Celotex Corporation
Testing Services

10301 Ninth Street North
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FIRE TESTING LABORATORY REPORT

April 28, 1998

Client: ECO-Block, LLC
513 Coconut Isle
Ft. Lauderdale, FL 33301

MTS Job No.: 258389E-1

Metro-Dade Notification No.: CAE 98022

Project: Ignition Properties of ECO-Block™ 2000 Expanded Polystyrene Material

Introduction:

This report presents the results of fire tests conducted on material submitted to our laboratory on January 23, 1998. Testing was completed on February 4, 1998.

Specimen Preparation:

Several insulated concrete form (ICF) building system specimens were supplied by the client and identified as ECO-Block™ 2000 material. Each ICF consisted of a nominal 16 by 48 by 2.5 inch expanded polystyrene (EPS) block with six (6) plastic connectors, placed 8 inches on center, embedded into the block insulation.

Twenty (20) 3 gram samples were fabricated from the EPS material. The plastic material was cut, stacked and melted in the specimen cups. The samples were conditioned in a controlled laboratory at 75°F and 50% relative humidity a minimum of 48 hours prior to testing.

ASTM D1929 Test Method:

The following results were determined in accordance with the test method below.

ASTM D1929-91a, "Standard Test Method for Ignition Properties of Plastics - Procedure B"

The plastic materials self-ignition and flash-ignition temperatures were determined using a "Setchkin" hot-air ignition furnace. *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 fire conditions. However, results of this test 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.*

Client: ECO-Block, LLC

MTS Job No.: 258389E-1

Summary of ASTM D1929 Test Results

Specimen I.D.	**Flash-Ignition Temperature**	**Self-Ignition Temperature**
ECO-Block™ 2000 EPS Material	370°C [698°F]	460°C [860°F]

Observations:

Constant air velocities of 5 ft/min were maintained in the furnace test chamber as specified by Section 9.1.1 of the Standard Test Method. The material melted and smoked during the flash and self ignition tests.

Tested by: William M. Gwynn
Laboratory Technician

Approved by: Stanley D. Gatland II
Research Engineer

This report is for the information of the client. It may be used in its entirety for the purpose of securing product acceptance from duly constituted approval authorities; however, this report or the name of Celotex Corporation shall not be used in publicity or advertising.

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FIRE TESTING LABORATORY REPORT

April 28, 1998

Client: ECO-Block, LLC
513 Coconut Isle
Ft. Lauderdale, FL 33301

MTS Job No.: 258389E-2

Metro-Dade Notification No.: CAE 98023

Project: Ignition Properties of ECO-Block™ 2000 Plastic Connector Material

Introduction:

This report presents the results of fire tests conducted on material submitted to our laboratory on January 23, 1998. Testing was completed on February 5, 1998.

Specimen Preparation:

Several insulated concrete form (ICF) building system specimens were supplied by the client and identified as ECO-Block™ 2000 material. Each ICF consisted of a nominal 16 by 48 by 2.5 inch expanded polystyrene (EPS) block with six (6) plastic connectors, placed 8 inches on center, embedded into the block insulation.

Twenty (20) 3 gram samples were fabricated from the material. The plastic connectors were cut, stacked and placed into the specimen cups. The samples were conditioned in a controlled laboratory at 75°F and 50% relative humidity a minimum of 48 hours prior to testing.

ASTM D1929 Test Method:

The following results were determined in accordance with the test method below.

ASTM D1929-91a, "Standard Test Method for Ignition Properties of Plastics - Procedure B"

The plastic materials self-ignition and flash-ignition temperatures were determined using a "Setchkin" hot-air ignition furnace. *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 fire conditions. However, results of this test 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.*

Client: ECO-Block, LLC

MTS Job No.: 258389E-2

Summary of ASTM D1929 Test Results

Specimen I.D.	Flash-Ignition Temperature	Self-Ignition Temperature
ECO-Block™ 2000 Plastic Connector Material	320°C [608°F]	340°C [644°F]

Observations:

Constant air velocities of 5 ft/min were maintained in the furnace test chamber as specified by Section 9.1.1 of the Standard Test Method. The material melted and smoked during the flash and self ignition tests.

Tested by: William M. Gwynn
Laboratory Technician

Approved by: Stanley D. Gatland II
Research Engineer

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FIRE TESTING LABORATORY REPORT

March 3, 1998

Client: ECO-Block, LLC
513 Coconut Isle
Ft. Lauderdale, FL 33301

MTS Job No.: 258389H

Metro Dade Notification No.: CAE 98024

Project: Rate of Burning Characteristics of ECO-Block™ 2000 Plastic Connector Material

Introduction:

This report presents the results of fire tests conducted on material submitted to our laboratory on January 23, 1998. Testing was completed on March 2, 1998.

Specimen Preparation:

Several insulated concrete form (ICF) building system specimens were supplied by the client and identified as ECO-Block™ 2000 material. Each ICF consisted of a nominal 16 by 48 by 2.5 inch expanded polystyrene (EPS) block with six (6) plastic connectors, placed 8 inches on center, embedded into the block insulation. Twenty (20) 125 by 12.5 by 4 millimeter samples were cut from the plastic connector specimens. The samples were conditioned in a controlled laboratory at 70°F and 50% relative humidity a minimum of 2 days prior to testing.

ASTM D635 Test Method:

The following results were determined in accordance with the test method below.

ASTM D635-91, "Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Self-Supporting Plastics in a Horizontal Position".

The plastic materials rate of burning and/or extent and time of burning were determined using a small scale laboratory apparatus as described in Section 6 of the above standard test method. The following caveat is required by Section 9.3.8 of the D635 standard test method. *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 fire conditions. However, results of this test 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.*

Client: ECO-Block, LLC

MTS Job No.: 258389H

Summary of ASTM D635 Test Results

Specimen I.D.	Average Rate of Burning
ECO-Block™ 2000 Plastic Connector Material	1.43 cm/min [0.56 in/min]

Observations:

The above reported rate of burning characteristics are the average of three (3) consecutive samples which did burn to the 100-mm gage mark. The average specimen thickness was 4 mm. The range of time to burn was 346 to 417 seconds. All samples burned melted and dripped onto wire gauze below the specimen.

The ECO-Block™ 2000 plastic connector material was classified using the South Florida Building Code (Revision 1994), Section 3505.2(a) criteria. The average measured burning characteristics were determined between the plastic sample's 25-mm mark and the 100-mm mark. The material was identified as Class C-1.

Tested By: William M. Gwynn
Laboratory Technician

Approved By: Stanley D. Gatland II
Research Engineer

This report is for the information of the client. It may be used in its entirety for the purpose of securing product acceptance from duly constituted approval authorities; however, this report or the name of Celotex Corporation shall not be used in publicity or advertising.

ASTM E119-00
Fire Tests of Building Construction and Materials*

ECO-Block Concrete Wall

Project No. 16233-108915

SMALL SCALE FIRE RESISTANCE TESTS OF CONCRETE BLOCK WALL ASSEMBLIES

January 16, 2002

* The test was modified, in that the three test articles were less than the required 100 ft^2 exposure size.

Prepared for:

ECO-Block, LLC
1100 Centennial Blvd, Suite 190
Richardson, TX 75081

OMEGA POINT LABORATORIES

ABSTRACT

Reduced scale test walls were thermally evaluated by the ASTM E119-00 & ISO 834-75 time-temperature exposures, and their results compared to a full-scale loadbearing fire test done earlier on an 8" thick specimen. The small scale walls were 48" x 48" and the interior concrete was 4", 6" and 8" thick. The intent was, by correlation of the large- and small-scale 8" thick walls, to determine the fire endurance rating of the 4" and 6" specimens. The results are indicated in the table below:

CONCRETE THICKNESS (IN.)	FIRE ENDURANCE RATING (HR)
4	2
6	≥ 4
8	≥ 4

The description of the test specimen and the results presented herein are true and correct to the best of our knowledge and within the bounds of normal engineering methods and techniques.

Deggary N. Priest, President — January 16, 2002 (Date)

Reviewed and approved:

William E. Fitch, P.E. No. 55296 — Date: January 16, 2002

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INTRODUCTION[1]

The discussion and results contained herein are intended to be considered in light of the results obtained in Project 16233-106668, a loadbearing, full-scale (10 ft x 10 ft) fire endurance test of an ECO-Block Concrete Wall (eight inches thick concrete), performed on September 28, 2000. That wall was tested under a load (combined dead plus live load) of 7000 lbf per linear foot (total load = 70,000 lbf). The intent of this project was to evaluate three small-scale test specimens (4", 6" & 8" thick concrete), and, by correlating the 8" small- and large-scale test results, to determine the fire endurance rating of all three.

"The performance of walls, columns, floors, and other building members under fire exposure conditions is an item of major importance in securing constructions that are safe, and that are not a menace to neighboring structures nor to the public. Recognition of this is registered in the codes of many authorities, municipal and other. It is important to secure balance of the many units in a single building, and of buildings of like character and use in a community; and also to promote uniformity in requirements of various authorities throughout the country. To do this it is necessary that the fire-resistive properties of materials and assemblies be measured and specified according to a common standard expressed in terms that are applicable alike to a wide variety of materials, situations, and conditions of exposure.

Such a standard is found in the methods that follow. They prescribe a standard exposing fire of controlled extent and severity. Performance is defined as the period of resistance to standard exposure elapsing before the first critical point in behavior is observed. Results are reported in units in which field exposures can be judged and expressed.

The methods may be cited as the "Standard Fire Tests," and the performance or exposure shall be expressed as "2-h," "6-h," "1/2-h," etc.

When a factor of safety exceeding that inherent in the test conditions is desired, a proportional increase should be made in the specified time-classification period.

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[1] ASTM E119-00 **Standard Methods of FIRE TESTS OF BUILDING CONSTRUCTION AND MATERIALS**, American Society for Testing and Materials, Volume 04.07 Building Seals and Sealants, 2000 Annual Book of ASTM Standards.

The ASTM E119 test procedure is identical or very similar to the following standard test methods:

UL 263
UBC 43-1
NFPA 251
ANSI A2.1
ULC S101

1. Scope

1.1 These methods are applicable to assemblies of masonry units and to composite assemblies of structural materials for buildings, including bearing and other walls and partitions, columns, girders, beams, slabs, and composite slab and beam assemblies for floors and roofs. They are also applicable to other assemblies and structural units that constitute permanent integral parts of a finished building.

1.2 It is the intent that classifications shall register performance during the period of exposure and shall not be construed as having determined suitability for use after fire exposure.

1.3 *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 fire conditions. However, results of this test 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.*

Note 1 - A method of fire hazard classification based on rate of flame spread is covered in ASTM Method E84, Test for Surface Burning Characteristics of Building Materials.

1.4 The results of these tests are one factor in assessing fire performance of building construction and assemblies. These methods prescribe a standard fire exposure for comparing the performance of building construction assemblies. Application of these test results to predict the performance of actual building construction requires careful evaluation of test conditions.

2. Significance

2.1 This standard is intended to evaluate the duration for which the types of assemblies noted in 1.1 will contain a fire, or retain their structural integrity or exhibit both properties dependent upon the type of assembly involved during a predetermined test exposure.

2.2 The test exposes a specimen to a *standard* fire *exposure* controlled to achieve specified temperatures throughout a specified time period. In some instance, the *fire exposure* may be followed by the application of a *specified standard* fire hose stream.

The exposure, however, may not be representative of all fire conditions which may vary with changes in the amount, nature and distribution of fire loading, ventilation, compartment size and configuration, and heat sink characteristics of the compartment. It does, however, provide a relative measure of fire performance of comparable assemblies under these specified fire exposure conditions. Any variation from the construction or conditions (that is, size, method of assembly, and materials) that are tested may substantially change the performance characteristics of the assembly.

2.3 The test standard provides for the following:

2.3.1 In walls, partitions and floor or roof assemblies:

2.3.1.1 Measurement of the transmission of heat.

2.3.1.2 Measurement of the transmission of hot gases through the assembly, sufficient to ignite cotton waste.

2.3.1.3 For load bearing elements, measurement of the load carrying ability of the *test specimen* during the test exposure.

2.3.2 For individual load bearing assemblies such as beams and columns: Measurement of the load carrying ability under the test exposure with some consideration for the end support conditions (that is, restrained or not restrained).

2.4 The test standard does not provide the following:

2.4.1 Full information as to performance of assemblies constructed with components or lengths other than those tested.

2.4.2 Evaluation of the degree by which the assembly contributes to the fire hazard by generation of smoke, toxic gases, or other products of combustion.

2.4.3 Measurement of the degree of control or limitation of *the passage of* smoke or products of combustion through the assembly.

2.4.4 Simulation of the fire behavior of joints between building elements such as floor-wall or wall-wall, etc., connections.

2.4.5 Measurement of flame spread over surface of tested element.

2.4.6 The effect of fire endurance of conventional openings in the assembly, that is electrical receptacle outlets, plumbing pipe, etc., unless specifically provided for in the construction tested."

ADDITIONAL TEST CONDITIONS

At the request of the client, the exposure conditions of this test were altered (within the allowance of the ASTM E119 test method) to meet, as far as possible, the conditions and requirements of the ISO 834-75 Fire Resistance of Building Materials test. This test, which utilizes a fire exposure curve similar or identical to virtually all of the European fire resistance standards, is slightly hotter than the E119 exposure. However, due to the rapid-response thermocouples utilized in the ISO 834-75 standard, the actual temperature inside a furnace controlled by the E119 probes is more severe for the first 90 minutes[2]. For that reason, in order to remain on the "high" side of each test standard, the furnace was operated along the E119 curve for the first 90 minutes and then along the ISO 834 curve for the remainder of the test. The E119 furnace probes (the most severe) were utilized throughout the test for furnace control.

As a consequence, the thermal exposure given in this test is considered to have met or exceeded the requirements of the following test standards:

ISO 834-75 Fire resistance tests — Elements of building construction

BS 476:Pt. 20:1987 Fire tests on building materials and structures. Method of determination of the fire resistance of elements of construction (general principles).

DIN 4102, Part 2: Fire Behaviour of Building Materials and Building Components.

The pressure within the test furnace was controlled at +0.00 inches of water column at the top of the test specimens. While the ISO 834-75 standard requires a higher pressure, the test specimens (essentially, 4", 6" & 8" thick concrete) would not be effected by the furnace pressure[3], and so this was not considered to be significant.

The temperatures on the unexposed surface were monitored using the standard 6" x 6" x 3/8" thermocouple pads required by the E119 standard. These have been demonstrated to register higher temperatures than the ISO 834 thermocouple assemblies, so once again, the most severe conditions were utilized.

TEST PROCEDURE

Test Furnace

The test furnace is designed to allow the specimen to be uniformly exposed to the specified time-temperature conditions. It is fitted with 5 symmetrically-located propane gas burners designed to allow an even heat flux distribution across the face

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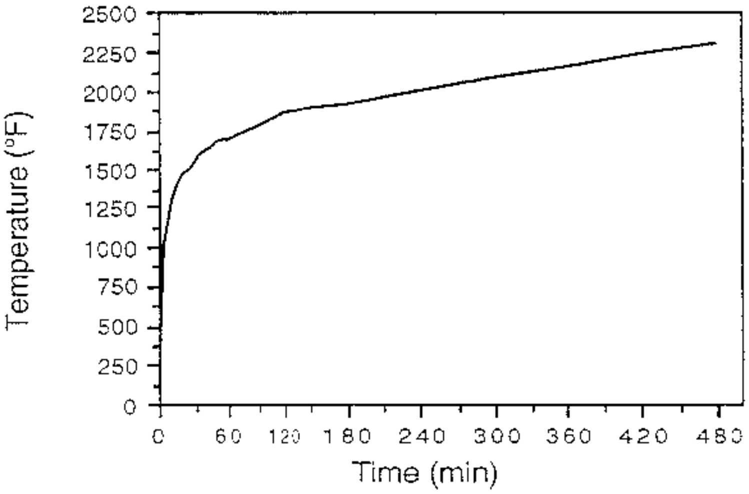
[2] Comparison of Severity of Exposure in ASTM E119 and ISO 834 Fire Resistance Tests, **Journal of Testing and Evaluation**, pp 371- 375, November 1987, American Society for Testing and Materials.

[3] Furnace Pressure in Standard Fire Resistance Tests, **Fire Technology**, 23 (2), May 1987 (Viewpoint), T.Z. Harmathy.

of a test specimen.

The temperature within the furnace is determined to be the mathematical average of thermocouples located symmetrically within the furnace and positioned six inches away from the vertical face of the test specimen. The materials used in the construction of these thermocouples are those suggested in the test standard. During the performance of a fire exposure test, the furnace temperatures are recorded at least every 15 seconds and displayed for the furnace operator to allow control along the specified temperature curve.

The fire exposure is controlled to conform with the standard time-temperature curve shown in Figure 1, as determined by the table below:



Time (min)	Temperature (°F)
0	68
5	1000
10	1300
20	1462
30	1550
60	1700
90	1792
120	1850
180	1925
240	2000
300	2075
360	2150
420	2225
480	2300

Figure 1

The furnace interior temperature during a test is controlled such that the area under the time•temperature curve is within 10% of the corresponding area under the standard time•temperature curve for 1 hour or less tests, 7.5% for those less than 2 hours and 5% for those tests of 2 hours or more duration.

Temperatures of Unexposed Surfaces

Temperatures of unexposed surfaces are monitored using 24 gage, type K thermocouples placed under 6 in. x 6 in. x 0.4 in. thick dry, felted pads as described in the standard. Temperature readings are taken at not less than nine points on the surface, at intervals not exceeding 1.0 minute. The temperature on the unexposed surface of a test specimen during the test is taken to be the average value of all nine thermocouples.

Fire Endurance Test

The fire exposure is continued on the specimen with its applied load if applicable, until failure occurs, or until the specimen has withstood the test conditions for the desired fire endurance rating.

CONDITIONS OF ACCEPTANCE

7.4 Where the conditions of acceptance place a limitation on the rise of temperature of the unexposed surface, the temperature end point of the fire endurance period shall be determined by the average of the measurements taken at individual points; except that if a temperature rise of 30% [325°F above initial temperature] in excess of the specified limit occurs at any one of these points, the remainder shall be ignored and the fire endurance period judged as ended.

TEST SPECIMEN CONSTRUCTION

The test specimen identification is as provided by the client and Omega Point Laboratories, Inc. accepts no responsibility for any inaccuracies therein. Omega Point did not randomly select the specimens and has not verified the composition, manufacturing techniques or quality assurance procedures. The samples were, however, selected and shipped to the Laboratory by Mr. Ron Graves, R&D Services, Inc. Each bag of foam blocks contained the R&D Services Mark. There were no obvious discrepancies with the descriptions supplied.

The ECO-Block panels were reported to be formed from EPS, with a density of 1.5 pcf, a compressive strength of 22 psi, with a panel thickness of 2.5 inches, height of 16" and length of 48" (dimensions verified by OPL). The connectors were reported to be formed from homopolymer polypropylene (specific gravity = 0.90, melting point = 248 – 338°F). Vertical rebars were inserted 16" o.c. (two per wall). Horizontal rebars were positioned at each block and rebars in both directions were tied together using plastic ties at top and bottom horizontal rebars. The 4" thick wall utilized #3 rebar and the 6" and 8" thick walls were fitted with #4 rebars.

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The concrete installed into the test forms was ordered by the client and delivered to the laboratory by a premix company. The concrete mix was described by the premix company as:

DESCRIPTION	AMOUNT (LB)
Alamo Cement	517
Aggregate Stone	1600
Silica Sand	1400
Water	to consistency

The ECO-Block forms were assembled and the concrete pumped into them on May 31, 2001. The normal weight concrete had a measured slump of 1-1/2 inches, and an intended compressive strength of 3500 psi. The concrete was allowed to set for approximately two weeks and then the EPS form on one side of each wall was removed on June 15, 2001.

The walls were then exposed to a temperature of approximately 120 - 135°F to cause the moisture equilibrium to accelerate. ¾" holes were drilled to the centers of the concrete at a distance greater than 12" from one edge of the wall, and used to monitor the relative humidity of the air within. Rubber corks sealed the holes when not in use. Periodically, the corks were removed and a relative humidity meter was inserted to the nominal center of the concrete and the moisture content of the internal air measured. The walls were left at that temperature until their internal relative humidities had fallen to less than 75%. They were then removed from the heat and considered ready to test.

THERMOCOUPLES

All temperatures monitored on the unexposed surface of this wall assembly were measured using 24 GA., electrically-welded, Type K Chromel-Alumel, glass-glass insulated (Special Limits of Error: ±1.1°C) thermocouples, purchased with calibration certifications and lot traceability.

Five thermocouples were installed on the unexposed surface of each wall, directly on the EPS forms and covered with 6 in. x 6 in. x 0.40 in. thick dry, felted, mineral fiber pads, held in place with a small daub of silicone adhesive on each corner. These thermocouples were distributed across the unexposed surface of the wall, with one at the center and one at the center of each quarter section. Since the E119 standard thermocouple assemblies register a hotter temperature than do the ISO 834 thermocouple assemblies under similar conditions, it was not considered necessary to utilize the ISO 834 devices.

TEST RESULTS AND OBSERVATIONS - 4" THICK WALL (PROJECT NO. 108916)

The test wall, contained in a nonbearing frame assembly, was placed in front of the Laboratory's small scale vertical wall furnace with the bare concrete side towards the heat on September 27, 2001. The thermocouple leads were then connected to the data acquisition system and their outputs verified. The laboratory air temperature was 80°F, with a humidity of 53%. At 1:45 PM, the furnace was fired and the ASTM E119 time-temperature curve followed for a period of 90 minutes. At that time, the furnace temperature was increased to follow the ISO 834-75 time-temperature curve, which was maintained throughout the remainder of the test. The pressure difference between the inside of the furnace (measured by a pressure tap located approximately 1/3 of the way down from the top of the specimen, on the horizontal centerline of the furnace) and the laboratory ambient air, was maintained at +0.00 in. of water column throughout the entire test, following the first five minutes of the test.

Observations made during the test are as follows:

Time (h:min:sec)	Observation
0:0:00	Furnace fired at 1:45 PM.
0:1:00	Plastic strips melting and flaming on the exposed surface.
0:4:00	Plastic connector strips have melted away.
0:40:00	Visible emission of steam on the cold side of the wall.
0:60:00	The EPS foam on the unexposed side of the wall is deforming.
1:15:00	The surface of the EPS foam is distorting, resulting in the lifting of the thermocouple pads from the surface. Attempts were made to tape them flat to keep them in contact.
1:22:00	TC#2 fell from wall. Bare concrete was visible below TC #2.
1:27:00	TC#2 replaced.
1:30:00	TC#4 fell and was replaced.
2:25:00	The top 2/3 of the EPS on the unexposed surface of the wall fell.
2:37:00	Burn through occurred at one of the plastic ties. Furnace extinguished. The specimen was removed from the furnace and allowed to cool.

The wall withstood the fire endurance test without passage of flame or gases hot enough to ignite cotton waste, for a period of two hours, 37 minutes. Transmission of heat through the wall during the fire endurance test did not raise the average temperature on the unexposed surface more than 250°F, nor any individual temperature more than 325°F.

Listings and plots of the furnace control temperatures and specimen unexposed surface temperatures may be found in Appendix C1. A photographic documentation of the test has been included in Appendix D2.

TEST RESULTS AND OBSERVATIONS – 6" THICK WALL (PROJECT NO. 108917)

The test wall, contained in a nonbearing frame assembly, was placed in front of the Laboratory's small scale vertical wall furnace with the bare concrete side towards the heat on October 31, 2002. The thermocouple leads were then connected to the data acquisition system and their outputs verified. The laboratory air temperature was 64°F, with a humidity of 89%. At 8:27 AM, the furnace was fired and the standard E119 time-temperature curve followed for a period of 270 minutes. (It was intended to rise to meet the ISO 834 curve at 90 minutes, but due to operator error, that was not accomplished until 270 minutes. It is not anticipated that the outcome of the test was significantly affected, however.) At that time, the furnace temperature was increased to follow the ISO 834-75 time-temperature curve. The pressure difference between the inside of the furnace (measured by a pressure tap located approximately ⅓ of the way down from the top of the specimen, on the horizontal centerline of the furnace) and the laboratory ambient air, was maintained at +0.00 in. of water column throughout the entire test, following the first five minutes of the test.

Observations made during the test are as follows:

Time (h:min:sec)	Observation
0:0:00	Furnace fired at 8:27 AM.
0:2:29	Plastic strips melting and flaming on the exposed surface.
1:00:00	Small drip of water appeared on the top of the right-most joint in the ECO-Block.
1:50:00	Upper left EPS curling at connector. EPS deforming over ~40% of the unexposed surface.
2:00:00	Thermocouple pads beginning to separate from the EPS surface.
2:18:00	TC #5 fell.
2:25:00	TC #4 fell.
2:33:00	TC #5 replaced.
2:36:00	TC #4 replaced.

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Time (h:min:sec)	Observation (continued)
2:57:00	TC #4 fell. Not replaced.
3:09:00	TC #3 fell. Not replaced.
3:50:00	TC #3 replaced.
5:05:00	Top section of EPS fell from wall.
5:35:00	Middle section of EPS fell from wall.
5:43::30	Burn-through occurred at the location of a plastic through-tie piece. Furnace extinguished and the sample removed and photographed.

The wall withstood the fire endurance test without passage of flame or gases hot enough to ignite cotton waste, for a period of five hours, 43 minutes. Transmission of heat through the wall during the fire endurance test did not raise the average temperature on the unexposed surface more than 250°F, nor any individual temperature more than 325°F.

Listings and plots of the furnace control temperatures and specimen unexposed surface temperatures may be found in Appendix C2. A photographic documentation of each the has been included in Appendix D3.

TEST RESULTS AND OBSERVATIONS - 8" THICK WALL (PROJECT NO. 108915)

The test wall, contained in a nonbearing frame assembly, was placed in front of the Laboratory's small scale vertical wall furnace with the bare concrete side towards the heat on September 24, 2001. The thermocouple leads were then connected to the data acquisition system and their outputs verified. The laboratory air temperature was 78°F, with a humidity of 60%. The furnace was then fired and the standard E119 time-temperature curve followed for a period of 90 minutes. At that time, the furnace temperature was increased to follow the ISO 834-75 time-temperature curve. The pressure difference between the inside of the furnace (measured by a pressure tap located approximately 1/3 of the way down from the top of the specimen, on the horizontal centerline of the furnace) and the laboratory ambient air, was maintained at +0.03 in. of water column throughout the entire test, following the first five minutes of the test, which resulted in a pressure of approximately +0.07 in. water column at the top of the test specimen.

Observations made during the test are as follows:

Time (h:min:sec)	Observation
0:0:00	Furnace fired.
0:2:00	Plastic strips melting and flaming on the exposed surface (see photo).
0:20:00	Light flaming at the connectors on the exposed surface.
3:15:00	Slight sagging of the EPS near the top right on the unexposed surface.
3:45:00	Steam coming from the bottom right over TC #5. The thermocouple pad over TC #4 was distorting a little.
4:05:00	TC #8 replaced with 1" x 1" pad, to try to keep it in position.
4:30:00	Furnace extinguished. Max temperature = 156°F. The wall had not failed, and showed no indication that failure was immanent. However, it was obvious that four hours had been easily met and it was not felt that much would be gained by running the test for many more hours.

The wall withstood the fire endurance test without passage of flame or gases hot enough to ignite cotton waste, for a period of four hours, 30 minutes. Transmission of heat through the wall during the fire endurance test did not raise the average temperature on the unexposed surface more than 250°F, nor any individual temperature more than 325°F.

Listings and plots of the furnace control temperatures and specimen unexposed surface temperatures may be found in Appendix C3. A photographic documentation of each the has been included in Appendix D4.

CORRELATION OF TEST RESULTS

Concrete-filled foam form walls are difficult to evaluate. The main problem, is that the moisture from the concrete is very slow to leave the wall, since it must evaporate through the existing EPS foam insulation on both surfaces. To speed the moisture equilibrium of the specimen, one face of the foam insulation is removed following a suitable set-up period for the concrete. The entire wall specimen is then placed in an elevated temperature room and heated to approximately 180°F and held there until the moisture content of the concrete is sufficiently low to allow the test to proceed (see Section X4 in the ASTM E119 standard). This temperature does not affect the remaining EPS material, but speeds up the evaporation of water from the concrete significantly. The specimens can still require up to three months to reach equilibrium.

Normally, an exterior wall assembly will be covered on the exterior surface with an exterior cladding and on the interior with gypsum wallboard. However, using Harmathy's second rule of fire endurance[4], "The fire endurance of a construction does not decrease with the addition of further layers", it can be assumed that if the wall is tested with the bare concrete against the fire, then the addition of virtually anything will not decrease the fire endurance. That is to say, if the EPS had not been removed, the fire endurance would have been at least as long as it was with the EPS removed. Along that same reasoning, if the fire endurance is determined by placing the thermocouples directly on the EPS on the unexposed surface, and covering with the standard thermocouple pads, then the fire endurance of the wall can only be increased by the addition of another cladding material such as gypsum wallboard.

Accordingly, these types of wall assemblies are tested with the bare concrete against the fire and bare EPS on the cold side of the wall. Whatever fire endurance the wall achieves is recognized as the fire endurance of that system with virtually any cladding on either side of the wall.

As often is the case, however, materials do not behave as nicely as one could wish. The EPS form on the cold side of the wall tends to melt and fall away when temperatures on the cold side of the concrete reach around 215°F. This results in thermocouples falling away from the wall and other unpredictable results. It must be considered, that these things happen long before the surface of the concrete reaches its maximum allowable temperature. In fact, these walls tend to achieve their maximum fire endurance ratings when the plastic connector rods (those plastic pieces which hold the two EPS faces of the form together during casting of the concrete) melt through the concrete wall, causing an opening in the wall through which fire passes.

Our purpose herein was to find a method for comparing the performance of 4", 6" & 8" thick concrete foam block walls tested to failure as 4' x 4' small scale specimens, with the results obtained in a full scale test performed on a similar 8" thick wall assembly.

The full scale 8" thick wall test (OPL Project No. 16233-106668) was continued until burn-through occurred at one of the connector locations at 4 hours, 19 minutes. The test was terminated and the hose stream test performed. Examining the specimen after the hose stream test showed that there was a fault in the concrete at the location of the failure, caused by incomplete vibration of the concrete in that location. To get a true indication of the fire endurance rating of the wall, it would have been

[4] T.Z. Harmathy, "Ten Rules of Fire Endurance Ratings," *Fire Technology (35)*, May, 1965.

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appropriate to continue the test until other locations had failed also. However, that was not recognized at the time.

Similarly, during the performance of the 4' x 4' small scale test walls, while the 4" and 6" walls were performed until burn-through occurred, the 8" thick wall was terminated at 4 hours, 30 minutes, since it was noticed that the cold-side temperatures were tracking the full scale 8" test closely.

Consequently, there is no direct comparison between all four tests. However, much data exists which can allow the desirable comparison to be done. Our approach was to consider the temperature rise on the cold side of each wall to a temperature below that at which the EPS begins to shrink and melt (causing dramatic differences between adjacent thermocouples). Choosing a temperature of 115°F (chosen because the temperature rise on all walls was fairly steady at that temperature) and comparing the average temperature rise for each wall assembly (after dropping any which fell or were otherwise atypical in their outputs) yields the following data:

THICKNESS (INCHES)	TIME TO 115°F (MIN)
4" (small scale)	53.5
6" (small scale)	130
8" (small scale)	230*
8" (full scale)	218*

Note: The times to 115°F for the small- and full-scale 8" thick wall are within 5.5% of each other, which is negligible difference, and serves to reinforce the argument that the small scale test closely models the full scale one. Plots of each of the four tests can be found in Appendix E. These plots were used to determine the times in the table above.

Now, by preparing a graph with the results of the three small scale tests (thickness versus time to 115°F), and performing a linear regression fit to the data, it can be seen that the data are quite linear. Consequently, if the times to 115°F are linear when compared to the thickness of the wall, it can be assumed that the times to final burn-through should be fairly linear, as well.

So, a graph was prepared containing the thickness of the 4" and 6" walls versus their times to failure by burn-through (4" = 160 min; 6" = 345 minutes). This plot was then extrapolated to a thickness of 8", yielding a fire endurance time of 525 minutes. This is a large number, and in fact, exceeds the maximum fire endurance period of eight hours, for which the E119 standard is described, and therefore should be described as "greater than 8 h." (See Appendix D for the graphs used to perform this extrapolation.

Finally, since the work above indicated a good correlation between the 8" small scale test and the 8" thick full scale test, it has been determined that the true fire endurance of the 8" thick full scale wall is greater than 8 h, also. The fire endurance ratings for each of the three thicknesses of wall are indicated in the table below:

THICKNESS (INCHES)	FIRE ENDURANCE (HOURS)
4	>2
6	>5
8	>8

While these fire endurance periods are longer than for bare concrete, it must be realized that one of the characteristics of EPS is that it melts and shrinks away from a hot surface, forming an insulating air layer between the concrete and the cold surface of the wall. For this reason, the fire endurance periods are somewhat extended. However, as is indicated in the Conclusions section of this document, much more conservative values have been used.

CONCLUSIONS

The test specimens' identifications are as provided by the client and Omega Point Laboratories, Inc. accepts no responsibility for any inaccuracies therein. Omega Point did not select the specimens and has not verified the composition, manufacturing techniques or quality assurance procedures utilized. The test specimens were selected and shipped to the Laboratory by Mr. Ron Graves, R&D Services. Visual examination of the materials revealed no obvious discrepancies.

The bearing wall assemblies consisting of concrete walls formed by filling the ECO-Block forms with normal weight concrete (resulting in 4", 6" & 8" thick concrete walls) with overall thicknesses of 9", 11" and 13" including the forms, produced, assembled and tested as described herein, were tested in accordance with the most severe temperature exposure conditions of **ASTM Method E119-98 FIRE TESTS OF BUILDING CONSTRUCTION AND MATERIALS** and **ISO 834-75 Fire resistance tests — Elements of building construction**.

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Since no U.S. building code requires a fire endurance greater than four hours, it was agreed, following discussions with the client, that the three different thicknesses of concrete wall would be qualified as follows:

CONCRETE THICKNESS (IN.)	FIRE ENDURANCE RATING (HR)
4	≥2
6	≥4
8	≥4

These fire endurance ratings are solidly backed up by the data herein, and are definitely lower than the actual tests indicate. They are, therefore inarguably conservative and valid ratings.

ASTM E119-98
Fire Tests of Building Construction and Materials

ECO-Block Concrete Wall

Project No. 16233-106668

FOUR-HOUR FIRE RESISTANCE TEST OF A BEARING WALL ASSEMBLY.

October 3, 2000

Prepared for:

ECO-Block, LLC
1100 Centennial Blvd, Suite 190
Richardson, TX 75081

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ABSTRACT

A bearing wall assembly consisting of a concrete wall formed by filling the ECO-Block forms with normal weight concrete (resulting in an 8" thick reinforced concrete wall) with an overall thickness of 13" including the forms, produced, assembled and tested as described herein, successfully met the conditions of acceptance as outlined in **ASTM Method E119-98 FIRE TESTS OF BUILDING CONSTRUCTION AND MATERIALS** for a fire endurance rating of 240 minutes (4-h) with the fire exposure against either side. The test was also performed in accordance with the **ISO 834-75 Fire resistance tests — Elements of building construction,** achieving a 4-h fire resistance rating by that standard also.

~~The description of the test specimen and the results presented herein are true and correct to the best~~ of our knowledge and within the bounds of normal engineering methods and techniques.

Deggary N. Priest, President

October 3, 2000
Date

Reviewed and approved:

William E. Fitch, P.E. No. 55296

Date: October 3, 2000

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INTRODUCTION[1]

"The performance of walls, columns, floors, and other building members under fire exposure conditions is an item of major importance in securing constructions that are safe, and that are not a menace to neighboring structures nor to the public. Recognition of this is registered in the codes of many authorities, municipal and other. It is important to secure balance of the many units in a single building, and of buildings of like character and use in a community; and also to promote uniformity in requirements of various authorities throughout the country. To do this it is necessary that the fire-resistive properties of materials and assemblies be measured and specified according to a common standard expressed in terms that are applicable alike to a wide variety of materials, situations, and conditions of exposure.

Such a standard is found in the methods that follow. They prescribe a standard exposing fire of controlled extent and severity. Performance is defined as the period of resistance to standard exposure elapsing before the first critical point in behavior is observed. Results are reported in units in which field exposures can be judged and expressed.

The methods may be cited as the "Standard Fire Tests," and the performance or exposure shall be expressed as "2-h," "6-h," "1/2-h," etc.

When a factor of safety exceeding that inherent in the test conditions is desired, a proportional increase should be made in the specified time-classification period.

The ASTM E119 test procedure is identical or very similar to the following standard test methods:

UL 263
UBC 43-1
NFPA 251
ANSI A2.1
ULC S101

1. Scope

1.1 These methods are applicable to assemblies of masonry units and to composite assemblies of structural materials for buildings, including bearing and other walls and partitions, columns, girders, beams, slabs, and composite slab and beam assemblies for floors and roofs. They are also applicable to other assemblies and structural units that constitute permanent integral parts of a finished building.

1.2 It is the intent that classifications shall register performance during the period of exposure and shall not be construed as having determined suitability for use after fire exposure.

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[1] ASTM E119-98 Standard Methods of FIRE TESTS OF BUILDING CONSTRUCTION AND MATERIALS, American Society for Testing and Materials, Volume 04.07 Building Seals and Sealants.

1.3 *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 fire conditions. However, results of this test 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.*

Note 1 - A method of fire hazard classification based on rate of flame spread is covered in ASTM Method E84, Test for Surface Burning Characteristics of Building Materials.

1.4 The results of these tests are one factor in assessing fire performance of building construction and assemblies. These methods prescribe a standard fire exposure for comparing the performance of building construction assemblies. Application of these test results to predict the performance of actual building construction requires careful evaluation of test conditions.

2. Significance

2.1 This standard is intended to evaluate the duration for which the types of assemblies noted in 1.1 will contain a fire, or retain their structural integrity or exhibit both properties dependent upon the type of assembly involved during a predetermined test exposure.

2.2 The test exposes a specimen to a *standard* fire *exposure* controlled to achieve specified temperatures throughout a specified time period. In some instance, the *fire exposure* may be followed by the application of a *specified standard* fire hose stream. The exposure, however, may not be representative of all fire conditions which may vary with changes in the amount, nature and distribution of fire loading, ventilation, compartment size and configuration, and heat sink characteristics of the compartment. It does, however, provide a relative measure of fire performance of comparable assemblies under these specified fire exposure conditions. Any variation from the construction or conditions (that is, size, method of assembly, and materials) that are tested may substantially change the performance characteristics of the assembly.

2.3 The test standard provides for the following:

2.3.1 In walls, partitions and floor or roof assemblies:

2.3.1.1 Measurement of the transmission of heat.

2.3.1.2 Measurement of the transmission of hot gases through the assembly, sufficient to ignite cotton waste.

2.3.1.3 For load bearing elements, measurement of the load carrying ability of the *test specimen* during the test exposure.

2.3.2 For individual load bearing assemblies such as beams and columns: Measurement of the load carrying ability under the test exposure with some consideration for the end support conditions (that is, restrained or not restrained).

2.4 The test standard does not provide the following:

2.4.1 Full information as to performance of assemblies constructed with components or lengths other than those tested.

2.4.2 Evaluation of the degree by which the assembly contributes to the fire hazard by generation of smoke, toxic gases, or other products of combustion.

2.4.3 Measurement of the degree of control or limitation of *the passage of* smoke or products of combustion through the assembly.

2.4.4 Simulation of the fire behavior of joints between building elements such as floor-wall or wall-wall, etc., connections.

2.4.5 Measurement of flame spread over surface of tested element.

2.4.6 The effect of fire endurance of conventional openings in the assembly, that is electrical receptacle outlets, plumbing pipe, etc., unless specifically provided for in the construction tested."

ADDITIONAL TEST CONDITIONS

At the request of the client, the exposure conditions of this test were altered (within the allowance of the ASTM E119 test method) to meet, as far as possible, the conditions and requirements of the ISO 834-75 Fire Resistance of Building Materials test. This test, which utilizes a fire exposure curve similar or identical to virtually all of the European fire resistance standards, is slightly hotter than the E119 exposure. However, due to the rapid-response thermocouples utilized in the ISO 834-75 standard, the actual temperature inside a furnace controlled by the E119 probes is more severe for the first 90 minutes[2]. For that reason, in order to remain on the "high" side of each test standard, the furnace was operated along the E119 curve for the first 90 minutes and then along the ISO 834 curve for the remainder of the test. The E119 furnace probes (the most severe) were utilized throughout the test for furnace control.

As a consequence, this test is considered to have met or exceeded the requirements of the following test standards:

ISO 834-75 Fire resistance tests — Elements of building construction

BS 476:Pt. 20:1987 Fire tests on building materials and structures. Method of determination of the fire resistance of elements of construction (general principles).

DIN 4102, Part 2: Fire Behaviour of Building Materials and Building Components.

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[2] Comparison of Severity of Exposure in ASTM E119 and ISO 834 Fire Resistance Tests, **Journal of Testing and Evaluation**, pp 371- 375, November 1987, American Society for Testing and Materials.

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The pressure within the test furnace was controlled at +0.06 inches of water column at the top of the test specimen. While the ISO 834-75 standard requires slightly more pressure, the test specimen (essentially, 8" thick concrete) would not be effected by the furnace pressure[3], and so this was not considered to be significant.

The temperatures on the unexposed surface were monitored using the standard 6" x 6" x 3/8" thermocouple pads required by the E119 standard. These have been demonstrated to register higher temperatures than the ISO 834 thermocouple assemblies, so once again, the most severe conditions were utilized.

TEST PROCEDURE

Test Furnace

The test furnace is designed to allow the specimen to be uniformly exposed to the specified time-temperature conditions. It is fitted with 39 symmetrically-located propane gas burners designed to allow an even heat flux distribution across the face of a test specimen. Furnace pressures may be maintained at any value from +0.04" W.C. to -0.20" W.C. It must be realized that any full-size vertical fire test furnace will have a pressure difference between the bottom and top of approximately 0.1 in. W.C. after operating temperatures are reached. For this reason, the furnace is operated by controlling the pressure within the furnace (with respect to the laboratory ambient pressure) by regulating the pressure at a specific horizontal plane in the furnace. Many times the furnace pressure will be adjusted so that the "neutral pressure plane" (that where the pressure difference between the furnace interior and the laboratory is zero) is at a desired location: for instance; at the top, at a point 1/3 of the way down from the top, or at the bottom of the specimen.

The temperature within the furnace is determined to be the mathematical average of thermocouples located symmetrically within the furnace and positioned six inches away from the vertical face of the test specimen. The materials used in the construction of these thermocouples are those suggested in the test standard. During the performance of a fire exposure test, the furnace temperatures are recorded at least every 15 seconds and displayed for the furnace operator to allow control along the specified temperature curve.

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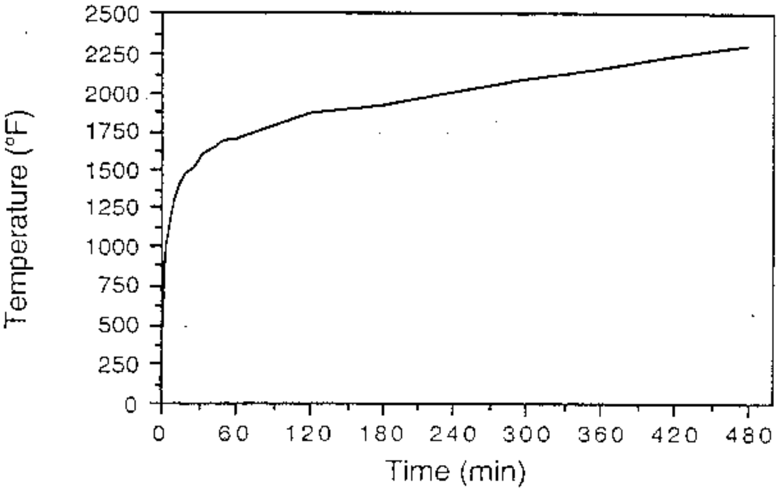
[3] Furnace Pressure in Standard Fire Resistance Tests, **Fire Technology**, 23 (2), May 1987 (Viewpoint), T.Z. Harmathy.

The fire exposure is controlled to conform with the standard time-temperature curve shown in Figure 1, as determined by the table below:



Time (min)	Temperature (°F)
0	68
5	1000
10	1300
20	1462
30	1550
60	1700
90	1792
120	1850
180	1925
240	2000
300	2075
360	2150
420	2225
480	2300

Figure 1

The furnace interior temperature during a test is controlled such that the area under the time•temperature curve is within 10% of the corresponding area under the standard time•temperature curve for 1 hour or less tests, 7.5% for those less than 2 hours and 5% for those tests of 2 hours or more duration.

Temperatures of Unexposed Surfaces

Temperatures of unexposed surfaces are monitored using 24 gage, type K thermocouples placed under 6 in. x 6 in. x 0.4 in. thick dry, felted pads as described in the standard. Temperature readings are taken at not less than nine points on the surface, at intervals not exceeding 1.0 minute. The temperature on the unexposed surface of a test specimen during the test is taken to be the average value of all nine thermocouples.

Applied Load

If required, this test method may be used to expose a wall to fire and hose stream tests while maintaining a compressive load on the wall. Unlike a non-load bearing test (in which the specimen is typically constructed within the bounds of a masonry/structural steel frame, and is effectively restrained on all four perimeter sides), a load bearing test is performed by "pinching" the test wall from top to bottom, while leaving the vertical sides unrestrained. This is accomplished at this laboratory, by the use of a load-bearing frame which has a movable bottom section. The test wall is placed (or constructed in place) between the top and bottom beams of the load frame, and hydraulic actuators press upwards on the bottom beam until the desired load is applied to the wall assembly. The entire frame, while maintaining the desired load, is moved into position in front of the vertical fire resistance furnace and the fire exposure and subsequent hose stream tests are performed.

Fire Endurance Test

The fire exposure is continued on the specimen with its applied load if applicable, until failure occurs, or until the specimen has withstood the test conditions for the desired fire endurance rating.

Hose Stream Test

"10.1 Where required by the conditions of acceptance, subject a duplicate specimen to a fire exposure test for a period equal to one half of that indicated as the resistance period in the fire endurance test, but not for more than 1 h, immediately after which subject the specimen to the impact, erosion, and cooling effects of a hose stream directed first at the middle and then at all parts of the exposed face, changes in direction being made slowly.

10.2 *Exemption* - The hose stream test shall not be required in the case of constructions having a resistance period, indicated in the fire endurance test, of less than 1 h.

10.3 *Optional Program* - The submitter may elect, with the advice and consent of the testing body, to have the hose stream test made on the specimen subjected to the fire endurance test and immediately following the expiration of the fire endurance test.

10.4 *Stream Equipment and Details* - The stream shall be delivered through a 2½-in. (64-mm) hose discharging through a National Standard Playpipe of corresponding size equipped with a 1⅛-in. (28.5-mm) discharge tip of the standard-taper smooth-bore pattern without shoulder at the orifice. The water pressure and duration of the application shall be as prescribed [in the table below]:

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Conditions For Hose Stream Test		
Resistance Period	Water Pressure at Base of Nozzle, psi (kPa)	Duration of Application, min/100 ft^2 (9 m^2) exposed area
8 h and over	45 (310)	6
4 h and over if less than 8 h	45 (310)	5
2 h and over if less than 4 h	30 (207)	2-1/2
1-1/2 h and over if less than 2 h	30 (207)	1-1/2
1 h and over if less than 1-1/2 h	30 (207)	1
Less than 1 h, if desired	30 (207)	1

10.5 *Nozzle Distance* - The nozzle orifice shall be 20 ft (6-m) from the center of the exposed surface of the test specimen if the nozzle is so located that when directed at the center its axis is normal to the surface of the test specimen. If otherwise located, its distance from the center shall be less than 20 ft by an amount equal to 1 ft (305-mm) for each 10 deg of deviation from the normal."

Correction Factor

When the indicated resistance period is 1/2 h or over, determined by the failure criteria of the standard, a correction shall be applied for variation of the furnace exposure from that prescribed, where it will affect the classification. This is to be done by multiplying the indicated period by two thirds of the difference in area between the curve of average furnace temperature and the standard curve for the first three fourths of the period and dividing the product by the area between the standard curve and a base line of 68°F (20°C) for the same part of the indicated period, the latter area increased by 3240°F•min to compensate for the thermal lag of the furnace thermocouples during the first part of the test. For a fire exposure in the test higher than standard, the indicated resistance period shall be increased by the amount of the correction. For a fire exposure in the test lower than standard, the indicated resistance period shall be similarly decreased for fire exposure below standard. The correction is accomplished by mathematically adding the correction factor, *C*, to the indicated resistance period.

The correction can be expressed by the following equation:

$$C = \frac{2\,I\,(A - A_s)}{3\,(A_s + L)}$$

where:

C = correction in the same units as I,
I = indicated fire-resistance period,
A = area under the curve of indicated average furnace temperature for the first three fourths of the indicated period,
A_s = area under the standard furnace curve for the same part of the indicated period, and
L = lag correction in the same units as A and A_s (54°F•h or 30°C•h (3240°F•min or 1800°C•min))

CONDITIONS OF ACCEPTANCE

16. Conditions of Acceptance – [Loadbearing Walls]

16.1 Regard the test as successful if the following conditions are met:

16.1.1 The wall or partition shall have sustained the applied load during the fire endurance test without passage of flame or gases hot enough to ignite cotton waste, for a period equal to that for which classification is desired.

16.1.2 The wall or partition shall have sustained the applied load during the fire and hose stream test as specified in Section 11, without passage of flame, of gases hot enough to ignite cotton waste, or of the hose stream. The assembly shall be considered to have failed the hose stream test if an opening develops that permits a projection of water from the stream beyond the unexposed surface during the time of the hose stream test.

16.1.3 Transmission of heat through the wall or partition during the fire endurance test shall not have been such as to raise the [average] temperature on its unexposed surface more than 250°F (139°C) above its initial temperature.

[The E119 standard further states:]

7.4 Where the conditions of acceptance place a limitation on the rise of temperature of the unexposed surface, the temperature end point of the fire endurance period shall be determined by the average of the measurements taken at individual points; except that if a temperature rise of 30% [325°F above initial temperature] in excess of the specified limit occurs at any one of these points, the remainder shall be ignored and the fire endurance period judged as ended.

TEST SPECIMEN CONSTRUCTION

The test specimen identification is as provided by the client and Omega Point Laboratories, Inc. accepts no responsibility for any inaccuracies therein. Omega Point did not randomly select the specimens and has not verified the composition, manufacturing techniques or quality assurance procedures. From a simply visual inspection however, there were no discrepancies with the descriptions supplied. The concrete installed into the test forms was ordered by the client and delivered to the laboratory by a premix company. The concrete mix was described by the premix company as:

DESCRIPTION	TARGET AMOUNT (LB)	ACTUAL AMOUNT (LB)
GR 7 LS	4890	5200
Alamo Cement T1	3612	3625
X15 MidrangeC	0	0
MFG Sand	8512	8280
Fly Ash	900	900
NR	72	73
Silica Sand	5519	5480
Water	696	689

Total amount of normal weight concrete in the batch was 6.0 cubic yards. When the concrete arrived, an admixture (Supercizer 7 Premium Superplasticizer, Fritz-Pak Corporation, 2.5 lb bags) was added to the concrete at the rate of 2.5 lbs per cubic yard of concrete and mixed thoroughly.

The ECO-Block panels were reported to be formed from EPS, with a density of 1.5 pcf, a compressive strength of 22 psi, with a panel thickness of 2.5 inches, height of 16" and length of 48" (dimensions verified by OPL). The connectors were reported to be formed from homopolymer polypropylene (specific gravity = 0.90, melting point = 248 – 338°F). No. 5 steel rebars were placed 16" o.c. horizontally and 12" o.c. vertically inside the forms prior to pouring the concrete.

The ECO-Block forms were assembled and the concrete pumped into them on April 16, 2000. The normal weight concrete had a measured slump of 1-1/2 inches, and an intended compressive strength of 3500 psi. The finished wall dimensions were 120" tall and 120" wide. The concrete was allowed to set for two weeks and then the EPS form on one side of the wall was removed on April 31, 2000.

The wall was placed within the confines of an insulated room and the temperature brought to 120°F. A 3/4" hole was drilled to the center of the concrete at a distance greater than 12" from one edge of the wall, and used to monitor the relative humidity of the air within. A rubber cork sealed the hole when not in use. Periodically, the cork was removed and a relative humidity meter was inserted to the nominal center of the concrete and the moisture content of the internal air measured. The wall was left at that temperature until its internal relative humidity had fallen to 75.5%. It was then removed from the room and considered ready to test. (See Appendix C for time-moisture data.)

THERMOCOUPLES

All temperatures monitored on the unexposed surface of this wall assembly were measured using 24 GA., electrically-welded, Type K Chromel-Alumel, glass-glass insulated (Special Limits of Error: ±1.1°C) thermocouples, purchased with calibration certifications and lot traceability.

To meet the requirements of ASTM E119, nine thermocouples were installed on the unexposed surface of the wall, directly on the EPS forms and covered with 6 in. x 6 in. x 0.40 in. thick dry, felted, mineral fiber pads, held in place with a small daub of silicone adhesive on each corner. Anticipating the sagging of the EPS, three vertical thin steel wires were also installed and each thermocouple pad was attached to one of these wires with adhesive tape. These thermocouples were distributed across the unexposed surface of the wall at various locations (see Fig. 2, Thermocouple Locations, Appendix B). Since the E119 standard thermocouple assemblies register a hotter temperature than do the ISO 834 thermocouple assemblies under similar conditions, it was not considered necessary to utilize the ISO 834 devices.

TEST RESULTS AND OBSERVATIONS

The test wall, contained in a loadbearing frame assembly, was placed in front of the Laboratory's vertical wall furnace with the bare concrete side towards the heat on September 28, 2000. The wall was placed under a total load of 7000 lbf per linear foot (total load = 70,000 lbf). The thermocouple leads were then connected to the data acquisition system and their outputs verified. The laboratory air temperature was 73°F, with a humidity of 72%. At 10:11 a.m., the furnace was fired and the standard E119 time-temperature curve followed for a period of 90 minutes. At that time, the furnace temperature was increased to follow the ISO 834-75 time-temperature curve. The pressure difference between the inside of the furnace (measured by a pressure tap located approximately ⅓ of the way down from the top of the specimen, on the horizontal centerline of the furnace) and the laboratory ambient air, was maintained at +0.03 in. of water column throughout the entire test, following the first five minutes of the test, which resulted in a pressure of approximately +0.07 in. water column at the top of the test specimen.

Observations made during the test are as follows:

Time (h:min:sec)	Observation
0:0:00	Furnace fired at 10:11 a.m.
0:1:58	Plastic strips melting and flaming on the exposed surface (see photo).
0:3:22	Some popping, slight spalling of the concrete surrounding the vertical plastic strips.
0:31:00	Condensed moisture is collecting on the unexposed surface, soaking the thermocouple pads.
2:28:00	EPS deforming at the top left of the unexposed side. On middle right and bottom center, some steam is escaping from small cracks.
3:13:00	The EPS behind TC #8 is sagging.
3:18:00	Further deformation of EPS in specific locations.
3:30:35	Replaced thermocouple pads that were wet.
4:10:00	The EPS on the unexposed surface has begun to sag and a hole has melted into the face, revealing the concrete and the plastic connector fastener (just above and to the right of TC #1).
4:16:00	The cotton waste test was performed in the area of the hole. No ignition occurred.
4:19:00	The plastic connector piece at the hole has melted away, revealing the radiant energy from the furnace, with small flames coming from the hole. The wall was judged to have failed at this point.
4:30:00	Furnace extinguished. The test specimen was removed from the furnace and exposed to the hose stream test.
4:32:25	Hose stream test started. The pressure was 45 psi from a distance of 20 feet.
4:37:25	Hose stream test stopped. The wall withstood the hose stream test, except at the hole which had previously burned through (approximately 1/2" diameter hole prior to the hose stream, which had opened to approximately 3/4" diameter after the hose stream).

The wall withstood the fire endurance test without passage of flame or gases hot enough to ignite cotton waste, for a period of four hours, 19 minutes. Transmission of heat through the wall during the fire endurance test did not raise the average temperature on the unexposed surface more than 250°F, nor any individual temperature more than 325°F.

Following the 270 minute fire exposure test, the test wall was removed from the furnace, and exposed, against the heated surface, to the impact, cooling and erosion effects of the standard hose stream test. The nozzle pressure was 45 psi, the distance between the nozzle and the wall surface was 20 feet and the water was applied for a total period of five minutes.

The wall withstood the fire and hose stream tests without passage of flame, of gases hot enough to ignite cotton waste, or of the passage of water from the hose stream. No openings developed that permitted a projection of water from the stream beyond the unexposed surface during the time of the hose stream test, with the exception of the small hole which had burned through the wall. This hole developed at a visible interface between successive concrete pours, and was judged to be a weakness in the concrete. Since the remainder of the wall met the hose stream, it was not considered necessary to repeat the fire test for a period of 60 minutes for the purposes of meeting the hose stream test, since the wall would certainly pass under those conditions. However, since the wall had not burned through at that point at four hours of fire exposure, it was considered extremely likely that the wall would have passed the hose stream test had the fire test been terminated at four hours. For that reason, the wall has been considered to have achieved a four hour fire endurance period.

The table below shows the maximum temperatures measured at each location during the 270 minute fire endurance test.

TC #	MAX. TEMP (°F)	TC #	MAX. TEMP (°F)
1	112	6	126
2	127	7	121
3	115	8	179
4	124	9	110
5	162	Average	**125**

During the fire test, the wall was measured for deflection at three points along it's vertical centerline: at 30" (position #1), 60" (position #2) and 90" (position #3) from the left side of the wall. Measurements were made from a taught string to the wall surface at each location.

TIME (min)	DEFLECTION (inches)		
	Position #1	Position #2	Position #3
unloaded	0	0	0
Loaded: 0:00	0	0	0
25	0.5	0.75	0.375
51	0.75	0.875	0.5
93	0.75	0.875	0.5
140	0.75	0.875	0.5
180	0.75	0.875	0.5
218*	1.000	1.000	0.625

* Following this measurement, the EPS surface was too uneven to make further measurements meaningful.

Obviously, the wall did not warp excessively during the fire test.

In accordance with the E119 test standard, a calculation for any correction to the indicated fire resistance period was done. The correction factor was then mathematically added to the indicated fire resistance period, yielding the fire resistance period achieved by this specimen:

ITEM	DESCRIPTION	TEST VALUE
C	correction factor	+4.80 min (+288 seconds)
I	indicated fire-resistance period	259 min
A	area under the curve of indicated average furnace temperature for the first three fourths of the indicated period	329 454°F•min
As	area under the standard furnace curve for the same part of the indicated period	320 452°F•min
L	lag correction	3240°F•min
	FIRE RESISTANCE PERIOD ACHIEVED BY THIS SPECIMEN ==>	264 min

Note: The standard specifies that the fire resistance be determined to the nearest integral minute. Consequently, if the correction factor is less than 30 seconds, and the test specimen met the criteria for the full indicated fire resistance period, no correction is deemed necessary. Since this test was purposefully performed at a hotter than normal exposure, a 5 minute increase in the fire resistance period is indicated.

OMEGA POINT LABORATORIES

Listings and plots of the furnace control temperatures and specimen unexposed surface temperatures may be found in Appendix C. A drawing showing the location of the pressure tap and all furnace control thermocouples may also be found in Appendix C. A photographic documentation of each test has been included in Appendix D.

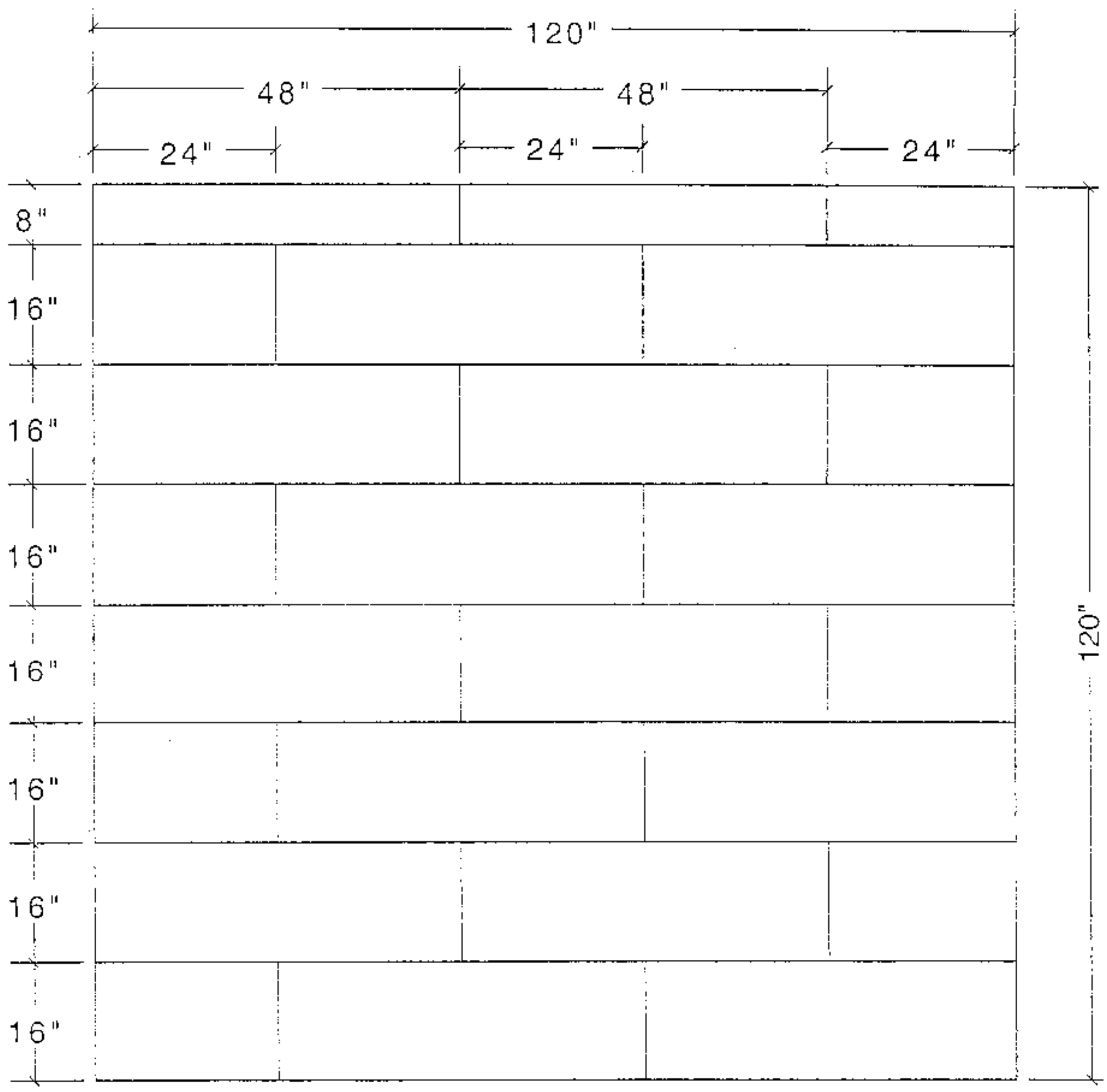
CONCLUSIONS

The test specimen identification is as provided by the client and Omega Point Laboratories, Inc. accepts no responsibility for any inaccuracies therein. Omega Point did not select the specimen and has not verified the composition, manufacturing techniques or quality assurance procedures utilized. Visual examination of the materials revealed no obvious discrepancies.

The bearing wall assembly consisting of a concrete wall formed by filling the ECO-Block forms with normal weight concrete (resulting in an 8" thick reinforced concrete wall) with an overall thickness of 13" including the forms, produced, assembled and tested as described herein, successfully met the conditions of acceptance as outlined in **ASTM Method E119-98 FIRE TESTS OF BUILDING CONSTRUCTION AND MATERIALS** for a loadbearing fire endurance rating of 240 minutes (4-h) with the fire exposure against either side. The test was also performed in accordance with the **ISO 834-75 Fire resistance tests — Elements of building construction**, achieving a 4-h fire resistance rating by that standard, also. The wall was tested under a total load of 7,000 lbf per linear foot.

APPENDIX A

CONSTRUCTION DRAWINGS



ELEVATION VIEW

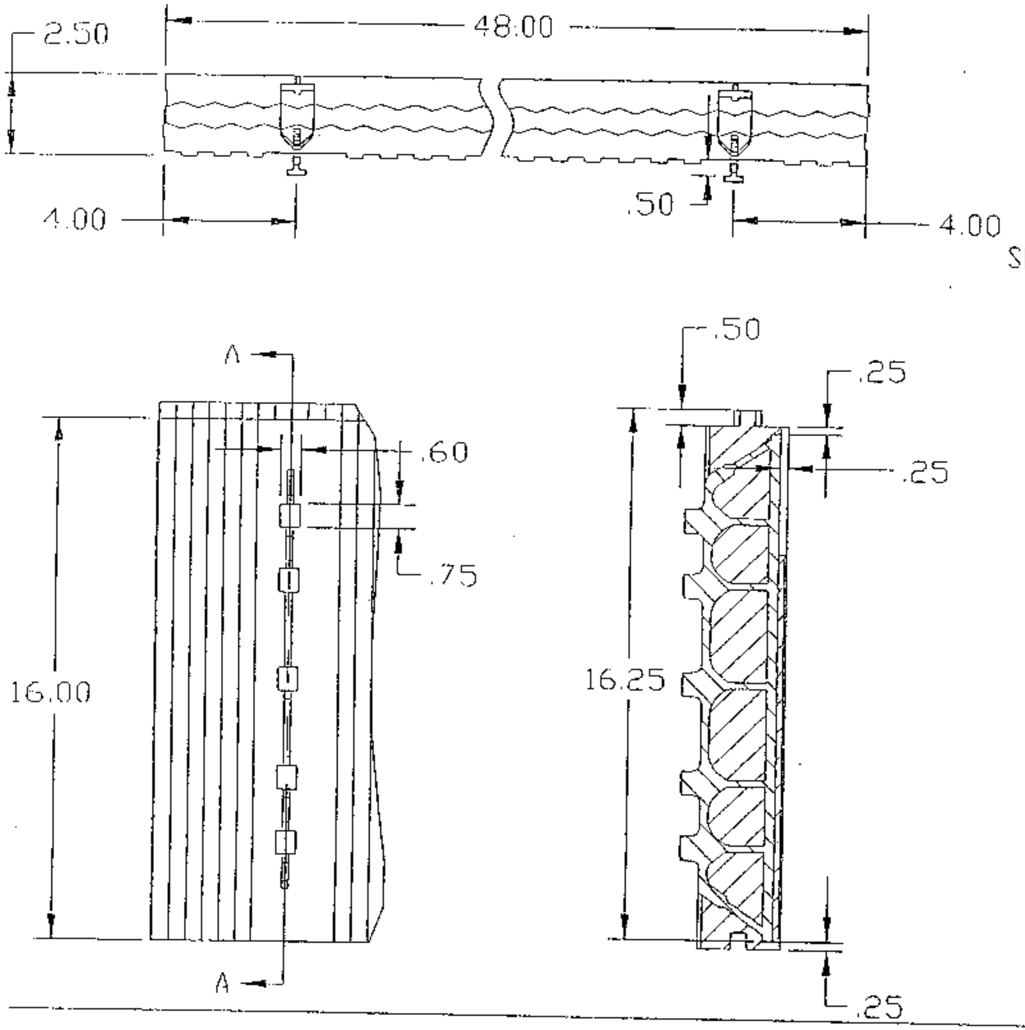
NOTE:
The test wall was constructed by assembling the ECO-Blocks as indicated, placing rebar within and pouring concrete into the form.

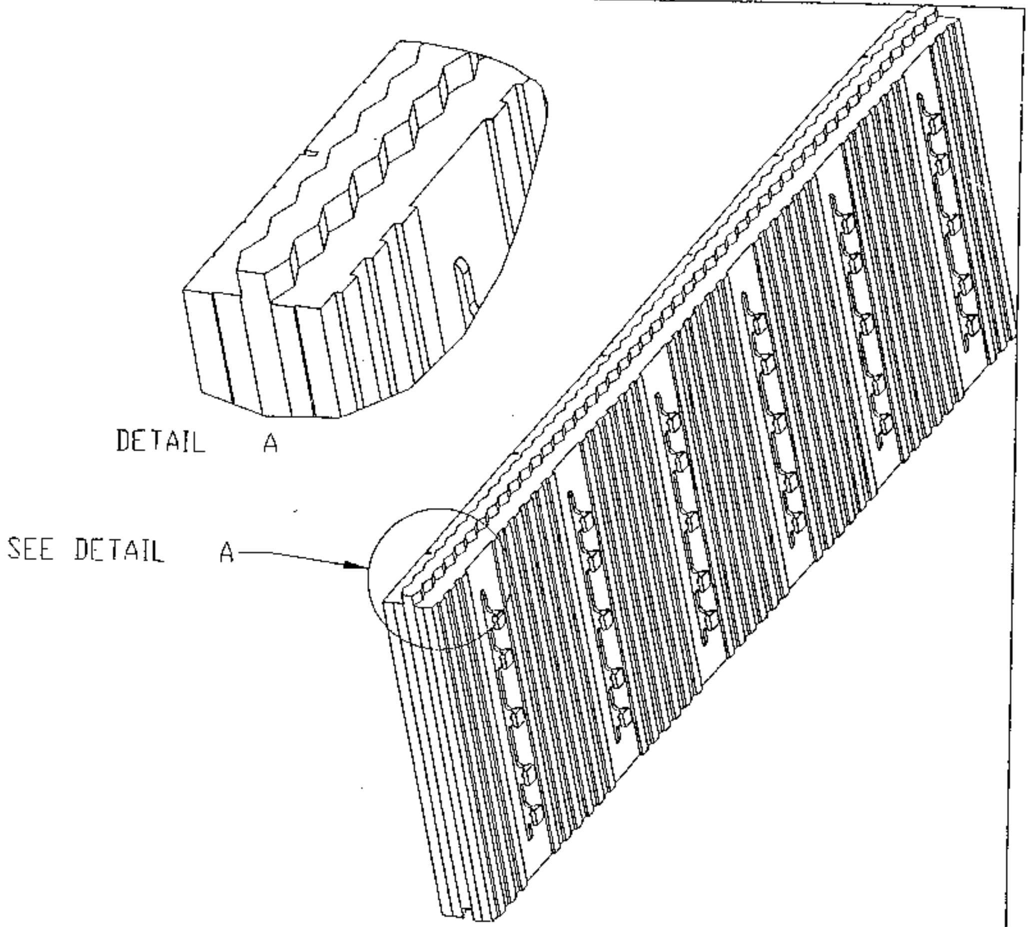
OMEGA POINT LABORATORIES, INC Project No. 16223-106668
ECO-Block, LLC
Fig. 1 Wall Details

Scale: 1/2"=1'

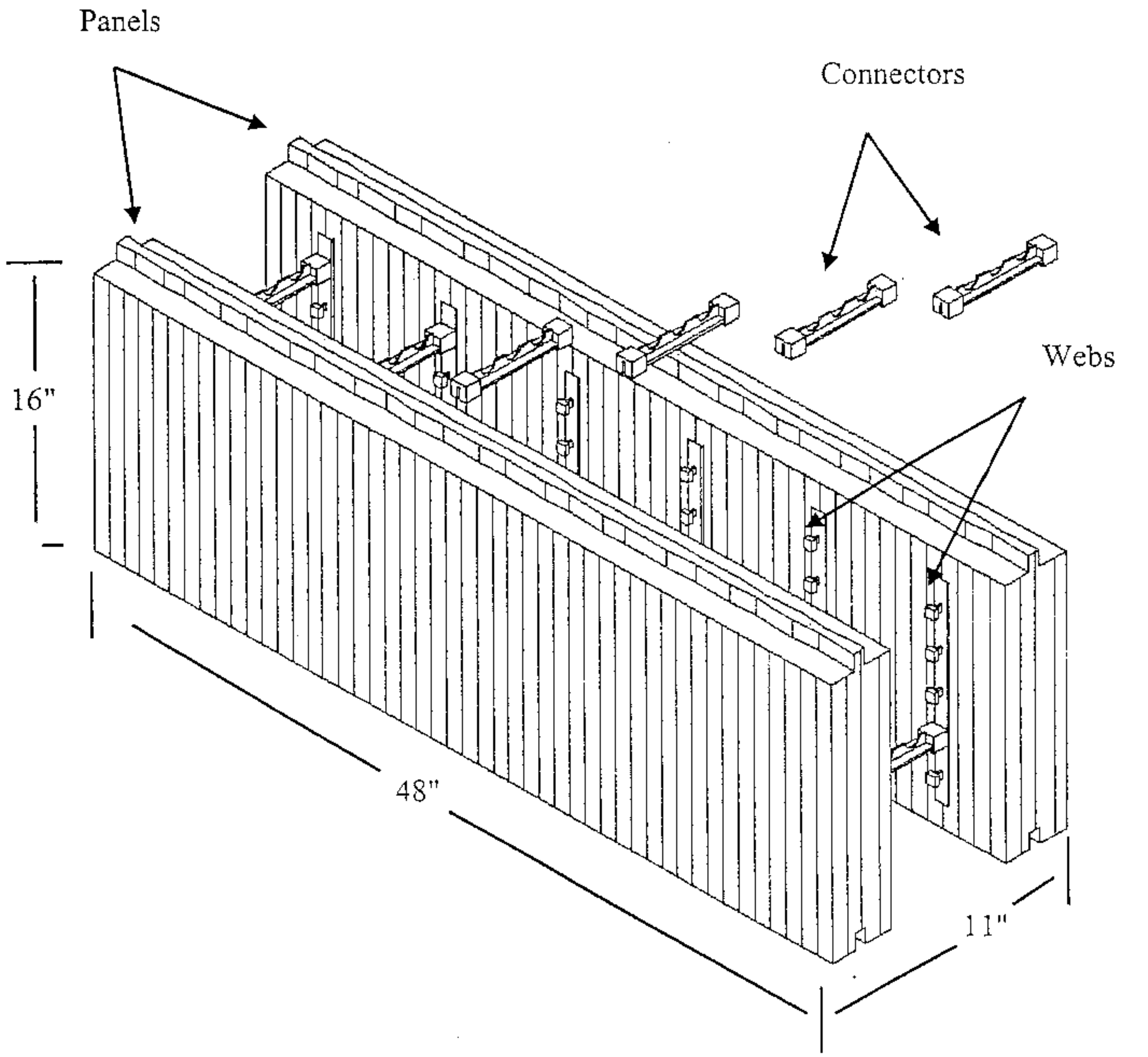
OMEGA POINT LABORATORIES

4" STANDARD PANEL	STPL
6" STANDARD PANEL	STPL
8" STANDARD PANEL	STPL





ITEM	PART NAME - DESCRIPTION	PART NO.	QT'Y
1	STANDARD EPS MOLDING	SEPM	1
2	STANDARD WEB	STWB	6
3			



Note: Walls greater than 8" thick, can be made by using two or more connectors and a connector splice

Celotex Corporation
Testing Services

10301 Ninth Street North
St. Petersburg, Florida 33716
(813) 578-4316
Fax (813) 578-4280

FIRE TESTING LABORATORY REPORT

April 28, 1998

Client: ECO-Block, LLC
513 Coconut Isle
Ft. Lauderdale, FL 33301

MTS Job No.: 2583891

Test Date: February 25, 1998

Metro-Dade Notification No.: CAE 98025

Project: Surface Burning Characteristics of ECO-Block™ 2000 Insulated Concrete Form Building System

Introduction:

This report presents the results of a fire test conducted on material submitted to our laboratory on January 23, 1998. Testing was completed on February 25, 1998. The test was performed in accordance with the following American Society for Testing and Materials (ASTM) test standard:

ASTM E 84 - 97a, "Standard Test Method for Surface Burning Characteristics of Building Materials"

The test method was used to determine the relative burning behavior of the material by observing the flame spread along the specimen. Flame spread and smoke developed index numbers are reported for the tested material.

Specimen Identification:

Several insulated concrete form (ICF) building system specimens were supplied by the client and identified as ECO-Block™ 2000 material. Each ICF consisted of a nominal 16 by 48 by 2.5 inch expanded polystyrene (EPS) block with six (6) plastic connectors, placed 8 inches on center, embedded into the block insulation. Nine (9) specimens were cut in half and 1 inch was removed from each end to form a nominal 16 by 22 by 2.5 inch ICF sample. The new blocks had three (3) symmetrically spaced plastic connectors. A tongue and groove joint was provided along the 22 inch length. Eighteen (18) pieces were placed together to create the 24 foot length test specimen.

Client: ECO-Block, LLC

MTS Job No.: 2583891

Fire Test Chamber:

The fire test chamber or "Steiner Tunnel" consists of a horizontal 25 foot length furnace duct with a nominal interior width of 17.75 inches and depth of 12 inches. The furnace walls are insulated with refractory fire brick. Observation windows, placed 24 inches on center, are provided the entire length of one side of the tunnel. Specimens are supported on a 1 inch wide ledge along the top of the chamber. A removable insulated, stainless steel cap is used to completely cover the chamber and the test samples.
The lid's edges, submerged in a perimeter water tray, prevent air leakage into the test chamber with a complete seal. The chamber was constructed in accordance with Section 5, "Apparatus", of the above standard.

Specimen Preparation and Installation:

The eighteen (18) 16 by 22 by 2.5 inch ECO-Block™ 2000 ICF building system samples were placed together end to end on the furnace support ledge with the plastic connectors surface towards the chamber floor. The 24 foot length test specimen consisted of the eighteen (18) sections. Three (3) 24 by 96 inch and one (1) 24 by 12 inch flat, inorganic reinforced cement boards were placed end to end on top of the test specimen for furnace lid protection.

The samples were conditioned in a controlled laboratory at 70 °F and 50% relative humidity a minimum of 48 hours prior to testing.

Test Procedure:

The flame spread distances, smoke obscuration percentages, and furnace temperatures were transmitted to an automated data acquisition system with a linear voltage transducer, a linear photometer system, and 18 gage, Type K thermocouples, respectively. The average flame front was observed and followed, with the linear voltage transducer, by a trained technician. Measurements were recorded over a 10 minute test time period.

Client: ECO-Block, LLC

MTS Job No.: 2583891

Test Results:

The rounded test results as required by Section 9, "Interpretation of Results", are summarized on the following table. The unrounded test results, test data and graphical plots for flame spread, smoke, and temperature developed data are located in the Appendix.

Specimen Identification	Flame Spread Index (Unitless)	Smoke Index (Unitless)
ECO-Block™ 2000 ICF Building System	0	300

Observations:

The material melted and dripped away from the tunnel ledge within 3 minutes. The test was terminated for safety considerations at 3 minutes, 32 seconds since no material remained at the flame source.

Tested By: William M. Gwynn
Research Technologist

Approved By: Stanley D. Gatland II
Research Engineer

December 20, 2002
Revised: October 10, 2003

ECO-Block, LLC
11112 Grader Street
Dallas, TX 75238

Attention: Mr. Travis W. Mills

Dear Sir:

Re: Project No. 3036367

Intertek Testing Services NA Ltd./Warnock Hersey conducted a review of fire test reports and documentation submitted by ECO-Block, LLC, to determine eligibility for 2-, 3-, and 4-Hour ratings in accordance with CAN/ULC S101-M89.

The ECO-Block concrete forming system consists of expanded polystyrene foam (EPS), 2.5 in. in thickness, with embedded plastic webs. Plastic connectors of differing lengths are available to create a 4 in., 6 in., 8 in., or greater concrete wall thickness.

ECO-Block, LLC submitted two test reports to support the evaluation; Omega Point Laboratories Project No. 16233-106668, describing a full-scale fire test of a bearing wall assembly for a 4-Hour fire resistance rating, and Omega Point Laboratories Project No. 16233-108915, describing small-scale fire resistance tests of concrete block wall assemblies. The full-scale fire test report describes a 4-Hour, 30 minute duration fire test of a load-bearing ECO-Block wall with 8 in. concrete thickness. The assembly provided a 4-Hour fire resistance rating in accordance with the acceptance criteria of CAN/ULC S101-M89 under load-bearing capacity of 7000 lbs/lineal foot. The concrete was steel reinforced, 12 in. on center vertically and 16 in. on center horizontally, using No. 5 steel rebar.

The second test report describes a series of small-scale wall assembly fire tests to determine comparative fire resistance ratings for 8 in., 6 in., and 4 in. concrete wall thicknesses when using the ECO-Block wall forming system. The fire resistance determined was as follows:

Concrete Wall Thickness	Rating Achieved
4 in.	2 Hours, 37 minutes
6 in.	5 Hours, 43 minutes
8 in.	4 Hours, 30 minutes

The correlation for time to burn-through of the 8 in. wall between the full-scale and small-scale did not occur. The burn-through of the plastic ties was the point of failure on the 8 in. wall full-scale test at 4-Hours, 30 minutes, yet the burn-through of the ties on the 6 in. wall small-scale did not occur until 5-Hours, 43 minutes.

/...2

Intertek Testing Services NA Ltd.
211 Schoolhouse St., Coquitlam, BC V3K 4X9
Telephone: 604-520-3321 Fax: 604-524-9186 Web: www.intertek-etlsemko.com

This shows that the small-scale test results are much better than was shown in the full-scale fire test. Omega Point Laboratories then describes an analysis to justify fire resistance ratings of 2-Hours for 4 in. concrete walls, and 4-Hours for 6 in. and 8 in. concrete walls.

We do not disagree with the conclusions of Omega Point Laboratories, however, we compared the data to the ratings permitted by the National Building Code of Canada for monolithic concrete walls, as shown in the table below:

Type S or N Concrete	Fire Resistance Rating
113 mm / 4.45 in.	2 Hours
142 mm / 5.6 in.	3 Hours
167 mm / 6.6 in.	4 Hours

We know from experience that Code ratings are conservative. As confirmed by Omega Point Laboratories, the presence of the EPS foam on the unexposed surface of the concrete will reduce the temperature rise of the wall. Temperature rise is the limiting criteria on concrete walls.

In conclusion, we confirm that the ECO-Block concrete wall forming system will provide the following fire resistance ratings in accordance with CAN/ULC S101-M89 under load-bearing conditions.

ECO-Block Concrete Thickness	Fire Resistance Rating
4 in. (100 mm)	2 Hours
6 in. (150 mm)	4 Hours
8 in. (200 mm)	4 Hours

The ECO-Block, LLC system is eligible for Listing by ITS/Warnock Hersey. The enclosed Listing will be submitted for publication in the ITS Directory of Listed Products.

Yours truly,

INTERTEK TESTING SERVICES NA LTD.

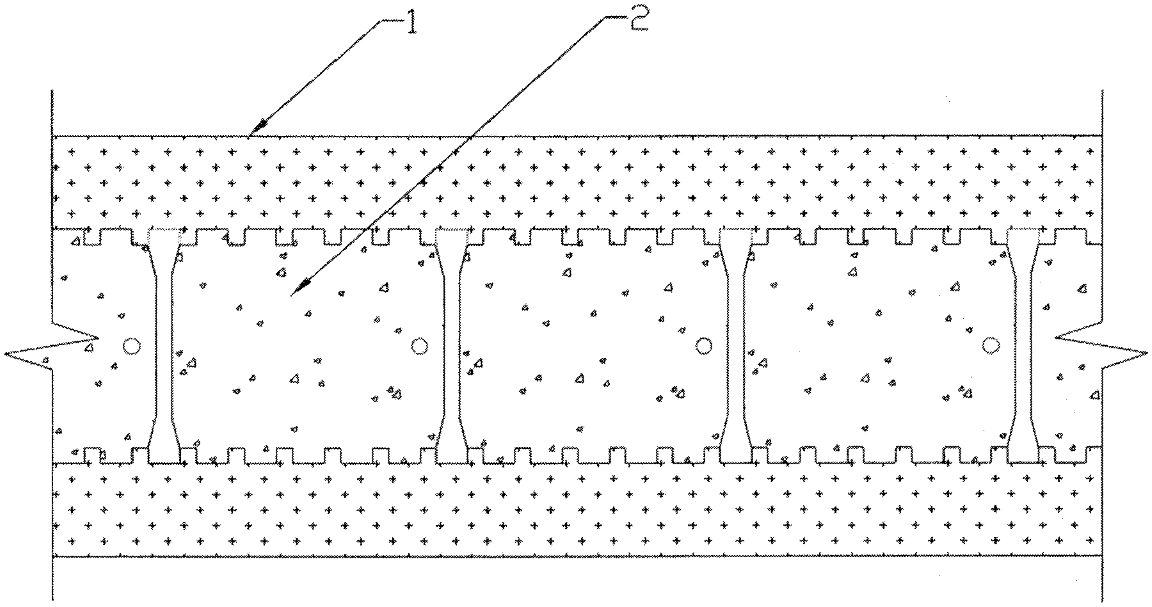
M. van Geyn

Michael van Geyn, A.Sc.T.
Manager – Fire Testing & Technical Programs

MVG/bjm

Encl.

DESIGN NO. ECO/WA 240-01
Assembly Rating: 2-, 3-, and 4-Hours
Load-Bearing Wall Assembly



1. ECO-Block insulated concrete wall forming system.

Formed Wall Thickness	Maximum Fire Resistance Rating	Combined Live & Dead Load (lbs./lin.ft.)
4 in.	2 Hours	35,000
6 in.	4 Hours	52,000
8 in.	4 Hours	70,000

2. Steel reinforced concrete, minimum 3500 psi concrete.

Michael van Geyn, A.Sc.T.
Manager – Fire Testing

ITS Intertek Testing Services

SOUTHWEST RESEARCH INSTITUTE®

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CHEMISTRY AND CHEMICAL ENGINEERING DIVISION
DEPARTMENT OF FIRE TECHNOLOGY
WWW.FIRE.SWRI.ORG
FAX (210) 522-3377

FIRE PERFORMANCE EVALUATION OF AN EXPANDED POLYSTYRENE MATERIAL (ECO-BLOCK® ICF'S) IN ACCORDANCE WITH NFPA 259-98, *STANDARD TEST METHOD FOR POTENTIAL HEAT OF BUILDING MATERIALS*

FINAL REPORT
Consisting of 7 Pages

SwRI® Project No. 01.06061.01.729
September 2003

Prepared for:

Eco-Block, LLC
1131 Westview Terrace
Oakville, Ontario L6M 3M1
Canada

Submitted by:

Jason P. Huczek
Research Engineer
Material Flammability Section

Approved by:

Marc L. Janssens, Ph.D.
Director
Department of Fire Technology

EXECUTIVE SUMMARY

An expanded polystyrene material (ECO-BLOCK® ICF's) was tested in accordance with NFPA 259-98, *Standard Test Method for Potential Heat of Building Materials*, for Eco-Block, LLC. Testing was conducted on August 12, 2003, at Southwest Research Institute's (SwRI) Department of Fire Technology and on September 3, 2003 at SwRI's Department of Fuels & Lubricants Research, both located in San Antonio, Texas. A summary of the test results is provided below.

Material Description	Average Potential Heat (kJ/kg)	Average Potential Heat (BTU/lb)
ECO-BLOCK® ICF'S	39,898	17,153

TABLE OF CONTENTS

1.0 INTRODUCTION

The objective of this test program was to perform a fire performance evaluation of an expanded polystyrene material for Eco-Block, LLC located in Oakville, Ontario, Canada. The material was tested in accordance with National Fire Protection Association (NFPA) Standard 259-98, *Standard Test Method for Potential Heat of Building Materials*. Testing was conducted on August 12, 2003, at Southwest Research Institute's (SwRI) Department of Fire Technology and on September 3, 2003 at SwRI's Department of Fuels & Lubricants Research, both located in San Antonio, Texas.

This test method is intended to measure and describe the properties of materials or products in response to heat and flame under controlled laboratory conditions. The results of this test may be used as elements of a complete fire hazard assessment or a fire risk assessment, which takes into account all the factors that are pertinent to an assessment of the fire hazard or fire risk of a particular end use. The results apply specifically to the specimens tested, in the manner tested, and not to similar materials, nor to the performance when used in combination with other materials.

2.0 NFPA 259 TEST DESCRIPTION

2.1 Test Procedure

The gross and net calorific potential of materials are determined as described in NFPA 259-98. The apparatus, specimen preparation, and test protocol are described in detail in this standard. The bomb calorimeter apparatus used is shown in Figure 1. There are two test procedures used in this standard to determine the potential heat of a material. The first procedure is the oxygen bomb calorimeter test procedure.

A specimen weighing nominally 0.5 g is placed in a porcelain crucible, which is then placed in a stainless steel bomb with combustion promoter. The sample is tested in general accordance with ASTM D 2015-96, *Test Method for Gross Calorific Value of Solid Fuel by the Adiabatic Bomb Calorimeter*. This procedure yields a gross heat of combustion. Two tests are conducted for repeatability. If the first two tests do not agree to within 10%, a third test is performed.

The second test procedure, the electric muffle furnace test procedure, requires a test specimen cut in the shape of a rectangular prism measuring 13 mm wide by 19 mm long by 64 mm high to be placed on the wire specimen holder, which is placed in the specimen container. The specimen container has a cap on one end and a hole to allow fresh air to circulate around the test sample to promote complete combustion. The specimen container, cap, and wire specimen holder are shown in Figure 2.

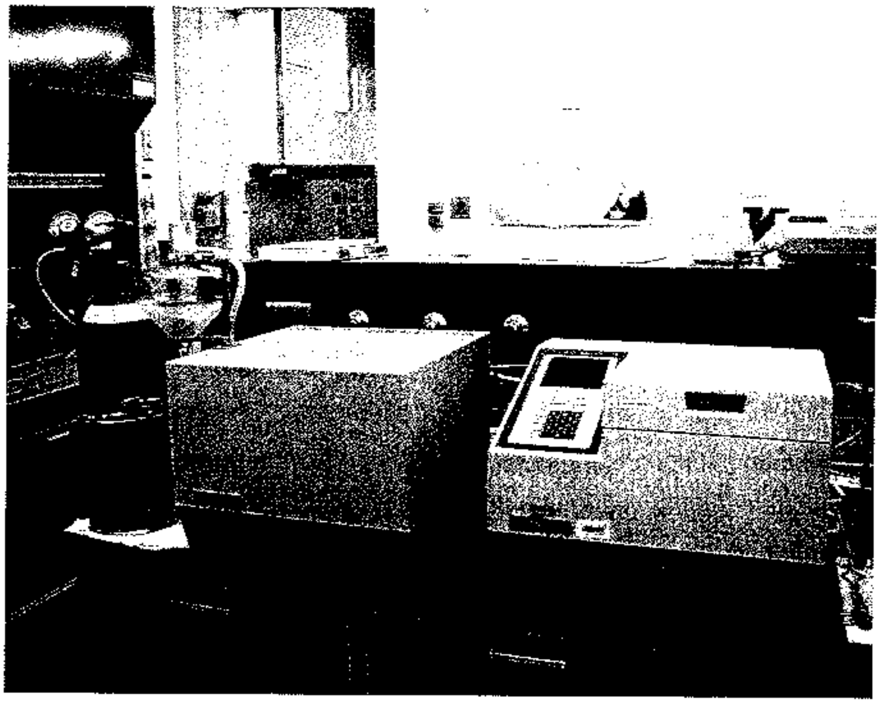

Figure 1. Bomb Calorimetry Apparatus.

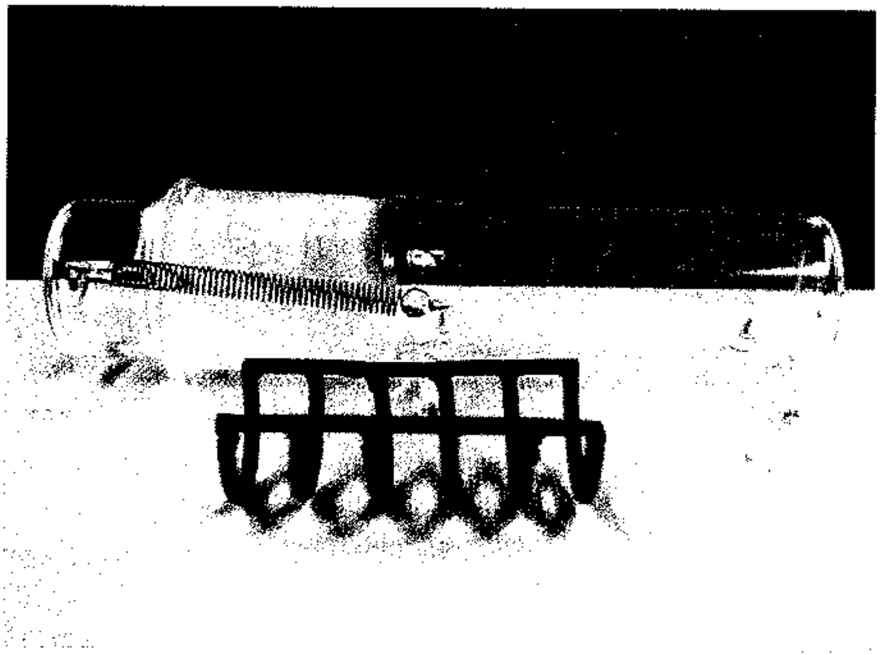

Figure 2. Wire Specimen Holder, Specimen Container and Cap.

The test sample is exposed to furnace conditions (750 ± 10°C) for 2 hours with a regulated airflow supplied at 47 cm^3/sec referenced to 20°C and 101 kPa, *i.e.*, standard temperature and pressure. After 2 hr, the test sample is removed from the furnace and placed in a desiccator to cool. Once the specimen has cooled to room temperature, the mass is measured.

If the mass of the residue remaining after the electric muffle furnace test procedure is not more than 5 percent of the initial mass of the test specimen, then the gross heat of combustion measured in the oxygen bomb calorimeter test procedure is considered to be the potential heat of the material tested.

If the mass of the residue is greater than 5 percent of the initial mass of the test specimen, then the residue must be tested according to the oxygen bomb calorimeter test procedure. Two tests must be performed. If the results from the first two tests differ by more than 10 percent, a third test is performed. The potential heat of the material is the difference between the gross heat of combustion measured in the first test procedure and the gross heat of combustion of the residue (as defined in NFPA 259) from the second procedure.

2.2 Measured Parameters

Gross Heat of Combustion (Q_{gr}) – The amount of heat released by the complete combustion of a unit of mass of the material, corrected for the heats of formation of H_2NO_3 and H_2SO_4, and for the heat of combustion of the firing wire and combustion promoter (if required). The gross calorific potential has a different value when combustion occurs in a constant pressure environment from that obtained in a constant volume environment. Tests are performed in a constant volume.

Potential Heat (Q_p) – The difference between the gross heat of combustion per unit mass of a representative specimen of the material and the heat of combustion per unit mass of any residue remaining after exposure of a representative specimen of the material to a defined heat source (*i.e.*, muffle furnace) using combustion calorimetric techniques.

3.0 DESCRIPTION OF TEST SPECIMENS

Eco-Block, LLC, located in Oakville, Ontario, Canada, provided an expanded polystyrene material for testing in accordance with NFPA 259. The material identification for this material is ECO-BLOCK® Insulating Concrete Forming System. The trade name of the product is ECO-BLOCK® ICF's. The sample was described by the Client as 1.5-pcf expanded polystyrene. The material was white in color. The composition was described as expanded polystyrene Nova 35 MB at 1.5 pcf. Sample materials were received at SwRI on August 7, 2003.

SwRI personnel prepared specimens for bomb calorimeter testing in accordance with NFPA 259. Samples were prepared and combined with a combustion promoter (mineral oil). For the electric muffle furnace test procedure, specimens were prepared to the appropriate dimensions per NFPA 259.

Samples were placed in a conditioned environment of 23 ± 2°C and 50 ± 5% relative humidity from the time they were received until specimen preparation and then again until just prior to testing.

4.0 TEST RESULTS

Electric muffle furnace testing was conducted on August 12, 2003. The oxygen bomb calorimetry testing was conducted on September 3, 2003. Table 1 contains the test data set from the electric muffle furnace procedure, and Table 2 includes the test data from the bomb calorimeter test procedure.

The first two test runs for the oxygen bomb calorimeter test procedure were less than 10 percent different from each other, therefore, a third test run was not performed. The first two runs for the electric muffle furnace test procedure were within 10 percent, so a third run was not necessary.

Table 1. NFPA 259 Electric Muffle Furnace Test Results – ECO-BLOCK® ICF's.

Test No.	Initial Mass of Furnace Sample (g)	Final Mass of Furnace Sample (g)	Percentage of Residue (%)
1	0.15	N/A	0
2	0.16	N/A	0

Table 2. NFPA 259 Bomb Calorimeter Test Results – ECO-BLOCK® ICF's.

Test No.	Gross Heat of Combustion (BTU/lb)	Gross Heat of Combustion of Residue (BTU/lb)	Potential Heat (BTU/lb)
1	17,011	N/A	17,011
2	17,295	N/A	17,295
Average:	**17,153**		**17,153**

Crawl Space Fire Exposure Evaluation

Residential Insulated Concrete Forms

Project No. 16223 - 108518

May 1, 2001

Prepared for:

ECO - Block, LLC
11112 Grader Street
Dallas, TX 75238

OMEGA POINT LABORATORIES

ABSTRACT

A residential expanded polystyrene form system, submitted by ECO - Block, LLC was tested with the following results: The specimen, as submitted and installed, performed satisfactorily when tested in accordance with Southwest Research Institute Test Procedure 99-02.

The description of the test procedure, as well as the observations and results obtained, contained herein are true and accurate within the limits of sound engineering practice. These results apply only for the specimens tested, in the manner tested, and may not represent the performance of other specimens from the same or other production lots nor of the performance when used in combination with other materials.

The test specimen identification is as provided by the client and Omega Point Laboratories, Inc. accepts no responsibility for any inaccuracies therein. Omega Point did not select the specimen and has not verified the composition, manufacturing techniques or quality assurance procedures.

This report does not imply certification of the product by Omega Point Laboratories, Inc. Any use of the Omega Point Laboratories name, any abbreviation thereof or any logo, mark, or symbol therefore, for advertising material must be approved in writing in advance by Omega Point Laboratories, Inc. The client must have entered into and be actively participating in a Listing & Follow-up Service program. Products must bear labels with the Omega Point Laboratories' Certification Mark to demonstrate acceptance by Omega Point Laboratories, Inc. into the Listing program.

Ernst L. Schmidt Jr.
Manager, Flammability Testing

5/18/01
Date

Reviewed and approved:

William E. Fitch, P.E. No. 55296

5/18/01
Date

OMEGA POINT LABORATORIES

INTRODUCTION

This report describes the results of the testing procedure that was performed on a expanded polystyrene concrete insulating form specimen submitted by ECO - Block, LLC and identified as the *Residential Insulating Concrete Form.* The purpose was to compare the fire performance characteristics of two configurations of crawl space insulation materials. In addition to the material mentioned above, an R-11 kraft paper faced fiberglass insulation was tested as a comparison sample.

TEST SPECIMEN

The test specimen was described by the client as the "Residential Insulating Concrete Form". The concrete forms were witnessed during production by Ron Graves of R & D Services, Inc. (NVLAP Code 200265-0) on March 6, 2001 at Lifelike Foam Products in Waxahachie, Texas. The insulating concrete forms were molded from Huntsman modified beads #7454, Lot # 117096. There were twenty bundles of insulating concrete forms marked by R & D Services for the testing project. The insulating concrete forms used in the testing consisted of bundles marked as 1 - 31 and 1 - 32 which correspond to R & D Services numbers RD200141 and RD200140. Each insulating concrete form measured 16 in. wide x 48 in. tall x 2.5 in. thick. The six panels in the corner were attached to the concrete block test structure using Tapcon concrete anchors manufactured by Buildex (ICBO #3370). The anchors were 0.25 in. x 3.75 in. with flat phillips head drive and were positioned every 8 in. in the polypropylene webs of the insulating concrete forms. The other twelve panels were attached with only two anchors per panel.

TEST PROCEDURE

A concrete block three-walled test structure was constructed with each wall measuring 8 ft. long x 4 ft. high. The floor / ceiling above the simulated crawl space was constructed of 2 in. x 8 in. joist headers, 16 in. on center with a surface of 15/32 in. thick, 4 ply APA graded A-C plywood sub flooring. The joists in the test chamber ran perpendicular to the cameras line of sight through the front of the test chamber. There was 1 in. of sand placed on the floor of the test chamber. There was a 22 lb. wood crib constructed of 2 in. x 2 in. white pine, with a plan of 15 in. square. The crib was placed in the rear left corner of the test chamber, 1 in. from the surface of the wall material. There was 150 ml of ethyl alcohol placed in a metal pan below the wood crib which was used as the ignition source.

TEST RESULTS

The test was performed on the comparative R-11 kraft faced fiberglass insulation which covered the walls and ceiling of the test structure. The test was performed at Omega Point Laboratories on March 21, 2001 with the following observed results:

TIME (min:sec)	OBSERVATION
0:00	The ethyl alcohol was ignited.
0:33	The kraft paper on the walls surrounding the wood crib ignited.
0:57	The kraft paper on the ceiling above the wood crib ignited.
1:06	There were flames seen exiting the front opening of the test structure.
1:30	The flames had receded back into the test structure.
2:40	A piece of ceiling insulation above the wood crib fell from position.
3:26	There were steady flames exiting the test structure.
8:38	The flames had burned through the wood floor / ceiling assembly.

The test was performed on the Residential Insulating Concrete Forms which covered the walls of the test structure, there was R - 11 kraft faced fiberglass insulation installed in the floor / ceiling assembly. The test was performed at Omega Point Laboratories on March 21, 2001 with the following observed results:

TIME (min:sec)	OBSERVATION
0:00	The ethyl alcohol was ignited.
0:17	The foam was seen melting on the walls surrounding the wood crib.
1:20	The kraft paper on the ceiling above the wood crib ignited.
1:36	There were flames seen exiting the front opening of the test structure.
1:50	The foam on the walls had ignited.
2:40	The flames were increasing in intensity.
3:00	There were intermittent flames exiting the test structure.
4:59	A piece of ceiling insulation above the wood crib fell from position.
5:28	There were steady flames exiting the test structure.
5:51	There was additional fiberglass insulation falling from position.

7:15	**There was additional fiberglass insulation falling from position.**
9:00	**The flames had burned through the wood floor / ceiling assembly.**

Conclusions

The Residential Insulated Concrete Forms did not pass flame out of the test structure or burn through the wood / ceiling assembly earlier than the fiberglass specimen. These times are noted in the table below:

Time to flames exiting the test structure for the fiberglass specimen	1:06
Time to flames exiting the test structure for the Residential Insulated Concrete Form specimen	1:36
Time to burn through for the fiberglass specimen	8:38
Time to burn through for the Residential Insulated Concrete Form specimen	9:00

OMEGA POINT LABORATORIES

Thursday, July 24, 2003

Mr. Sheldon Warman
ECO-Block L.L.C.
11112 Grader Street
Dallas, Texas 75238

Re: OPL Report No. 15498-104229
UBC 26-3
ECO-Block 2000

Dear Mr. Warman

The above referenced test was conducted at Omega Point Laboratories on January 22, 1999. This test was performed on ECO-Block 2000 (ECO-Block Insulating Concrete Foam System) with the requirements of UBC 26-3 test standard. Technically, UBC 26-3 test procedures are equivalent to that of UL 1715 test procedure. Hence, the results of the UBC 26-3 test on the material referenced above will in all aspects be the same as that of the UL 1715 test.

Please do not hesitate to contact me for any questions or comments.

Sincerely,

Majid Mehrafza
Manager, Small Scale and Research

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UBC 26-3
ROOM FIRE TEST STANDARD FOR INTERIOR OF FOAM PLASTIC SYSTEMS

Eco – Block 2000

Project No. 15498 – 104229 Rev 2

Rev 2: Corrected fastener spacing details in Specimen Description section of report.

March 12, 2004

Prepared for:

R & D Services, Inc.
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ABSTRACT

This report describes the results obtained when the Eco – Block 2000 insulated concrete form panel system manufactured by Life Like Products and identified as the "Eco – Block 2000" was tested in accordance with UBC 26-3 Room Fire Test Standard For Interior of Foam Plastic Systems. The test material covered an 8 ft. x 8 ft. section of the left wall and an 8 ft. x 8 ft. section of the back wall. Based on observations after the test, the specimen met the criteria as set forth in the UBC 26 –3.

Signed:

Javier O. Trevino
Manager, Special Projects

Date: March 12, 2004

Reviewed and approved:

William E. Fitch P.E.

Date: March 12, 2004

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INTRODUCTION

This report presents the results of an investigation of a room corner fire test conducted according to UBC 26 - 3 Room Fire Test Standard For Interior of Foam Plastic Systems. This document contains a description of the material evaluated, procedures used, and the test results. Note that the results listed apply only to the specimens tested, in the manner tested, and not to the entire production of this or similar materials, nor to the performance of this material when used in combination with other materials.

PROCEDURE

The standard test facility consists of an 8 ft. wide by 12 ft. long by 8 ft. high room with walls and ceiling and a doorway 2-1/2 ft. wide and 7 ft. high centered in one of the 8 ft. walls. All vertical or horizontal joint details must be representative of those intended for use in field conditions. The remainder of the interior of the room is constructed of 5/8 in. gypsum wallboard screwed to 2 in. x 4 in. metal studs. The test structure is located inside of a building which is free of excessive drafts.

The fuel source is a wood crib constructed of 1.5 in. x 1.5 in. sticks of white fir cut to 15 in. lengths. The crib must have a dry wood weight of 30 lbs. and be 15 in. square in plan. One 8d nail is driven at each intersection of two sticks. The crib is assembled in tiers of five sticks each with each tier oriented 90 degrees to the sticks in the adjacent tiers.

The crib is placed on four brick pieces, one under each corner of the crib, to provide not less than a 3 in. space between the floor and the lower surface of the crib. Ignition of the crib is accomplished by evenly distributing 1 lb. of shredded and fluffed wood excelsior beneath the crib over a 21 in. x 21 in. area and soaking with 4 oz. of ethyl alcohol.

A minimum of four Type K, Chromel-Alumel thermocouples are utilized for temperature measurement in the test room. The placement of these thermocouples is shown in Figure 1 in Appendix B. Documentation of the test consists of color video tape, thermocouple data and stack smoke release data. Temperature readings on all thermocouples are taken prior to the start of the test and continued at 6 second intervals to the completion of the fire exposure.

TEST SPECIMEN

The test specimen consisted of the Eco – Block 2000 insulated concrete form system that was mechanically attached to the left side and back walls of the test room facility.

The left side and back wall of the test specimen consisted of expanded polystyrene panels with polypropylene webs running horizontally through the panel. The panels were 16 in. wide x 48 in. long x 2.5 in. thick. The panels were fastened to the walls of the test room facility by running 3 in. long screws through the polypropylene webbing into the gypsum board of the test room. There was 0.5 in. regular gypsum board attached to the face of the Eco – Block 2000 panels. The gypsum board that was attached to the face of the specimen was mechanically attached by using 1 in. long screws that were run through the gypsum board and into the polypropylene webbing. The fastener spacing was 24 in o.c vertically and 24 in. o.c horizontally **(Rev 2)**. The gypsum board was taped and floated according to standard installation practice. The installation of the test specimen was done by Omega Point Laboratories, Inc. personnel.

The panels that were used in the test were selected from Life Like Products warehouse stock by an Omega Point Laboratories, Inc. field inspector, Stanley Modjsky, on November 19, 1998. The material that was selected was from Lot # 322, which was manufactured on November 18, 1998. Each bundle of material was marked with the OPL stamp, the inspectors initials and the date. A copy of a letter from Mr. Modjesky to OPL Scheduling Coordinator, Jeannette Perry, had been included in Appendix B.

Omega Point Laboratories received the specimen on December 1, 1998. The test specimen was then placed in a conditioning room with a constant temperature of 73 ± 5°F and a relative humidity of 50 ± 5%.

For a test configuration drawing, thermocouple locations, and mounting diagram see Appendix B - Figures.

TEST CRITERIA

After the test, the test specimen shall not be charred at the extremities. Additionally, the specimen shall not produce excess smoke during the test. Although not specified, flashover is considered to be an extreme type of failure. According to UBC 8-2, flashover shall be judged to have occurred when the heat flux at the floor level exceeds 20 kW/m^2, upper level air temperatures exceed 1100°F or flames project out the room door opening.

TEST RESULTS

The test was started at 10:20 a.m. on December 29, 1998. The ambient temperature was 67 °F with a relative humidity of 40%. The thermocouples were positioned in accordance with the standard, and their outputs verified after connection to the data acquisition system. Critical events during the course of the test are described below.

TIME	OBSERVATION
0:00	Ignition of the excelsior.
1:00	The wood crib flames had reached a height of 4 ft. above the crib.
1:30	There was a discoloration on the back wall behind and above the wood crib.
2:05	The flames from the wood crib had reached the ceiling.
2:20	The side wall was beginning to discolor.
2:35	The paper on the gypsum board ignited on both the side and back walls.
3:00	There was 2 ft. lateral flame spread along the wall / ceiling joint on both the back and side walls.
11:30	There was intermittent ignition in the corner above the wood crib.q

14:00	The back wall paper reignited in the area of the wood crib.
14:45	The smoke level in the test room began to increase slightly.
15:00	The test was terminated.

Post Test Observations:

After the test, the test room was allowed to cool and the following observations were made:

Side Wall
Side Wall Extremity: The foam had slightly melted and there was a light discoloration on the surface of the gypsum board.

Back Wall
Back Wall Extremity: The foam had slightly melted and there was a light discoloration on the surface of the gypsum board.

The paper on the surface of the gypsum board was consumed in an area behind the wood crib, vertically above the wood crib, and laterally along the wall / ceiling joint 4 ft. from the corner above the wood crib. There was a dark discoloration around the edges of where the paper had been consumed and a light discoloration at the wall / ceiling joint from approximately 4 ft. from the corner above the wood crib to the edges of the specimen. The foam behind the gypsum board was consumed in an area behind the wood crib upward to the 5 ft. point. There was slight melting of the foam vertically above that area and it extended along the wall / ceiling joint to the edges of the specimen.

CONCLUSIONS

The sample submitted, installed, and tested as described in this report, met the criteria of the UBC 26-3.