Our ref:

Enquiries: J Strobos

Tel: (012) 428-6009

Report : 2538/1357/07

Date: 2007-05-08

Quad Lock Building System
Attention: Mrs A Heidgen
PO Box 362
MAGALIESSIG
2067

QUAD-LOCK BUILDING SYSTEM

1 OBJECT OF EVALUATION

The object of the evaluation was to assess the documentation submitted (See appendixes) to the SABS and to evaluate tests conducted on the sample description (Refer section 7) by independent Laboratories.

2 RECOMMENDATION

2.1 The submitted documents were evaluated and the SABS concludes that every aspect of the National Building Regulation SANS 10400 has been addressed satisfactorily.

2.2 SABS endorses all documentation described and attached to this report.

2.3 The following aspects were covered:

2.3.1 Structural strength and stability
2.3.2 Behaviour in fire
2.3.3 Water penetration
2.3.4 Thermal performance
2.3.5 Durability and the maintenance required
2.3.6 The likelihood of condensation forming on the inside of the building
2.3.7 Acoustic performance
2.3.8 The applicant's quality system

NOTE: Source document are available on request.

3. SAMPLE DESCRIPTION

3.1 Description

Refer section 7.

4 Documents and information contained in this report are reflected in the index. Page 2 refers.

Index

SECTION 1

ANALYSIS OF VAPOUR BARRIER REQUIREMENTS OF QUAD LOCK WALL SYSTEM

INTRODUCTION

In early 1994, Ecotope, Inc. Performed a series of Frame 3.1 simulations (Enermodal Engineering, Ontario, Canada) and parallel heat flow calculations to evaluate the thermal performance of composite foam and reinforced concrete block wall systems manufactured by Building Technologies, Inc. (BTI).

One of BTI's walls, QUADLOCK, had a lower thermal conductivity (U-value) than the code required in Blimet Zone 1 (west of the mountains) for homes in Washington and Oregon. Additional insulation must be added to the basic QUADLOCK wall to meet energy code requirements in Climate Zone 2 (most locations in the interior Pacific Northwest) and Climate Zone 3 (mountainous areas in the four state region, most of Canada, and Alaska).

At the time the thermal simulations were performed, no consideration was given to the likely performance of the wall in resisting water vapor diffusion. Local building code officials in British Columbia, Canada are now concerned that QUADLOCK might need a continuous vapor barrier (such as that required for conventional frame walls) to prevent damage to the wall interior and possible structural and/or aesthitic problems. The purpose of this technical memorandum is to offer a range of scenarios in which the wall might be installed and evaluate the likely performance of the wall in responding to interior moisture conditions.

The analysis is broken into two parts. In the first, we address the permeability of the material used to manufacture the wall. In the second part, we consider various scenarios of weather, indoor relative humidity, and wall penetrations in predicting the performance of the wall.

Water Vapor Permeance of Continuous Sections

The QUADLOCK wall system consists of two expanded polystyrene (EPS) layers sandwiching an interior core of reinforced concrete. (See attached detail(. The layers are the same width on each side (57,2 mm); the concrete core is of variable width (approximately 152 mm to 254 mm). Of interest in this analysis is the permeability of the inboard foam layer in situations where no unintentional or international penetrations have occurred. The product is sheathed on the interior with gypsum wall board (itself very permeable to water vapor relative to high-density EPS).

The material use by BTI is high density (32,04 kg/meter^3) expanded polystyrene. The 1993 ASRAE Fundamentals (American Society of Heating, Refrigeration, & Air Conditioning Engineers, Atlanta, Georgia) show a range of permeance per inch for expanded polystryrene of between 5.8 perm and 2.0 perm. Because the BTI EPS density is at the uppermost end, a perm rating of 2.0 per 25,4 mm is appropriate. The inboard layer of EPS is a uniform 57,15 mm thick, the perm rating of the wall is thus 2.0 perm-in/57,2 mm or 0.89 perm.

The Washington State Energy Code, one of the most stringent in the United States, required a perm rating of 1.0 or less for above-grade walls. The EPS used in QUADLOCK thus exceeds this perm rating and is a very effective barrier to water vapor penetration as a continuous layer.

Moisture and Wall Penetrations

Where the QUADLOCK wall presents a continuous layer to air-borne indoor water vapor, the perm rating of the EPS is sufficient to impede moist air from migrating into the wall assembly and perhaps depositing some of the moisture as liquid water when a surface at or below the moist air's dewpoint is encountered. If the wall contains small penetrations at various joint, concern has arisen over the possibility of water (or ice) collecting on the inboard surface of the concrete.

To test the likelihood of condensation, three scenarios were considered. Ecotope exhumed its Frame 3.1 run for the QUADLOCK wall and use minimum design temperatures (ASHRAE 1993) for various Pacific Northwest cities. In each case, the wall is configured to meet the requirements of the appropriate energy code. Milder climates require only the basic block with customary sheatings; for harsher continental climates, additional insulation is required to meet energy codes in some areas and is added to the basic wall in the simulations.

The program plots isotherms (lines of constant temperature) in a cross-section of the wall. These temperature estimate can then be combined with likely ambient conditions inside the heated space to predict whether the dew point will be reached on the inboard surface of the concrete. A psychrometric chart is used to complete the analysis. The isotherm plots for each climate are available in the source documents.

For each scenario, indoor conditions are 21,1 EC and 40% relative humidity. The wall is modeled so that it contains two metal clips used for attaching interior and exterior sheathing. A small penetration 246 cm^3 is made in the wall to simulate an electrical junction box. (Note BTI has no plans to add intentional penetrations in its QUADLOCK walls; this penetration is done purely for illustrative purposes, as it would be a common penetration in a frame wall).

For the Vancouver, B.C.)Or Portland, OR) case (97,5% design dry bulb temperature of (-7,2 EC), Frame and Ecotope's interpolation predict a dry bulb temperature of 7,5 EC at the inboard side of the concrete at the wall penetration. Because the dew point for air at 40% relative humidity is 6,5 EC, no condensation will occur under these conditions.

In the Kamloops, B.C (or Idaho Falls, ID) case (97,5% design dry bulb temperature of -26,1 EC), 25,4 mm of EPS is attached to the exterior of the wall, bringing its above-grade U-value to about 0,227 w/m^2 K. (The Washington State Energy Code requires a U-value of 0.044 in Climate Zone 2 for houses heated with electricity). At an outside dry bulb temperature of -26,1 EC, the inboard concrete surface has an estimated temperature of 7,5 EC. (Psychrometric readings and calculations are done using sea level data atmospheric pressure; this is a reasonable approximation since Kamloops is about 335,3 meters above sea level). Condensation will not form on the concrete's surface under these conditions.

In Fairbanks, Alaska (97,5% design dry bulb temperature of -43,9 EC) , a 25,4 mm polyisocyanurate is attached to the wall's exterior, bringing its U-value to about 0,204 Wm^2K. At an outside dry bulb temperature of -43,9 EC, the inboard concrete surface has an estimated temperature of 7 EC. (Psychrometric readings and calculations are done using seal level data atmospheric pressure).

There is the possibility of condensation of water vapor on the concrete surface at this temperature. However, Ecotope's experience consulting for builders in Fairbanks suggests that normal indoor relative humidities in new construction are commonly much less that 15% in the winter time. (Fairbanks is in a climate best described as an Arctic desert). Even if some water vapor were to find its way tot he inboard concrete surface, the absolute amount of liquid water forming would be very small (on the order of less than 1 mg water per kg of air). Because the inboard concrete surface is well above freezing at the design temperature, no ice would form.

It should be noted that these calculations are performed at severe design conditions, with outside dry bulb temperatures predicted to occur during a very small percentage (2,5%) of the time. Under common outdoor conditions, average outdoor temperatures will be considerably higher, the inboard surface of the concrete will be warmer than estimated above and therefore higher indoor relative humidities will be supported without the possibility of any condensate formation.

Where Would the Water Go?

There is a possibility that, given the right conditions (sufficient crack in the wall, high relative humidity, positive pressure inside house relative to outside, sustained outdoor frigid temperatures) some liquid water might form in the wall assembly. One must ask, however, where the water might collect. Unlike a wood-framed wall with fiberglass batt or blown insulation, a composite wall such as QUADLOCK offers very little free cavity space for liquid water accumulation and absorption. And even if a film of moisture were to form on the concrete surface, we must further ask how it could damage inert substances such as concrete and expanded polystyrene. Ice formation would be a possible structural concern, but we have shown that no ice would form on the concrete under nearly the most extreme conditions a wall would ever encounter (Fairbanks, Alaska at -44 EC)

Below-Grade Applications

In below-grade applications, an approved exterior waterproof membrane must be used before the wall is back-filled to meet the requirements of applicable building codes. Note that even in long-term frost-zone climates (such as Fairbanks), the exterior wall temperature will be only 0EC (rather than the much colder design dry bulb exterior air temperatures used above). The basic block provides sufficient thermal insulating value to prevent condensation at elevated indoor relative humidities (up to about 90% relative humidity, which again would be very rare in Fairbanks).

Findings

Ecotope's analysis suggests that adding a vapor diffusion barrier to the BTI QUADLOCK wall should not be necessary. The perm rating of the wall is sufficient to effectively stop moist air migration into the wall and condensation of water vapor on the inboard concrete surface. Even if there are wall penetrations, the insulating value of the outboard foam (whether from the basic QUADLOCK block or from a combination of the block with an additional 25,4 mm of foam) is sufficient to assure the temperature of the concrete will remain above the dew point of interior moist air for most combinations of outdoor temperature and indoor relative humidity.

Even if some small amount of water were to condense on the concrete, it should not cause structural or cosmetic problems and it will certainly vanish in all but the most extreme conditions (i.e. where the exterior temperature remains at the 97,5% design dry bulb condition for an extended period).

Recommendations

- In Climate Zone 1 (west of the mountains), the wall as constructed is sufficient to prevent possible condensation on the inboard concrete surface.

- In Climate Zone 2 (most other locations in the Pacific Northwest), an additional 25,4 mm of EPS on the wall's exterior is required to meet local energy codes (in some cases) and is recommended to consistently keep the temperature of the inboard concrete surface above the dewpoint.

- In the harshest climates (such as Alaska or Northern Canada), addition of 1 inch layer of rigid polyisocyanurate is required to meet model energy codes (Long Term Super Good Cents of R2000) and is recommended by Ecorope as a prudent measure to ensure cost-effective energy conservation and homeowner comfort. The additional rigid insulation certainly assures the interior surface of the concrete will not fall below the freezing point and will prevent formation of liquid water on available inboard concrete surfaces in most circumstances.

SUMMARY SHEET

QUADLOCK Foam and Concrete W all System (Typical Installations)		
ABOVE GRADE	MATERIALS	R-VALUE
	1. Inside Air	0,68
	2. 13 mm G.W.B	0,45
	3. 57 mm 2PCF EPS	9,79
	4. 152 mm Concrete	0,50
	5. 57 mm 2PCF EPS	9,79
	6. Stucco Finish	0,27
	7. Outside Air	0,25
	Overall R-Value	21,73

BELOW GRADE WALL SECTION WITH INTERIOR DRYWALL			
Heat Loss Coefficients	Depth below Grade (mm)		
	610	1067	2134
U-VALUE (W(m².K)	0,216	0,204	0,182
F-VALUE (W(m².K)	0,582	0,550	0,502

SECTION 2

PHYSICAL PROPERTIES

INTRODUCTION

Warnock Hersey, at the request of Building Technologies, Inc., has conducted Physical Properties testing on submitted samples of Quad-lock EPS (Expanded Polystyrene) concrete form panels.

PRODUCT DESCRIPTION

The following products were sampled at the storage facility by a representative of Warnock Hersey Professional Services Ltd. September 1994 at 7398 - 132nd Street, Surrey, B.C.:

Expanded Polystyrene Form Panels, 55,9 mm x 304,8 mm x 1219,2 mm

The samples (see Appendix A for details) were identified as being expanded from polystyrene beads manufactured by:

Arco Chemical Co
3801 West Chester Pike
Newton Square
Pennsylvania, U.S.A., 19073

TEST STANDARD

The following physical properties tests were conducted in accordance with the American Society of Testing and Materials (ASTM):

1. ASTM D1621 — *Compressive Strength Procedure A*
2. ASTM D2842 — *Water Absorption*
3. ASTM D2126 — *Dimensional Stability*
4. ASTM C203 — *Flexural Strength Method 1, Procedure B*
5. ASTM E 96 — *Water Vapour Permeance*
6. ASTM C177 — *Thermal Resistance*
7. ASTM D1622 — *Test Method for Apparent Density of Rigid Cellular Plastics*

Nature of test	Results
Compressive strength, kPa average at 10% deformation	222
Water absorption 96 h immersion in water, % average	2,7
Dimensional stability (7d at 70 EC), % average	0,26
Flexural strength, kPa average	466
Density, kg/m³ average	31,1
Water vapour permeance, mg/Pa.s.m² average	14,3
Thermal Resistance, m²K/w average	0,812

SECTION 3

4 HOUR FIRE ENDURANCE TEST

PREFACE

This report describes the tests, standards and details of the test specimens as installed for this program.

This product has met certain performance requirements to be eligible for a W arnock Hersy Certification program. The report does not imply product certification. Products must bear WHI labels to demonstrate Warnock Hersey Certification.

Warnock Hersey authorizes the named client to reproduce this report. It must be copies in its entirety.

INTRODUCTION

On April 12, 1995,Warnock Hersey Coquitlam conducted a 4 hour fire endurance test on a Building Technologies Inc.QUAD-LOCK expanded polystyrene foam concrete wall form system. Testing was conducted in accordance with CAN/ULC S101, ASTM E 119, and UBC 7-1 with exception to the size of sample being tested.

The objective of the test was to determine whether the polyethylene bridging ties, a component of te form system, would melt out and cause a los of support for the non-fire side standard 12,7 mm gypsum thermal barrier and consequently create a through opening in the concrete wall, and/or flaming of the polyethylene ties and expanded polystyrene foam on the unexposed side or create openings in the concrete wall that would result in the ignition of cotton waste. A reduced scale sample was selected for the fire endurance test as these results would be shown with equal certainty whether the sample was tested on a reduced scale or on a full scale basis.

The fire test sample was constructed to be representative of the code requirements for a foam insulated concrete wall system. A wall incorporating the use of foam plastic as a component of its construction requires the use of a thermal barrier. The 1994 Unif orm Building Code states in Chapter 26, Section 2602.4, “The interior of the building shall be separated from the foam plastic insulation by an approved thermal barrier having an index of 15 when tested in accordance with UBC standard 26-3. The thermal barrier shall be installed in such a manner that it will remain in place for the time of its index classification based on approved diversified tests. “The Building Technologies Ltd. QUAD-LOCK expanded polystyrene foam concrete wall from system was tested in accordance with UBC 26-3, *Room Fire Test Standard For Interior of Foam Plastic Systems*, (refer to Warnock Hersey report number 6807), and met the conditions of acceptance for a 15 minute index. The standard 12,7 mm gypsum wallboard thermal barrier and mounting method used on the test sample evaluated in this report were identical to that used for the construction of the test sample for the room fire test.

Pre-test inspections were conducted by Michael van Geyn, representing Warnock Hersey in August 1994 and September 1994 to document the materials used and methods of manufacture for the components of the QUAD-LOCK concrete wall form system.

MATERIAL SPECIFICATION

QUAD-LOCK Panels

Description:	Interlocking stackable foam panels for concrete forms (See Figure I)
Height:	304,8 mm
Length:	1219,2 mm
Thickness:	57,2 mm
Material:	Fire retardant expanded polystyrene
Colour:	Granite
Density:	32 kg/m³

QUAD-LOCK Bridging Ties

Description:	Bridging tie to be placed at horizontal or vertical panel joints provide a positive connection between wall sides (See Figure I)
Material:	High density polyethylene
Colour:	Colour coded for different wall thickness

TEST SAMPLE INSTALLATION

QUAD-LOCK panels were assembled to construct a concrete wall form. QUAD-LOCK half ties and full ties were installed on 304,8 mm centres in between the fire side and non-fire sides of the wall as per the QUAD_LOCK installation guide to hold the panels together for the pouring of the concrete. Two to three strips of 50,8 mm tape were, placed around the ends of the form. The finished form dimensions were 2,19 m in length by 1,83 m in height by 102,4 mm in thickness. Concrete was pumped into the form, packed and allowed to cure for 6 months prior to running the fire test. Standard 12,7 mm gypsum wallboard oriented vertically was installed over the foam panels and was fastened to the polyethylene bridging ties using 41,28 mm Type S screws spaced 609,6 mm apart vertically and 304,8 mm apart horizontally.

THERMOCOUPLE LOCATIONS

A total of five 24 gauge Type J welded thermocouples were installed on the face of the sample wall underneath ceramic insulating pads as required by the standards to determine unexposed surface temperature rise performance.

THE FIRE TEST

The test assembly was mounted on our pilot scale vertical fire test furnace. The furnace opening had dimensions of 1473 mm in width by 1575 mm in height. Furnace temperatures are measured by six uniformly distributed thermocouples, horizontally extending to 304,8 mm from the test wall. The exhaust opening is located along the back of the furnace. Six natural gas burners are located in the furnance, as are then 50,8 mm secondary air inlets.

The burners were ignited and controlled to maintain furnace temperature rise to conform as closely as possible to the standard time/temperature curve. After four hours of fire exposure, the test was discontinued. Observations, furnance temperatures and unexposed temperatures were recorded throughout the test duration.

FIRE TEST OBSERVATIONS

TIME	EXPOSED SIDE	UNEXPOSED SIDE
1:17	Dry wall discoloured	
5:13	Drywall intact - no paper left	Slight venting
14:02		Steam coming out, foam may be melting, 5th thermocouple added at centre
15:00	Venting flames into furnace from seam in drywall	Foam crackling, flames from seal at top of furnace
20:30	Drywall cracking	Melted polystyrene on floor flaming
1:00:00	Drywall fallen at top area	
1:02:48	Drywall fallen at lower area	
1:07:00	Concrete beginning to spall, concrete absorbs heat of furnace, therefore reduces temperature	
1:22:07	Spalling has stopped	
1:34:14	No change	No change
1:52:30	Not change	No change
1:55:36	Spalling beginning again	
2:07:42	Spalling stopped	No change
2:26:30	No change	No change
2:39:42	No change	Appears to be foam venting and steam emanating from unexposed foam
3:27:18	No change	No change
4:00:00	No change	No change

DISCUSSION

The photographs taken after the fire test show solid unmelted polystyrene foam and intact polyethylene bridging ties on the unexposed side of the test sample. After the remov al of the gypsum, the bridging ties were analyzed. The polyethylene bridging ties extended into the test sample from the unexposed side, (as can be seen from the cross-sectional photograph), for a minimum of 25,4 mm. The ties were not overly flexible and would no readily pull out of the concrete.

It was not possible to conduct a hose stream test on the sample as it was not reinforced with rebar and/or steel mesh. As it was removed from the furnace, it collapsed. Had the sample been reinforced, it would have passed a hose stream test after the full test duration. The remaining polyethylene sections would not have been dislodged by the hose stream test.

SECTION 4

PRODUCT EVALUATION - PLASTIC TIES

INTRODUCTION

Warnock Hersey Professional Services Ltd., at the request of Aqua-Pak Stryro Containers Ltd., has conducted Shear and Pull-Out strength testing on submitted samples of "Quad-Lock" plastic ties at various temperatures.

PRODUCT DESCRIPTION

The products submitted were plastic "Quad-Lock" ties that secure EPS foam blocks when pouring concrete foundations. The screws used were 38,1 mm , #6 drywall, coarse thread screws.

TEST METHOD

Test 1

The drywall screw was threaded into two pieces of plastic "Quad-Lock" and the force required to shear the "Quad-Lock" at -40EC and +35 EC was measured with a calibrated load cell.

Test 2

The drywall screw was threaded into a single piece of "Quad-Lock" and the force required to withdraw the screw at -40EC and +35 EC was measured with a calibrated load cell.

Three additional Pull-Out tests at -40 EC performed using various steel screws:

Sample Identification	Thread diameter, mm	Thread length, mm	Force, kg
1. Steel Metal Screw	4,9	38,1	125
2. Wood Screw	5,1	38,1	118
3. Wood Screw	4,5	38,1	122

OBSERVATION

As screw was withdrawn, it left a ridge in the "Quad-Lock" where removed.

Shear test at 35 EC - Using #6 Drywall screws

Sample identification	Maximum Withdrawal Strength, kg
1	75
2	75
3	73
4	73
5	73
6	77
7	70
8	75
9	64
10	73
Average	**73**

OBSERVATION

In all above cases, the fastener failed.

Shear test at -40 EC - Using #6 Drywall screws

Sample identification	Maximum Withdrawal Strength, kg
1	98
2	64
3	50
4	52
5	95
6	113
7	93
8	98
9	98
10	111
Average	**86**

OBSERVATION

In all above cases, the fastener failed.

Pull-out test at -40 EC - Using #6 Drywall screws

Sample identification	Maximum Withdrawal Strength, kg
1	66
2	54
3	64
4	50
5	57
6	61
7	57
8	64
Average	**59**

OBSERVATION

As screw was withdrawn, it left a ridge in the “Quad-Lock” sample - plastic failure

PULL-OUT TESTS AT 35EC - USING #6 DRYWALL SCREWS
(Force required to withdraw screw from tie)

Sample identification	Maximum withdrawal strength, kg
1	45
2	45
3	48
4	43
5	48
6	45
7	50
8	41
9	43
10	41
Average	**45**

OBSERVATION

As screw was withdrawn, it left a ridge in the “Quad-Lock” where removed.

SECTION 5

THERMAL PERFORMANCE

INTRODUCTION

Ecotope Inc has evaluated the thermal performance of the QUAD LOCK foam wall system. The system's performance is evaluated in a variety of likely above-grade scenarios by using parallel heat loss calculations. Below-grade performance is also evaluated using the finite-difference simulation program, SUNCODE (SERI-RES).

In typical above-grade applications (interior finish of 12,7 mm gypsum wallboard, 15,9 mm T1-11 exterior siding), the nominal 152 mm QUAD-LOCK wall has a U-value of 0.256 N/m²R. This value is more than 27% better than a standard 2x6 frame wall with R19 batt and more than 22% better than a standard 2x6 wall with high-density R-21 batt. The stud cavities of a 2x6 frame wall would have to be insulated with extruded polystyrene (Dow Blueboard or equivalent, at R-5/25,4 mm) to match the performance of the QUAD-LOCK system.

Composite wall systems such as QUAD-LOCK offer another energy benefit. When properly installed, the composite wall will provide a tighter infiltration barrier, reducing heating costs and uncomfortable drafts.

The first section below describes the geometry and materials used in the wall system itself. The next section presents the analysis of the steady state heat flow through the panel in above-grade applications. The below-grade analysis is then presented. The final section summarized the findings.

DESCRIPTION OF WALL SYSTEM ANALYZED

The QUAD-LOCK wall system uses 304,8 x 1219 mm interlocking panels, 57,15 mm thick, held together with polyethylene ties. The panels are constructed of expanded polystyrene (EPS), molded beads (density of 32,04 kg/m³). The space between the panels is then filled with concrete to form a solid wall. The nominal thickness of the concrete can be varied in 50,8 mm increments from 102 to 254 mm by using different length ties. A detail of the panel is shown in Figure 1 (Attached).

QUAD-LOCK walls are typically finished on the inside surface with 12,7 mm gypsum wallboard (GWB) glued to the surface of the foam. The outside is typically finished with 15,9 mm T1-11 (screwed directly to the ties). If a finish is desired which requires mechanical fastening such as lapped wood siding, 1x2 nailers are screwed to the polyethylene ties and the siding then attached to the nailers. This detail creates a 19,05 mm airspace between the nailers and exterior siding.

Above-Grade Wall Performance

The QUAD-LOCK system produces a wall with a very uniform cross section which is relatively easy to analyze using standard ASHRAE parallel heat loss calculations. Since the polyethylene ties are made of a non-thermally conductive material, they have a negligible impact on the thermal performance of the wall.

The 152,4 and 254 mm wall systems have slightly different thermal conductivities because of the effect of the additional concrete. The heat loss rate of the 152,4 mm QUAD-LOCK wall alone is calculated at 0,270 w/(m²K). The 254 mm wall heat loss rate is 0,266 w/(m²K). The U-value include the effect of a still air film on the inside surface and a 3,4 m/s wind on the outside surface.

The 152 mm and 254 mm were each evaluated with three different wall finish combinations. In all cases, the interior finish is 13 mm GWB glued to the interior QUAD_LOCK panel. The three exterior finishes were 15,8 mm, 1x2 nailers with 13 mm lapped wood siding, and 13 mm stucco.

The materials used in the calculations (and their thermal resistivities) are listed below:

Concrete	- 0,575 km²/W
EPS	- 29,121 km²/W
Gypsum wall board	- 0,079 km²/W
Lapped wood siding	- 0,143 km²/W
T1-11 siding	- 0,137 km²/W
Stucco	- 0,042 km²/W
Vertical still air	- 0,166 km²/W

Summary of Above-Grade Thermal Performance of QUAD-LOCK and Code Bases

Wall type	U-Value W/(m²K)
Unfinished 152 mm QUAD-LOCK wall	0,273
152 mm QUAD-LOCK w/15,9 mm T1-11	0,256
152 mm QUAD-LOCK w/1x2 nailers and 12,7 mm lapped wood sliding	0,244
152 mm QUAD-LOCK w/12,7 mm stucco	0,261
Unfinished 254 mm QUAD-LOCK wall	0,267
254 mm QUAD-LOCK w/15,9 mm T1-11	0,250
254 mm QUAD-LOCK w/1x2 nailers and 12,7 mm lapped wood siding	0,244
254 mm QUAD-LOCK w/12,7 mm stucco	0,256
Standard R-19 frame wall (2x6 studs 406 mm, 152 mm thick FG batt) & T1-11	0,352
Standard R-21 frame wall (2x6 studs 406 mm, 140 mm thick HD FG batt) & T1-11	0,329
R-19 frame wall w/extruded polystyrene in joist cavities & T1-11	0,256

All cases assume interior finish of 12,7 mm GWB

Below-Grade Performance Analysis & Results

The below-grade analysis relies on a multizone thermal simulation program adapted from the SUNCODE building performance program. Heat loss coefficients are calculated using a finite-difference procedure which integrates heat flow into the ground over the heating season. The heat flow is then normalized with heating season degree hours.

Heat flow through the below-grade wall is reported as a U-value (W/cm.K), and the heat flow through the basement floor is reported as an F-value (Btu/hr EF per lineal foot of slab perimeter). Although the wall is the focus of the analysis, both heat loss coefficients are reported to give a full description of heat loss in the basement. Below-grade heat loss rates are most accurately described as a combination of wall and slab edge heat loss, and changing the slab detail will influence the overall wall U-value. These procedures are explained in detail in an Ecotope report to the Bonneville Power Administration.

In effect, the model examines the pie-slice of a typical basement with an area to perimeter ratio of 9 to 1. Three difference basement depths were evaluated: 0,609 m, 0,914 m and 2,134 m below-grade. The wall area includes a mudsill which extends 152 mm above-grade. Each case was evaluated with two different soil conductivities: 2093 and 4186 J/(kg.K). The final reported U and F-values include an interpolation to a soil conductivity of 3140 J/(kg.K) customary for regional earth contact heat loss calculations.

The variation in QUAD-LOCK wall concrete thickness has a very small effect on above-grade thermal performance. Therefore, the U-value for te 152 mm QUAD-LOCK wall is used in all below-grade simulations. The wall is modeled with 13 mm GWB on the inside surface. The panel is assumed to step on a footing, with the floor slab floating inside of the concrete wall. This effectively gives the floor slab a thermal break at the edge.

The below-grade performance of the 152 mm QUAD-LOCK wall is considerably better than a standard 202,8 mm concrete wall with either R-10 exterior insulation or R-19 interior insulation. (Slab-edge thermal breaks are not required by the code so the values reported below for the comparison walls do not include a thermal break).

Summary of Below-Grade Performance of Basement Walls

Wall Type	Depth of Basement, mm	U-Value w/m² K	F-Value w/m²K	Heat Loss Rate w/m²
152 mm QUAD-LOCK	610	0,215		
	1067	0,204		
	2134	0,182		
203 mm concrete w/R-10 exterior insulation	610	0,505		
	1067	0,426		
	2134	0,329		
203,2 mm concrete w/R-19*	610	0,238		
	1067	0,233		
	2134	0,204		

* Furred with 2x4s and finished with 13 mm GWB

The final column, titled *Heat Loss Rate per ...*, calculates the overall heat loss rate of the below-grade basement wall and floor per foot of basement perimeter. This is the most accurate way to compare basement insulation details, since wall heat loss rate influences heat loss through the slab edge (and vice versa). The heat loss rate per foot of basement perimeter assumes an overall wall height of the listed basement depth plus a 152,4 mm mudsill extending above-grade. Note the U-value and F-value improve with depth (because of the buffering effect of the ground) but the heat loss rate per foot increase because the area of wall considered increases with depth.

As an example, the heat loss rate per meter of a 10,7 m basement would include the 10,7 m of below-grade wall, the .... mudsill, and the slab perimeter, and would be calculated to have a heat loss rate of:

12,2 m² x (basement wall U-value (from table) + 3,0 m x (listed slab F-value from table)

Conclusion and Summary

Ecotope's analysis shows that in typical construction, QUAD-LOCK above-grade walls perform much better than typical R-19 and R-21 frame walls; the QUAD-LOCK performance is equivalent to a 2x6 frame wall insulated with 139,7 mm of Dow Blueboard (R-5 per mm). In below-grade applications, QUAD-LOCK significantly outperforms standard construction (203,2 mm concrete wall with R-10 exterior rigid insulation).

The QUAD-LOCK wall system should out-perform frame walls in ways that cannot be quantified by a steady-state heat loss analysis. Standard parallel heat flow calculations assume that the fiberglass insulation is uniformly installed with no voids or compressed batts. This is not what is usually found in the field. If installed correctly, concrete walls will not settle, bend, sag, and crack, as framed walls will do with time. The QUAD-LOCK system should also create a wall which is significantly more airtight than a standard framed wall.

SUMMARY SHEET		
QUADLOCK Foam and Concrete Wall System (Typical Installations)		
ABOVE GRAD	MATERIAL	R-VALUE
	1. Inside Air	0,68
	2. 12,7 mm G.W.B.	0,45
	3. 57,2 mm 2PCF EPS	9,79
	4. 152 mm Concrete	0,50
	5. 57,2 mm 2PCF EPS	9,79
	6. 167 mm T1-11 Finish	0,78
	7. Outside Air	0,25
	Overall R-Value	22,24
OVERALL U-VALUE OF ABOVE GRADE WALL SECTION: 0,045		

BELOW GRADE WALL SECTION WITH INTERIOR SHEETROCK			
Heat Loss Coefficients	Depth Below Grade, m		
	0,610 m	1, 067 m	2,134 m
U-VALUE w/m² K	0,215	0,204	0,182

SECTION 6

ACCEPTANCE CRITERIA OF FOAM PLASTIC INSULATION

PREFACE

The observations and test results in this report are relevant only to the sample tested. This report by itself does not imply that the material, product or servi ce is or has ever been under an ITS certification program.

INTRODUCTION

Intertek Testing Services SA Ltd./Warnock Hersey has conducted testing on the Quad-Lock Polystyrene Insulated Concrete Formwork in accordance with ICBO ES AC12 *"Acceptance Criteria for Foam Plastic Insulation"* in conjunction with ASTM C578-95 *"Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation"*. Gavin Campbell of ITS Coquitlam, sampled the product on October 18, 2001 at the Aqua-Pak Styro Containers facility in Surry, British Columbia, Canada.

PRODUCT DESCRIPTION

Quad-Lock Type II

Foam Description:	Expanded polystyrene (EPS) foam block.
Material:	Expanded polystyrene foam manufactured from BASF BFL327 Beads.
Color:	White/Green

TEST PROGRAM

1. **Expanded Polystyrene Testing**

Density

(ASTM C1622-98 Test Method for Apparent Density of Rigid Cellular Plastics)

Compressive Strength

(ASTM C165-00 Test Method for Compressive Properties of Rigid Cellular Plstics)

Flexural Strength Testing

(ASTMC203-99 Test Methods for Breaking Load and FlexuralProperties of Block-Type Thermal Insulation)

TEST RESULTS

Expanded - Polystyrene Testing

1. Density (ASTM C1622-98)

TYPE	TEST RESULT	REQUIREMENT	STATUS
BASF BFL327 Type II	10,54 Pa	4,5 Pa	Complied

2. Compressive Strength (ASTM C-165-00)

TYPE	TEST RESULT	REQUIREMENT	STATUS
BASF BFL327 Type II	149 Pa	103 Pa	Complied

3. Flexural Strength (ASTM C 203-99)

TYPE	TEST RESULT	REQUIREMENT	STATUS
BASF BFL327 Type II	375,1 Pa	275,8 Pa	Complied

CONCLUSION

The expanded polystyrene systems identified in this report have met the requirements of ICBO Evaluation Service AC 12 *Acceptance Criteria for Foam Plastic Insulation* (July 2000) in conjunction with the ASTM C578-95 "*Standard Specification for Rigid Cellular Polystyrene Thermal Insulation*" for the tests reported.

EPS Foam Flexural Strength Test

Equipment Used: 2000g setra scale SN 144363, and Mititoyo CD-18 SN 7003817

Test Standard: ASTM C203-99 Standard Test Methods for Breaking Load and Flexural Properties of Block- Type Thermal Insulation

Crosshead Speed: 4,2 mm/min of sample thickness

Sample #	Dimensions, mm			Max Load, kg	Max Fiber Stress, kPa
	Length	Width	Thickness		
1	305	102	27	7,2	369
2	306	102	27	7,1	363
3	306	102	27	7,5	384
4	305	102	27	7,1	365
5	304	101	27	7,1	363
6	306	102	28	7,3	373
7	305	102	27	7,8	403
8	305	102	27	7,2	371
9	305	102	27	7,5	386
Averages	**305**	**102**	**27,2**	**7,3**	**375**

Span = 254 mm
Load Cell Weights = 0 grams

Type II Requirement	276 kPa
Actual Results	375 kPa

EPS Compressive Strength

Standard: ASTM C165 (Standard Test Method for Measuring Compressive Properties of Thermal Insulation)
Date: 10-24-01
Project: 484-1873
Equipment Used: Artech 500lb LC SN 200613, digital calipers I.D # 52650 s/n 0098865

Crosshead speed: 2,54 mm/per minutes, dial @ 2,05.

Type 2	1	2	3	4	5	6
kPa	155	180	129	131	146	148

Note: Force were measured at 10% deflection.

Average kPa 148,1

Type II Requirement Minimum Allowable	104 kPa

Density

Client: Aqua-Pak Styro containers Ltd

Product: EPS Foam Type II

Test Standard ASTM D1622 Standard Test Method for Apparent Densit y of Rigid Cellular Plastics

Condition: 40 hrs. 23 ± 3EC and 50% Relative Humidity

Apparatus: 5 Digital Calipers S/N 0098865, Scale Setra 2000g s/m 144363

Sample	Length			Width			Depth			Weight	Density
	mm	mm	mm	mm	mm	mm	mm	mm	mm	grams	kg/m³
1	102,28	102,06	101,92	101,81	102,02	102,19	25,56	26,95	26,56	10,102	36
2	102,22	102,38	102,14	101,86	101,79	101,78	27,21	27,00	26,70	9,584	34
3	102,07	102,56	102,32	101,68	102,00	102,13	27,01	27,01	27,17	9,629	34
4	102,38	102,54	102,49	101,96	102,04	102,09	26,68	26,81	26,66	9,941	36
5	102,44	102,45	102,43	101,53	101,50	101,68	26,56	26,89	25,90	9,678	35
6	101,8	102,18	101,98	101,86	102,06	101,97	27,07	27,12	27,10	10,237	36
									Average		35
									Allowable(min)		22

SECTION 7

DESCRIPTION OF SAMPLE

QUAD-LOCK POLYSTYRENE FORMS FOR CONCRETE WALLS

1. SUBJECT

Quad-lock Polystyrene Forms for Concrete Walls

2. DESCRIPTION

2.1 General

Quad-lock insulating concrete forms are expanded polystyrene (EPS) foam plastic panels serving as formwork for concrete bearing and nonbearing walls, shear walls, beams and lintels, foundation stem walls, basement walls and retaining walls. The EPS panels are stacked in a running bond pattern to create concrete formwork that remains in place after concrete curing. Walls made from the EPS panels must be covered with an approved interior thermal barrier, interior finish, and exterior wall covering system.

2.2 Material

2.2.1 **Quad-Lock Formwork**

The Quad-Lock EPS panels are 305 mm high, 1219 mm long and 57 mm thick. The EPS panels interlock on the top and bottom, and interconnect with plastic ties spaced at 305 mm on center. The ties retain the opposing EPS panels, which form a cavity where reinforcement bars and concrete are placed.

The EPS panels are molded from EPS beads. Recognized beads types are Stryropor Type BFL327, manufactured by BASF Corporation (ER-3401); and Starex Type 301H manufactured by Cheil Industries, Inc. (ER-5624). The EPS has a nominal density of 29 kg/m³ and complies with ASTM C 578, Type II, and has a flame-spread index of 25 or less and a smoke-density index of 450 or less, when tested in accordance with UBC Standard 8-1 or ASTM E 84.

Two types of interconnecting ties, the full and half tie, connect the EPS panels, and are made of high-density polyethylene. The ties are 191, 241, 292, 343 and 394 mm long, permitting the cavity formed by the EPS panels to be, respectively 95, 146, 197, 248 or 298 mm wide. The ties have 38 mm by 127 mm flanges, which are located 8 mm below the exterior EPS surface. The plastic tie flanges provide a mechanism for attaching interior and exterior wall coverings. Metal corner brackets are used in the assembly of 90 degree corners, and metal tracks are used at the base to start the wall. Figure 1 provides additional details.

2.2.2 Concrete

Normal-weight concrete must comply with Chapter 10 of the 1997 *Uniforn Building Code™* (UBC) rot he 2000 *International Building Code®* (IBC), and have a 28-day minimum compressive strength fo 13,8 MPa. Maximum aggregate size shall be 19 mm. If construction of the Quad-lock systems is based on the 2000 International Residential Code® (IRC), concrete shall comply with Section R611.6.1 fi the IRC.

2.2.3 Reinforcement

Concrete members shall be reinforced with minimum No 4 deformed steel reinforcing bars having a minimum yield strength of 275,8 MPa, and shall comply with Section 1903 of the UBC ro Chapter 3 of ACI-318-99 (IBC). If construction is based on the IRC, reinforcing steel shall comply with Sections R611.6.2 and R404.4.6 of the IRC.

2.2.4 Other

When required by the building official, wood members in contact with concrete shall be treated with an approved wood preservative, and shall be attached with galvanized steel fasteners in accordance with Section 2304.3 of the UBC or Section 2304.9.5 of the IBC. Materials other than wood, such as vinyl, shall be allowed for window and door framing if permitted by the applicable code or approved by the building official.

2.3 Design

2.3.1 General

Concrete members formed by the Quad-Lock EPS form units shall be designed and constructed in accordance with Chapter 19 of the UBC or IBC. Wall design lo ading shall be in accordance with Chapter 16 of the UBC or IBC. Stem walls complying with Section 2.6 are permited without a design.

2.3.2 Alternate Design

In lieu of calculations required by Section 2.3.1 of this report, for use under the UBC or IBC, or where an engineered design is submitted in accordance with Section R301.1.2 of the IRC, the structural design of reinforced concrete formed by Quad-Lock EPS form units for residential construction is permitted to comply with the *Prescriptive Method for Insulating Concrete Forms in Residential Construction* (publication no EB118), dated May 1998, published by the Portland Cement Association (PCA), subject to all applicability and use limits for a flat ICF wall system specified in Table 1.1 of that document. The PCA document shall be made available to the building official upon request. Buildings constructed with the Quad-lock system and designed in accordance with this section (Section 2.3.2) must not exceed a height of two stories plus a basement, where the maximum unsupported wall height is 3048 mm.

2.3.3 Design in Accordance with the IRC

Insulating concrete walls constructed with the Quad-Lock system shall be designed and constructed in accordance with Section R611 or Section R404.4 of the IRC.

2.4 Interior Finish

Quad-Lock Forms exposed to the building interior shall be finished with an approved thermal barrier such as minimum 12,7 mm regular gypsum wallboard, and attached to the plastic bridging flanges with 3,9 mm by 38 mm, coarse-thread, Type S gypsum wallboard screws spaced 305 mm on center horizontally and 305 mm on center vertically. The wall board edges shall be aligned with the plastic flanges to assure perimeter attachment.

2.5 Exterior Finish

2.5.1 Above Grade

The form units shall be covered on the exterior with an approved water-resistive barrier and exterior wall covering in accordance with the applicable code or current evaluation report. The wall covering shall be attached to the plastic ties with 3,9 mm diameter coarse-thread gypsum wallboard screws. The screws shall be corrosion-resistant and have sufficient length to penetrate the plastic ties at least 19 mm. Fasteners have an allowable pullout capacity of 169 N and an allowable lateral capacity of 342 N. Negative wind pressure capacity of the exterior finish material is recogni zed in the applicable code for generic wall-covering materials, and in a current evaluation report for proprietary wall-covering materials.

In addition to wall coverings described in the applicable code, suitable wall covering materials include R-Wall Exterior Wall Insulation and Finish Systems (ER-3617), manufactured by STO industries, Division of STO Corporation, Dryvit Outsulation System (ER-2728), manufactured by El Rey Stucco Company; or FASTWALL™ Fiber-reinforced Stucco wall System (ER-5129). The base coat, finish coat, and fabric are applied over the EPS panels in accordance with the referenced evaluation report.

2.5.2 Below Grade

Materials used to dampproof basement walls are specified by Quad-Lock Building Systems and shall be compatible with the Quad-Lock form foam plastic components.

2.6 Foundation Stemwalls

Under the UBC, Quad-Lock wall systems may be used as a foundation stem wall when supporting wood-framed construction when the wall and concrete footings supporting the wall comply with UBC Table 18-1-C. Compliance with UBC Table 18-1-C is mandatory when regulation is by the UBC.

Under the IBC, Quad-Lock wall systems may be used as a foundation stem wall supporting light-framed construction when the wall and concrete footings supporting the wall comply with IBC Table 1805.4.2. Under the IRC, installation of the Quad-Lock wall system as foundation walls shall comply with Section R404 of the IRC.

2.7 Crawl Spaces

The form units located in underfloor crawl spaces are permitted to be exposed to the crawl space, subject to the following conditions:

1. Entry to the crawl space is only to service utilities, and no heat-producing appliances are permitted.

2. There are no interconnected basement areas.

3. Air in the crawl space is not circulated ot other parts of the building.

4. Under-floor ventilation complies with the applicable code.

2.8 Installation

The Quad-Lock systems including the concrete need to be supported on concrete footings complying with Chapter 18 of the UBC or IBC, or Chapter 4 of the IRC. Vertical rebars, embedded in the footing, extend a minimum of 610 mm, or a development length complying with Section 1912 of the UBC or Chapter 12 of ACI 318-99 (IBC or IRC), into the concrete wall system. The form units shall be installed in a running bond pattern, with the plastic full ties spaced 305 mm on center. The ties shall be vertically aligned to support the interior and exterior finish materials. Placement and cover of vertical and horizontal steel reinforcement bars shall comply with the applicable code and the approved design. Basement walls designed to retain soil are not backfilled until the concrete has cured and the complete floor system is in place. Concrete quality, mixing and placing comply with Chapter 19 of the UBC and IBC, and Section R611 of the IRC. Figure 2 provides typical details.

Wood ledgers are attached to the concrete wall by removing the face shell of the form units around the anchor bolts, with the height of the removed portion being equal to the depth of the wood ledger. Wood plates are anchored to the top of the wall. Anchor bolts used to connect the wood ledgers or plates to the concrete are cast in-place, with the bolts sized and spaced as required by design. Other methods may be acceptable when specified/approved by an evaluation report or a qualified engineer.

2.9 Fire-resistive Construction

Concrete walls formed by the Quad-Lock system have the fire-resistance ratings listed in Item 7-1.1 of Table 7-B of the UBC when meeting the stated construction specifications.

3 FINDINGS

That the Quad-Lock Building Systems described in this report comply with the 1997 *Uniform Building Code*^{TM} (UBC), the 2000 *International Building Code*® (IBC), and the 2000 *International Residental Code*® (IRC), subject to the following conditions:

3.1 Quad-Lock form units are manufactured, identified, and installed in accordance with this report and the manufacturer's published installation instructions.

3.2 When regulated by the UBC or IBC, walls constructed with the Quad-Lock System are considered combustible construction.

3.3 Calculations showing compliance with the general design requirements of Chapter 16 of the UBC ot the IBC are submitted to the building official for approval, except calculations are notrequired when the building design is based on Section 2.3.2 or 2.3.3 of this evaluation report.

3.4 The EPS foam forms are separated from the building interior with an approved thermal barrier, such as minimum 12,7 mm gypsum wallboard installed as specified in this report. Other thermal barriers, having an index of 15 of higher, are acceptable, provided they are recognized in a current evaluation report.

3.5 When regulation is under the UBC or IBC, special inspection is provided in accordance with Section 2.10 of this report.

3.6 When regulation is under the IRC, compliance with Section R324.4 of the IRC must be demonstrated.

3.7 Manufacturing of Quad-Lock form units is by Aqua-Pak Styro Containers Ltd., 7398 132nd Street, Surrey, British Columbia, Canada, under a quality control program with inspections by Intertek Testing Services NA Inc. (AA-647).

This report is subject to re-examination in two years.

Note: subsection 3 corresponds to subsection 4 of the source document.

SECTION 8

ROOM FIRE TEST

INTRODUCTION

On November 9, 1994, Warnock Hesey conducted a room fire test in accordance with the Uniform Building Code Standard 26-3, 1994, *Room Fire Test Standard for Interior of Foam Plastic Systems.* The objective of the test was to evaluate the protection of the QUAD-LOCK EPS foam concrete form system manufactured by Building Technologies Inc. The protection consisted of gypsum wallboard fastened as described in the Test Sample Installation.

Pre-test inspections were conducted by Michael van Geyn representing Warnock Hersey in August 1994 and September 1994d to document the materials used and methods of manufacture for the components used in the construction of the QUAD-LOCK foam panel system.

TEST ROOM CONSTRUCTION

A test room was constructed inside our laboratory building using steel stud walls faced on the room interior side with 12,7 mm conventional gypsum wallboard. The room interior dimensions after the installation of the foam plastic and its protection were 2,43 m in height and width and 3,66 m in length. A door opening measuring 0,762 m in width by 2,13 m in height was centred in the end 2,44 m wall. The ceiling was constructed from steel studs faced on the underside with 12,7 mm conventional gypsum wallboard. The gypsum wallboard joints were taped and filled. A 609,6 mm by 609,6 piece of 15,9 mm. Type X gypsum wallboard was fastened to the ceiling in the corner above the crib.

MATERIAL SPECIFICATION

QUAD-LOCK Panels

Description:	Interlocking stackable foam panels for concrete forms (See Figure I)
Height:	305 mm
Length:	1219 mm
Thickness:	57 mm
Material:	Fire retardant expanded polystyrene
Colour:	Granite
Density:	32 kg/m³

QUAD-LOCK Bridging Ties

Description:	Bridging tie to be placed at horizontal or vertical panel joints provide a positive connection between wall sides (See Figure I)
Material:	High density polyethylene
Colour:	Colour coded for different wall thickness

QUAD-LOCK Finish Anchors

Description:	26 gauge metal finish anchors (See Figure 1)
Material:	Galvanized mild steel, punched and formed

TEST SAMPLE INSTALLATION

QUAD-LOCK panels were assembled to construct a concrete wall form with a 90 degree corner. The finished form was 2,438 m long in one direction, 2,444 m long in the other and 2,44 m high. The final concrete thickness was to be 143 mm. QUAD-LOCK half ties and full ties were installed on 304 mm centres in between the fire side and non-fire sides of the wall as per the QUAD-LOCK installation guide to hold the panels together for the pouring of the concrete. Two to three strips of 50,8 mm tape were placed around the ends of the form. Finish anchors were installed in between the successive rows of foam panels at 406 mm on centres. Concrete was pumped into the form, packed and allowed to cure for a few weeks prior to running the fire test. Standard 13 mm gypsum wallboard oriented vertically was installed over the foam panels and was fastened using 41,3 mm Type S screws. At the 2,13 m elevation screws were located 406 mm on centres and were mounted through the drywall into the finish anchors. Each sheet of gypsum wallboard was also fastened to the plastic ties with an additional 6 screws per 4 x 8 sheet, located 152 mm to 203 mm from the vertical meeting edge of each sheet and spaced 0,610 m apart. The burn room was constructed around the sample wall such that the sample wall was located at the end of the room opposite the door opening and on the right side adjacent wall.

Although finish anchors were installed between successive rows of panels, it was decided prior to mounting the drywall that the plastic ties would serve as anchoring for the drywall screws and consequently only the finish anchors at he 2,13 m elevation were used.

THERMOCOUPLE LOCATIONS

A total of six 24 gauge Type K welded termocouples were installed in the corner above the wood crib at the following locations:

Thermocouple No	Location
1	1,524 m below ceiling, 76,2 mm from adjacent wall surfaces
2	0,914 m below ceiling, 76,2 mm from adjacent wall surfaces
3	305 mm below ceiling, 76,2 mm from adjacent wall surfaces
4	25,4 mm below ceiling; 1219 mm from each test sample wall
5	Between drywall and foam at centre of crib 305 mm above floor
6	As on TC #5, but on adjacent wall

Thermocouples 1, 2 and 3 were fastened to a metal support frame built for this test. The support frame has horizontal rods extending from it to allow for thermocouple mounting at the required elevations.

THE FIRE TEST

A wood crib was constructed from nominal 50,8 mm x 50,8 mm clear douglas fir kiln dried, finish lumber, measuring 381 mm x 381 mm. The crib was constructed with five sticks in each of nine tiers and was fastened together with one 8d nail at each end of each stick. The crib was dried until it averaged 12% moisture content, at which time it weighed 13,6 kg. The crib was further conditioned until the moisture content was reduced to less that 8%. The crib was supported on its corners on cut bricks such that it was located 88,9 mm above te floor. A 610 mm x 610 mm section of 12,7 mm calcium silicate board was placed on the floor beneath the crib to prevent the concrete floor from spalling due to the heat of the fire during the test.

0,5 kg of shredded and fluffed wood excelsior was distributed under and around the bricks covering an area approximately 533,4 mm x 533,4 mm. Just prior to the start of the test, the excelsior was soaked with 0,113 kg of reagent ethyl alcohol except for an area approximately 152 mm diametrically opposite the intersection of the walls.

The crib was positioned on the bricks 25,4 mm from the test wall surfaces, the excelsior was ignited and the test was started, observations were recorded throughout the 15 minute test duration. The temperatures of the termocouples were automatically recorded every 5 seconds. A video camera was used to record the test and lights were used to show smoke levels and enhance the video picture.

FIRE TEST OBSERVATIONS

TIME, min	OBSERVATIONS
1:00	Flames to 1,219 m
1:30	Flames to ceiling
1:50	Flames to ceiling but more intense
2:30	Ceiling getting discoloured
4:00	Ceiling charred 0,914 m diametrically opposite corner
5:00	Foam temperature 95 degrees celsius behind crib
8:00	Steam emanating from exterior of ceiling gypsum
9:30	Foam temperature 90 degrees celsius behind crib
10:50	No excessive smoke generated
12:30	Foam temperature 140 degrees celsius behind crib
13:00	Flame plume receding
15:00	Crib remains intact, fire extinguished.

Immediately upon the extinguishment of the fire, the gypsum wallboard at the extremities of the sample was removed to document the extent of damage to the foam. There was absolutely no charring of the foam at the extremities of the test sample.

CONDITIONS OF ACCEPTANCE

Section 26.304 states:

"A foam plastic wall or ceiling assembly shall be considered as meeting the requirements for acceptable performance within the following conditions:

1. Charring of the foam plastic shall no extend to the outer extremities of the test area within a 15 minute period after ignition of the excelsior. Discoloration extending not more than 6 mm into the foam plastic shall not be considered as charring.

2. Smoke levels generated during the test period shall not be excessive.

3. Structural panels shall sustain the applied load during the test period".

CONCLUSION

The Building Technologies Inc. Quad Lock EPS form wall protected by 12,7 mm conventional wallboard installed as described in this report met the criteria of acceptance of the Uniform Building Code Standard 26-3 (1994).

SECTION 9

FASTENER WITHDRAWAL AND LATERAL SHEAR RESISTANCE

Fastener Withdrawal and Lateral Shear Resistance - Report no 3066411-2 revised –replaces Report no 306611-2, issued January 21, 2005™

Intertek Testing Services NA Ltd. (Intertek) has performed fastener withdrawal and lateral shear resistance tests for Quad-Lock Building Systems Ltd. on submitted specimens of Quad-Lock. The tests were conducted on December 6 to 7, 2004 in general accordance with ASTM D 1761-88 *"American Society for Testing and Materials International Standard Test Methods for Mechanical Fasteners in Wood*".

SAMPLE SELECTION

The submitted specimens were identified as Quad-Lock QPX-2 FS Panels, and insulating concrete form product. The Quad-Lock FS panels are molded from Expanded Polystyrene and contain ABS plastic fastening strips embedded into the EPS with the aid of 40 mm wide by 3,5 mm thick detailed flange connections. The fastening strips are spaced at 305 mm centres in the panels, and are designed to interlock with the Quad-Lock ties to present a continuous vertical stri p on the interior or exterior of a Quad-Lock wall, into which screws may be driven to fasten finish materials.

TEST PROCEDURE

Withdrawal and shear tests were conducted in three types of fasteners as indicated below. The prepared specimens were conditioned for 24 hours at a temperature of 35 ± 2 EC. Quad-Lock specifies that this is a "worst case scenario" of temperature conditions, which their product is exposed to.

Ten withdrawal tests were conducted on each configuration by threading the fasteners into the middle porti on of the plastic fastening strip and pulling it out perpendicular to the strip surface. Maximum loads were recorded and averaged. Ten shear tests were conducted on each configuration by attaching a piece of pre-drilled cementitious board to the sample and forcing it laterally downward until failure. Maximum loads were recorded and averaged. A deviation from the ASTM D 1761 test method was that load versus deflection values were not recorded for the shear resistance tests.

REVISION TABLE

Revision Date	Page	Revision
March 14, 2005	Page 1	Revised Sample Selection description

TEST RESULTS

Table 1 - Fastener Withdrawal Test Results			
Fastener	Failure Mode	Maximum Load, N	Coefficient of Variation, %
Type W Drywall Screw	Fasteners pulled through	866	3,8
Cement board Fasteners CHS8158JBWG2	Fasteners pulled through	943	7,0
Cement Board Fasteners CHSS81587JBW	Fasteners pulled through	924	2,4

Table 1 - Lateral Shear Resistance Test Results			
Fastener	Failure Mode	Maximum Load, N	Coefficient of Variation, %
Type W Drywall Screw	Fasteners pulled through	883	5,3
Cement board Fasteners CHS8158JBWG2	Fasteners pulled through	953	6,9
Cement Board Fasteners CHSS81587JBW	Fasteners pulled through	906	4,8

SECTION 10

FINAL TEST REPORT

Object: **Final Test Report #3080072-01 of Extruded Polystyrene Foam Insulation, models EPS Insulation for Quad-Lock Building Systems Ltd.**

Tests were performed on an Extruded Polystyrene foam Insulation, Model EPS Insulation, manufactured at the Brockway Penn, Facility for Quad-Lock Building Systems Ltd.

The following tests were conducted on the Extruded Polystyrene foam Insulation, Model EPS Insulation:

- Thermal	ASTM C518
- Flame Spread	ASTM E84
- Water Absorption	ASTM C1104
- Standard Specification for Mineral-fiber Blanket Thermal Insulation for light frame Construction and Manufactured Housing	ASTM C665
- Section 13.8 - Corrosiveness	ASTM C665
- Odor Emission	ASTM C1304
- Water Vapour Transmission	ASTM E96
- Critical radiant flux of Exposed Attic Floor Insulation	ASTM E970
- Fungi Resistance	ASTM C1338

Upon reception of the samples at the laboratory, they were placed in a conditioning room where they remained in an atmosphere of 23 ± 3EC and 50 ± 5% relative humidity for a period of 48 hours minimum.

TEST RESULTS

Tests	Standards	Average Results	Remarks
Standard Specification for Mineral-Fiber Blanket Thermal Insulation for light frame construction and Manufactured Housing Section 13.8 - Corrosiveness	ASTM C665	Steel: 40 $ 21 Copper: 40 $ 21 Aluminium: Neither type of samples have shown(unit less) sign of corrosion	Conform
Odor Emission	ASTM C1304	None of the panellists have classified the odor as strong and objectionable	Conform
Water Vapour Transmission	ASTM E96	3,03 g/h x m²	Complete
Critical radiant flux of Exposed Attic Floor Insulation	ASTM E970*	™ 1,0	Complete
Fungi Resistance	ASTM C1338*	Refer to table IV and V for results	Conform
Thermal	ASTM C518	1,646 K m²/W	Complete
Flame Spread	ASTM E84		Reported separately
Water Vapor Sorption	ASTM C1104	Ave. Weight increase: 0,16% Ave. Volume increase: 0,005%	Complete

* These tests were subcontracted

For detailed results, please refer to tables I, II, III, IV

EQUIPMENT USED

List of instruments and equipment used during testing:

Calibration records are kept in file for future reference. The calibration matrix of all equipment meets the requirements of ISO 17025.

Description	Number	Calibration due date	Measurement Uncertainty
Oven	170-060	December 2005	Refer to cal. file
Caliper	180-413	January 2006	Refer to cal. file
Netzsch Lambda 2000 Heat flow Meter Model 436/3/1 Serial No 183A-1204-606000390	280-01-0725	December 2005	5%
Sling psychrometer	180-318	August 2006	±5% RH
0-8000 gr Scale	180-280	October 2005	Refer to cal. file

Table I

Critical Radiant Flux of model EPS Insulation ASTM E970

Samples	Distance Burned (mm)	Critical Radiant Flux (W/cm^2)	Standard Deviation	Coefficient of Variation
1	0	> 1,0	-	-
2	0	> 1,0	-	-
3	0	> 1,0	-	-
	Average	> 1,0	0,00	0,00

Table II

Water Vapor Sorption
ASTM C1104-2000

Sample	Measurements					Moisture-free weight (w_1)	Post-exposure weight (w_2)
	Width 1 (mm)	Width 2 (mm)	Thickness (mm)	Volume (m^3)	Volume (cm^3)	(g)	Sample moist weight (g)
S1	152,49	152,66	58,20	0,001355	1355	40,4	40,4
S2	152,80	152,04	57,75	0,001342	1342	40,0	40,1
S3	152,53	153,04	57,56	0,001344	1344	44,2	44,3

Table III

Test Method of Steady-State Thermal Transmission Properties by Heat of the Heat Flow Meter Apparatus ASTM C518-04

Orientation: Mid Height of the specimen

Thermal Transmission Properties	
Description	**SI Units**
Specimen thickness	57,70 mm
Upper surface temperature	34,93EC
Lower surface temperature	13,14EC
Temperature differential	21,7EC
Mean specimen temperature	24,04EC
Rate of heat flux	13,248 W/m²
Thermal conductance	0,608 W/m²K
Thermal resistance	1,646EK m²/W
Thermal conductivity	0,034 W/mK
Thermal resistivity	28,490 K m/W
Thermal resistance at 25 mm	0,713 K m²/W

Orientation: Joint formed by two sections

Thermal Transmission Properties	
Description	**SI Units**
Specimen thickness	57,91 mm
Upper surface temperature	34,81EC
Lower surface temperature	12,98EC
Temperature differential	21,83EC
Mean specimen temperature	23,89EC
Rate of heat flux	14,561 W/m²
Thermal conductance	0,667 W/m²K
Thermal resistance	1,500 K m²/W
Thermal conductivity	0,039 W/mK
Thermal resistivity	25,907 K m/W
Thermal resistance at 25 mm	0,648 K m²/W

Table IV
Conformance to ASTM C 1338-00

Sample Designation	Mold and Mildew Resistance		Observations (Rating*)	
Insulation material	**7 Days**	**14 Days**	**21 Days**	**28 Days**
#1	0	0	0	0
#2	0	0	0	0
#3	0	0	0	0
Controls				
Cotton	4	4	4	4
Filter paper	4	4	4	4
Potato dextrose agar	4	4	4	4
Glass slides	0	0	0	0
		Rating		
	Not growth Traces Light Moderate Heavy	0 1 2 3 4		

Table V

Conformance to ASTM C 1313-00 Standard specification for Sheet Radiant Barriers for Building construction Applications.
Twenty (20) day cultures of the following pure culture fungi were harvested, washed and their spore counts adjusted to 1,000,000 ± 2000,000/ml:

Organism	ATCC Number
Asperfillus niger	9642
Penicillium pinophilum	11797
Asperfills vresicolor	11730
Aspergillus flavus	9643
Chaetomium globusum	6205

The spore suspensions were combined and sprayed on the samples and controls, which were placed on mineral slats agar and placed in the test chamber. The samples along with controls were incubated for 28 days and examined weekly.

Conclusion: The foam insulation did not allow any fungus growth (Rating 0)

SECTION 11

15 MINUTES FIRE EXPOSURE

INTRODUCTION

On December 22, 2005, Intertek Testing Services Na Ltd./Warnock Hersey conducted a fire endurance test of the Quad-Lo ck® exterior wall system. The objective of the test was to determine if the James Hardie Hardiplank® sliding attached to the Quad-Lock EPS wall system would remain in place after 15 minutes of fire exposure.

Testing was conducted in accordance with CAN/ULC S101-04 and ASTM E119, *Standard Test Methods for Fire Tests of Building Construction and Materials*, to determine compliance with the National Building Code of Canada, Sentence 3.2.3.7, the Ontario Building Code 1997, Sentence 3.2.3.7, Clause 7b and 8, and the City of Vancouver Building By-Law 1999, Sentence 3.2.3.7, Clause 7b and 8.

MATERIAL SPECIFICATION

Concrete From Panels:	Expanded polystyrene (EPS) foam panels with embedded plastic webs
Panel Length:	1219,2 mm
Panel Width:	304,8 mm
Panel Thickness:	57,15 mm
Concrete Thickness:	101,6 mm
Colour:	White
Web Description:	Polythylene
Web Colour:	Black
Web Dimensions:	190,5 mm long by 139,7 wide
Web Width:	38,1 mm
Web Spacing:	304,8 mm on centre
Strapping:	Nominal 25,4 mm by 50,8 mm solid sawn wood strapping
Siding:	James Hardie Building Products, Hardiplank® 8 mm thick by 159 mm wide by 3658 mm long
Starter Track:	20 gauge galvanized steel metal track
Top Ties:	190,5 mm long wire top ties

TEST WALL CONSTRUCTION

The wall assembly was constructed in our full-scale vertical fire endurance furnace test frame. The Quad-Lock® blocks were assembled to form a 2,743 m by 3,657 m wall concrete form. The vertical ends of the formwork were then capped using 12,7 mm plywood. 28 MPa concrete with pea sized aggregate and 152 mm slump was pumped into the form to the full height.

After 36 hours of cure time, the James Hardie Hardiplank® siding was installed. Nominal 25,4 by 50,8 mm vertical wood strapping, spaced 304,8 mm on centres was attached to the EPS foam plastics ties using 50,8 mm long bugle head drywall screws spaced 203 mm on centres. The James Hardie Hardiplank® siding, cut to 3,658 mm lengths, was fastened horizontally to the wood strapping using 31,75 mm fibreboard screws, with 101,6 mm siding face exposure (50,8 mm overlap).

THE FIRE TEST

The test wall assembly was mounted in the full-scale vertical furnace mounting frame.

The moveable frame containing the test wall assembly was secured to the furnace. The pilot burners were ignited and burned until the temperature inside the furnace reached 20 ± 2 EC.

All burners were fired and timing was begum immediately upon achieving maximum high fire.

The temperatures inside the furnace are monitored by twelve equally spaced thermocouples. These reading were recorded by a calibrated Fluke “Hydra Data Bucket” automatic data recorder every 5 seconds and automatically displayed every 15 seconds.

The wall assembly was subjected to the standard time/temperature curve of CAN/ULC S101-04 and ASTM E119, and the exposed surface was observed. The test was continued for 15 minutes.

FIRE TEST OBSERVATIONS

TIME (min)	EXPOSED SIDE	UNEXPOSED SIDE
10:00	No visible change	Venting at top of wall
12:30	Wall remains flat	
14:00	No change	
15:00	All panels remain	
16:00	No change, test discontinued	

NOTE: A Time Temperature curve illustrates how the temperature raised to 760EC in 10 min
(Refer to source document Report 3088663, page 7 of 9)

SECTION 12

WATER VAPOR PERMEANCE

Intertek Testing Services NA Ltd. (Intertek) confirms that the Quad-Lock Insulated Concrete Forms meet the Manitoba Building Code (MBC) as it relates to Water Vapor Permeance.

Water Vapor Transmission testing per ASTM E96 was conducted by the Coquitlam laboratory of intertek (Test Report 484-7045 dated February 1995) and results showed a water permeance of 14,3 ng/Pa.s.m^2.

Article 9.25.4.2 (1) of the MBC states that vapor barriers shall have an initial permeance not greater than 45 ng/Pa.s.m^2, and thus this product is within the acceptable limit

SECTION 13

EVALUATION REPORT

1 Purpose of Evaluation

The proponent sought confirmation from the Canadian Construction Materials Centre (CCMC) that "Quad-Lock®" can serve as a wall forming system, resulting in a monolithic concrete wall conforming to the intent of the National Building Code of Canada (NBC) 1995.

2 Opinion

Subject to the limitations and conditions stated in this report, test results and assessments provided by te proponent show that "Quad-Lock®" complies with CCMC's Technical Guide for Modular, Expanded-polystyrene or Polyurethane Concrete Forms, MasterFormat number 03131, dated 200-09-16, and provides a level of performance equivalent to that required in:

* NBC 1995, Article 4.3.3.1, Subsection 9.3.1, Section 9.4, and Subsection 9.15.4 with respect to wall construction.

Canada Mortgage and Housing Corporation permits the use of this product in construction financed or insured under the National Housing Act.

Note: The attachment of exterior cladding and interior finishing materials has not been assessed by the present evaluation.

3 Description

"Quad-Lock®" is a modular, interlocking concrete form system consisting of two expanded polystryrene (EPS) insulation panels that are connected on side with a series of high-density polyethylene plastic ties that are placed horizontally at 305 mm on centre.

The EPS face panels have preformed dimples along their top and bottom edges of facilitate stacking and to prevent the leakage of freshly placed concrete. The forms are dry-laid and stacked in a running(staggered) configuration to form a rectangular space, which, after being filled with concrete, forms and insulated, monolithic concrete wall of uniform thickness.

Reinforcement is to be placed where required to satisfy strength requirements for above or below-grade load-bearing walls, beams, lintels and shear walls.

The EPS insulation panels forming the faces of the units have external dimensions of 1220 mm long and 305 mm high, with a thickness of 57 mm with. The high-density polyethylene plastic ties are available in two lengths to produce 150 mm and 200 mm thick concrete walls.

The "Quad-Lock®" form unit and components are illustrated in Figure 1. Typical details for residential construction are shown infigueres2, 3, 4 and 5.

4 Usage and Limitations

The use of “Quad-Lock®” is permitted in construction of houses and small buildings up to two storeys high that fall under the provisions of Part 9 of NBC 1995, subject to the following conditions:

- The stuctural applications of “Quad-Lock®” must be in strict accordance with the design analysis as prepared for “Quad-Lock®” Building System Ltd., by C.A. Boom Engineering (1985) Ltd., Report No. 02-213 dated October 2002 from which tables 1a, 1b, 2a, 2b, and 2c have been reproduced.

- The concrete used in “Quad-Lock®” must be Type 10, or Type 30 with a minimum compressive strength of 20 MPa and a maximum slump of 100 mm.

- For a standard wall height (2,44 m), the pouring of concrete must be made in consecutive lifts, each lift is limited to a maximum of 1 m.

- The EPS insulation used in this system must comply with CAN/ULC-S701-97 “Standard For Thermal Insulation, Polystyrene, boards and Pipe Covering” Type 2.

- The aging of “Quad-Lock®” EPS insulation panels must not be less than three weeks from the date of manufacturing.

- The interior face of “Quad-Lock®” panels shall be protected from the inside of the building in accordance with Sentence 9.10.16.10(1) of NBC 1995.

- For above grade installations, the exterior face of “Quad-Lock®” shall be protected with materials that conform to NBC 1995, Sections 9.20., 9.27 and/or 9.28.

- The attachment of exterior cladding and interior finishing materials has not been assessed by the present evaluation.

- For foundation-wall installations the backfill shall be placed in such a way as to avoid damaging the wall, the exterior insulation panel and the waterproofing and dampproofing protection.

- The concrete must be cured for a minimum of seven days before backfilling. The top of the foundation wall must be supported by the first floor prior to backfilling.

- For below grade installations, dampproofing material compatible with the EPS insulation must be provided in accordance with NBC 1995, Article 9.13.1.1.

- Where hydrostatic pressure exists, waterproofing compatible with the EPS insulation must be provided in accordance with NBC 1995, Article 9.13.1.2.

- The backfill material must be well drained and a drainage system must be installed around the footing in accordance with the NBC 1995.

- Installation of “Quad-Lock®” shall be in strict compliance with the “Quad-Lock® Product Manual” dated July 2002.

- Only installers who have been trained and authorized by “Quad-Lock® Building Systems Led.” shall be contracted to set up the wall system.

5 Performance

Compliance of the expanded polystyrene insulation thermal insulation with the requirements of CAN/ULC-S701-97 was conducted at laboratories recognized by CCMC and is covered by Intertek Testing Services Report no 484-7045.

The design analysis of walls using “Qua-Lock®” that was prepared for “Quad-Lock® Building Systems Ltd/” is summarized in tables 1a, 1b, 2a, 2b, 2c and 2d.

The tables provide steel reinforcement designs for a number of different wall and lintel applications based on the structural loads. The design assumptions are indicated below each table. When “Quad-Lock®” is used in structural applications outside the scope of the reference design analysis, a registered professional engineer skilled in concrete design must certify the design analysis and the design drawings for such buildings. The engineer shall certify that the construction provides a level of performance equivalent to that required by Part 4 and/or Part 9 of NBC 1995.

Table 1a Refer to Vertical and horizontal Steel Reinforcement for “Quad-Lock®” Below-grade Walls in Seismic Zones 0 - 4

Table 1b Refer to Vertical and Horizontal Steel Reinforcement for “Quad-Lock®” Above-grade Walls in Seismic Zones

Table 2a Refer to Minimum Steel Reinforcement of 200 mm deep Lintels with 150 mm and 200 mm “Quad-Lock®” Forms

Table 2b Refer to Minimum Steel Reinforcement of 300 mm deep Lintels with 150 mm and 200 mm “Quad-Lock®” Forms

Table 2c Refer to Minimum Steel Reinforcement of 400 mm deep Lintels with 150 mm and 200 mm “Quad-Lock®” Forms

Table 2d Refer to Minimum Steel Reinforcement of 610 mm deep Lintels with 150 mm and 200 mm "Quad-Lock®" Forms.

The tables referred to above can be found in the source document. Refer section 15.

SECTION 14

SURFACE BURNING CHARACTERISTICS

INTRODUCTION

This report described the results of the UL 723 Test for SURFACE BURNING CHARACTERISTICS OF BUILDING MATERIALS, a method for determining the comparative surf ace burning behavior of building material. This test is applicable to exposed surfaces, such as ceilings or walls, provided that the material or assembly of materials, by its own structural quality or the manner in which it is tested and intended for use, is capable of supporting itself in position of being supported during the test period.

The purpose of the method is to determine the relative burning behavior of the material by observing the flame spread along the specimen. Flame spread and smoke density developed are reported, however, there is not necessarily a relationship between these two measurements.

“The use of supporting materials on the underside of the test specimen may lower the flame spread index from that which might be obtained if the specimen could be tested without such support. This method may not be appropriate for obtaining comparative surface burning behavior of some cellular plastic materials. Testing of materials that melt, drip, or delaminate to such a degree that the continuity of the flame front is destroyed, results in low flame spread indices that do not relate directly to indices obtained by testing material that remain in place.”

This test method is also published under the following designations:

ANSI 2,5
NFPA 255
UBS 8-1
ASTM E84-05

This standard should be used to measure and describe the properties of materials, products, or assemblies in response to heat and flame under controlled laboratory conditions and should not be used to describe or appraise the fire hazard or fire risk of materials, products, or assemblies under actual fir conditions. However, results of this rest may be used as elements of a fire risk assessment which takes into account all of the factors which are pertinent to an assessment of the fire hazard of a particular end use.

II PURPOSE

The UL 723 (7,62 m tunnel) test method is intended to compare the surface flame spread and smoke developed measurement to those obtained from tests of mineral fiber cement board and select grade red oak flooring. The test specimen surface (457 mm wide and 7,32 m long) is exposed to a flaming fire exposure during the 10 minute test duration, while flame spread over its surface and density of the resulting smoke are measured and recorded. Test results are presented as the computed comparisons to the standard calibration materials.

The furnace is considered under calibration when a 10 minutes test of red oak decking will pass flame out the end of the tunnel in five minutes, 30 seconds, plus or minus 15 seconds. Glass fiber cement board forms the zero point, while the red oak flooring smoke developed rating is set as 100.

III DESCRIPTION OF TEST SPECIMEN

Specimen Identification:	Quad Lock ICF
Date Received:	September 28, 2006
Date Conditioned:	September 28, 2006
Date Tested:	October 12, 2006
Conditioning (23EC % 50% r.h.):	14 days
Specimen Width, mm:	609,6
Specimen length, mm:	7,315
Specimen Thickness, mm:	56,66
Material Weight:	N/A
Total Specimen Weight, kg:	7,85
Adhesive or coating application rate:	N/A

Mounting Method

The foam panels were self-supporting

Specimen Description:

The specimen consisted of (12) 1219 mm long x 305 mm wide x 56,7 mm thick, EPS panels used to build reinforced concrete walls. The blocks were interlocked together to achieve the 7,315 m long x 609,6 mm wide x 56,7 mm thick, test specimen. The EPS blocks were blue in color.

IV TEST RESULTS & OBSERVATIONS

The test results, computed on the basis of observed flame front advance and electronic smoke density measurements are presented in the following table. In recognition of possible variations and limitations of the test method, the results are computed to the nearest number divisible by five, as outlined in the test method.

Test Specimen	Flame Spread Index	Smoke Developed Index
Mineral Fiber Cement Board	0	0
Red Oak Flooring		100
Qual Lock ICF		
Ceiling Burning Only*	10	5
Floor Burning Only*	35	1150

* The practice of separating the Flame Spread and Smoke Developed Indices for floor and ceiling burning is not described in any of the standard test methods. This practice has apparently been established by Underwriters Laboratories even though not included in their UL 723 standard. Due to the acceptance of this practice by the U.S. model building code evaluation services, it has been included in this document. The calculations have been made by determining the maximum flame front progression on the ceiling at any point prior to the occurrence of floor ignition and using that time distance value to calculate $A_{T(\text{ceiling only})}$. The Flame Spread Index given as "Floor Burning" has been calculated using the same procedure as for the "Ceiling Only", except that the ceiling portion of the flame from progression has been removed and the floor burning calculations start when the material on the runnel floor ignited. The smoke developed index for each has been calculated by considering the area under the %T-time curve. The "Ceiling Only" index has been calculated using the area under the curve up to the point of ignition of the floor. The "Floor Only" index has been calculated using the area under the curve after ignition of the material on the tunnel floor.

The Smoke Developed Index on the data sheet is that calculated in accordance with the UL 723 standard for the total test.

The data sheets are included in Appendix A. These sheets are actual print-outs of the computerized data system which monitors the UL 723 apparatus, and contain all calibration ans specimen data needed to calculate the test results.

V OBSERVATIONS

The EPS foam began to melt a 0:05 (min:sec). Flaming drops began to fall from the specimen at 0:07 (min:sec). The specimen ignited at 0:12 (min:sec). The floor ignited in front of the burners at 0:39 (min:sec). The test continued for the 10:00 duration. After the test burners were turned off, a 60 second after flame was observed.

After cooling, lifting the tunnel lid and removing the runnel board backing, the specimen was observed to be totally consumed from 0 m - 7,32 m.

INTERTEK TESTING SERVICES NA, INC

UL 723 DATASHEETS

Client: Quad-Lock Building Systems Ltd.
Date: 10/12/2006
Test Number: 1
Project Number: 3105457SAT-001
Operator: TA.MJP

Specimen ID: "Quad-Lock ICF, The specimen consisted of (6) 1,22 m long x 0,610 m wide panels. The specimen was self-supporting. The panels were it, blue in color. The EPS panels were sampled at the Quad Lock Building System plant in Surrey, BC Canada.

TEST RESULTS:

FLAME SPREAD INDEX; (Ceiling Only) 10
SMOKE DEVELOPED INDEX: (Ceiling Only) 5
FLAME SPREAD INDEX: (Floor Only) 35
SMOKE DEVELOPED INDEX: (Floor Only) 1150

SPECIMEN DATA

Time to Ignition	=	12 (sec)
Time to Max FS	=	447 (sec)
Maximum FS	=	5,8 (m)
Time to 527EC (sec)	=	Never Reached
Max Temp	=	688,9 EC
Time fo Max Temp	=	964,22 (sec)
Total Fuel Burned	=	1,451 m^3
Smoke Area	=	738.30 (%A*min)
Unrounded F.S.I.	=	45,0376

CALIBRATION DATA

Time to Ignition of Last Red Oak	=	00:46 (min:sec)
Red Oak Smoke Area	=	64, 23 (%A*min)

E Seeger
MANAGER: BUILDING AND CONSTRUCTION

J Strobos
TEST OFFICER