

Proposed Change 2225

Code Reference(s):	NBC25 Div.B 5.9.1.1. (first printing) NBC25 Div.B 9.25.2.2.(1) (first printing) NBC25 Div.B 9.25.2.5.(1) (first printing) NBC25 Div.B 9.36.2.4.(1) (first printing)
Subject:	Environmental Separation
Title:	Introduction of References to CAN/ULC 743.1:2020 and CAN/ULC 743.2:2021
Description:	This proposed change introduces references to CAN/ULC 743.1:2020, "Standard for Thermal Insulation – Low Pressure Applied Two Component Spray Polyurethane Foam, Part 1: Material Specification," and CAN/ULC 743.2:2021, "Standard for Thermal Insulation – Low Pressure Applied Two Component Spray Polyurethane Foam, Part 2: Installation," to the NBC.
Related Code Change Request(s):	CCR 1656, CCR 1657

This change could potentially affect the following topic areas:

- | | |
|--|---|
| ☐ Division A | ☒ Division B |
| ☐ Division C | ☒ Design and Construction |
| ☐ Building operations | ☒ Housing |
| ☒ Small Buildings | ☒ Large Buildings |
| ☐ Fire Protection | ☐ Occupant safety in use |
| ☐ Accessibility | ☐ Structural Requirements |
| ☒ Building Envelope | ☐ Energy Efficiency |
| ☐ Heating, Ventilating and Air Conditioning | ☐ Plumbing |
| ☐ Construction and Demolition Sites | |

Problem

Currently, no explicit requirements related to low-pressure spray-applied two-component polyurethane foam are included in Parts 5 or 9 of the National Building Code of Canada (NBC). Nevertheless, this material is commonly used in practice to provide resistance to heat flow and air movement.

This situation leads to inconsistencies in the use of this material in design and construction across Canada and in the performance of this material where used. These inconsistencies could result in poor thermal barrier performance and poor air barrier performance, which could result in inadequate indoor air quality, mould growth and the reduced resistance to deterioration of wall and roof assemblies.

Justification

Currently, the use of low-pressure spray-applied two-component polyurethane foam in Canada is not governed by minimum requirements in the NBC. Therefore, it is very difficult for building officials to enforce minimum performance requirements for this material, which has led to its inconsistent use in design and construction. To address this situation, this proposed change introduces references to standards in Parts 5 and 9 of the NBC that provide the minimum material and installation requirements for low-pressure spray-applied two-component polyurethane foam.

CAN/ULC 743.1, "Standard for Thermal Insulation – Low Pressure Applied Two Component Spray Polyurethane Foam, Part 1: Material Specification," and CAN/ULC 743.2, "Standard for Thermal Insulation – Low Pressure Applied Two Component Spray Polyurethane Foam, Part 2: Installation,"

- reflect the minimum performance level in terms of material specification and installation,
- are suitable for reference in the NBC,
- would harmonize the minimum performance of this material across Canada, and
- would support minimizing the risks to the health of Canadians caused by poor thermal performance and poor air barrier performance, which could result in inadequate indoor air quality, mould growth and the reduced resistance to deterioration of wall and roof assemblies.

PROPOSED CHANGE

NBC25 Div.B 5.9.1.1. (first printing)

[5.9.1.1.] 5.9.1.1. Compliance with Applicable Standards

- [1] 1)** Except as provided in Sentence (2) and elsewhere in this Part, materials and components, and their installation, shall conform to the requirements of the applicable standards in Table 5.9.1.1. where those materials or components are
- [a] a) incorporated into environmental separators or assemblies exposed to the exterior, and
- [b] b) installed to fulfill the requirements of this Part.
- (See Note A-5.9.1.1.(1).)
- [2] 2)** The requirements for *flame-spread ratings* contained in thermal insulation standards shall be applied only as required in Part 3.

Table [5.9.1.1.] 5.9.1.1.
Standards Applicable to Environmental Separators and Assemblies Exposed to the Exterior
Forming Part of Sentence [5.9.1.1.] 5.9.1.1.([1] 1)

Issuing Agency	Document Number	Title of Document
ANSI	A135.6	Engineered Wood Siding
ASME	B18.6.1	Wood Screws (Inch Series)
ASTM	A123/A123M	Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM	A153/A153M	Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM	A653/A653M	Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM	C4	Standard Specification for Clay Drain Tile and Perforated Clay Drain Tile
ASTM	C73	Standard Specification for Calcium Silicate Brick (Sand-Lime Brick)
ASTM	C126	Ceramic Glazed Structural Clay Facing Tile, Facing Brick, and Solid Masonry Units
ASTM	C212	Standard Specification for Structural Clay Facing Tile
ASTM	C412M	Standard Specification for Concrete Drain Tile

Issuing Agency	Document Number	Title of Document
ASTM	C444M	Standard Specification for Perforated Concrete Pipe
ASTM	C553	Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications
ASTM	C612	Standard Specification for Mineral Fiber Block and Board Thermal Insulation
ASTM	C700	Standard Specification for Vitrified Clay Pipe, Extra Strength, Standard Strength, and Perforated
ASTM	C726	Standard Specification for Mineral Wool Roof Insulation Board
ASTM	C834 ⁽¹⁾	Standard Specification for Latex Sealants
ASTM	C836/C836M	Standard Specification for High Solids Content, Cold Liquid-Applied Elastomeric Waterproofing Membrane for Use with Separate Wearing Course
ASTM	C840 ⁽¹⁾ ⁽²⁾	Standard Specification for Application and Finishing of Gypsum Board
ASTM	C920	Standard Specification for Elastomeric Joint Sealants
ASTM	C991	Standard Specification for Flexible Fibrous Glass Insulation for Metal Buildings
ASTM	C1002	Standard Specification for Steel Self-Piercing Tapping Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs
ASTM	C1177/C1177M	Standard Specification for Glass Mat Gypsum Substrate for Use as Sheathing
ASTM	C1178/C1178M	Standard Specification for Coated Glass Mat Water-Resistant Gypsum Backing Panel
ASTM	C1184 ⁽¹⁾	Standard Specification for Structural Silicone Sealants
ASTM	C1280	Standard Specification for Application of Exterior Gypsum Panel Products for Use as Sheathing
ASTM	C1311 ⁽¹⁾	Standard Specification for Solvent Release Sealants
ASTM	C1330 ⁽¹⁾	Standard Specification for Cylindrical Sealant Backing for Use with Cold Liquid-Applied Sealants
ASTM	C1396/C1396M ⁽³⁾	Standard Specification for Gypsum Board
ASTM	C1658/C1658M ⁽⁴⁾	Standard Specification for Glass Mat Gypsum Panels
ASTM	D1227/D1227M	Standard Specification for Emulsified Asphalt Used as a Protective Coating for Roofing
ASTM	D3019/D3019M ⁽⁵⁾	Standard Specification for Lap Cement Used with Asphalt Roll Roofing, Non-Fibred, and Fibred
ASTM	D3679 ⁽⁶⁾	Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Siding
ASTM	D4477 ⁽⁷⁾	Standard Specification for Rigid (Unplasticized) Poly(Vinyl Chloride) (PVC) Soffit
ASTM	D4479/D4479M	Standard Specification for Asphalt Roof Coatings – Asbestos-Free

Issuing Agency	Document Number	Title of Document
ASTM	D4637/D4637M	Standard Specification for EPDM Sheet Used in Single-Ply Roof Membrane
ASTM	D4811/D4811M	Standard Specification for Nonvulcanized (Uncured) Rubber Sheet Used as Roof Flashing
ASTM	D6878/D6878M	Standard Specification for Thermoplastic Polyolefin Based Sheet Roofing
ASTM	D7254 ⁽⁸⁾	Standard Specification for Polypropylene (PP) Siding
ASTM	D7793 ⁽⁹⁾	Standard Specification for Insulated Vinyl Siding
ASTM	E2190	Standard Specification for Insulating Glass Unit Performance and Evaluation
BNQ	BNQ 3624-115	Polyethylene (PE) Pipe and Fittings for Soil and Foundation Drainage
CGSB	CAN/CGSB-12.1	Safety Glazing
CGSB	CAN/CGSB-12.2-M	Flat, Clear Sheet Glass
CGSB	CAN/CGSB-12.3-M	Flat, Clear Float Glass
CGSB	CAN/CGSB-12.4-M	Heat Absorbing Glass
CGSB	CAN/CGSB-12.8	Insulating glass units
CGSB	CAN/CGSB-12.9	Spandrel glass
CGSB	37-GP-9Ma	Primer, Asphalt, Unfilled, for Asphalt Roofing, Dampproofing and Waterproofing
CGSB	CAN/CGSB-37.50-M	Hot-Applied, Rubberized Asphalt for Roofing and Waterproofing
CGSB	CAN/CGSB-37.54	Polyvinyl Chloride Roofing and Waterproofing Membrane
CGSB	CAN/CGSB-51.33-M	Vapour Barrier Sheet, Excluding Polyethylene, for Use in Building Construction
CGSB	CAN/CGSB-51.34	Polyethylene sheet for use in building construction – Material specification
CSA	A23.1	Concrete materials and methods of concrete construction
CSA	CAN/CSA-A82	Fired masonry brick made from clay or shale
CSA	CAN3-A93-M	Natural Airflow Ventilators for Buildings
CSA	CAN/CSA-A123.2	Asphalt-Coated Roofing Sheets
CSA	A123.3	Asphalt Saturated Organic Roofing Felt
CSA	CAN/CSA-A123.4	Asphalt for Constructing Built-Up Roof Coverings and Waterproofing Systems
CSA	A123.5	Asphalt shingles made from glass felt and surfaced with mineral granules
CSA	CAN/CSA-A123.16	Asphalt-coated glass-base sheets
CSA	A123.17	Asphalt Glass Felt Used in Roofing and Waterproofing
CSA	A123.23	Product specification for polymer-modified bitumen sheet, prefabricated and reinforced

Issuing Agency	Document Number	Title of Document
CSA	A123.24	Standard test method for wind resistance of vegetated roof assembly
CSA	A123.25	Asphalt core boards used in roofing
CSA	A123.51	Asphalt shingle application on roof slopes 1:6 and steeper
CSA	A165.1	Concrete block masonry units
CSA	A165.2	Concrete Brick Masonry Units
CSA	A165.3	Prefaced concrete masonry units
CSA	CAN/CSA-A179	Mortar and Grout for Unit Masonry
CSA	CAN/CSA-A220 Series	Concrete Roof Tiles
CSA	CAN/CSA-A371	Masonry Construction for Buildings
CSA	A3001	Cementitious Materials for Use in Concrete
CSA	B182.1	Plastic drain and sewer pipe and pipe fittings
CSA	G40.21	Structural quality steel
CSA	G401	Corrugated steel pipe and buried structures
CSA	CAN/CSA-O80 Series	Wood preservation
CSA	O118.1	Western Red Cedar Shakes and Shingles
CSA	O118.2	Eastern White Cedar Shingles
CSA	O121	Douglas fir plywood
CSA	O141	Softwood Lumber
CSA	O151	Canadian softwood plywood
CSA	O153	Poplar plywood
CSA	O325	Construction sheathing
CSA	O437.0	OSB and Waferboard
HPVA	ANSI/HPVA HP-1	American National Standard for Hardwood and Decorative Plywood
ULC	CAN/ULC-704.1	Standard for Thermal Insulation, Polyurethane and Polyisocyanurate, Boards, Faced
ULC	CAN/ULC 712.1	Standard for Thermal Insulation – Light Density, Open Cell Spray Applied Semi-Rigid Polyurethane Foam – Material Specification
ULC	CAN/ULC 712.2	Standard for Thermal Insulation – Light Density, Open Cell Spray Applied Semi-Rigid Polyurethane Foam – Installation
ULC	CAN/ULC 717.1	Standard for Flat Wall Insulating Concrete Form (ICF) Units – Material Properties
ULC	CAN/ULC 743.1:2020	Standard for Thermal Insulation – Low Pressure Applied Two Component Spray Polyurethane Foam, Part 1: Material Specification
ULC	CAN/ULC 743.2:2021	Standard for Thermal Insulation – Low Pressure Applied Two Component Spray Polyurethane Foam, Part 2: Installation

Issuing Agency	Document Number	Title of Document
ULC	CAN/ULC-S701.1	Standard for Thermal Insulation, Polystyrene Boards
ULC	CAN/ULC-S702.1	Standard for Mineral Fibre Thermal Insulation for Buildings, Part 1: Material Specification
ULC	CAN/ULC-S703	Standard for Cellulose Fibre Insulation (CFI) for Buildings
ULC	CAN/ULC-S705.1	Standard for Thermal Insulation – Spray Applied Rigid Polyurethane Foam, Medium Density – Material Specification
ULC	CAN/ULC-S705.2	Standard for Thermal Insulation – Spray Applied Rigid Polyurethane Foam, Medium Density – Application
ULC	CAN/ULC-S706.1	Standard for Insulating Wood Fibre Boards for Buildings
ULC	CAN/ULC-S710.1	Standard for Bead-Applied One Component Polyurethane Air Sealant Foam, Part 1: Material Specification
ULC	CAN/ULC-S711.1	Standard for Bead-Applied Two Component Polyurethane Air Sealant Foam, Part 1: Material Specification

Notes to Table [5.9.1.1.] 5.9.1.1.:

- (1) See Note A-Table 5.9.1.1.
- (2) Flat wall insulating concrete form units shall conform to CAN/ULC 717.1 in lieu of ASTM E2634 as indicated in ASTM C840.
- (3) The *flame-spread rating* of gypsum board shall be determined in accordance with CAN/ULC-S102 in lieu of ASTM E84 as indicated in ASTM C1396/C1396M.
- (4) The *flame-spread rating* of gypsum panels shall be determined in accordance with CAN/ULC-S102 in lieu of ASTM E84 as indicated in ASTM C1658/C1658M.
- (5) For the purpose of compliance with Part 5, ASTM D3019/D3019M shall only apply to the non-fibred and non-asbestos-fibred types of asphalt roll roofing.
- (6) The *flame-spread rating* of rigid polyvinyl chloride siding shall be determined in accordance with CAN/ULC-S102.2, in lieu of ASTM E84 as indicated in ASTM D3679.
- (7) The *flame-spread rating* of rigid polyvinyl chloride soffits shall be determined in accordance with CAN/ULC-S102.2, in lieu of ASTM E84 as indicated in ASTM D4477.
- (8) The *flame-spread rating* of polypropylene siding shall be determined in accordance with CAN/ULC-S102.2, in lieu of ASTM E84 as indicated in ASTM D7254.
- (9) The *flame-spread rating* of insulated vinyl siding shall be determined in accordance with CAN/ULC-S102.2, in lieu of ASTM E84 as indicated in ASTM D7793.

NBC25 Div.B 9.25.2.2.(1) (first printing)

[9.25.2.2.] 9.25.2.2. Insulation Materials

- [1] 1)** Except as required in Sentence (2), thermal insulation shall conform to the requirements of
- [a] a) ASTM C726, "Standard Specification for Mineral Wool Roof Insulation Board",
 - [b] b) CAN/CGSB-51.25-M, "Thermal Insulation, Phenolic, Faced",

- [c] c) CGSB 51-GP-27M, "Thermal Insulation, Polystyrene, Loose Fill",
- [d] g) CAN/ULC-704.1, "Standard for Thermal Insulation, Polyurethane and Polyisocyanurate, Boards, Faced",
- [e] j) CAN/ULC 712.1, "Standard for Thermal Insulation – Light Density, Open Cell Spray Applied Semi-Rigid Polyurethane Foam – Material Specification",
- [f] --) [CAN/ULC 743.1:2020, "Standard for Thermal Insulation – Low Pressure Applied Two Component Spray Polyurethane Foam, Part 1: Material Specification"](#),
- [g] d) CAN/ULC-S701.1, "Standard for Thermal Insulation, Polystyrene Boards",
- [h] e) CAN/ULC-S702.1, "Standard for Mineral Fibre Thermal Insulation for Buildings, Part 1: Material Specification",
- [i] f) CAN/ULC-S703, "Standard for Cellulose Fibre Insulation (CFI) for Buildings",
- [j] h) CAN/ULC-S705.1, "Standard for Thermal Insulation – Spray Applied Rigid Polyurethane Foam, Medium Density – Material Specification", [or](#)
- [k] i) CAN/ULC-S706.1, "Standard for Insulating Wood Fibre Boards for Buildings". ~~or~~

NBC25 Div.B 9.25.2.5.(1) (first printing)

[\[9.25.2.5.\] 9.25.2.5. Installation of Spray-Applied Polyurethane](#)

- [1] 1)** Spray-applied polyurethane insulation shall be installed in accordance with
 - [a] b) CAN/ULC 712.2, "Standard for Thermal Insulation – Light Density, Open Cell Spray Applied Semi-Rigid Polyurethane Foam – Installation",
 - [b] --) [CAN/ULC 743.2:2021, "Standard for Thermal Insulation – Low Pressure Applied Two Component Spray Polyurethane Foam, Part 2: Installation", or](#)
 - [c] a) CAN/ULC-S705.2, "Standard for Thermal Insulation – Spray Applied Rigid Polyurethane Foam, Medium Density – Application". ~~or~~

NBC25 Div.B 9.36.2.4.(1) (first printing)

[\[9.36.2.4.\] 9.36.2.4. Calculation of Effective Thermal Resistance of Assemblies](#)

- [1] 1)** In calculating the thermal resistance of assemblies for the purpose of comparison with the requirements of Articles 9.36.2.6. and 9.36.2.8., the thermal bridging effect of closely spaced, repetitive structural members, such as studs and joists, and of ancillary members, such as lintels, sills and plates, shall be accounted for. (See Note A-9.36.2.4.(1).)

Note A-9.36.2.4.(1) Calculating the Effective Thermal Resistance of Building Envelope Assemblies.

The general theory of heat transfer is based on the concept of the thermal transmittance through an element over a given surface area under the temperature difference across the element (see Sentence 9.36.1.2.(2)). As such, the NECB requires all building envelope assemblies and components to comply with the maximum U-values (overall thermal transmittance) stated therein. However, the requirements in Subsection 9.36.2. are stated in RSI values (effective thermal resistance values), which are the reciprocal of U-values.

To calculate effective thermal resistance, Section 9.36. requires that contributions from all portions of an assembly—including heat flow through studs and insulation—be taken into account because the same insulation product (nominal insulation value) can produce different effective thermal resistance values in different framing configurations. The resulting effective thermal resistance of an assembly also depends on the thermal properties and thickness of the building materials used and their respective location.

The following paragraphs provide the calculations to determine the effective thermal resistance values for certain assemblies and the thermal characteristics of common building materials. The Tables in Notes A-9.36.2.6.(1) and A-9.36.2.8.(1) confirm the compliance of common building assemblies.

Calculating the Effective Thermal Resistance of a Steel-frame Assembly

The parallel-path flow method described above for wood-frame assemblies involves simple one-dimensional heat flow calculations based on two assumptions:

- that the heat flow through the thermal bridge (the stud) is parallel to the heat flow through the insulation, and
- that the temperature at each plane is constant.

Tests performed on steel-frame walls have shown that neither of these assumptions properly represents the highly two-dimensional heat flow that actually occurs. The difference between what is assumed and what actually occurs is even more significant in steel-frame assemblies. The results achieved using the calculation method below compare well with those achieved from actual tests. The method provides a good approximation if a thermal resistance value of 0.0000161 (m²×K)/W per mm (or a conductivity of 62 (W×m)/(m²×°C)) is used (this value is associated with galvanized steel with a carbon content of 0.14%).

To calculate the effective thermal resistance of a building envelope assembly consisting of steel framing, RSI_{eff} , use the following equation:

$$RSI_{eff} = K_1 RSI_{T1} + K_2 RSI_{T3}$$

where

- RSI_{T1} = effective thermal resistance of building envelope assembly determined using parallel-path flow method for wood-frame assemblies (use framing and cavity percentages in Table A-9.36.2.4.(1)-C),
- RSI_{T3} = RSI_{T2} + thermal resistance values of all other components except steel studs and insulation, where RSI_{T2} = effective thermal resistance of steel studs and insulation determined using parallel-path flow method for wood-frame assemblies,
- K_1 = applicable value from Table A-9.36.2.4.(1)-B, and
- K_2 = applicable value from Table A-9.36.2.4.(1)-B.

Table [A-9.36.2.4.\(1\)-B](#) A-9.36.2.4.(1)-B
Values for K_1 and K_2

Framing Spacing, mm	K_1	K_2
< 500 without insulating sheathing	0.33	0.67
< 500 with insulating sheathing	0.40	0.60
≥ 500	0.50	0.50

Table [A-9.36.2.4.(1)-C] A-9.36.2.4.(1)-C
Framing and Cavity Percentages for Typical Steel-frame Assemblies ⁽¹⁾

Steel-frame Assemblies	Frame Spacing, mm o.c.							
	< 500		≥ 500		< 2100		≥ 2100	
	% Area Framing	% Area Cavity	% Area Framing	% Area Cavity	% Area Framing	% Area Cavity	% Area Framing	% Area Cavity
Roofs, ceilings, floors	0.43	99.57	0.33	99.67	—	—	—	—
Above-grade walls and strapping	0.77	99.23	0.67	99.33	—	—	—	—
Below-grade walls and strapping	0.57	99.43	0.33	99.67	—	—	—	—
Sheet steel wall	—	—	—	—	0.08	99.92	0.06	99.94

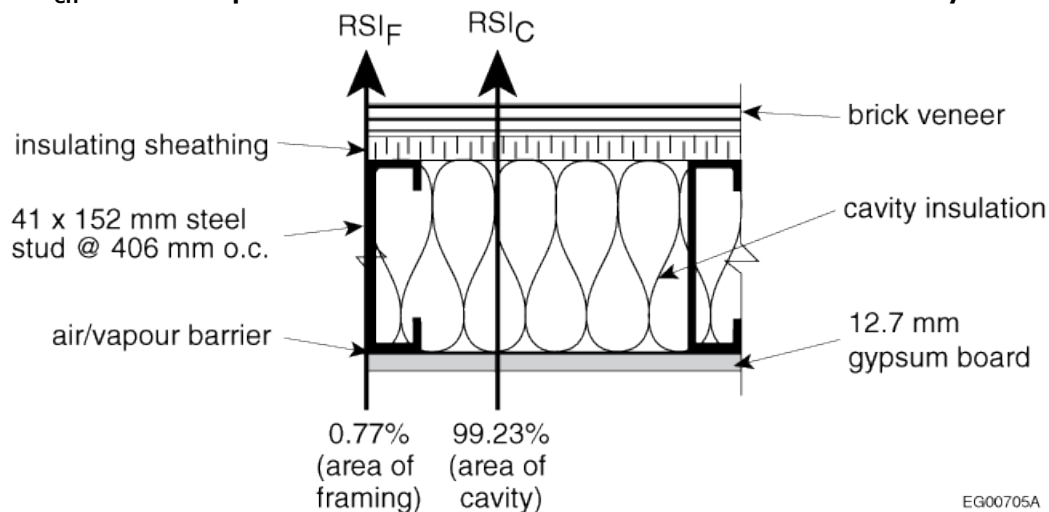
Note to Table [A-9.36.2.4.(1)-C] A-9.36.2.4.(1)-C:

- (1) The framing percentages given in this Table are based on common framing practices and not simply on the width of the studs and cavity. They are based on 18-gauge (1.2 mm) steel; however, test results indicate that, for the range of thicknesses normally used in light-steel framing, the actual thickness has very little effect on the effective thermal resistance. If the actual % areas of framing and cavity are known, those should be used rather than the ones in this Table.

Example – Calculation of RSI_{eff} for a 41 × 152 mm Steel-frame Wall Assembly with Studs 406 mm o.c.

Figure [A-9.36.2.4.(1)-B] 1-

RSI_{eff} calculation parameters for a 41 × 152 mm steel-frame wall assembly



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1. Calculate RSI_{T1}

Materials in Assembly	RSI_F (thermal resistance through framing)	RSI_C (thermal resistance through cavity)
Outside air film	0.03	0.03
Brick veneer	0.07	0.07
Air space (25 mm thick)	0.18	0.18
Extruded polystyrene (38 mm thick × RSI 0.035/mm)	1.33	1.33
Steel stud (152 mm thick × RSI 0.0000161/mm)	0.0023	—
Insulation (152 mm thick; RSI 3.52 (R20) batts)	—	3.52
Polyethylene (vapour barrier)	—	—
Gypsum (12.7 mm thick)	0.08	0.08
Interior air film	0.12	0.12
Total	1.81	5.33
% area framing and cavity from Table A-9.36.2.4.(1)-C	0.77%	99.23%
$RSI_{T1} = \frac{100}{\frac{0.77}{1.81} + \frac{99.23}{5.33}} = \frac{5.25(m^2K)}{W}$		(U-value = 0.19 W/(m ² ×K))

2. Calculate RSI_{T2}

Materials in Assembly	RSI_F (thermal resistance through framing)	RSI_C (thermal resistance through cavity)
Steel stud (152 mm thick × RSI 0.0000161/mm)	0.0023	—
Insulation (152 mm thick; RSI 3.52 (R20) batts)	—	3.52

Materials in Assembly	RSI _F (thermal resistance through framing)	RSI _C (thermal resistance through cavity)
Total	0.0023	3.52
% area framing and cavity from Table A-9.36.2.4.(1)-C	0.77%	99.23%
$RSI_{T2} = \frac{100}{\frac{0.77}{0.0023} + \frac{99.23}{3.52}} = \frac{0.27(m^2K)}{W}$	(U-value = 3.69 W/(m ² ×K))	

3. Calculate RSI_{T3}

Materials in Assembly	RSI through Assembly
Outside air film	0.03
Brick veneer	0.07
Air space (25 mm thick)	0.18
Extruded polystyrene (38 mm thick × RSI 0.035/mm)	1.33
RSI _{T2}	0.27
Polyethylene (vapour barrier)	—
Gypsum (12.7 mm thick)	0.08
Interior air film	0.12
	RSI _{T3} = 2.08 (m ² ×K)/W (U-value = 0.48 W/(m ² ×K))

4. Calculate RSI_{eff}

$$RSI_{eff} = (K_1 \times RSI_{T1}) + (K_2 \times RSI_{T3}) = (0.40 \times 5.25) + (0.60 \times 2.08) = 3.35 (m^2 \times K)/W \text{ (U-value} = 0.30 W/(m^2 \times K))$$

Table [A-9.36.2.4.(1)-D] A-9.36.2.4.(1)-D
Thermal Resistance Values of Common Building Materials (1)

Air Films	Thickness of Material	Thermal Resistance (RSI), (m ² ×K)/W per mm	Thermal Resistance (RSI), (m ² ×K)/W for thickness listed
Exterior:			
ceiling, floors and walls wind 6.7 m/s (winter)	—	—	0.03

Interior:			
ceiling (heat flow up)	—	—	0.11
floor (heat flow down)	—	—	0.16
walls (heat flow horizontal)	—	—	0.12
Air Cavities ⁽²⁾ ⁽³⁾	Thickness of Air Space	Thermal Resistance (RSI), (m ² ×K)/W per mm	Thermal Resistance (RSI), (m ² ×K)/W for thickness listed
Ceiling (heat flow up) faced with non-reflective material ⁽⁴⁾	13 mm	—	0.15
	20 mm	—	0.15
	40 mm	—	0.16
	90 mm	—	0.16
Floors (heat flow down) faced with non-reflective material ⁽⁴⁾	13 mm	—	0.16
	20 mm	—	0.18
	40 mm	—	0.20
	90 mm	—	0.22
Walls (heat flow horizontal) faced with non-reflective material ⁽⁴⁾	9.5 mm	—	0.15
	13 mm	—	0.16
	20 mm	—	0.18
	40 mm	—	0.18
	90 mm	—	0.18
Cladding Materials	Thickness of Material	Thermal Resistance (RSI), (m ² ×K)/W per mm	Thermal Resistance (RSI), (m ² ×K)/W for thickness listed
Brick:			
fired clay (1 800–2 200 kg/m ³)	90 mm	0.0007	0.063
concrete: sand and gravel, or stone (2 400 kg/m ³)	90 mm	0.0004	0.036
Cement/lime, mortar, and stucco	—	0.0009	—
Wood shingles:			
400 mm, 190 mm exposure	—	—	0.15
400 mm, 300 mm exposure (double exposure)	—	—	0.21
insulating backer board	8 mm	—	0.25
Siding:			

Metal or vinyl siding over sheathing:			
hollow-backed	—	—	0.11
insulating-board-backed	9.5 mm nominal	—	0.32
foiled-backed	9.5 mm nominal	—	0.52
Wood:			
bevel, 200 mm, lapped	13 mm	—	0.14
bevel, 250 mm, lapped	20 mm	—	0.18
drop, 200 mm	20 mm	—	0.14
hardboard	11 mm	—	0.12
plywood, lapped	9.5 mm	—	0.10
Stone:			
quartzitic and sandstone (2240 kg/m ³)	—	0.0003	—
calcitic, dolomitic, limestone, marble, and granite (2240 kg/m ³)	—	0.0004	—
Fibre-cement: single-faced, cellulose fibre-reinforced cement	6.35 mm	0.003	0.023
	8 mm	0.003	0.026
Roofing Materials ⁽⁵⁾	Thickness of Material	Thermal Resistance (RSI), (m ² ×K)/W per mm	Thermal Resistance (RSI), (m ² ×K)/W for thickness listed
Asphalt roll roofing	—	—	0.03
Asphalt/tar	—	0.0014	—
Built-up roofing	10 mm	—	0.06
Crushed stone	—	0.0006	—
Metal deck	—	—	negligible
Shingle:			
asphalt	—	—	0.08
wood	—	—	0.17
Slate	13 mm	—	0.01
Sheathing Materials	Thickness of Material	Thermal Resistance (RSI), (m ² ×K)/W per mm	Thermal Resistance (RSI), (m ² ×K)/W for thickness listed

Gypsum sheathing	12.7 mm	0.0063	0.08
Insulating fibreboard	—	0.016	—
Particleboard:			
low density (593 kg/m ³)	—	0.0098	—
medium density (800 kg/m ³)	—	0.0077	—
high density (993 kg/m ³)	—	0.0059	—
Plywood – generic softwood	9.5 mm	0.0087	0.083
	11 mm		0.096
	12.5 mm		0.109
	15.5 mm		0.135
	18.5 mm		0.161
Plywood – Douglas fir	9.5 mm	0.0111	0.105
	11 mm		0.122
	12.5 mm		0.139
	15.5 mm		0.172
	18.5 mm		0.205
Sheet materials:			
permeable felt	—	—	0.011
seal, 2 layers of mopped (0.73 kg/m ³)	—	—	0.210
seal, plastic film	—	—	negligible
Waferboard (705 kg/m ³)	—	0.0095	—
Oriented strandboard (OSB)	9.5 mm	0.0098	0.093
	11 mm		0.108
Insulation Materials ⁽⁶⁾	Thickness of Material	Thermal Resistance (RSI), (m ² ×K)/W per mm	Thermal Resistance (RSI), (m ² ×K)/W for thickness listed
Blanket and batt: rock or glass mineral fibre (CAN/ULC-S702.1)			
R12	89/92 mm	—	2.11
R14	89/92 mm	—	2.46
R19 ⁽⁷⁾ (R20 compressed)	140 mm	—	3.34
R20	152 mm	—	3.52
R22	140/152 mm	—	3.87
R22.5	152 mm	—	3.96
R24	140/152 mm	—	4.23

R28	178/216 mm	—	4.93
R31	241 mm	—	5.46
R35	267 mm	—	6.16
R40	279/300 mm	—	7.04
Insulation Materials ⁽⁶⁾ (continued)	Thickness of Material	Thermal Resistance (RSI), (m ² ×K)/W per mm	Thermal Resistance (RSI), (m ² ×K)/W for thickness listed
Boards and slabs:			
Roof board	—	0.018	—
Building board or ceiling tile, lay-in panel	—	0.016	—
Polyisocyanurate/polyurethane- faced sheathing: Types 1, 2 and 3 (CAN/ULC-704.1)			
permeably faced	25 mm	0.03818	0.97
	50 mm	0.0360	1.80
impermeably faced	25 mm	0.03937	1.00
	50 mm	0.0374	1.87
Expanded polystyrene (CAN/ULC-S701.1) ⁽⁸⁾			
Type 1	25 mm	0.026	0.65
Type 2	25 mm	0.028	0.71
Type 3	25 mm	0.030	0.76
Extruded polystyrene: Types 2, 3 and 4 (CAN/ULC-S701.1)	25 mm	0.035	0.88
	50 mm	0.0336	1.68
Semi-rigid glass fibre wall/roof insulation (48 kg/m ³)	25 mm	0.0298	0.757
Semi-rigid rock wool wall insulation (56 kg/m ³)	25 mm	0.0277	0.704
Loose-fill insulation			
Cellulose (CAN/ULC-S703)	—	0.025	—
Glass fibre loose fill insulation for attics (CAN/ULC-S702.1)	112 to 565 mm	0.01875	—
Glass fibre loose fill insulation for walls (CAN/ULC-S702.1)	89 mm	0.02865	2.55
	140 mm	0.0289	4.05
	152 mm	0.030	4.23

Perlite	—	0.019	—
Vermiculite	—	0.015	—
Spray-applied insulation			
Sprayed polyurethane foam			
medium density (CAN/ULC-S705.1)	25 mm	0.036	0.90
	50 mm	0.036	1.80
light density (CAN/ULC 712.1)	25 mm	0.026	0.65
Low pressure applied two component spray polyurethane foam (CAN/ULC 743.1:2020)	50 mm	0.028	1.40
Sprayed cellulosic fibre (CAN/ULC-S703)	settled thickness	0.024	—
Spray-applied glass-fibre insulation (CAN/ULC-S702.1)			
density: 16 kg/m ³	89 mm	0.025	2.30
	140 mm	0.025	3.53
density: 28.8 kg/m ³	89 mm	0.029	2.64
	140 mm	0.029	4.06
Structural Materials	Thickness of Material	Thermal Resistance (RSI), (m ² ×K)/W per mm	Thermal Resistance (RSI), (m ² ×K)/W for thickness listed
Concrete			
Low-density aggregate			
expanded shale, clay, slate or slags, cinders (1 600 kg/m ³)	—	0.0013	—
perlite, vermiculite, and polystyrene bead (480 kg/m ³)	—	0.0063	—
Normal-density aggregate			
sand and gravel or stone aggregate (2 400 kg/m ³)	—	0.0004	—
Hardwood ⁽⁹⁾ ⁽¹⁰⁾			
Ash	—	0.0063	—
Birch	—	0.0055	—
Maple	—	0.0063	—
Oak	—	0.0056	—

Softwood ⁽⁹⁾ ⁽¹⁰⁾			
Amabilis fir	—	0.0080	—
California redwood	—	0.0089	—
Douglas fir-larch	—	0.0069	—
Eastern white cedar	—	0.0099	—
Eastern white pine	—	0.0092	—
Hemlock-fir	—	0.0084	—
Lodgepole pine	—	0.0082	—
Red pine	—	0.0077	—
Western hemlock	—	0.0074	—
Western red cedar	—	0.0102	—
White spruce	—	0.0097	—
Yellow cyprus-cedar	—	0.0077	—
Wood, structural framing, spruce-pine-fir ⁽¹¹⁾	—	0.0085	—
Steel, galvanized sheet, 0.14% carbon content	—	0.0000161	—
Concrete Blocks	Thickness of Material	Thermal Resistance (RSI), (m ² ×K)/W per mm	Thermal Resistance (RSI), (m ² ×K)/W for thickness listed
Limestone aggregate with 2 cells			
cells filled with perlite	190 mm	—	0.37
	290 mm	—	0.65
Light-weight units (expanded shale, clay, slate or slag aggregate) with 2 or 3 cells			
no insulation in cells	90 mm	—	0.24
	140 mm	—	0.30
	190 mm	—	0.32
	240 mm	—	0.33
	290 mm	—	0.41
cells filled with perlite	140 mm	—	0.74
	190 mm	—	0.99
	290 mm	—	1.35
cells filled with vermiculite	140 mm	—	0.58
	190 mm	—	0.81

	240 mm	—	0.98
	290 mm	—	1.06
cells filled with molded EPS beads	190 mm	—	0.85
molded EPS inserts in cells	190 mm	—	0.62
Medium-weight units (combination of normal- and low-mass aggregate) with 2 or 3 cells			
no insulation in cells	190 mm	—	0.26
cells filled with molded EPS beads	190 mm	—	0.56
molded EPS inserts in cells	190 mm	—	0.47
cells filled with perlite	190 mm	—	0.53
cells filled with vermiculite	190 mm	—	0.58
Normal-weight units (sand and gravel aggregate) with 2 or 3 cells			
no insulation in cells	90 mm	—	0.17
	140 mm	—	0.19
	190 mm	—	0.21
	240 mm	—	0.24
	290 mm	—	0.26
cells filled with perlite	190 mm	—	0.35
cells filled with vermiculite	140 mm	—	0.40
	190 mm	—	0.51
	240 mm	—	0.61
	290 mm	—	0.69
Hollow Clay Bricks	Thickness of Material	Thermal Resistance (RSI), $(m^2 \times K)/W$ per mm	Thermal Resistance (RSI), $(m^2 \times K)/W$ for thickness listed
Multi-celled without insulation in cells	90 mm	—	0.27
Rectangular 2-cell			
no insulation in cells	140 mm	—	0.39
	190 mm	—	0.41
	290 mm	—	0.47
cells filled with vermiculite	140 mm	—	0.65

	190 mm	—	0.86
	290 mm	—	1.29
Rectangular 3-cell			
no insulation in cells	90 mm	—	0.35
	140 mm	—	0.38
	190 mm	—	0.41
	240 mm	—	0.43
	290 mm	—	0.45
cells filled with vermiculite	140 mm	—	0.68
	190 mm	—	0.86
	240 mm	—	1.06
	290 mm	—	1.19
Interior Finish Materials ⁽¹²⁾	Thickness of Material	Thermal Resistance (RSI), (m ² ×K)/W per mm	Thermal Resistance (RSI), (m ² ×K)/W for thickness listed
Gypsum board	—	0.0061	—
Hardboard – medium-density (800 kg/m ³)	—	0.0095	—
Interior finish (plank, tile) board	—	0.0198	—
Particleboard			
low-density (590 kg/m ³)	—	0.0098	—
medium-density (800 kg/m ³)	—	0.0074	—
high-density (1 000 kg/m ³)	—	0.0059	—
underlay	15.9 mm	—	0.140
Plywood	—	0.0087	—
Flooring material			
Carpet and fibrous pad	—	—	0.370
Carpet and rubber pad	—	—	0.220
Cork tile	3.2 mm	—	0.049
Hardwood flooring	19 mm	—	0.120
Terrazzo	25 mm	—	0.014
Tile (linoleum, vinyl, rubber)	—	—	0.009
Tile (ceramic)	9.5 mm	—	0.005
Wood subfloor	19 mm	—	0.170
Plastering			

Cement plaster: sand aggregate	—	0.0014	—
Gypsum plaster			
low-density aggregate	—	0.0044	—
sand aggregate	—	0.0012	—

Notes to Table [\[A-9.36.2.4.\(1\)-D\]](#) A-9.36.2.4.(1)-D:

- (1) The thermal resistance values given in Table A-9.36.2.4.(1)-D are generic values for the materials listed or minimum acceptable values taken from the standards listed. Values published by manufacturers for their proprietary materials may differ slightly but are permitted to be used, provided they were obtained in accordance with the test methods referenced in Article 9.36.2.2. For materials not listed in the Table or where the listed value does not reflect the thickness of the product, the thermal resistance value has to be calculated by dividing the material's thickness, in m, by its conductivity, in W/(m×K), which can be found in the manufacturer's literature.
- (2) RSI values can be interpolated for air cavity sizes that fall between 9.5 and 90 mm, and they can be moderately extrapolated for air cavities measuring more than 90 mm.
- (3) Where strapping is installed, use the RSI value for an air layer of equivalent thickness.
- (4) Reflective insulation material may contribute a thermal property value depending on its location and installation within an assembly. Where a value is obtained through evaluation carried out in accordance with Clause 9.36.2.2.(4)(b), it may be included in the calculation of the thermal resistance or transmittance of the specific assembly.
- (5) Materials installed towards the exterior of a vented air space in a roof assembly cannot be included in the calculation of effective thermal resistance of the roof assembly.
- (6) All types of cellular foam plastic insulation manufactured to be able to retain a blowing agent, other than air, for a period longer than 180 days shall be tested for long-term thermal resistance (LTTR) in accordance with CAN/ULC-S770, "Standard Test Method for Determination of Long-Term Thermal Resistance of Closed-Cell Thermal Insulating Foams". This LTTR value shall be input as the design thermal resistance value for the purpose of energy calculations in Section 9.36. Product standards contain a baseline LTTR for a thickness of 50 mm, from which the LTTR for other thicknesses can be calculated.
- (7) An RSI 3.52 (R20) batt compressed into a 140 mm cavity has a thermal resistance value of 3.34 (R19); if installed uncompressed in a 152 mm cavity (e.g. in a metal stud assembly), it will retain its full thermal resistance value of 3.52 (m²×K)/W.
- (8) Expanded polystyrene insulation is not manufactured to be able to retain a blowing agent; it is therefore not necessary to test its LTTR. See ⁽⁶⁾.

- (9) The thermal resistance values for wood species are based on a moisture content (MC) of 12%. In Canada, equilibrium moisture content for wood in buildings ranges from 8–14%. The difference between the thermal properties of wood species with 12% MC and those with 14% MC is negligible.
- (10) For wood species not listed in the Table, the RSI value of a wood species of equal or greater density (or specific gravity (relative density)) can be used since the thermal resistance of wood is directly related to its density (higher density wood has a lower thermal resistance).
- (11) 0.0085 is considered a common value for structural softwood (see also the "ASHRAE Handbook – Fundamentals").
- (12) Materials installed towards the interior of a conditioned air space cannot be included in the calculation of effective thermal resistance of the assembly.

Impact analysis

This proposed change is expected to result in no or low cost implications. In practice, manufacturers have been expected to meet the requirements of the material standard (CAN/ULC 743.1) since it was first published in 2020. Designers and installers have had access to the installation standard (CAN/ULC 743.2) since it was first published in 2021.

Enforcement implications

Because neither of these standards has ever been included in the NBC, designers and authorities having jurisdiction have not been able to enforce minimum requirements when low-pressure spray-applied two-component polyurethane foam has been used. As a result of this proposed change, building officials would be able to request proof of compliance with the material standard, CAN/ULC 743.1, and the installation standard, CAN/ULC 743.2. Compliance with these standards could be enforced without additional resources.

In addition, the inclusion of references to these standards would provide uniform minimum performance requirements across Canada for use by building officials when evaluating design submissions, thus improving the enforcement of the NBC.

Who is affected

Adding references to these two standards in the NBC would decrease the likelihood of confusion for building officials, building owners, designers, specification writers, contractors and manufacturers, as the Code would contain explicit minimum performance requirements for these materials.

OBJECTIVE-BASED ANALYSIS OF NEW OR CHANGED PROVISIONS

NBC25 Div.B 5.9.1.1. (first printing)

[5.9.1.1.] 5.9.1.1. ([1] 1)

[F20,F22,F51,F54,F55,F61,F63,F80-OH1.1,OH1.2] [F41,F55-OH1.1] [F55,F61,F80-OH1.3]

[\[5.9.1.1.\]](#) 5.9.1.1. ([\[1\]](#) 1) [F20,F80-OS2.1] [F20,F22,F51,F61,F63,F80-OS2.3] [F51-OS2.5]

[\[5.9.1.1.\]](#) 5.9.1.1. ([\[1\]](#) 1) [F20-OS2.2] [F80-OS2.3]

[\[5.9.1.1.\]](#) 5.9.1.1. ([\[1\]](#) 1) [F80,F61,F63-OS3.1]

[\[5.9.1.1.\]](#) 5.9.1.1. ([\[1\]](#) 1) [F80,F61,F63-OH4] Applies to floor assemblies.

[\[5.9.1.1.\]](#) 5.9.1.1. ([\[1\]](#) 1) ([\[a\]](#) a) [F61,F63-OS1.4] Applies where required life safety systems are incorporated in environmental separators.

[\[5.9.1.1.\]](#) 5.9.1.1. ([\[1\]](#) 1) [F20,F80-OP2.1,OP2.3] [F22,F80-OP2.4]

[\[5.9.1.1.\]](#) 5.9.1.1. ([\[1\]](#) 1) [F42-OH2.5]

[\[5.9.1.1.\]](#) 5.9.1.1. ([\[2\]](#) 2) no attributions

NBC25 Div.B 9.25.2.2.(1) (first printing)

[\[9.25.2.2.\]](#) 9.25.2.2. ([\[1\]](#) 1) [F51,F63,F80-OH1.1,OH1.2]

[\[9.25.2.2.\]](#) 9.25.2.2. ([\[1\]](#) 1) [F63,F80-OS2.3]

NBC25 Div.B 9.25.2.5.(1) (first printing)

[\[9.25.2.5.\]](#) 9.25.2.5. ([\[1\]](#) 1) [F51,F41,F63-OH1.1] [F51,F63-OH1.2]

[\[9.25.2.5.\]](#) 9.25.2.5. ([\[1\]](#) 1) [F63-OS2.3]

NBC25 Div.B 9.36.2.4.(1) (first printing)

[\[9.36.2.4.\]](#) 9.36.2.4. ([\[1\]](#) 1) [F92-OE1.1]