

UL U356

TER No. 1109-01

**One-Hour Fire-Resistance Rated, Limited
Load Bearing Wall Assemblies for STYROFOAM SIS™ &
SIS™ Plus Using IBC Section 722 Calculation Method
(Exposed to Fire on Interior Face Only)**

Issue Date: October 5, 2011

Updated: March 28, 2017

Subject to Renewal: January 1, 2018

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DIVISION: 06 00 00 – WOOD, PLASTICS AND COMPOSITES

Section: 06 02 00 – Design Information

Section: 06 11 00 – Wood Framing

Section: 06 12 00 – Structural Panels

Section: 06 12 19 – Shear Wall Panels

DIVISION: 07 00 00 – THERMAL AND MOISTURE PROTECTION

Section: 07 21 00 – Thermal Insulation

Section: 07 25 00 – Water-Resistive Barriers/Weather Barriers

Section: 07 27 00 – Air Barriers

1. Products Evaluated:

- 1.1. STYROFOAM SIS™ Structural Insulated Sheathing (SIS)
- 1.2. STYROFOAM SIS™ Plus Structural Insulated Sheathing (SIS)
- 1.3. For the most recent version of this Technical Evaluation Report (TER), visit drjengineering.org. For more detailed state professional engineering and code compliance legal requirements and references, visit drjengineering.org/statelaw. DrJ is fully compliant with all state professional engineering and code compliance laws.

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 **Learn more about DrJ's Accreditation**

- DrJ is an ISO/IEC 17065 accredited product certification body through ANSI Accreditation Services.
- DrJ provides certified evaluations that are signed and sealed by a P.E.
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- 1.4. Requiring an evaluation report from a specific organization (ICC-ES, IAPAMO, CCMC, DrJ, etc.) is a violation of international, federal, state, provincial and local anti-trust and free trade regulations and constitutes restraint of trade. Building code regulations require that evaluation reports are provided by an approved agency meeting specific requirements. Any agency accredited in accordance with ANSI ISO/IEC 17065 meets this requirement within ANSI's scope of accreditation. For a list of accredited agencies, visit ANSI's [website](#). For more information, see [drjcertification.org](#)
- 1.5. This TER can be used to obtain product approval in any country that is an IAF MLA Signatory (all countries found [here](#)) and covered by an [IAF MLA Evaluation](#) per the [Purpose of the MLA](#) (as an example, see [letter to ANSI](#) from the Standards Council of Canada). Manufacturers can go to jurisdictions in the U.S., Canada and other [IAF MLA Signatory Countries](#) and have their products readily approved by authorities having jurisdiction using [DrJ's ANSI accreditation](#).

2. Applicable Codes and Standards:¹

- 2.1. 2009, 2012 and 2015 International Building Code (IBC)
- 2.2. 2009, 2012 and 2015 International Residential Code (IRC)
- 2.3. 1996 BOCA National Building Code
- 2.4. 1994 Uniform Building Code
- 2.5. 1994 Standard Building Code
- 2.6. ASTM E119 – Standard Test Methods for Fire Tests of Building Construction and Materials

3. Performance Evaluation:

- 3.1. STYROFOAM SIS™ and STYROFOAM SIS™ Plus were evaluated in accordance with ASTM E119 to determine:
 - 3.1.1. Performance as a component element of one-hour rated wall assemblies using UL U356 design.
- 3.2. For other sheathing performance characteristics that may be required in an exterior wall assembly, please see [TER No. 0804-01: STYROFOAM SIS™ and SIS™ Plus](#).
- 3.3. Any code compliance issues not specifically addressed in this section are outside the scope of this evaluation.

4. Product Description and Materials:

- 4.1. STYROFOAM SIS™ and STYROFOAM SIS™ Plus are structural rigid insulation sheathing products (see [TER No. 0804-01](#)).
- 4.2. STYROFOAM SIS™ and STYROFOAM SIS™ Plus are structural, rigid insulation sheathing products consisting of a proprietary fibrous sheathing board laminated to one side of a proprietary rigid foam plastic insulation.
 - 4.2.1. The proprietary fibrous sheathing is a laminated board made of fibered, specially treated plies that are pressure-laminated with a water-resistant adhesive. The surface finish consists of a facer on one or both sides. STYROFOAM SIS™ utilizes a 0.113" (2.9 mm) nominal thickness fibrous sheathing board and STYROFOAM SIS™ Plus utilizes a 0.137" (3.4 mm) nominal thickness fibrous sheathing board.
 - 4.2.2. The foam plastic insulation is a proprietary rigid polyisocyanurate, which can have facings on one or both sides.
- 4.3. Material Availability
 - 4.3.1. STYROFOAM SIS™ and STYROFOAM SIS™ Plus:
 - 4.3.1.1. Thicknesses range from 0.5" (12.7 mm) up to 1.0" (25.4 mm).

¹ Unless otherwise noted, all references in this code compliant technical evaluation report (TER) are from the 2015 version of the codes and the standards referenced therein, including, but not limited to, ASCE 7, SDPWS and WFCM. This product also complies with the 2000-2012 versions of the IBC and IRC and the standards referenced therein. As required by law, where this TER is not approved, the building official shall respond in writing, stating the reasons this TER was not approved. For variations in state and local codes, if any, see [Section 8](#).

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4.3.1.2. The standard product width is 48" (1219 mm).

4.3.1.3. Standard lengths include 96", 108" and 120" (2438, 2743 and 3048 mm).

4.3.2. Gypsum Wallboard (GWB) Sheathing

4.3.2.1. Thicknesses range from 0.5" (12.7 mm) up to maximums that vary by product.

4.3.2.2. The standard product width is 48" (1219 mm).

4.3.2.3. Standard lengths include 96" and 144" (2438 and 3657 mm).

5. Applications:

5.1. One Hour Fire Assemblies using Design No. U356

5.1.1. Two full-scale *ASTM E119* fire endurance tests and fire and hose stream tests of a limited load bearing unsymmetrical exterior wall assembly were conducted by the Building Research Laboratory at Ohio State University by Dr. Richard Bletzacker of Bletzacker and Associates.²

5.1.1.1. OSU Test project number 7187 had a fire endurance performance of 65 minutes and had a finish rating for the 5/8" Type X GWB membrane of 19.9 minutes.

5.1.1.2. OSU Test project number 3518 had a fire endurance performance of 60 minutes and had a finish rating for the 5/8" Type X GWB membrane of 20.4 minutes.

5.1.1.3. OSU also tested 10 small-scale assemblies that were fully thermocoupled, which provided knowledge of the thermal transfer with respect to fire resistance layers with fire from one side of the assembly.

5.1.2. The key structural sheathing component of STYROFOAM SIS™ and STYROFOAM SIS™ Plus was the exterior sheathing on both assemblies.

5.1.3. The finish rating for the 5/8" Type X GWB membrane of this assembly was 20.4 minutes.

5.1.3.1. This is the GWB membrane finish rating used in [IBC Section 722](#)³ calculations.

5.1.3.2. GWB membrane comparisons will be made for the application of this tested finish rating to other fire rated assemblies having GWB membrane finish ratings of 20.4 minutes or greater.

5.1.4. The following table provides an [IBC Section 703.3](#) "Alternative methods for determining fire resistance" based fire endurance assembly.

5.1.4.1. This section allows for substitutions of STYROFOAM SIS™ and STYROFOAM SIS™ Plus as the exterior sheathing in the above mentioned one-hour rated fire tests conducted by the Building Research Laboratory at Ohio State University using code complying calculation procedures that incorporate specific thermal protection performance data taken directly from the fire testing performed.

5.1.4.2. This assembly is solely for fire endurance performance where the assembly is exposed to fire on the interior face only and where interior GWB is the protective membrane.

5.1.4.3. This is defined as an unsymmetrical fire endurance assembly where performance is from the interior side only.

5.1.5. Loading Requirements

5.1.5.1. The original wall assembly was loaded to 55% of the allowable load.

5.1.5.2. A superimposed load of 1,800 lbs. per stud was applied to the assembly at the start of the test and was maintained throughout the test. This superimposed load imposed a stress of 342.9 psi, compression parallel to grain.

5.1.5.3. This results in a wall assembly permitted to be built as follows:

² Testing conducted by the Engineering Experiment Station at Ohio State University in Columbus, Ohio, 43212. The test is *Standard ASTM Fire Endurance Test and a Fire and Hose Stream Test on Duplicate Limited Load Bearing Unsymmetrical Exterior Wall Assemblies*, which was conducted by the Building Research Laboratory, Larry L. Whitaker, Supervisor, Test Operations.

³ [2009 IBC Section 721](#)

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5.1.5.3.1. 8' wall heights can be loaded to a maximum of 1,800 lbs. per stud (1,350 plf).

5.1.5.3.2. 9' wall heights can be loaded to a maximum of 1,180 lbs. per stud (885 plf).

Fire Endurance Assembly Type or Designation	Hourly Rating Per UL Directory & IBC Section 721.6 or Section 722.6	GWB Manufacturer	GWB Fastener & Fastener Spacing	Exterior Side of Assembly Only SIS™ & SIS™ Plus Fasteners & Spacing UL356 Item #5 Substitute	Wood Studs	Maximum Applied Compression Load (plf)	Finish Rating Must be Greater than 20.4 Minutes	Wall Performance after Finish Rating is Achieved (minutes)	Total Fire Endurance Performance of UL U356 Assembly as Defined (minutes)
UL U356 Exterior Side SIS™ Attached to Studs then Assembly Siding Types Applied	One-Hour Rated Assembly Fire Endurance from Interior Side Only	See UL U356 for a listing of 5/8" Fire Rated GWB manufacturers that can be applied to achieve a Finish Rating of 21 minutes or greater as designated	Per UL U356 Or max of 2"-long GWB nails spaced 6" o.c. around the perimeter and 12" o.c. on intermediate studs	Attached Directly to Studs Staples 16-gauge min, 7/16" crown penetrating a min of 1" into the stud Or 0.113" nail min. penetrating a min of 1" into stud Spacing: 3" o.c perimeter, 6" o.c. field	Min SPF studs spaced at a maximum of 16" o.c.	1,350 plf at a maximum 8' wall height 885 plf at a maximum 9' wall height	Base Finish Rating for UL U356 Assembly ranges from 23 to 25 minutes	39.6	62.6 to 64.6

Table 1: [UL U356](#) with STYROFOAM SIS™ & SIS™ Plus Applied as Exterior Structural Sheathing in One-Hour Rated Fire Endurance Wall Assemblies (Exposed to Fire on Interior Face Only) for GWB Manufacturers with Finish Ratings over 21 Minutes

5.2. Justification of the One-Hour Fire Endurance Assembly Rating Pursuant to Using the Method in [IBC Section 722.6](#)⁴ and Data from UL Fire Assembly Hourly Ratings Found in the UL Directory.

5.2.1. Two (2) full-scale *ASTM E119* fire endurance tests and subsequent fire and hose stream tests of a limited load bearing unsymmetrical exterior wall assembly were conducted by the Building Research Laboratory at Ohio State University.

5.2.2. Finish Rating Assessment

5.2.2.1. The worst-case finish rating for the 5/8" Type X GWB membrane of Test 7187 was 19.9 minutes. It had an *ASTM E119* fire endurance time of 64 minutes, at which time the wall assembly could no longer sustain the imposed load.

5.2.2.2. The worst-case finish rating for the 5/8" Type X GWB membrane of Test 3518 was 20.4 minutes. It had an *ASTM E119* fire endurance time of 60 minutes, at which time the wall assembly could no longer sustain the imposed load.

5.2.2.3. The worst-case GWB membrane finish rating for 5/8" Type X GWB based on these assembly tests was 20.4 minutes.

5.2.2.3.1. This is the GWB membrane time that will be used in [IBC Section 722](#)⁵ calculations, and membrane comparisons for the application of this test to fire rated assemblies having GWB membrane finish ratings of 21 minutes or greater.

5.2.2.3.2. The higher number is used because the remaining assembly fire endurance performance had the lowest results. Then, when another gypsum membrane finish rating is used to determine a final fire endurance performance, the resulting calculation is conservative.

5.2.3. The test was unsymmetrical with the fire side of the wall being external to the 5/8" Type X GWB.

5.2.3.1. The wallboard for Test 7187 was 5/8"-thick Georgia-Pacific Firestop Type X GWB with tapered edges. It was supplied in 4'-wide by 8'-long sheets. The wallboard was Underwriters Laboratories, Inc. Classified, Issue No. B-3575 Type GPFS-6. The average measured weight of the wallboard was 2,354 lbs. per 1,000 sq. ft. The average measured edge thickness was 0.587" and the average measured thickness of the central portion was 0.623". The GWB was erected vertically with the joints located over studs. The wallboard was attached to the studs and plates with the 2"-long GWB nails spaced 6" o.c. around the perimeter of each sheet and 12" o.c. on the intermediate studs. The

⁴ [2009 IBC Section 721.6](#)

⁵ [2009 IBC Section 721](#)

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wallboard nails and joints were coated with joint compound and the joint tape was embedded. After the first coat had set, a second coat of joint compound was applied to complete the construction.

- 5.2.3.2.** The wallboard for Test 3518 was $\frac{5}{8}$ "-thick Gold Bond Fire-Shield Type X GWB with tapered edges. It was supplied in 4'-wide by 8'-long sheets. The wallboard was Factory Mutual approved, Type FSW. The average measured weight of the wallboard was 2,194 lbs. per 1,000 sq. ft. The average measured edge thickness was 0.588" and the average measured thickness of the central portion was 0.627". The GWB was erected vertically with the joints located over studs. The wallboard was attached to the studs and plates with 2"-long GWB nails spaced 6" o.c. around the perimeter of each sheet and 12" o.c. on the intermediate studs.
- 5.2.4.** The insulation was $3\frac{5}{8}$ "-thick by $15\frac{1}{4}$ "-wide by 94"-long R-13 unfaced friction fit glass fiber batts. The manufacturer certified that the insulation conformed to Federal Specifications HH-I-521E, Type 1 for both tests.
- 5.2.5.** The structural sheathing was a proprietary laminated fibrous board sheathing, the same structural sheathing component of STYROFOAM SIS™ and STYROFOAM SIS™ Plus, fiber-based board faced on both sides. The sheathing was supplied in by 4'-wide by 8'-long sheets. This fiber-based board is the structural sheathing used in the SIS™ product line. The structural sheathing was a minimum of 0.113" thick, and it was attached to the unexposed side of the studs and plates with $1\frac{1}{4}$ "-long roofing nails spaced 3" o.c. around the perimeter of each sheet and 6" o.c. on the intermediate studs. The sheathing was erected vertically with the butt joints over studs.
- 5.2.5.1.** The fasteners used to attach this proprietary sheathing were $1\frac{1}{4}$ "-long 11 ga galvanized roofing nails with $\frac{7}{16}$ "-diameter heads and diamond points.
- 5.2.5.2.** Structural testing has shown that the sheathing can also be installed vertically with edges blocked and fastened with $\frac{1}{2}$ "-crown by $1\frac{1}{2}$ "-long staples on all framing members at 3" on edges and 6" in the field of the panel to obtain equivalent or better performance.
- 5.2.6. Siding**
- 5.2.6.1.** The siding for Test 7187 was $\frac{19}{32}$ "-thick by 4'-wide by 8'-long plywood panel siding. The siding was Group I, exterior panel siding graded in accordance with U.S. Product Standard PS 1-74. The measured weight of the siding was 1.46 lbs. per sq. ft. The surface treatment was a reverse board and batten pattern.
- 5.2.6.2.** The siding for Test 3518 was 0.024"-thick unbacked aluminum lap siding. It was manufactured by the Wolverine Aluminum Corporation and was wood grain embossed with a white finish. The siding was provided in 12' 6" lengths with an 8" exposure. The measured weight of the siding was 0.28 lbs. per lineal ft.
- 5.2.7. Fasteners**
- 5.2.7.1.** The fasteners used to erect the framing were $2\frac{1}{2}$ "-long, 8d cement coated sinker nails with counter sunk heads and diamond points. The fasteners used to attach the GWB were 2"-long $12\frac{1}{2}$ ga annular ringed GWB nails with $\frac{19}{64}$ "-diameter heads and long diamond points for both tests.
- 5.2.7.2.** The fasteners used to attach the siding in Test 7187 were $2\frac{1}{2}$ "-long 8d galvanized box nails with flat heads and diamond points.
- 5.2.7.3.** The fasteners used to attach the siding in Test 3518 were $1\frac{1}{4}$ "-long $12\frac{1}{2}$ ga painted aluminum trim nails.
- 5.2.8. Construction**
- 5.2.8.1.** The construction was performed by skilled workmen employed by and under the direct supervision of the sponsor. Two assemblies were constructed as follows.
- 5.2.8.2.** Insulation was placed along the vertical edges of the test frame to provide a furnace seal and to prevent restraint. Two plates were anchored to the top of the test frame and a single base plate was anchored to the top of a 2'-high solid concrete block filler. The filler was necessary to reduce the 10' test frame height to the desired 8' height.

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- 5.2.8.3. The studs were cut to length, erected 16" o.c. and toe nailed to the base and top plates with six (6) 8d cement coated sinker nails per stud end.
- 5.2.8.4. The minimum 0.113" structural sheathing was attached.
- 5.2.8.5. The insulation batts were friction fit into the stud cavities.
- 5.2.8.6. The GWB was erected vertically with the joints located over studs. The wallboard was attached to the studs and plates with the 2"-long GWB nails spaced 6" o.c. around the perimeter of each sheet and 12" o.c. on the intermediate studs.
- 5.2.8.7. The wallboard nails and joints were coated with joint compound and the joint tape was embedded. After the first coat had set, a second coat of joint compound was applied to complete the construction.

5.2.9. Drying and Aging

- 5.2.9.1. The moisture content of the studs, as measured with an electrical resistance moisture meter, was less than 14 percent at the time of construction. The completed assembly was allowed to set and air dry for a minimum of seven (7) days to insure dryness of the joint compound. During the drying period, the specimen stood in the normal atmosphere of the testing laboratory where air could circulate freely about both faces.

5.3. IBC Section 722⁶ Code Compliance Evaluation of Fire Endurance Performance in One-Hour Fire Rated Assembly Applications

5.3.1. Calculation Methodology for Equivalent Fire Endurance Assembly Performance

- 5.3.1.1. The building code has long recognized that there will be instances when materials and assemblies one wishes to use in a building may not be readily available from prescriptive tables and tests.
- 5.3.1.2. Theoretical methods offer an alternative to full-scale fire tests using procedures defined in BOCA International's Guidelines for Determining Fire resistance Ratings of Building Elements.⁷
- 5.3.1.3. These procedures date back to all legacy codes and have been incorporated into the ICC family of codes as a credible means of creating fire rated assemblies. For example:
 - 5.3.1.3.1. Section 704.1.1 of the *BOCA National Building Code/1996*, Section 703.3 of the *1994 Uniform Building Code* and 701.2.1 of the *Standard Building Code/1994* permit fire resistance ratings of building assemblies and structural elements to be determined in accordance with an approved analytical method.⁸
 - 5.3.1.3.2. IBC Section 722.6⁹ contains the alternate calculation provisions.
 - Wood assemblies.** The provisions of this section contain procedures by which the fire resistance ratings of wood assemblies are established by calculations.
 - Section 721.6.1 General.** This section contains procedures for calculating the fire resistance ratings of walls, floor/ceiling and roof/ceiling assemblies, based in part on the standard method of testing referenced in Section 703.2.
 - 5.3.1.3.3. One theoretical method known as the "Ten Rules of Fire Endurance Ratings" was published by T.Z. Harmathy in the May 1965 edition of *Fire Technology*. Harmathy's Rules provide a foundation for extending fire endurance assembly data. These rules will be used extensively in this report.¹⁰
- 5.3.1.4. Fire endurance assembly calculations are also delineated in:
 - 5.3.1.4.1. The calculated assembly listed in the UL Fire Resistance Directory, Design Number L538¹¹.

⁶ 2009 IBC Section 721

⁷ All fire endurance performance calculation concepts in this evaluation use the *Guidelines for determining Fire resistance Ratings of Building Elements*, BOCA International, May 1994, pg. 52, Section 7.2.3 and May 2001 Chapter 1 and Chapter 6 and the relevant current building code requirements.

⁸ Code references and language adapted from *Guidelines for determining Fire resistance Ratings of Building Elements*, BOCA International, May 1994, pg. 52, Section 7.2.3 and May 2001 Chapter 1 and Chapter 6.

⁹ 2009 IBC Section 721.6

¹⁰ T.Z. Harmathy, "Ten Rules of Fire Endurance Rating," *Fire Technology*, 1(2), May 1965, pp. 93-102.

¹¹ www.database.ul.com

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- 5.3.1.4.1.1.** This assembly was calculated using the component additive method (CAM) principles that will be used here and adopted into a UL directory assembly. The telltale sign that this is a calculated assembly is that the finish rating for this assembly states that it is “more than 90 minutes”, and
- 5.3.1.4.1.2.** The Component Additive Method for Calculating and Demonstrating Assembly Fire Endurance (DCA 4 - CAM for Calculating and Demonstrating Assembly Fire Endurance by the American Wood Council)¹².

5.3.1.5. The calculations and analysis used to create [Table 1](#) in this report are based upon:

- 5.3.1.5.1.** ASTM E119 assembly testing of the proprietary fibrous sheathing board from the interior side ($\frac{5}{8}$ " GWB side) only.
- 5.3.1.5.2.** Finish rating performance of the GWB membrane on the interior (fire) side of the assembly.
- 5.3.1.5.3.** Gypsum Association's *Fire Resistance and Sound Control Design Manual*¹³.
- 5.3.1.5.4.** UL directory¹⁴.
- 5.3.1.5.5.** CAM principles for wall assemblies as used in [IBC Section 722](#)¹⁵.

5.3.2. Membrane Protection

- 5.3.2.1.** The critical feature of any fire endurance assembly is the performance of the gypsum membrane.
- 5.3.2.2.** In order for an assembly to obtain a given fire endurance resistance performance, the membrane must stay intact for as long as possible prior to failing.
- 5.3.2.3.** IBC-specific information pertaining to fire endurance membranes and their performance, with respect to use with a wall system, follows.
- 5.3.2.3.1.** [IBC Section 722.6.2.2](#)¹⁶ states:
- 5.3.2.3.1.1.** [Table 722.6.2\(1\)](#)¹⁷ indicates the time assigned to membranes on the fire-exposed side.”

¹² www.awc.org/publications/dca/dca4/dca4.pdf

¹³ [www.gypsum.org/pdf/GA-600-09 Print 7 Meqs.pdf](http://www.gypsum.org/pdf/GA-600-09%20Print%207%20Meqs.pdf)

¹⁴ [General Information for Fire Resistance Ratings – ANSI/UL 263](#)

¹⁵ [2009 IBC Section 721](#)

¹⁶ [2012 IBC Section 721.6.2.2](#)

¹⁷ [2012 IBC Table 721.6.2\(1\)](#)

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TABLE 722.6.2(1)
TIME ASSIGNED TO WALLBOARD MEMBRANES^{a, b, c, d}

DESCRIPTION OF FINISH	TIME ^e (minutes)
$\frac{3}{8}$ -inch wood structural panel bonded with exterior glue	5
$\frac{15}{32}$ -inch wood structural panel bonded with exterior glue	10
$\frac{19}{32}$ -inch wood structural panel bonded with exterior glue	15
$\frac{3}{8}$ -inch gypsum wallboard	10
$\frac{1}{2}$ -inch gypsum wallboard	15
$\frac{5}{8}$ -inch gypsum wallboard	30
$\frac{1}{2}$ -inch Type X gypsum wallboard	25
$\frac{5}{8}$ -inch Type X gypsum wallboard	40
Double $\frac{3}{8}$ -inch gypsum wallboard	25
$\frac{1}{2}$ -inch + $\frac{3}{8}$ -inch gypsum wallboard	35
Double $\frac{1}{2}$ -inch gypsum wallboard	40

For SI: 1 inch = 25.4 mm.

- These values apply only where membranes are installed on framing members that are spaced 16 inches o.c. or less.
- Gypsum wallboard installed over framing or furring shall be installed so that all edges are supported, except $\frac{5}{8}$ -inch Type X gypsum wallboard shall be permitted to be installed horizontally with the horizontal joints staggered 24 inches each side and unsupported but finished.
- On wood frame floor/ceiling or roof/ceiling assemblies, gypsum board shall be installed with the long dimension perpendicular to framing members and shall have all joints finished.
- The membrane on the unexposed side shall not be included in determining the fire resistance of the assembly. Where dissimilar membranes are used on a wall assembly, the calculation shall be made from the least fire-resistant (weaker) side.
- The time assigned is not a finished rating.

5.3.2.3.1.2. Harmathy states that, "The thermal fire endurance of a construction consisting of a number of parallel layers is greater than the sum of the thermal fire endurance characteristics of the individual layers when exposed separately to the fire."

5.3.2.3.1.3. For example:

5.3.2.3.1.3.1. In [Table 722.6.2\(1\), \(2\), \(5\)](#)¹⁸, a single layer of $\frac{1}{2}$ " GWB yields a membrane rating of 15 minutes.

5.3.2.3.1.3.2. If one uses two such layers, the rating is 40 minutes, instead of the expected 30 if the membranes were simply added together.

5.3.2.3.1.3.3. This confirms the foregoing statement on the addition of multiple layers.

5.3.2.3.2. [IBC Section 722.6.2.3](#)¹⁹ states:

5.3.2.3.2.1. "For an exterior wall with a fire separation distance greater than 5 feet²⁰ (1524 mm), the wall is assigned a rating dependent on the interior membrane and the framing as described in [Tables 722.6.2\(1\)](#) and [722.6.2\(2\)](#)."

¹⁸ [2012 IBC Table 721.6.2\(1\), \(2\), \(5\)](#)

¹⁹ [2012 IBC Section 721.6.2.3](#)

²⁰ 2015 IBC states 10 feet (3048 mm)

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TABLE 721.6.2(2)
TIME ASSIGNED FOR CONTRIBUTION OF WOOD FRAME^{a, b, c}

DESCRIPTION	TIME ASSIGNED TO FRAME (minutes)
Wood studs 16 inches o.c.	20
Wood floor and roof joists 16 inches o.c.	10

For SI: 1 inch = 25.4 mm.

a. This table does not apply to studs or joists spaced more than 16 inches o.c.

b. All studs shall be nominal 2 × 4 and all joists shall have a nominal thickness of at least 2 inches.

c. Allowable spans for joists shall be determined in accordance with Sections 2308.8, 2308.10.2 and 2308.10.3.

5.3.2.3.3. [IBC Section 722.6.2.5](#) states:

5.3.2.3.3.1. “[Table 722.6.2\(5\)](#) indicates the time increments to be added to the fire resistance where glass fiber, rockwool, slag mineral wool or cellulose insulation is incorporated in the assembly.”

TABLE 721.6.2(5)
TIME ASSIGNED FOR ADDITIONAL PROTECTION

DESCRIPTION OF ADDITIONAL PROTECTION	FIRE RESISTANCE (minutes)
Add to the fire-resistance rating of wood stud walls if the spaces between the studs are completely filled with glass fiber mineral wool batts weighing not less than 2 pounds per cubic foot (0.6 pound per square foot of wall surface) or rockwool or slag material wool batts weighing not less than 3.3 pounds per cubic foot (1 pound per square foot of wall surface), or cellulose insulation having a nominal density not less than 2.6 pounds per cubic foot.	15

For SI: 1 pound/cubic foot = 16.0185 kg/m³.

5.3.2.3.4. [IBC Section 722.6.2.6](#) states:

5.3.2.3.4.1. “Fastening of wood frame assemblies and the fastening of membranes to the wood framing members shall be done in accordance with [Chapter 23](#).”

5.3.3. Membrane Finish Rating Additive Procedures²¹

5.3.3.1. To estimate the fire resistance ratings of a component that is part of an assembly, a key element of the assembly's performance is defined by the membrane finish rating, which provides an indication of the fire side protection afforded the overall assembly by the membrane.

²¹ www.fpl.fs.fed.us/documnts/pdf2009/fpl_2009_white001.pdf; Fire Resistance of Wood Members with Directly Applied Protection, Robert H. White, U.S. Forest Service, Forest Products Laboratory Madison, Wisconsin, U.S.A., Proceedings of the Fire and Materials 2009 Conference held at the Hyatt Hotel Fisherman's Wharf Hotel, San Francisco, California, USA 26-28 January 2009.

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5.3.3.2. Using the additive procedures as defined by the *IBC*, membrane finish ratings provide time values to add to the fire rating of the unprotected structural wood elements. The following approach conforms to the *IBC* and standards referenced in the *IBC*.

5.3.3.2.1. Use the finish ratings for the protective membrane obtained in the fire-resistance tests of the wall or floor assemblies as the basis for membrane substitution.

5.3.3.2.1.1. "The finish rating of the protective membrane is the resistance time for thermocouples placed between the wood stud or joist and the gypsum board to record a temperature rise of 139°C or individual temperature rise of 181°C. This temperature rise of 139°C corresponds to an actual temperature of 159°C for an initial temperature of 20°C."

5.3.3.2.1.2. "Because this finish rating temperature is less than the 288°C (550°F) or 300°C commonly assumed for the base of the char layer, a conservative assumption is that the structural wood element will not char prior to the duration of the finish rating."

5.3.3.2.1.3. "Finish ratings can be found in product listings such as the Underwriters Laboratories Fire Resistance Directory (www.ul.com). For wood stud wall assemblies, such a finish rating for double layer 5/8" thick gypsum board protective membrane includes 66 min. for UL Design No. U301."

5.3.3.2.1.4. "Finish ratings for a single layer of 5/8" fire-rated gypsum wall board are 20 to 26 minutes (for UL Design No. U305) and 27 minutes (for UL Design No. U309)."²²

5.3.3.2.2. The new assembly is of like construction. For instance:

5.3.3.2.2.1. It uses the same (i.e., 1/2" or 5/8") fire rated GWB attached to wood studs at 16" o.c.

5.3.3.2.2.2. All of the GWB connection details to the wood studs are equal to or better than the tested assembly. In this case, the GWB will need a finish rating greater than 20.4 minutes.

5.3.3.2.2.3. The installation of all other components are as tested (or more conservatively applied) in an assembly with a finish rating equal to or greater than 20.4 minutes per the existing *ASTM E119* test data as defined in the UL assembly description.

5.3.3.2.3. Use the times assigned to the protective membrane in the CAM for fire resistance ratings of wood wall and floor assemblies.

5.3.3.2.3.1. The times for the membranes are from the membrane table of the component additive method in *IBC Table 722.6.2(1)*.²³ For 5/8" Type X; the time is 40 minutes. The membrane rating this time is based on the 19- to 27-minute range per the *ASTM E119* testing that has been performed using 5/8" Type X gypsum.

5.3.3.2.3.2. In the component additive method, the membrane times are added to the times for "2×4" studs, 16" o.c., which is defined as 20 minutes per *IBC Table 722.6.2(2)*²⁴ in *Section 5.3.2.3.2*.

5.3.3.2.3.3. These times for the membranes are based on full-scale *ASTM E119* tests of wall and floor assemblies.

5.3.3.2.3.4. Given this, if a tested assembly has a membrane finish rating of 20.4 minutes or greater, "substitution of the components on the opposite side of this gypsum wallboard membrane can be made into a new composite assembly."²²

5.3.3.2.3.4.1. The reason for this is the assembly performed for at least 39.6 minutes after the finish rating was reached. The higher the finish rating, the longer the GWB protects the structural framing behind it and the better the assembly performance should be because of the greater protection and reduced charring of the studs.

²² Ibid.

²³ *2012 IBC Table 721.6.2(1)*

²⁴ *2012 IBC Table 722.6.2(2)*

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5.4. Assembly Fire Endurance Performance Enhancements

- 5.4.1. The following additional enhancements can be made that will provide a one-hour rated assembly as well.
- 5.4.2. Harmathy states that the fire endurance of constructions containing continuous air gaps or cavities is greater than the fire endurance of similar constructions of the same weight, but containing no air gaps or cavities.²⁵ The validity of this rule rests on the fact that the insertion of voids produces an additional resistance to the path of heat flow, much like a storm window. For example, the addition of resilient channels between the studs or between GWB layers will enhance the hourly rating of any of the tabulated assemblies above. This serves the following functions:
 - 5.4.2.1. It creates a continuous air space that will enhance the fire performance of the membrane system and forms dead air space that is insulating.
 - 5.4.2.2. Attaching the resilient channel over any first layer of gypsum provides additional support for, and therefore enhances the stability of, the first layer of GWB. This will aid in keeping the layer of gypsum in place, resulting in better assembly fire performance.
 - 5.4.2.3. The addition of resilient channels will enhance the hourly rating of any of the tabulated assemblies.
- 5.4.3. Harmathy states that the fire endurance of constructions containing multiple layers of identical material will provide fire resistance that is greater than the sum of the individual layers. The validity of the rule is seen in [IBC Table 722.6.2\(1\)](#)²⁶ for ½" GWB and double ½" GWB.
 - 5.4.3.1. The addition of another GWB layer will enhance the hourly rating of any of the tabulated assemblies above.

6. Installation:

- 6.1. Installation shall comply with the manufacturer's installation instructions and this TER. In the event of a conflict between the manufacturer's installation instructions and this TER, the more restrictive shall govern.
- 6.2. Fire Endurance Assembly Details
 - 6.2.1. The assembly shall be constructed using the more restrictive of:
 - 6.2.1.1. ASTM E119 tested assembly specifications defined in [Section 5.2](#), and/or
 - 6.2.1.2. Specifications defined in [Table 1](#), and/or
 - 6.2.1.3. Specifications defined in the UL Directory (e.g., UL assembly U356)
- 6.3. Structural Applications
 - 6.3.1. STYROFOAM SIS™ and STYROFOAM SIS™ Plus may be installed in either the vertical or horizontal orientation on wood studs with all joints backed by studs, plates or blocks.
 - 6.3.2. Sheathing joints may be butted together.
 - 6.3.3. Butt joints shall be placed over framing members and fastened with a single row of fasteners at each panel edge and shall be installed with a small gap (1/16" to 1/8") between panels.

7. Test and Engineering Substantiating Data:

- 7.1. Evaluation and analysis of ASTM E119 testing conducted by the Building Research Laboratory at Ohio State University by Dr. Richard Bletzacker of Richard W. Bletzacker & Associates Inc.
- 7.2. Harmathy, T.Z., 1965, "Ten Rules of Fire Endurance Ratings," Fire Technology, 1(2), pp. 93-102.
- 7.3. American Wood Council, 2014, "The Component Additive Method (CAM) for Calculating and Demonstrating Assembly Fire Resistance," American Wood Council, Leesburg, VA.
- 7.4. Gypsum Association, 2009, "Fire Resistance and Sound Control Design Manual," Gypsum Association, Hyattsville, MD.

²⁵ Harmathy, *loc. cit.*

²⁶ [2012 IBC Table 721.6.2\(1\)](#)

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- 7.5. Underwriter Laboratories Fire-Resistance Ratings – ANSI/UL 263
- 7.6. White, Robert H., 2009, “Fire Resistance of Wood Members with Directly Applied Protection,” *Proceedings of the Fire and Materials 2009 Conference*, U.S. Forest Service, Forest Products Laboratory, San Francisco, CA. *FM Approvals – Approval Guide*, Specification Tested Products, January 2008.
- 7.7. *Guidelines for determining Fire Resistance Ratings of Building Elements*, BOCA International, May 1994, pg. 52, Section 7.2.3
- 7.8. The product(s) evaluated by this TER falls within the scope of one or more of the model, state or local building codes for building construction. The testing and/or substantiating data used in this TER is limited to buildings, structures, building elements, construction materials and civil engineering related specifically to buildings.
- 7.9. The provisions of model, state or local building codes for building construction do not intend to prevent the installation of any material or to prohibit any design or method of construction. Alternatives shall use consensus standards, performance-based design methods or other engineered alternative means of compliance. This TER assesses compliance with defined standards, generally accepted engineering analysis, performance-based design methods, etc. in the context of the pertinent building code requirements.
- 7.10. Some information contained herein is the result of testing and/or data analysis by other sources, which DrJ relies on to be accurate as it undertakes its engineering analysis.
- 7.11. DrJ has reviewed and found the data provided by other professional sources are credible. This information has been approved in accordance with DrJ's procedure for acceptance of data from approved sources.
- 7.12. DrJ's responsibility for data provided by approved sources is in accordance with professional engineering law.
- 7.13. Where appropriate, DrJ relies on the derivation of design values, which have been codified into law through codes and standards (e.g., *IRC*, *WFCM*, *IBC*, *SDPWS*, etc.). This includes review of code provisions and any related test data that helps with comparative analysis or provides support for equivalency to an intended end-use application.

8. Findings:

- 8.1. The use of vinyl siding will not affect the one-hour fire resistance rating of the STYROFOAM SIS™ and SIS™ Plus wall assembly.
- 8.2. The assembly as described in [Table 1](#) is an accurate assessment of fire endurance performance for the STYROFOAM SIS™ and SIS™ Plus wall assembly.
- 8.3. [IBC Section 104.11](#) and [IRC Section R104.11](#) ([IFC Section 104.9](#) is similar) state:

104.11 Alternative materials, design and methods of construction and equipment. The provisions of this code are not intended to prevent the installation of any material or to prohibit any design or method of construction not specifically prescribed by this code, provided that any such alternative has been *approved*. An alternative material, design or method of construction shall be *approved* where the *building official* finds that the proposed design is satisfactory and complies with the intent of the provisions of this code, and that the material, method or work offered is, for the purpose intended, at least the equivalent of that prescribed in this code. ... Where the alternative material, design or method of construction is not *approved*, the *building official* shall respond in writing, stating the reasons the alternative was not *approved*.²⁷
- 8.4. This product has been evaluated with the codes listed in [Section 2](#), and is compliant with all known state and local building codes. Where there are known variations in state or local codes that are applicable to this evaluation, they are listed here:
 - 8.4.1. No known variations
- 8.5. This TER uses professional engineering law, the building code, ANSI/ASTM consensus standards and generally accepted engineering practice as its criteria for all testing and engineering analysis. DrJ's professional engineering work falls under the jurisdiction of each state Board of Professional Engineers, when signed and sealed.

²⁷ The last sentence is adopted language in the 2015 codes.

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9. Conditions of Use:

- 9.1. The STYROFOAM SIS™ and STYROFOAM SIS™ Plus Structural Insulated Sheathing described in this TER comply with, or are suitable alternatives to, the applicable fire endurance assembly sections of the *IBC* and *IRC*, as listed in [Section 2](#) of this TER, and are subject to the following conditions:
 - 9.1.1. The STYROFOAM SIS™ and STYROFOAM SIS™ Plus Structural Insulated Sheathing shall be used in accordance with [TER No. 0804-01](#).
 - 9.1.2. These products are not recommended as a structural nailing base for claddings.
 - 9.1.3. In areas where the probability of termite infestation is very heavy, in accordance with [IBC Section 2603.9](#) or [IRC Section R318.4](#), these products must not be placed on exterior walls located within 6" (152 mm) of the ground.
- 9.2. Where required by the authority having jurisdiction (AHJ) in which the project is to be constructed, this report and the installation instructions shall be submitted at the time of permit application.
- 9.3. Any generally accepted engineering calculations needed to show compliance with this TER shall be submitted to the code official for review and approval.
- 9.4. Design loads shall be determined in accordance with the building code adopted by the jurisdiction in which the project is to be constructed.
- 9.5. Design
 - 9.5.1. Building Designer Responsibility
 - 9.5.1.1. Unless the AHJ allows otherwise, the Construction Documents shall be prepared by a Building Designer (e.g., Owner, Registered Design Professional, etc.) for the Building and shall be in accordance with [IRC Section R106](#) and [IBC Section 107](#).
 - 9.5.1.2. The Construction Documents shall be accurate and reliable and shall provide the location, direction and magnitude of all applied loads and shall be in accordance with [IRC Section R301](#) and [IBC Section 1603](#).
 - 9.5.2. Construction Documents
 - 9.5.2.1. Construction Documents shall be submitted to the Building Official for approval and shall contain the plans, specifications and details needed for the Building Official to approve such documents.
- 9.6. Responsibilities
 - 9.6.1. The information contained herein is a product, engineering or building code compliance technical evaluation report performed in accordance with the referenced building codes, testing and/or analysis through the use of accepted engineering procedures, experience and technical judgment.
 - 9.6.2. DrJ technical evaluation reports provide an assessment of only those attributes specifically addressed in the Products Evaluated or Code Compliance Process Evaluated section.
 - 9.6.3. The engineering evaluation was performed on the dates provided in this TER, within DrJ's professional scope of work.
 - 9.6.4. This product is manufactured under a third-party quality control program in accordance with [IRC Section R104.4](#) and [R109.2](#) and [IBC Section 104.4](#) and [110.4](#).
 - 9.6.5. The actual design, suitability and use of this TER for any particular building is the responsibility of the Owner or the Owner's authorized agent, and this TER shall be reviewed for code compliance by the Building Official.
 - 9.6.6. The use of this TER is dependent on the manufacturer's in-plant QC, the ISO/IEC 17020 third-party inspection process, proper installation per the manufacturer's instructions, the Building Official's inspection and any other code requirements that may apply to assure accurate compliance with the applicable building code.

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10. Identification:

- 10.1.** All STYROFOAM SIS™ and STYROFOAM SIS™ Plus boards described in this TER are identified by a label on the board or packaging material bearing the manufacturer's name, product name, label of the third-party inspection agency, and other information to confirm code compliance.
- 10.2.** Additional technical information can be found at www.oxengineeredproducts.com.

11. Review Schedule:

- 11.1.** This TER is subject to periodic review and revision. For the most recent version of this TER, visit drjengineering.org.
- 11.2.** For information on the current status of this TER, contact DrJ Engineering.



- [Mission and Professional Responsibilities](#)
- [Product Evaluation Policies](#)
- [Product Approval – Building Code, Administrative Law and P.E. Law](#)

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Appendix A:

UL U356 Gypsum Wallboard Manufacturers with Finish Ratings over 21 Minutes

1. Wood Studs — Nom 2 by 4 in. spaced 16 in. OC with two 2 by 4 in. top and one 2 by 4 in. bottom plates. Studs laterally-braced by wood structural panel sheathing (Item 5).

When Mineral and Fiber Boards* (Item 5A) are considered as bracing for the studs, the load is restricted to 76% of allowable axial load. Walls effectively fire stopped at top and bottom of wall.

2. Gypsum Board* — Nom 5/8 in. thick, 4 ft. wide, applied vertically and nailed to studs and bearing plates 7 in. OC with 6d cement-coated nails, 1-7/8 in. long with 1/4 in. diam head. Finish Rating is 23 minutes.

Any UL Classified Gypsum Board that is eligible for use in Design Nos. L501, G512 or U305. See **Gypsum Board** (CKNX) Category for names of Classified companies.

2A. Gypsum Board* — (As an alternate to Item 2, not shown) - Any 5/8 in. thick 4 ft. wide gypsum panels that are eligible for use in Design Nos. L501, G512 or U305, supplied by the Classified Companies listed below shown in the **Gypsum Board*** (CKNX) category. Applied vertically and attached to studs and bearing plates with 1-1/4 in. long Type W coarse thread gypsum panel steel screws spaced a max 8 in. OC, with last screw 1 in. from edge of board. Finish Rating is 23 minutes.

CGC INC

UNITED STATES GYPSUM CO

USG MEXICO S.A. DE C.V.

2B. Gypsum Board* — (As an alternate to Item 2, not shown) - 5/8 in. thick 4 ft. wide gypsum panels applied vertically and attached to studs and bearing plates with 1-1/4 in. long Type W coarse thread gypsum panel steel screws spaced a max 8 in. OC, with last screw 1 in. from edge of board. Finish Rating is 23 minutes.

AMERICAN GYPSUM CO — Types AGX-1, M-Glass, AG-C

CERTAINTED GYPSUM INC — ProRoc Type C or ProRoc Type X

CERTAINTED GYPSUM CANADA INC — ProRoc Type C or ProRoc Type X

PABCO BUILDING PRODUCTS LLC, DBA PABCO GYPSUM — Type PG-11

TEMPLE-INLAND — Types X, Veneer Plaster Base-Type X, Water Rated-Type X, Sheathing Type-X, Soffit-Type X, Type X ComfortGuard Sound Deadening Gypsum Board.

2C. Gypsum Board* — (As an alternate to Item 2, not shown) - For Use with Item 5A only - 5/8 in. thick 4 ft. wide gypsum panels applied horizontally and attached to studs and bearing plates with 1-1/4 in. long Type W coarse thread gypsum panel steel screws spaced a max 8 in. OC, with last screws 1 in. and 4 in. from edges of board. Finish Rating is 25 min.

PABCO BUILDING PRODUCTS LLC, DBA PABCO GYPSUM — Type PG-11

TEMPLE-INLAND — Type X, Veneer Plaster Base-Type X, Water Rated-Type X, Sheathing Type-X Soffit-Type X

2D. Gypsum Board* — (As an alternate to Item 2) - Not to be used with item 7. 5/8 in. thick, 4 ft. wide, paper surfaced, applied vertically only and fastened to the studs and plates with 6d cement coated nails 1-7/8 in. long, 0.0915 in. shank diam and 1/4 in. diam heads, 7 in. OC. Finish Rating is 23 minutes.

NATIONAL GYPSUM CO — SoundBreak XP Type X Gypsum Board

2E. Wall and Partition Facings and Accessories* — (As an alternate to Items 2 through 2D) — Nominal 5/8 in. thick, 4 ft. wide panels, secured as described in Item 2. Finish Rating is 23 minutes.

SERIOUS ENERGY INC — Type QuietRock ES, Type QuietRock QR-527.

2F. Gypsum Board* — (As an alternate to Item 2) - Not to be used with item 7. 5/8 in. thick, 4 ft. wide, paper surfaced, applied vertically only and fastened to the studs and plates with 6d cement coated nails 1-7/8 in. long, 0.0915 in. shank diam and 1/4 in. diam heads, 7 in. OC. Finish Rating is 23 minutes.

CERTAINTED GYPSUM INC — Type SilentFX

3. Joints and Nailheads — (Not Shown) — Wallboard joints covered with tape and joint compound. Nail heads covered with joint compound.

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4. Batts and Blankets* — Mineral fiber or glass fiber insulation, 3-1/2 in. thick, pressure fit to fill wall cavities between studs and plates. Mineral fiber insulation to be unfaced and to have a min density of 3 pcf. Glass fiber insulation to be faced with aluminum foil or kraft paper and to have a min density of 0.9 pcf (min R-13 thermal insulation rating).

See **Batts and Blankets*** (BKNV) Category in the Building Materials Directory and **Batts and Blankets***(BZJZ) Category in the Fire Resistance Directory for names of Classified Companies.

4A. Fiber, Sprayed* — As an alternate to Batts and Blankets (Item 4) — Spray applied cellulose material. The fiber is applied with water to completely fill the enclosed cavity in accordance with the application instructions supplied with the product. Nominal dry density of 3.0 lb/ft³. Alternate application method: The fiber is applied with U.S. Greenfiber LLC Type AD100 hot melt adhesive at a nominal ratio of one part adhesive to 6.6 parts fiber to completely fill the enclosed cavity in accordance with the application instructions supplied with the product. Nominal dry density of 2.5 lb/ft³.

US GREENFIBER LLC — Cocoon2 Stabilized or Cocoon-FRM (Fire Rated Material)

4B. Fiber, Sprayed* — As an alternate to Item 4 and 4A — Spray applied cellulose material. The fiber is applied with water to completely fill the enclosed cavity in accordance with the application instructions supplied with the product. Nominal dry density of 4.58 lb/ft³.

NU-WOOL CO INC — Cellulose Insulation

4C. Fiber, Sprayed* — As an alternate to Batts and Blankets (Item 4) - Spray applied cellulose fiber. The fiber is applied with water to completely fill the enclosed cavity in accordance with the application instructions supplied with the product. The minimum dry density shall be 4.30 lb/ft³.

INTERNATIONAL CELLULOSE CORP — Celbar-RL

5. Wood Structural Panel Sheathing — Min 7/16 in. thick, 4 ft wide wood structural panels, min grade "C-D" or "Sheathing". Installed with long dimension of sheet (strength axis) or face grain of plywood parallel with or perpendicular to studs. Vertical joints centered on studs. Horizontal joints backed with nom 2 by 4 in. wood blocking. Attached to studs on exterior side of wall with 6d cement coated box nails spaced 6 in. OC at perimeter of panels and 12 in. OC along interior studs.

5A. Mineral and Fiber Boards* — As an alternate to Item 5 - Min 1/2 in. thick, 4 ft wide sheathing, installed vertically to studs. Vertical joints centered on studs. Horizontal joints backed with nom 2 by 4 in. wood blocking. Attached to studs on exterior side of wall with 1-1/2 in. long galvanized roofing nails spaced 6 in. OC at perimeter of panels and 12 in. OC along interior studs. As an option a weather resistive barrier may be applied over the Mineral and Fiber Boards.

TEMPLE-INLAND FOREST PRODUCTS CORP — Types FiberBrace or QuietBrace

5B. STYROFOAM SIS™ and STYROFOAM SIS™ Plus — As an alternate to Item 5 per the IBC Section 703.3, gypsum wallboard finish rating from ASTM E119 testing and the IBC Chapter 721.6/722.6 calculations. (For more information, see TER No. 0804-01 and No. 1109-01.)

6. Exterior Facings — Installed in accordance with the manufacturer's installation instructions. One of the following exterior facings is to be applied over the sheathing:

A. Vinyl Siding — Molded Plastic* — Contoured rigid vinyl siding having a flame spread value of 20 or less. See Molded Plastic (BTAT) category in the Building Materials Directory for names of manufacturers.

B. Particle Board Siding — Hardboard exterior sidings including patterned panel or lap siding.

C. Wood Structural Panel or Lap Siding — APA Rated Siding, Exterior, plywood, OSB or composite panels with veneer faces and structural wood core, per PS 1 or APA Standard PRP-108, including textured, rough sawn, medium density overlay, brushed, grooved and lap siding.

D. Cementitious Stucco — Portland cement or synthetic stucco systems with self-furring metal lath or adhesive base coat. Thickness from 3/8 to 3/4 in., depending on system.

E. Brick Veneer — Any type on nom 4 in. wide brick veneer. When brick veneer is used, the rating is applicable with exposure on either face. Brick veneer fastened with corrugated metal wall ties attached over sheathing to wood studs with 8d nail per tie: ties spaced not more than each sixth course of brick and max 32 in. OC horizontally. One in. air space provided between brick veneer and sheathing.

F. Exterior Insulation and Finish System (EIFS) — Nom 1 in. Foamed Plastic* insulation bearing the UL Classification Marking, attached over sheathing and finished with coating system, or Portland cement or synthetic stucco systems, in accordance with manufacturer's instructions. See **Foamed Plastic** (BRYX and CCVW) categories for names of Classified companies.

G. Siding — Aluminum or steel siding attached over sheathing to studs.

H. Fiber-Cement Siding — Fiber-cement exterior sidings including smooth and patterned panel or lap siding.