

April 27, 2015

Re: Code Review for The New Quik-Therm CIS System in Above Grade and Below Grade Exterior Wall Applications

The intent of this report is to support the use of Quik-Therm's new CIS in a non-structural capacity in concrete and concrete masonry exterior walls to provide insulation, air barrier and vapour diffusion control as called for in Parts 3 and 5 and Part 9 of the 2010 National Building Code of Canada (NBCC).

By way of qualification and bias I note that I:

- am a Professional Engineer (licensed to practice in the Province of Ontario, British Columbia, Alberta, and the Yukon Territory);
- specialize in the building envelope;
- am employed by Morrison Hershfield Limited, which has a history of product evaluations for Quik-Therm Insulation Solutions.

Background

The new CIS product consists of metalized polymer faced Type 1 expanded polystyrene (EPS) boards which are affixed directly to the interior side of the building's exterior concrete wall. Joints between boards and board edges are sealed to prevent convective air movement. Although the concrete wall typically is the air tight element in these applications, the CIS product can be made into an air barrier and provide radon control with proper sealing of joints. The system provides attachment and support of the code-required thermal barrier that is independent from foamed plastic components through L-Stud stabilizers that support the steel framing which the thermal barrier is attached to. A layout of the system and a detail of the thermal barrier attachment to is provided in Figures 1 and 2.



Figure 1: CIS Installed in Basement Application with Steel Framing (L-Studs)



Figure 2: CIS L-Stud Stabilizer for Attachment of L-Stud Steel Framing for the Thermal Barrier

The primary purpose of CIS is to provide resistance to heat transfer and vapour diffusion as required in Sections 5.3 and 5.4 and Subsections 9.25.2 and 9.25.4. In addition to these requirements, CIS also complies with applicable portions of Subsection 3.1.5 and Section 5.8, as well as Sections 9.10 and 9.13.

Compliance with the 2010 NBCC

Heat Transfer

Quik-Therm CIS has been reviewed for compliance with the following portions of the 2010 NBCC related to thermal resistance:

- Article 5.3.1.1 – Required Resistance to Heat Transfer
- Article 5.3.1.2 – Properties to Resist Heat Transfer to Dissipate Heat
- Article 5.3.1.3 – Location and Installation of Materials Providing Thermal Resistance
- Article 9.25.2.1 – Required Insulation
- Article 9.25.2.2 – Insulation Materials

Subsection 5.3.1 – Thermal Resistance of Assemblies

CIS complies with the thermal resistance requirements of Part 5 of the 2010 NBCC. The thermal resistance requirements of Subsection 5.3.1 relate to condensation control and energy use in the building as whole. The arrangement of materials in a concrete wall with CIS provides thermal resistance to exterior walls and effectively eliminates concerns regarding condensation on interior surfaces.

Subsection 9.25.2 – Thermal Insulation

As per CCMC Evaluation Listing 13393-L (Appendix A), the EPS used in CIS complies with the requirements of CAN/ULC-S701, “*Thermal Insulation, Polystyrene, Boards and Pipe Covering*” and therefore this system meets the requirements of 9.25.2.2.(1). CIS also provides a continuous layer of thermal insulation at least 50mm in thickness, with no interruptions from framing members or other elements. As such, the requirements of Sentences 9.25.2.3.(1) and 9.25.2.3.(2) are also satisfied.

Tested Thermal Performance

The Quik-Therm CIS product has been tested for its thermal performance according to ASTM C1363-05 *Standard Test Method for Thermal Performance of Building Materials and Envelope Assemblies by Means of a Hot Box Apparatus*. ASTM C1363-05 evaluates the thermal performance of homogeneous and non-homogeneous building assemblies at conditions typical of normal building applications. The data from this test is used to judge compliance with specifications and regulations, for design guidance, research, and the verification of, or use of simulation models. Both the 2” CIS and 6” CIS wall assemblies were tested by Architectural Testing Inc.

ASTM C1363-05 simulates above grade conditions, and therefore the thermal resistance of the assembly is slightly enhanced by the presence of an air film on the exterior surface. If installed



in a below grade space, i.e. basements, the air film is not present and therefore the assembly does not benefit from its presence. However, the thermal stability created by the surrounding soil will not result in any appreciable change to the thermal resistance of the assembly.

The tested thermal performance of the wall assemblies are summarized in Table 1 for 70" x 80" wall samples consisting of:

- 3 ½" concrete panel
- Quik-Therm insulation panel (2" and 6")
- Metal framing studs with plastic stabilizers
- ½" gypsum wall board

Table 1: Summary of Tested Thermal Performance

CIS Thickness	Thermal Transmittance¹, U-value (USI)	Effective Thermal Resistance¹, R-value (RSI)
2" (51 mm)	0.07 BTU/hrft ² °F (0.397 W/m ² K)	13.66 hrft ² °F/BTU (2.41 m ² K/W)
6" (152 mm)	0.03 BTU/hrft ² °F (0.189 W/m ² K)	29.33 hrft ² °F/BTU (5.17 m ² K/W)

¹Thermal performance includes air films as per ASTM C1363-05

It is appropriate to use the tested thermal resistance to determine compliance with ASHRAE 90.1 or minimum thermal resistance requirements in Canadian Building codes for the wall system as described as long as each layer is at least as thick as listed above. The results should be similar with a concrete block masonry wall with the same interior elements.

Although testing was conducted with 3 ½" concrete base wall with a density of 150 lb/ft³, the results may be applied to wall assemblies with different concrete thicknesses. Based on the values from ASHRAE 90.1, an increase in concrete thickness will increase the overall R-value by approximately R-0.14 per additional inch of similar concrete. Therefore, increasing the concrete thickness from 3 ½" to 8", for typical foundation wall, will increase the overall wall assembly R-value by R-0.63.

Quik-Therm also provides systems with 2 ½" to 5" of insulation. These systems have not been tested according to ASTM C1363-05. However, since the insulation is continuous without significant thermal bridging, the thermal performance may be conservatively estimated based on the performance of the tested wall systems. Table 2 lists the estimated thermal performance of the Quik-Therm CIS system with 8" of concrete at the thicknesses that are available.

Table 2: Summary of Estimated Thermal Performance

CIS Thickness	Thermal Transmittance ¹ , U-value (USI)	Effective Thermal Resistance ¹ , R-value (RSI)
2" (51 mm) (Tested)	0.07 BTU/hr·ft ² ·°F (0.397 W/m ² K)	14.29 hr·ft ² ·°F/BTU (2.52 m ² K/W)
2 ½" (64 mm)	0.06 BTU/hr·ft ² ·°F (0.350 W/m ² K)	16.25 hr·ft ² ·°F/BTU (2.86 m ² K/W)
3" (76 mm)	0.05 BTU/hr·ft ² ·°F (0.312 W/m ² K)	18.21 hr·ft ² ·°F/BTU (3.21 m ² K/W)
4" (102 mm)	0.05 BTU/hr·ft ² ·°F (0.256 W/m ² K)	22.13 hr·ft ² ·°F/BTU (3.90 m ² K/W)
5" (127 mm)	0.04 BTU/hr·ft ² ·°F (0.218 W/m ² K)	26.04 hr·ft ² ·°F/BTU (4.59 m ² K/W)
6" (152 mm) (Tested)	0.03 BTU/hr·ft ² ·°F (0.189 W/m ² K)	29.96 hr·ft ² ·°F/BTU (5.28 m ² K/W)

¹Thermal performance includes air films as per ASTM C1363-05

Air Leakage

Quik-Therm CIS has been reviewed for compliance with the following portions of the 2010 NBCC related to air leakage control:

- Article 5.4.1.1 – Required Resistance to Air Leakage
- Article 5.4.1.2 – Air Barrier System Properties
- Article 9.25.3.1 – Required Barrier to Air Leakage
- Article 9.25.3.2 – Air Barrier System Properties
- Article 9.25.3.3 – Continuity of the Air Barrier System

Although the concrete or concrete masonry is typically the air tight element in the air barrier system, joints between EPS boards and board edges of the CIS are sealed to prevent convective air movement and can be the primary air tight component of the wall assembly. CIS will meet all air leakage requirements in Subsection 5.4.1 and satisfies the requirements of Sentences 9.25.3.1.(1) and 9.25.3.3.(1) of the 2010 NBCC.

Vapour Diffusion

Quik-Therm CIS has been reviewed for compliance with the following portions of the 2010 NBCC with respect to vapour diffusion control:

- Article 5.5.1.1 – Required Resistance to Vapour Diffusion
- Article 5.5.1.2 – Vapour Barrier Properties and Installation
- Article 9.25.4.1 – Required Barrier to Vapour Diffusion
- Article 9.25.4.2 – Vapour Barrier Materials

Subsection 5.5.1 – Vapour Barriers

CIS satisfies the vapour diffusion resistance requirements of Sentence 5.5.1.1.(1) by controlling vapour diffusion with its metallic polymer film facing and Type 1 EPS insulation. The metallic polymer film on the interior face of the CIS has a permeance of $5.89 \text{ ng}/(\text{Pa}\cdot\text{s}\cdot\text{m}^2)$ as per the attached ASTM E96 test report provided by Architectural Testing, Inc. (Appendix B). Where the polymer film is not present at the stud stabilizer slots, vapour diffusion control is provided by the base of the plastic stud stabilizer which covers the breach.

Subsection 9.25.4 – Vapour Barriers

Quik-Therm CIS also meets the vapour barrier requirements in Part 9 of the 2010 NBCC. A vapour barrier with a permeance not greater than $60 \text{ ng}/(\text{Pa}\cdot\text{s}\cdot\text{m}^2)$ is required per Sentence 9.25.4.2.(1). As previously mentioned, the CIS is faced with a metallic polymer film between studs which has a permeance of $5.89 \text{ ng}/(\text{Pa}\cdot\text{s}\cdot\text{m}^2)$.

Ground Moisture

Quik-Therm CIS has been reviewed for compliance with the following portions of the 2010 NBCC related to in ground moisture and dampproofing:

- Article 5.8.2.1 – Required Moisture Protection
- Article 9.13.2.1 – Required Dampproofing
- Article 9.3.2.5 – Moisture Content

Exterior dampproofing on the concrete basement wall will be required to satisfy the requirements of Article 5.8.2.1 and Sentence 9.13.2.1.(1).

For below grade applications with lumber, the intent of the moisture content requirement in Sentence 9.3.2.5.(1) is achieved since Quik-Therm CIS consist of EPS, which is impervious to moisture.

Fire Protection

Quik-Therm CIS has been reviewed for compliance with the following portions of the 2010 NBCC related to fire protection:

- Article 3.1.5.1 – Noncombustible Materials
- Article 3.1.5.12 – Combustible Insulation and its Protection
- Article 3.2.3.8 – Protection of Exterior Building Face
- Article 3.1.11.2 – Fire Stopping in Wall Assemblies
- Article 3.1.11.7 – Fire Stop Materials
- Article 9.10.17.10 – Flame Spread Limits
- Article 9.29.5.8 – Spacing of Nails
- Article 9.29.5.9 – Spacing of Screws

Subsection 3.1.5 Noncombustible Construction

Foamed plastic insulation is required to be protected from exposure to fire on both the interior and exterior sides of building exterior walls.

Interior fire separation is provided by 12.7mm gypsum board as a thermal barrier. CIS provides an independently supported assembly which gypsum board can be fastened to meet the requirements of Sentence 3.1.5.12.(2) and (3). This independently supported assembly consists of 25 gauge steel 'L'-angle rails, which are fastened to the floor and the underside of the floor above, and 25 gauge steel 'L'-studs fastened to the top and bottom rails and stiffened by plastic stud stabilizers placed in the EPS insulation. The steel framing used in the CIS system is similar to typical steel framing commonly found to support gypsum board. The gypsum board is installed in vertically continuous sheets, supported against gravity at the floor below as well as at the steel studs and rail at the floor above. The drywall will be fastened to the studs at regular intervals similar to a typical drywall installation. This assembly ensures that the gypsum will be held in place even if the EPS and stud stabilizers were to melt. In our opinion, this meets code intent. The gypsum board can be taped and filled as part of the interior finish to meet the requirements of Sentence 3.1.5.12.(3) for non-sprinklered buildings that are more than 18m high.

Subsection 3.2.3 – Spatial Separation and Exposure Protection

Article 3.2.3.8 requires foamed plastic insulations used in exterior walls of a building more than 3 storeys be protected on its exterior surface by a non-combustible material or by at least 25mm of concrete or masonry. This provision applies in all cases where the type of construction is permitted to be either combustible or non-combustible per Table 3.2.3.7. Since CIS will be applied on the interior side of concrete or masonry concrete walls that will be not less than 25mm thick, the foamed plastic insulation is protected from fire, meeting the requirements of the 2010 NBCC where the area of unprotected openings is permitted to be more than 10% per Table 3.2.3.7.

Subsection 3.1.11 – Fire Stops in Concealed Spaces

Article 3.1.11.2 requires fire blocking be provided to block off concealed spaces within a wall assembly at every floor level, at every ceiling level where the ceiling forms part of an assembly required to have a fire-resistance rating, and at walls greater than 20m wide and 3m high except

as otherwise exempted by Sentence 3.1.11.2.(2). Gypsum board not less than 12.7mm thick and sheet steel not less than 0.38mm thick are acceptable fire blocking materials according to Article 3.1.11.7. As such, the continuous and unperforated galvanized steel rail that forms part of the independent supporting structure of the CIS must be greater than 0.38mm thick and installed at every 3m up the exterior wall for applications where floor to ceiling height is greater than 3m. For applications where the floor to ceiling height is less than 3m, the galvanized steel rail attached to the ceiling provides fire stopping to comply with Article 3.1.11.2.

It is worth noting that Sentence 3.1.5.5.(1) is not applicable to Quik-Therm CIS since this requirement is applicable to combustible exterior cladding and its associated components of exterior non-loadbearing wall assemblies. Since CIS will be applied to the interior of concrete or masonry walls it has no exterior combustible components and will be part of a loadbearing wall assembly.

Therefore, the Quik-Therm CIS will satisfy the 2010 NBCC requirements for protection of foamed plastics if a thermal barrier conforming to Sentence 3.1.5.12.(3) is installed on the interior side of the EPS insulation for any building. Note that this thermal barrier must be installed at all locations where CIS are present in order to comply with Part 3 of the 2010 NBCC. In addition, the conditions of Article 3.2.3.8 which references Article 3.2.3.7 and Table 3.2.3.7 restrict the installation to conditions where the percentage of unprotected openings is permitted to be more than 10%.

Subsection 9.10.17 – Flame Spread Limits

Article 9.10.17.10 requires that foamed plastics such as those used in the proposed assembly be protected from adjacent space by an approved thermal barrier listed in Sentence 9.10.17.10.(1). As previously mentioned, CIS incorporates an independently supported assembly to which gypsum board (or another permitted thermal barrier) can be fastened. The gypsum board is supported by galvanized steel rails fastened to the floor and floor joists above and galvanized steel studs attached to the angles and stud stabilizers placed in the EPS insulation. Location and spacing of stiffener should be as per 9.29.5.8 (nails) or 9.29.5.9 (screws). As mentioned before, the gypsum board is supported such that if the EPS stud were to melt, the gypsum is held in place and meets the code intent.

It is therefore our opinion that the CIS is in compliance with the requirements of the 2010 NBCC as a component of an Environmental Separation when installed in exterior above grade or below grade concrete or masonry walls.

Yours truly,
Morrison Hershfield Limited

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