Product Information Bulletin

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DuroFoam® Insulation
Insulating Sheathing per NBC 2015

DuroFoam® insulation board is a moulded expanded polystyrene (EPS) insulation that meets or exceeds CAN/ULC-S701.1, ***Standard for Thermal Insulation, Polystyrene, Boards***. The addition of a laminated film to the top and bottom surfaces of ***DuroFoam*** insulation board provides a more durable product that is less susceptible to handling damage.

Table 1 – *DuroFoam* Insulation Material Properties

Material Properties[1]	Units	Values
Thermal Resistance *Minimum per 25 mm (1 inch)* ASTM C518	$m^2 \cdot {}^oC/W$ ($ft^2 \cdot h \cdot {}^oF/BTU$)	0.65 (3.75)
Compressive Resistance *Minimum @ 10% Strain* ASTM D1621	kPa (psi)	70 (10)
Flexural Strength *Minimum* ASTM C203	kPa (psi)	170 (25)
Water Vapour Permeance[2] *Maximum* ASTM E96	$ng/(Pa \cdot s \cdot m^2)$ (Perms)	<30 <(0.5)
Water Absorption[3] *Maximum* ASTM D2842	% By volume	6.0
Dimensional Stability *Maximum* ASTM D2126	% Linear Change	1.5
Limiting Oxygen Index *Minimum* ASTM D2863	%	24
Flame Spread Rating CAN/ULC S102.2	NA	290
Smoke Developed Classification CAN/ULC S102.2	NA	Over 500

The reflective facer on ***DuroFoam*** insulation contains a thin layer of foil embedded within the film. The reflective facer does not increase ***DuroFoam*** insulation thermal resistance (RSI/R-value) – for additional information see Plasti-Fab PIB 253, ***Facts About Thermal Resistance of Reflective Insulation***. The printed green facer of ***DuroFoam*** insulation should be left exposed outwards to make use of markings provided for easy cutting of insulation and spacing of fasteners into interior framing as required.

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1. ***DuroFoam*** insulation material properties are third party certified to CAN/ULC-S701.1 under an Intertek third party certification program (see Intertek Code Compliance Research Report CCRR-1072 for additional information).
2. WVP values quoted are maximum values for 25-mm (1-inch) thick ***DuroFoam*** insulation with laminated film facers on both sides.
3. The water absorption laboratory test method involves complete submersion under a head of water for 96 hours. The water absorption values above are applicable to specific end-use design requirements only to the extent that the end-use conditions are similar to test method requirements.

This bulletin addresses use of ***DuroFoam*** insulation as an exterior insulating sheathing applied to above grade walls in compliance with the National Building Code of Canada 2015 (NBC 2015).

1. Air Barrier System Requirements

Article 9.25.3.1. requires wall assemblies separating conditioned space from unconditioned space to be constructed so as to include an air barrier system that will provide a continuous barrier to air leakage. ***DuroFoam*** insulation may be used as one component in an air barrier system; however, to meet air barrier system requirements in Articles 9.25.3.2. and 9.25.3.3., requirements for sealing of all air barrier penetrations, such as those created by the installation of doors, windows, electrical wiring, electrical boxes, piping or ductwork, must be addressed.

2. Vapour Barrier System Requirements

Section 9.25.4. requires a vapour barrier to be installed on the warm side of wall assemblies to provide a barrier to diffusion of water vapour from the interior into wall spaces. Although ***DuroFoam*** insulation has a vapour permeance less than 30 ng/(Pa•s•m^2), it is attached to the exterior (cold side) of above grade walls. See requirements below related to **Properties and Position of *DuroFoam* Insulating Sheathing** in the building envelope applicable to low air and vapour permeance thermal insulation.

3. Properties and Position of *DuroFoam* Insulating Sheathing

DuroFoam insulating sheathing has an air leakage characteristic less than 0.1 L/(s•m^2) at 75 Pa and a water vapour permeance less than 30 ng/(Pa•s•m^2). Article 9.25.5.1. requires that the location of low permeance thermal insulation as per Article 9.25.5.2. must be considered in order to address the possibility of moisture accumulation within the interior wall cavity.

Sentence 9.25.5.2.(1) requires that the ratio between the total thermal resistance of all materials outboard of the interior surface of ***DuroFoam*** insulating sheathing and the total thermal resistance of all materials inboard of that surface must be not less than that required by Table 9.25.5.2., ***Ratio of Outboard to Inboard Thermal Resistance***. Wall assemblies with a ratio of outboard to inboard thermal resistance greater than Table 9.25.5.2 ensure that the inner surface of ***DuroFoam*** insulating sheathing is likely to be warm enough for most of the heating season such that no significant accumulation of moisture will occur when the vapour barrier function is provided by a separate building element installed on the warm side of the assembly. For additional information on assumptions used in developing Table 9.25.5.2., refer to NBC 2015, Appendix note A-9.25.5.2.

Table 2 - Ratio of Outboard to Inboard Thermal Resistance per NBC 2015 Table 9.25.5.2.

Heating Degree-Days	Ratio	Heating Degree-Days	Ratio
up to 4,999	0.20	9,000 to 9,999	0.55
5,000 to 5,999	0.30	10,000 to 10,999	0.60
6,000 to 6,999	0.35	11,000 to 11,999	0.65
7,000 to 7,999	0.40	12,000 or higher	0.75
8,000 to 8,999	0.50		

Energy consumption required to keep the interior of a small building at 21°C when the outside air temperature is below 18°C is roughly proportional to the difference between 18°C and the outside temperature. This relationship holds true for average conditions of wind, radiation, exposure, and internal sources. A heating degree-day (HDD) is defined as the number of degrees the mean temperature (average of high and low temperature) for a given day is below 18°C. The sum of all the daily HDD contributions results in the annual HDD for a location.

Table 3 provides HDD for a number of building locations across Canada. NBC 2015, Division B, Appendix C, ***Climatic and Seismic Information for Building Design in Canada***, provides HDD information for building locations across Canada.

Table 3 - NBC 2015, Division B, Appendix C - Annual HDD (Celsius Degree-Days)

Province	Building Location	HDD (Celsius Degree Days)	Province	Building Location	HDD (Celsius Degree Days)
British Columbia	Victoria	2,650	**Quebec**	Montréal	4,200
	Vancouver	2,950		Trois-Rivières	4,900
	Kelowna	3,400		Québec	5,080
	Whistler	4,180		Gaspé	5,500
	Dawson Creek	5,900		Baie-Comeau	6,020
Alberta	Lethbridge	4,650		Schefferville	8,550
	Calgary	5,000	**New Brunswick**	Campbellton	5,500
	Edmonton	5,400		Edmunston	5,400
	Fort McMurray	6,550		Fredericton	4,650
Saskatchewan	Moose Jaw	5,270	**Nova Scotia**	Digby	4,020
	Regina	5,600		Truro	4,650
	Saskatoon	5,700		Halifax	4,200
	Prince Albert	6,100	**PEI**	Charlottetown	4,600
	Uranium City	7,500	**Newfoundland**	St. John's	4,800
Manitoba	Winnipeg	5,670		Labrador City	7,900
	Flin Flon	6,440			
	Thompson	7,600			

4. Insulating Sheathing in lieu of Sheathing Membrane

Subclause 9.27.3.4.(2)(b)(i) states that a separate sheathing membrane is not required over insulating sheathing where the joints between boards are sealed. Therefore, when the joints between ***DuroFoam*** insulation boards are sealed, a separate sheathing membrane is not required. Refer to PIB 232 for additional information on installation requirements.

5. *Effective Thermal Resistance (RSI_{eff}/R_{eff})* of Wall Assemblies with *DuroFoam* Insulation

Section 9.36 provides energy efficiency requirements for buildings 3 storeys or less in building height, having a building area not exceeding 600 m^2 and used for major occupancies classified as residential occupancies.

Table 4 provides minimum ***(RSI_{eff}/R_{eff})*** requirements per Tables 9.36.2.6.-A and 9.36.2.6.-B for above grade walls in Part 9 buildings with or without a heat-recovery ventilator (HRV) installed.

Table 4 - Minimum RSI_{eff}/R_{eff} of Above-ground Opaque Wall Assemblies

NBC 2015 Climate Zones	Zone 4	Zone 5	Zone 6	Zone 7A	Zone 7B	Zone 8
Heating Degree-Days (HDD) Celsius Degree-Days	< 3,000	3,000 to 3,999	4,000 to 4,999	5,000 to 5,999	6,000 to 6,999	≥ 7,000
RSI_{eff}/R_{eff} per Table 9.36.2.6.-A – without Heat-Recovery Ventilator (HRV)						
RSI_{eff} – m^2•°C/W	2.78	3.08	3.08	3.08	3.85	3.85
R_{eff} – ft^2•hr•°F/BTU	15.8	17.5	17.5	17.5	21.9	21.9
RSI_{eff}/R_{eff} per Table 9.36.2.6.-B – with Heat-Recovery Ventilator (HRV)						
RSI_{eff} – m^2•°C/W	2.78	2.97	2.97	2.97	3.08	3.08
R_{eff} – ft^2•hr•°F/BTU	15.8	16.9	16.9	16.9	17.5	17.5

DuroFoam insulation applied as continuous insulation over the exterior of the building envelope increases the ***RSI_{eff}/R_{eff}*** of a wall assembly by eliminating thermal shorts due to wood studs.

RSI_{eff}/R_{eff} requirements in Tables 9.36.2.6.-A and 9.36.2.6.-B are based upon calculations for building assemblies which include the effect of thermal bridging due to repetitive structural members such as wood framing members in wall assemblies calculated using the formula below.

$$RSI_{eff}\,(R_{eff}) = \frac{100\%}{\dfrac{\%\text{ with Framing}}{RSI_F\,(R_F)} + \dfrac{\%\text{ Area Cavity}}{RSI_C\,(R_C)}} + RSI(R)\text{ Continuous Material Layers}$$

Table 5 provides an example of ***RSI_{eff}/R_{eff}*** calculations for a 2 x 4 wood stud wall assembly to meet requirements per Table 4 for a building located in Climate Zones 4 to 7A using ***DuroFoam*** continuous insulation. Table 6 provides the ratio of outboard to inboard thermal resistance for this wall assembly demonstrating compliance with minimum requirements in Table 2.

Table 5 - *RSI_{eff}/R_{eff}* Calculation for a Building Located in Climate Zone 4 to 7A

Wall Assembly Construction (Building with or without HRV)	Framed Portion		Continuous Layers
	RSI_F	RSI_C	
Outside Air Film	----	----	0.03
Vinyl Cladding	----	----	0.11
2" (50.8 mm) DuroFoam Continuous Insulation	***----***	***----***	***1.32***
Stud Cavity Insulation	----	2.29	----
2 x 4 Wood Stud @ 16" (406 mm) o/c	0.76	----	----
6 mil polyethylene vapour barrier	----	----	----
1/2" (12.7 mm) Gypsum Wall Board	----	----	0.08
Inside Air Film	----	----	0.12
RSI Sub-Totals	**0.76**	**2.29**	**1.66**
% Area of Each Component	**23%**	**77%**	**100%**
RSI_{eff} (R_{eff})	**RSI-3.22 (R-18.3)**		

Table 6 - Ratio of Outboard to Inboard Thermal Resistance Calculation

Outboard Components	RSI	Inboard Components	RSI
Outside air film	0.03	Stud cavity insulation	2.29
Vinyl cladding	0.11	Gypsum board	0.08
2" (50.8 mm) DuroFoam Insulation	1.32	Inside air film	0.12
Total Outboard RSI	**1.46**	**Total Inboard RSI**	**2.49**
Ratio of Outboard to Inboard Thermal Resistance		**1.46/2.49**	**0.59**

<u>**Note:**</u> The same wall assembly in Table 5 using 1 ½" (38.1 mm) of ***DuroFoam*** continuous insulation would provide an ***RSI_{eff}*** (***R_{eff}***) of 2.89 (16.4) which would meet minimum requirements for a building located in Zone 4. Table 7 provides the ratio of outboard to inboard thermal resistance for this alternative Zone 4 wall assembly demonstrating compliance with Table 2 requirements.

Table 7 - Ratio of Outboard to Inboard Thermal Resistance Calculation

Outboard Components	RSI	Inboard Components	RSI
Outside air film	0.03	Stud cavity insulation	2.29
Vinyl cladding	0.11	Gypsum board	0.08
1 1/2" (38.1 mm) DuroFoam Insulation	0.99	Inside air film	0.12
Total Outboard RSI	**1.13**	**Total Inboard RSI**	**2.49**
Ratio of Outboard to Inboard Thermal Resistance		**1.13/2.49**	**0.45**

Table 8 provides an example of ***RSI_{eff}/R_{eff}*** calculations for a 2 x 6 wood stud wall assembly using ***DuroFoam*** continuous insulation to meet requirements per Table 4 for a building location in Climate Zones 4 to 8 with HDD less than 8,000 (with or without HRV). Table 9 provides the ratio of outboard to inboard thermal resistance for this wall assembly demonstrating compliance with requirements in Table 2.

Table 8 - *RSI_{eff}/R_{eff}* Calculation for Building in Climate Zones 4 to 8

Wall Assembly Construction (Building with or without HRV)	Framed Portion		Continuous Layers
	RSI_F	RSI_C	
Outside Air Film	----	----	0.03
Vinyl Cladding	----	----	0.11
2" (50.8 mm) DuroFoam Insulation	----	----	1.32
Stud Cavity Insulation	----	3.34	----
2 x 6 Wood Stud @ 16" (406 mm) o.c.	1.17	----	----
6 mil polyethylene vapour barrier	----	----	----
1/2" (12.7 mm) Gypsum Wall Board	----	----	0.08
Inside Air Film	----	----	0.12
RSI Sub-Totals	**1.17**	**3.34**	**1.66**
% Area of Each Component	**23%**	**77%**	**100%**
RSI_{eff} (R_{eff})	**RSI-4.00 (R-22.7)**		

Table 9 - Ratio of Outboard to Inboard Thermal Resistance Calculation

Ratio of Outboard to Inboard Thermal Resistance Calculation			
Inboard Components	**RSI**	**Outboard Components**	**RSI**
Outside air film	0.03	Stud cavity insulation	3.34
Vinyl cladding	0.11	Gypsum board	0.08
2" (50.8 mm) DuroFoam Insulation	1.32	Inside air film	0.12
Total Outboard RSI	**1.46**	**Total Inboard RSI**	**3.54**
Ratio of Outboard to Inboard RSI		**1.46/3.54**	**0.41**