and condensation risk. However, the exterior materials are typically permeable and so they allow outward vapour flow to prevent moisture build up, even if condensation does occur.



Wall with exterior and interior very low permeance vapour control



Wall with higher permeance interior vapour control

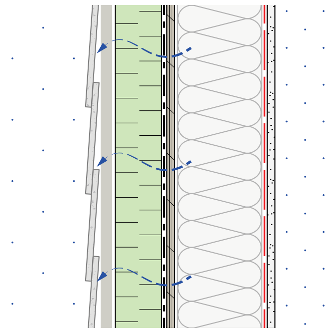


Wall with high insulation ratio and no interior vapour control required

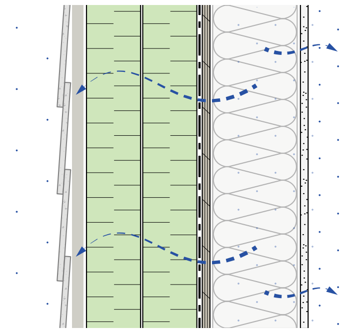
Exterior insulation keeps the sheathing warmer and reduces condensation risk, so it is always beneficial. However, low permeance exterior insulation limits vapour flow and drying. While not explicitly stated in the Code, low permeance exterior insulation essentially acts as a new vapour retarder in the wall assembly. So if an interior vapour retarder is also present, then there are two vapour retarders. In this scenario, moisture can get trapped in the assembly (left figure). Potential moisture sources include condensation, leakage, and built-in construction moisture. This is especially true for walls with very low permeance exterior insulation (0.1 perm) and a conventional 6 mil poly interior vapour retarder (0.1 perm). If low permeance exterior insulation can't be avoided, using a more permeable interior vapour retarder like smart vapour barrier or vapour barrier paint (typically around 1 perm) can allow some inward drying if needed over the long term (centre figure).

On the other hand, a high insulation ratio (see Table B-4) keeps the wall warm enough to avoid condensation, so an interior vapour retarder is not needed. In this scenario, the assembly can more easily accommodate moisture in the assembly since it allows inward drying (right figure). Note that Part 9 of the Code requires that wall assemblies either have a dedicated vapour retarder (which the low permeance exterior insulation provides) or be designed by a qualified design professional.

4 Insulation Ratio: What About Permeable Exterior Insulation?



Permeable exterior insulation allows vapour to flow through to the exterior if needed for drying, so there are no ratio requirements for this assembly. Note that while exterior insulation with a permeance of at least 60 ng/Pa·s·m^2 can be considered permeable, insulation with permeance of 300 ng/Pa·s·m^2, and even higher, provides more confidence that the assembly will readily permit outward drying.



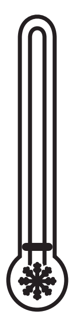
When a high ratio is used, the wall is kept warm enough so the interior vapour retarder can be omitted. Note however that Part 9 of the Code requires that wall assemblies either have a dedicated vapour retarder or be designed by a qualified design professional.

Table B-5 Recommended Outboard to Total R-value Ratios for High Ratio Assemblies With Permeable Exterior Insulation

Interior Vapour Retarder not Required[1]

Climate Zone	Standard Indoor Relative Humidity	Higher Indoor Relative Humidity
4	0.29	0.50
5	0.33	0.55
6	0.47	0.57
7A	0.57	0.63
7B	0.63	0.70
8	0.75	0.80

[1] *Part 9 of the Code requires that wall assemblies either have a dedicated vapour retarder or be designed by a qualified design professional.*



High Ratio Walls: Average Wintertime Outdoor Temperature

The average outdoor temperature has a large impact on the surface temperatures at the various layers throughout the wall assembly. In colder conditions, the wall sheathing can become cold enough to allow condensation on its interior surface.

To avoid this risk, the insulation ratio for high ratio walls with no interior vapour retarder should also account for the wintertime average outdoor temperature, and be high enough to keep the wall sheathing warm. The climate zone/Heating Degree Days categories shown in Table B-4 and Table B-5 roughly correlate to wintertime outdoor temperature, but the temperature average for the specific project location should also be checked based on local weather data. Refer to the References section for more information.

Beyond Insulation Ratios:

The wall design must consider the various other important critical barriers in the wall assembly in response to the insulation type and ratio chosen.

see next page

5 Check Other Design Criteria & Critical Barriers

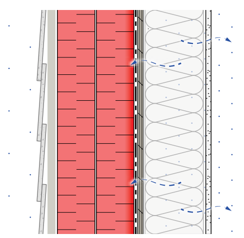
The arrangement of the other components and layers in the wall assembly must account for the exterior insulation type and thickness chosen. This includes the vapour control layer, the air barrier, the water resistive barrier, and the cladding installation.

5a Vapour Control

Assembly <u>Interior</u> Vapour Control Based on Exterior Insulation Type and Thickness

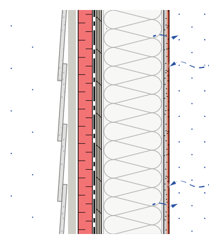
Low Permeance Insulation

XPS • Polyiso • Thicker/Faced EPS/GPS
Closed Cell Spray Foam



High Ratio

- Vapour flow is controlled by the exterior insulation.
- Vapour diffusion drying to interior is desirable.
- No interior vapour retarder is necessary.

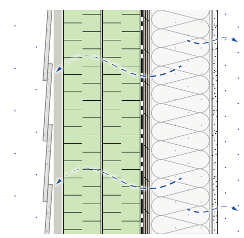


Low Ratio

- Smart vapour barrier material or vapour barrier paint is recommended to facilitate some inward drying, while still limiting outward vapour diffusion.

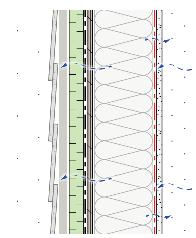
Permeable Insulation

Mineral Wool • Wood Fibre • Fibreglass •
Open Cell Spray Foam • Thinner Unfaced EPS/GPS



High Ratio

- Vapour diffusion drying occurs both outwards and inwards when conditions permit.
- No interior vapour barrier is necessary.
- A qualified design professional may need to be involved.

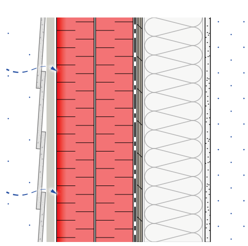


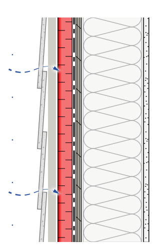
Low Ratio

- Vapour diffusion drying occurs outwards as well as inwards depending on interior vapour control.
- 6 mil poly, smart vapour barrier, or vapour barrier paint can be used.

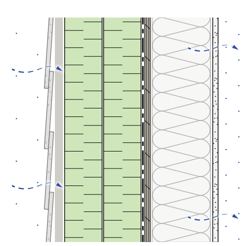
see Table B-4

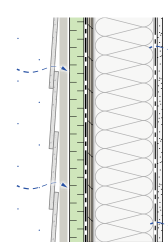
<u>Inward</u> Vapour Drive Control Based on Exterior Insulation Type and Thickness





- Inward vapour flow is limited by the rainscreen space behind the cladding and the low permeance exterior insulation.

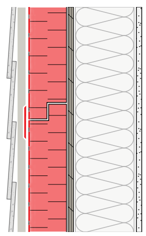




- Inward vapour flow is limited by the rainscreen space behind the cladding, and vapour diffusion drying can still occur in both directions when conditions permit.

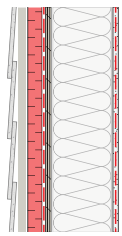
5b Airflow Control

Assembly Airflow Control Based on Exterior Insulation Type and Thickness



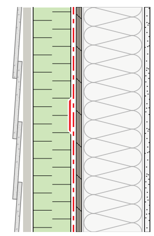
Exterior or mid-wall approaches most desirable:

- Airtight/sealed foam insulation
- Sealed sheathing membrane (exterior or mid-wall)
- Sealed sheathing



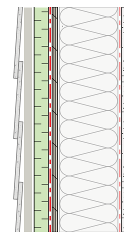
Risk of convective looping within cavity; provide some interior airtightness regardless:

- Sealed polyethylene
- Sealed sheathing
- Spray foam
- **At least airtight drywall**



Mid-wall approaches most desirable:

- Sealed sheathing
- Sealed sheathing Membrane
- Interior approaches also possible

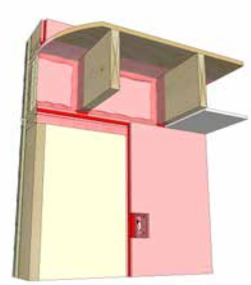


Mid-wall approaches most desirable:

- Sealed sheathing
- Sealed sheathing membrane
- Risk of convective looping within cavity; provide some interior airtightness.

Example Wall Air Barrier (AB) Types

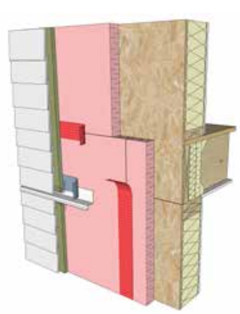
Sealed Polyethylene



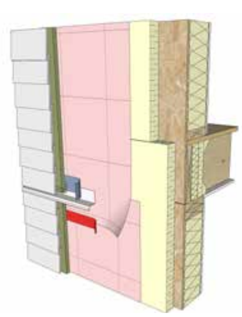
Airtight Drywall

Airtight Spray Foam

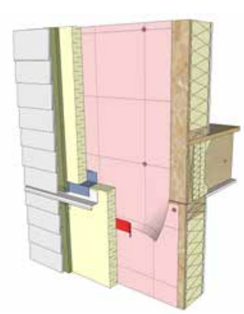
Sealed Interior Sheathing



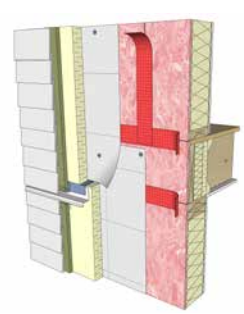
Airtight/Sealed Foam



Sealed Sheathing Membrane over Exterior Insulation



Sealed Sheathing Membrane



Sealed Exterior Sheathing

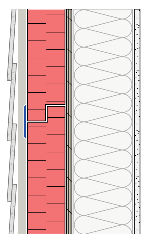
5c Water Management

The moisture index (MI) is a code-defined method of categorizing the potential exposure risk to rain moisture based on the building's location and climate (see 9.27.2.2. and NBC Appendix C).

Selection of Water Resistive Barrier (WRB) and cladding based on exposure and exterior insulation type

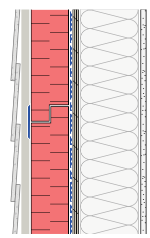
Low permeance exterior insulation can trap moisture against the wall structure. Therefore, additional moisture protection is needed, especially in locations with a Moisture Index above 0.9 per NBC Appendix C Climatic Data.

Low to Moderate Moisture Index (<0.9)

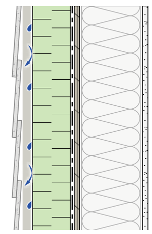


- Taped/sealed foam
- All details/flashings can be located on the exterior face of the foam

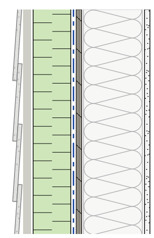
High to Severe Moisture Index(≥0.9)



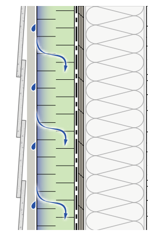
- Taped/sealed foam with WRB behind
- Include drainage space behind foam (see below):



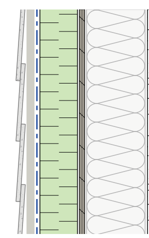
Moisture Tolerant Permeable Insulation
Mineral Wool • Thinner Unfaced EPS/GPS • Open Cell Spray Foam



- Permeable WRB behind exterior insulation or applied over exterior insulation

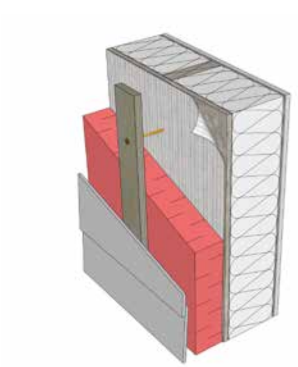


Moisture Sensitive Permeable Insulation
Wood Fibre • Fibreglass

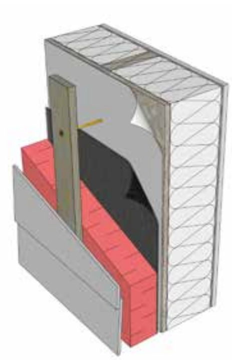


- Permeable WRB installed over exterior insulation
- All details/flashing on the exterior face of the insulation

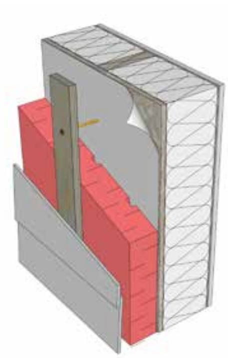
Options for Drainage Space Behind Lower Permeance Insulation for High Wetting Risk Conditions



Vertically grooved, textured, or dimpled sheathing membrane



Open-mesh drain mat

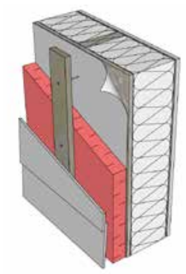


Vertically grooved insulation

5d Cladding Attachment

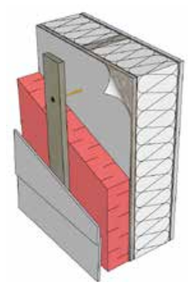
Selection of cladding attachment method based on exterior insulation type and thickness

≤2" Thick



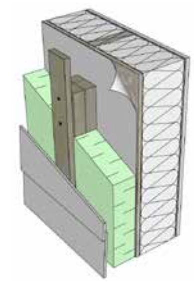
Nail/screw directly through insulation or use strapping and long nails/screws

>2" Thick



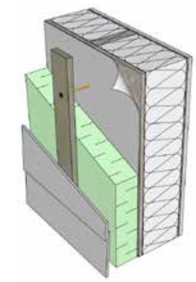
Use strapping and long screws

Semi-Rigid Permeable*

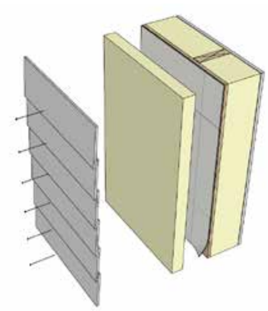


Clips or blocking through exterior insulation

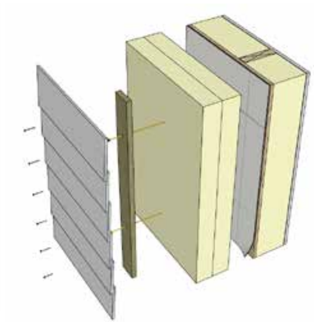
Rigid Permeable

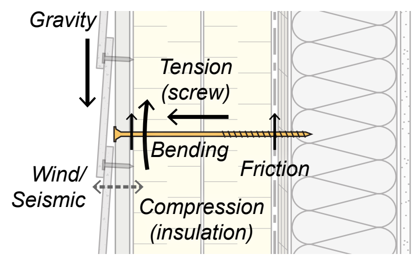


Same guidance as for lower permeance rigid insulation



Nail/screw directly through thin rigid insulation

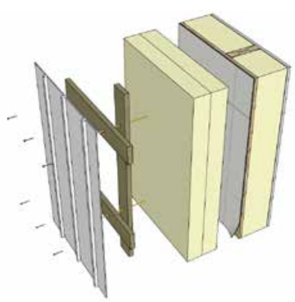




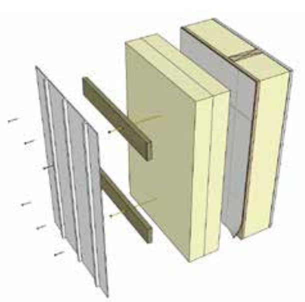
Service load state (section view)

Screws through vertical strapping and rigid insulation into backup wall assembly

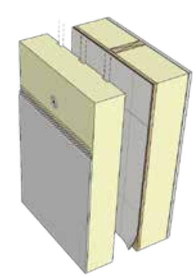
Other cladding attachment methods through exterior insulation



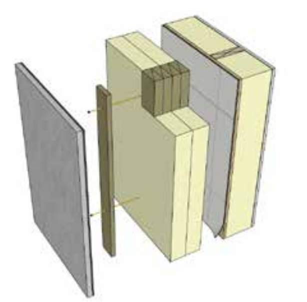
Cross-strapping for vertically-oriented cladding



Horizontal strapping for vertically-oriented cladding (where rainscreen not required)



Exterior insulation finish system (EIFS) with drainage channels behind insulation (see 9.27.13)

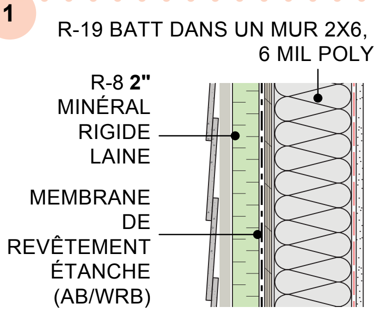


*Clips or blocking for heavy-weight cladding, semi-rigid insulation, or spray foam

Example Assemblies

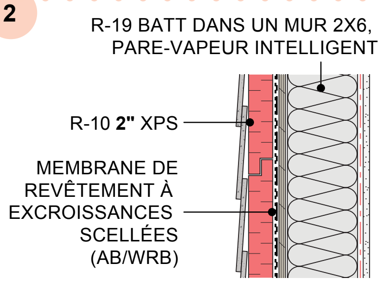
The following wall assembly examples show ratios and analysis based on the guidance in this flowchart, including using higher ratios than required by code-minimum to account for higher potential indoor relative humidity conditions.

1



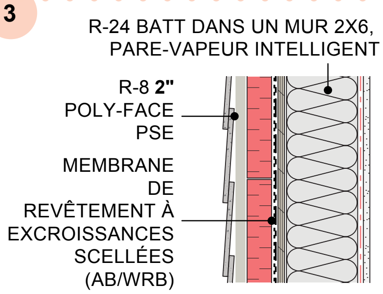
Are there ratio requirements?	No (permeable exterior insulation)
Outboard to total R-value ratio?	**0.31**
Appropriate climate zone(s)?	Any
Approx. effective R-Value?	R-24.3
Additional notes	Permeable insulation allows for standard practices and efficiently boosts R-value

2



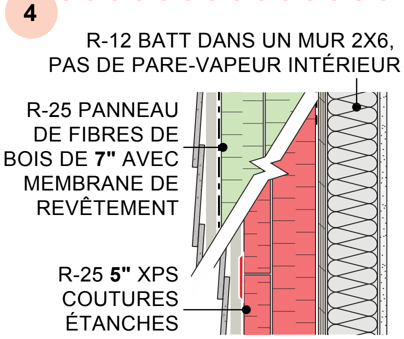
Are there ratio requirements?	Yes (low permeance exterior insulation)
Outboard to total R-value ratio?	**0.33**
Appropriate climate zone(s)?	Thru CZ 7A
Approx. effective R-Value?	R-25.4
Additional notes	Interior vapour retarder is key when using a low ratio wall

3



Are there ratio requirements?	Yes (low permeance exterior insulation)
Outboard to total R-value ratio?	**0.26**
Appropriate climate zone(s)?	Thru CZ 5
Approx. effective R-Value?	R-26
Additional notes	Interior vapour retarder is key when using a low ratio wall

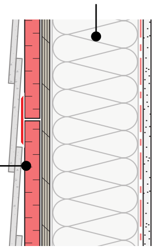
4



Are there ratio requirements?	Yes (no interior vapour retarder)
Outboard to total R-value ratio?	**0.66**
Appropriate climate zone(s)?	Thru CZ 7B, Standard Indoor RH
Approx. effective R-Value?	R-36.4
Additional notes	High ratio is needed to be able to omit the interior vapour retarder regardless of exterior insulation permeance

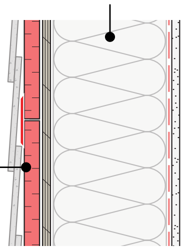
Example Assemblies Continued

5



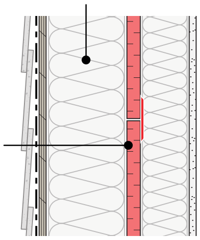
Are there ratio requirements?	Yes (low permeance exterior insulation)
Outboard to total R-value ratio?	**0.23**
Appropriate climate zone(s)?	Thru CZ 4, MI <0.9
Approx. effective R-Value?	R-21.3
Additional notes	Thin low permeance exterior insulation on standard walls with smart vapour barrier can work in milder climates

6



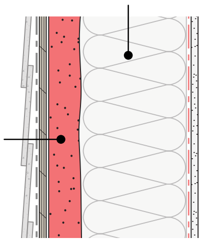
Are there ratio requirements?	Yes (low permeance exterior insulation)
Outboard to total R-value ratio?	**0.18**
Appropriate climate zone(s)?	Not recommended for any
Approx. effective R-Value?	R-27.2
Additional notes	Thin low permeance exterior insulation on a deeper wall is not appropriate for most scenarios

7



Are there ratio requirements?	Yes (low permeance insulation towards the exterior)
Outboard to total R-value ratio?	**0.64**
Appropriate climate zone(s)?	Thru CZ 7B, Standard Indoor RH
Approx. effective R-Value?	R-35
Additional notes	Ratio requirements apply for all low permeance insulation. Refer to LEEP NZE Wall Guide #4 for further guidance on deep wall assemblies

8



Are there ratio requirements?	Yes (low permeance insulation towards the exterior)
Outboard to total R-value ratio?	**0.27**
Appropriate climate zone(s)?	Thru CZ 5, MI <0.9
Approx. effective R-Value?	R-35
Additional notes	Ratio requirements apply for all low permeance insulation. Refer to LEEP NZE Wall Guide #4 for further guidance on deep wall assemblies

References

Recommended ratios in this flowchart are based on a number of industry resources. The primary source is the **Applied Building Technology Group (ABTG) Research Report No. 1410-03** *Assessment of Water Vapor Control Methods for Modern Insulated Light-Frame Wall Assemblies* (including its references). The ratios provided in this report are based on preventing the exterior sheathing from reaching high relative humidity and/or moisture content conditions that can support sustained mould growth and lead to degradation.

- The recommended ratios of outboard to total R-value for low ratio walls under higher indoor relative humidity conditions and with an interior vapour retarder are based on **Table 3 on page 33 of the ABTG Research Report No. 1410-03**.
- The recommended ratios of outboard to total R-value for high ratio walls under standard and higher indoor relative humidity conditions and with no interior vapour retarder are based on **Table 5 on page 45 of the ABTG Research Report No. 1410-03**.

Further to the ratios provided in this flowchart, additional analysis can be used to check how the outdoor wintertime temperature and indoor relative humidity effects the condensation risk at the wall sheathing, for a given location. The most conservative approach is to use the dew point temperature of the indoor air as the cutoff for the minimum sheathing surface temperature. The following table shows the results of a mathematical analysis based on this approach. For more information on calculating temperature gradients and dew point temperatures, refer to the National Research Council of Canada (NRC) Publication Archive *Building Practice Note - Estimating Temperature Gradients and Dew Point Temperatures for Building Envelopes, among other resources*.

Reference Insulation Ratio Table Based on Dew Point and Temperature Gradient Calculations for Average Winter Outdoor Temperature and Various Indoor Relative Humidity Conditions

Average Winter Temperature Low	Average Indoor Wintertime Relative Humidity (21°C Indoor Temperature)				
	20%	30%	40%	50%	60%
0°C	0.0	0.12	0.32	0.47	0.60
-10°C	0.23	0.40	0.54	0.64	0.73
-20°C	0.41	0.55	0.65	0.73	0.57
-30°C	0.53	0.64	0.72	0.78	0.80
-40°C	0.66	0.70	0.76	0.82	0.86

Crandell, J. (2015). Assessment of Water Vapor Control Methods for Modern Insulated Light-Frame Wall Assemblies, ABTG Research Report No. 1410-03, Applied Building Technology Group, rev. 2021

Scheuneman, E. C. (1982). Estimating Temperature Gradients and Dew Point Temperatures for Building Envelopes, National Research Council of Canada Publications Archive

Notes

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