Technical Evaluation Report

TO ASSIST WITH CODE COMPLIANCE

UL U356 One-Hour Fire-Resistance Rated, Limited Load Bearing Wall Assemblies for Thermo-Ply® Red & Blue Protective Sheathing Using *IBC* Section 722 Calculation Method (Exposed to Fire on Interior Face Only)

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Section: 06 12 00 – Structural Panels
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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. Thermo-Ply® Protective Sheathing:

1.1.1. Thermo-Ply® (Red) Protective Sheathing (structural)

1.1.2. Thermo-Ply® (Blue) Protective Sheathing (structural)

1.2. For the most recent version of this report, visit drjengineering.org.

2. Applicable Codes and Standards:[1]

2.1. *2006, 2009* and *2012 International Building Code* (*IBC*)

2.2. *2006, 2009* and *2012 International Residential Code* (*IRC*)

[1] Unless otherwise noted, code references are from the 2012 versions of the codes. This product is also approved for use with the 2000 and 2003 versions of the *IBC* and *IRC* and the standards referenced therein.

The *IBC* defines:

- APPROVED SOURCE – "An independent person, firm or corporation, *approved* by the *building official*, who is competent and experienced in the application of engineering principles to materials, methods or systems analyses."

DrJ's building construction professionals meet the competency requirements as defined in the *IBC* and can seal their work. DrJ is regularly engaged in conducting and providing engineering evaluations of single-element and full-scale building systems tests. This TER is developed from test reports complying with *IBC* Section 104.11.1 Research reports, which states, "Supporting data, where necessary to assist in the approval of materials or assemblies not specifically provided for in this code, shall consist of valid research reports from *approved* sources."

3. Performance Evaluation:

3.1. Performance as a component element of limited load bearing one-hour rated wall assemblies.

3.2. For other sheathing performance characteristics that may be used in an exterior wall assembly, see TER No. 1004-01: *Thermo-Ply® Protective Sheathing.*

4. Product Description and Materials:

4.1. Thermo-Ply® Protective Sheathing panels are composed of pressure laminated plies consisting of high-strength cellulosic fibers. These fibers are specially treated to be water resistant and are bonded with a proprietary water-resistive adhesive. Polymer facings are applied on both sides of the sheathing panels.

4.1.1. Facings may also be aluminum foil or a kraft/polymer/kraft laminate.

4.1.2. The panels are manufactured in three thicknesses:

4.1.2.1. Thermo-Ply® (Red) Protective Sheathing panels have a typical thickness of 0.113" +/- 0.005" and weigh 0.414 lbs +/- 0.020 lbs per square foot.

4.1.2.2. Thermo-Ply® (Blue) Protective Sheathing panels have a typical thickness of 0.135" +/- 0.006" and weigh 0.504 lbs +/- 0.025 lbs per square foot.

4.2. Material Availability:

4.2.1. Thicknesses range from 0.078" (1.98 mm) to 0.135" (3.42 mm).

4.2.2. Standard widths include 48" (1,219 mm) and 48 3/4" (1,238 mm).

4.2.3. Standard lengths include 96" (2,438 mm), 108" (2,743 mm) and 120" (3,048 mm).

4.2.4. Custom widths and lengths are available.

5. Applications:

5.1. Fire Endurance Assemblies

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 gypsum wallboard (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.

5.1.2. The key structural sheathing component for the wall assembly's exterior sheathing was Thermo-Ply® (Red) Protective Sheathing.

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 for the *2006* and *2009 IBC* Section 721 and *2012 IBC* Section 722 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 Thermo-Ply® (Blue) Protective Sheathing 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

[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.

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:

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 722.6	GWB Manufacturer	GWB Fastener & Fastener Spacing	Exterior Side of Assembly Only Thermo-Ply® Red or Blue 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, in Minutes	Total Fire Endurance Performance of UL U356 Assembly as Defined, in Minutes
UL U356 Exterior Side Thermo-Ply® Red or Blue 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 manufacturers of 5/8" Fire Rated GWB that can be applied to achieve a Finish Rating of 20.4 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 Attached using 1 1/4" long roofing nails spaced 3" o.c. around the perimeter of each sheet and 6" o.c. on the intermediate studs or 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 per SBCRI testing.	Min SPF studs spaced at a maximum of 16" o.c.	1,350 plf @ a maximum 8' wall height 885 plf @ 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 Thermo-Ply® Red or Blue 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
See Appendix A for assembly details and material descriptions.

5.2. Justification of the One-Hour Fire Endurance Assembly Rating Pursuant to the Use of the Fire Endurance Calculation Methods Defined in Section 721.6 of the *2006* and *2009 IBC* (Section 722.6 in the *2012 IBC*) and Data from UL Fire Assembly Hourly Ratings Found in the UL Directory:

5.2.1. 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.

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 had a fire endurance performance of 65 minutes and had a finish rating for the 5/8" Type X gypsum wallboard (GWB) membrane of 19.9 minutes.

5.2.2.2. The worst-case finish rating for the 5/8" Type X GWB membrane of Test 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.

5.2.3. 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 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 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 3-5/8"-thick by 15-1/4"-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 Thermo-Ply® Protective Sheathing. The sheathing was supplied in by 4'-wide by 8'-long sheets. The structural sheathing was a minimum of 0.113" thick, and it was attached to the unexposed side of the studs and plates with 1-1/4"-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 the sheathing were 1 1/4"-long 11 ga galvanized roofing nails with 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 1/2"-crown by 1 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 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 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 1/2 ga annular ringed GWB nails with 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 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 1/4"-long 12 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.

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 721 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.[3]

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.[4]

5.3.1.3.2. Section 721.6 of the *2006* and *2009 IBC* (Section 722.6 per the *2012 IBC*) 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]

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 are

[3] All fire endurance performance calculation concepts in this evaluation use the *Guidelines for determining Fireresistance 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.

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

[5] *2006*, *2009* and *2012 International Building Code* (*IBC*)

used extensively in this report.[6]

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 L538[7].

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 director 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)[8].

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 ($^5/_8$" 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*[9]

5.3.1.5.4. UL directory[10]

5.3.1.5.5. CAM principles for wall assemblies as used in Section 721 (*2012 IBC* Section 722) of the *IBC*.

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 721.6.2.2 Time assigned to membranes states, "Table 721.6.2(1) indicates the time assigned to membranes on the fire-exposed side."

[6] T.Z. Harmathy, "Ten Rules of Fire Endurance Rating," *Fire Technology*, 1(2), May 1965, pp. 93-102.
[7] http://database.ul.com/cgi-bin/XYV/template/LISEXT/1FRAME/showpage.html?name=BXUV.L538&ccnshorttitle=Fire+Resistance+Ratings+-+ANSI/UL+263&objid=1074328137&cfgid=1073741824&version=versionless&parent_id=1073984818&sequence=1
[8] www.awc.org/publications/dca/dca4/dca4.pdf
[9] www.gypsum.org/pdf/GA-600-09_Print_7_Megs.pdf
[10] General Information for Fire Resistance Ratings – ANSI/UL 263

TABLE 721.6.2(1)
TIME ASSIGNED TO WALLBOARD MEMBRANES[a, b, c, d]

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

For SI: 1 inch = 25.4 mm.

a. These values apply only when membranes are installed on framing members which are spaced 16 inches o.c.

b. Gypsum wallboard installed over framing or furring shall be installed so that all edges are supported, except 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.

c. 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.

d. The membrane on the unexposed side shall not be included in determining the fire resistance of the assembly. When dissimilar membranes are used on a wall assembly, the calculation shall be made from the least fire-resistant (weaker) side.

e. The time assigned is not a finished rating.

5.3.2.3.1.1. 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."

5.3.2.3.1.2. For example:

5.3.2.3.1.2.1. In Table 721.6.2(1), a single layer of 1/2" GWB yields a membrane rating of 15 minutes.

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

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

5.3.2.3.2. *IBC* Section 721.6.2.3 Exterior walls states, "For an exterior wall with a fire separation distance greater than 5 feet (1524 mm), the wall is assigned a rating dependent on the interior membrane and the framing as described in Tables 721.6.2(1) and 721.6.2(2)."

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 721.6.2.5 Additional protection states, "Table 721.6.2(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/m^3.

5.3.2.3.4. *IBC* Section 721.6.2.6 Fastening states, "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 Procedures[11]

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.

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." [12]

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." [13]

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." [14]

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)."[15]

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., ½" 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.

5.3.3.2.2.3. In this case, the GWB will need a finish rating greater than 20.4 minutes.

5.3.3.2.2.3.1. A longer finish rating is viewed as the worst case when using two tests because the GWB has to keep the temperature in the

[11] 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.
[12] Ibid.
[13] Ibid.
[14] Ibid.
[15] Ibid.

plenum space lower for longer in order for the overall assembly to meet the hourly rating that it has been tested to and assigned.

5.3.3.2.2.3.2. In this case, one test yielded a 19.9 minute finish rating for the GWB and the other 20.4 minutes.

5.3.3.2.2.4. 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 721.6.2(1).

5.3.3.2.3.1.1. For $^{5}/_{8}$" Type X; the time is 40 minutes.

5.3.3.2.3.1.2. The finish rating this membrane time is based on is in the 19 to 27 minute range per the ASTM E119 testing that has been performed using $^{5}/_{8}$" Type X gypsum.

5.3.3.2.3.1.3. Therefore, the membrane rating is roughly double the finish rating time as defined by ASTM E119 testing.

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 721.6.2(2) in Section 5.3.2.3.2.

5.3.3.2.3.3. These times for the membranes are based on full-scale ASTM E 119 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."[16]

5.3.3.2.3.4.1. The reason for this is the studs held their load carrying capacity as part of this assembly for at least 39.6 minutes after the finish rating was reached.

5.3.3.2.3.4.2. The higher the finish rating, the longer the GWB protects the structural framing behind it.

5.3.3.2.3.4.3. This means that the GWB finish rating performance is critical to the assembly performance and the 20.4 minutes is a minimum value.

5.3.3.2.3.4.4. Longer GWB or other sheathing types finish rating times are better, shorter times cannot be used, given an assembly's tested performance provides a finish rating calculation basis.

5.3.3.2.3.4.5. Longer GWB finish rating times, when compared to the tested finish rating time, yield better assembly performance because of the greater fire protection provided and reduced charring of the studs.

[16] Ibid.

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.[17] 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 an air space layer 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 longer, 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 above.

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 721.6.2(1) 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. Fire Endurance Assembly Details

6.1.1. The assembly shall be constructed using the more restrictive of:

6.1.1.1. ASTM E119 tested assembly specifications defined in Section 5.2, and/or

6.1.1.2. Specifications defined in Table 1, and/or

6.1.1.3. Specifications defined in the UL Directory (e.g., UL assembly U356) as found in Appendix A.

6.2. Structural Applications

6.2.1. Thermo-Ply® Protective Sheathing may be installed in either the vertical or horizontal orientation on wood studs with all joints backed by studs, plates or blocks.

6.2.2. Sheathing joints may be either butted or overlapped.

6.2.3. Lapped joints shall be overlapped by at least $^{3}/_{4}$" (19 mm) and fastened with a single row of fasteners

6.2.4. 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 testing, data and reporting of a full-scale fire endurance test and fire and hose stream test of a duplicate limited load bearing unsymmetrical exterior wall assembly conducted by the Building Research Laboratory at Ohio State University by Dr. Richard Bletzacker of Richard W. Bletzacker & Associates Inc., based on ASTM E119, December 1982.

7.2. *FM Approvals – Approval Guide*, Specification Tested Products, January 2008.

7.3. 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.

7.3.1. DrJ does not assume responsibility for the accuracy of data provided by testing facilities, but relies on each testing agency's accuracy and accepted engineering procedures, experience, and good technical judgment.

[17] Harmathy, *loc. cit.*

7.4. Where appropriate, DrJ relies on the derivation of design values, which have been codified into law through the codes and standards (e.g., *IRC*, *WFCM*, *IBC*, *SDPWS*, etc.), to undertake the review of test data that is comparative or shows equivalency to an intended end-use application.

7.4.1. DrJ does not assume responsibility for the accuracy of any code-adopted design values but relies upon their accuracy for engineering evaluation.

7.4.2. DrJ also relies on the fact that manufacturers of code-adopted products stand behind the legally established design values that have been created by the associations that publish code-defined design values for a given commodity product.

7.4.3. DrJ evaluates all equivalency testing and related analysis using this code-defined engineering foundation.

8. Findings:

8.1. *IBC* Section 104.11 and *IRC* Section R104.11 specifically state that:

> 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.

8.2. The use of vinyl siding will not affect the one-hour fire resistance rating of the Thermo-Ply® (Red and Blue) wall assembly.

8.3. The assembly as described in Table 1 is an accurate assessment of fire endurance performance for the Thermo-Ply® (Red and Blue) wall assembly.

9. Conditions of Use:

9.1. Thermo-Ply® (Red and Blue) Protective Sheathing described in this TER comply with, or are suitable alternatives to, the applicable fire endurance assembly sections of the *2006, 2009* and *2012 IBC* and the *2006, 2009* and *2012 IRC*, listed in Section 2 of this TER and are subject to the following conditions:

9.1.1. This TER and the installation instructions, when required by a code official, shall be submitted at the time of permit application.

9.1.2. The Thermo-Ply® (Red and Blue) Protective Sheathing shall be used in accordance with TER 1004-01.

9.1.3. Thermo-Ply® (Red and Blue) Protective Sheathing shall not be used as a structural nailing base for claddings.

9.1.4. In areas where the probability of termite infestation is very heavy, in accordance with *IBC* Section 2603.8 or *IRC* Section R318.4, Thermo-Ply® (Red and Blue) Protective Sheathing must not be placed on exterior walls located within 6" (152 mm) of the ground.

9.2. Design

9.2.1. Building Designer

9.2.1.1. The Construction Documents shall be prepared by a Building Designer for the Building and shall be of sufficient clarity to indicate the location, nature and extent of the work proposed, and show in detail conformance to the building code.

9.2.1.2. The Construction Documents shall provide information sufficiently accurate and reliable to be used for facilitating the supply of Thermo-Ply® Protective Sheathing (structural) Red and Blue and shall provide the following:

9.2.1.2.1. The location, direction and magnitude of all dead, live and lateral loads applicable to Thermo-Ply® Red or Blue and any other loads that are going to be applied to Thermo-Ply® Red or Blue.

9.2.1.2.2. All foundation anchorage designs required to resist uplift, gravity, and lateral loads.

9.2.2. Design loads shall not exceed the allowable loads as defined in this TER.

9.2.3. Construction Documents

9.2.3.1. Construction Documents shall be submitted to the Building Official for approval prior to construction.

9.2.3.2. Construction Documents shall contain the plans, specifications and details needed for the Building Official to approve such documents.

10. Identification:

10.1. Each Thermo-Ply® Protective Sheathing panel described in this TER is 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 oxpaperboard.com/thermo-ply.html.

11. Review Schedule:

11.1. This TER is subject to periodic review and revision. For the most recent version of this report, visit drjengineering.org.

11.2. For information on the current status of this report, contact DrJ.

Responsibility Statement

The information contained herein is a product, engineering or building code compliance research report performed in accordance with the referenced building codes, testing and/or analysis through the use of accepted engineering procedures, experience and good technical judgment. Product, design and code compliance quality control is the responsibility of the referenced company. Consult the referenced company for the proper detailing and application for the intended purpose. Consult your local jurisdiction or design professional to assure compliance with the local building code. DrJ (drjengineering.org) research reports are not to be construed as representing aesthetics or any other attributes not specifically addressed, nor are they to be construed as an endorsement of the subject of the report or a recommendation for its use. There is no warranty by DrJ, express or implied, as to any finding or other matter in this report or as to any product covered by this report.

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

CERTAINTEED GYPSUM INC — ProRoc Type C or ProRoc Type X

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

PABCO BUILDING PRODUCTS L L C, DBA

Design No. U356

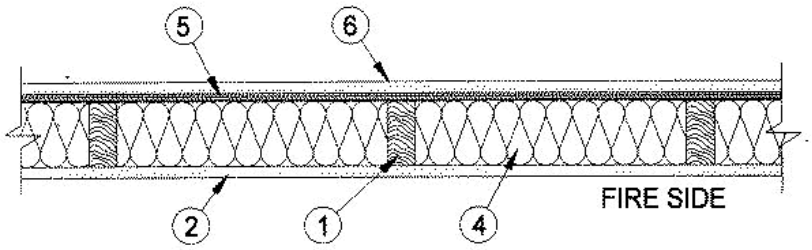
July 13, 2011

(Exposed to Fire on Interior Face Only)

Bearing Wall Rating — 1 Hr

Finish Rating — 23 Min or 25 Min (See Item 2C)

Load Restricted for Canadian Applications — See Guide BXUV7



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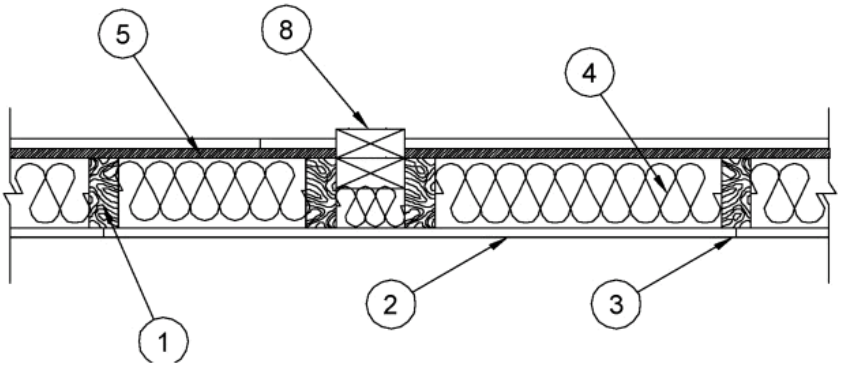

PABCO GYPSUM — Type PG-11

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 L L C, 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.

CERTAINTEED GYPSUM INC — Type SilentFX

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

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/ft^3. 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/ft^3.

U S GREENFIBER L L C — 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/ft^3.

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 lbs/ft^3.

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. Thermo Ply Red and Blue — 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.

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.

Appendix B:
TERs Are Comparable to, Compatible with, and Equivalent to the Purpose of an ICC-ES ESR

1. Technical Evaluation Reports (TERs), drafted and maintained by DrJ (professional engineering firm and ISO/IEC 17065 applicant through ANSI/ACLASS), assess how specific products comply with the provisions of the building code. DrJ is a code-defined "approved source," and DrJ employs professional engineers and follows state professional engineering rules and regulations.

2. TERs are comparable to, compatible with, and equivalent to the purpose of an ICC Evaluation Service (ICC-ES) Evaluation Service Reports (ESRs).[18]

2.1. ICC Evaluation Service does not provide an engineer's seal on any of its ESRs.

2.2. Furthermore, the ICC-ES Evaluation Report Purpose is defined as follows[19]:

ICC EVALUATION SERVICE

www.icc-es.org | (800) 423-6587 | (562) 699-0543 *A Subsidiary of the International Code Council®*

ICC EVALUATION SERVICE, LLC,
RULES OF PROCEDURE FOR EVALUATION REPORTS

1.0 PURPOSE

These rules set forth procedures governing ICC Evaluation Service, LLC (ICC-ES), issuance and maintenance of evaluation reports on building materials and products, methods of construction, prefabricated building components, and prefabricated buildings.

ICC-ES evaluation reports assist those enforcing model codes in determining whether a given subject complies with those codes. An evaluation report is not to be construed as representing a judgment about aesthetics or any other attributes not specifically addressed in the report, nor as an endorsement or recommendation for use of the subject of the report. Approval for use is the prerogative and responsibility of the Code Official; ICC-ES does not intend to assume, nor can ICC-ES assume, that prerogative and responsibility.

2.3. ICC ESR Disclaimer[20]:

ICC-ES Evaluation Reports are not to be construed as representing aesthetics or any other attributes not specifically addressed, nor are they to be construed as an endorsement of the subject of the report or a recommendation for its use. There is no warranty by ICC Evaluation Service, LLC, express or implied, as to any finding or other matter in this report, or as to any product covered by the report.

[18] ICC Evaluation Service, LLC and the ICC-ES Evaluation Reports logo are registered trademarks of ICC-ES.
[19] See the "ICC-ES Rules of Procedure" at www.icc-es.org/pdf/rules_evalrpts.pdf.
[20] Page 1 footer of each ICC-ES report that can be found at www.icc-es.org/reports/index.cfm.

3. DrJ Sealed Engineering

3.1. DrJ engineers have undertaken the rigorous engineering and analysis work to determine the subject of this report's compliance with the codes and standards referenced in Section 2.

3.2. DrJ work:

3.2.1. Complies with accepted engineering procedures, experience and good technical judgment.

3.2.2. Is the work of an independent person, firm or corporation who is competent and experienced in the application of engineering principles to materials, methods or systems analyses.

3.3. A Technical Evaluation Report generated by DrJ is in all "code-compliance-evaluation-processing" respects equivalent to an ICC-ES ESR, as ICC-ES defines its approach, with one material difference.

3.3.1. DrJ will seal all TERs, as needed, so that responsibility for the work is well-defined.

3.3.2. The DrJ responsibility statement is identical to that provided in ICC-ES ESRs.

> DrJ (drjengineering.org) research reports are not to be construed as representing aesthetics or any other attributes not specifically addressed, nor are they to be construed as an endorsement of the subject of the report or a recommendation for its use. There is no warranty by DrJ express or implied as to any finding or other matter in this report or as to any product covered by this report.

Appendix C:
Legal Aspects of Product Approval

1. Product Approval

1.1. In general, the model and local codes provide for the use of alternative materials, designs and methods of construction by having a legal provision that states something similar to:

> The provisions of this code/law 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/law, provided that any such alternative has been approved. An alternative material, design or method of construction shall be approved where the compliance official finds that the proposed design is satisfactory and complies with the intent of the provisions of this code/law, and that the material, design, method or work offered is, for the purpose intended, at least the equivalent of that prescribed in this code/law.

1.2. In concert with preserving "free and unfettered competition as the rule of trade", should this alternative material, design or method of construction not be approved, the building official shall respond in writing, stating the specific reasons for non-code-compliance and/or for non-professional engineering regulation compliance.

> Congress passed the first antitrust law, the Sherman Act, in 1890 as a "comprehensive charter of economic liberty aimed at preserving free and unfettered competition as the rule of trade." In 1914, Congress passed two additional antitrust laws: the Federal Trade Commission Act, which created the FTC, and the Clayton Act. With some revisions, these are the three core federal antitrust laws still in effect today.
>
> …Yet for over 100 years, the antitrust laws have had the same basic objective: to protect the process of competition for the benefit of consumers, making sure there are strong incentives for businesses to operate efficiently, keep prices down, and keep quality up….
>
> The Sherman Act outlaws "every contract, combination, or conspiracy in restraint of trade," and any "monopolization, attempted monopolization, or conspiracy or combination to monopolize." For instance, in some sense, an agreement between two individuals to form a partnership restrains trade, but may not do so unreasonably, and thus may be lawful under the antitrust laws. On the other hand, certain acts are considered so harmful to competition that they are almost always illegal.
>
> The penalties for violating the Sherman Act can be severe. Although most enforcement actions are civil, the Sherman Act is also a criminal law, and individuals and businesses that violate it may be prosecuted by the Department of Justice.[21]

2. Legal Validity of this TER

2.1. This TER is a code-defined (e.g., *2009 IBC* and *IRC* Section 104.11.1 and *2009 IBC* Section 1703.4.2) "research report" that provides supporting data to assist in the approval of materials, designs or assemblies not specifically provided for in this code.

2.2. Therefore, this TER is a valid research report from a professional engineering company that complies with the code definition of "approved source." If required by the authority having jurisdiction, this TER can also be sealed to comply with professional engineering laws and regulations.

[21] http://www.ftc.gov/bc/antitrust/antitrust_laws.shtm