



Research Report

Use of Fire Retardant Treated Wood in the Design of Wall Panels, Roof Trusses and Floor Trusses

DRR No. 1507-12

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Structural Building Components Association

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DIVISION: 06 00 00 – WOOD, PLASTICS, AND COMPOSITES

Section: 06 05 83 – Shop-Applied Wood Coatings

Section: 06 11 00 – Wood Framing

Section: 06 17 00 – Shop-Fabricated Structural Wood

1. Code Compliance Subject:

1.1. Fire retardant treated wood (FRTW) products

1.1.1. Lumber

1.1.2. Structural sheathing

1.2. For the most recent version of this report, 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.

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. ANSI/AWC NDS – National Design Specification (NDS) for Wood Construction

2.4. ANSI/TPI 1 -2014 National Design Standard for Metal Plate Connected Wood Truss Construction

2.5. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials

¹ Unless otherwise noted, all references in this research report 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 research report is not approved, the building official shall respond in writing, stating the reasons this research report was not approved. For variations in state and local codes, if any, see [Section 7](#).

DrJ Research Report

- 2.6. *ASTM D2898 - Standard Practice for Accelerated Weathering of Fire-Retardant-Treated Wood for Fire Testing.*
- 2.7. *ASTM D3201 - Standard Test Method for Hygroscopic Properties of Fire-Retardant Wood and Wood-Based Products*
- 2.8. *ASTM D5516 - Standard Test Method for Evaluating the Flexural Properties of Fire-Retardant Treated Softwood Plywood Exposed to Elevated Temperatures*
- 2.9. *ASTM D5664 - Standard Test Method for Evaluating the Effects of Fire-Retardant Treatments and Elevated Temperatures on Strength Properties of Fire-Retardant Treated Lumber*
- 2.10. *ASTM D6305 - Standard Practice for Calculating Bending Strength Design Adjustment Factors for Fire-Retardant-Treated Plywood Roof Sheathing*
- 2.11. *ASTM D6841 - Standard Practice for Calculating Design Value Treatment Adjustment Factors for Fire-Retardant-Treated Lumber*
- 2.12. *AWPA C20 - Structural Lumber - Fire-Retardant Treatment by Pressure Processes*
- 2.13. *AWPA T1 - Use Category System: Processing and Treatment Standard*
- 2.14. *AWPA U1 - Use Category System: User Specification for Treated Wood*
- 2.15. *UL 723 - Tests for Surface Burning Characteristics of Building Materials*

3. Evaluation Scope:

- 3.1. Code compliance requirements of fire retardant treated wood (FRTW) products have been evaluated with respect to current codes and standards where they are used in the manufacture of wall panels and metal plate connected roof and floor trusses. This evaluation is limited to FRTW use in wall panels, roof and floor trusses and considers the following code compliance issues:
 - 3.1.1. Structural performance and durability of FRTW in above ground exterior and interior applications.
 - 3.1.2. Requirements for metal connector plates when FRTW is used in the manufacture of trusses and wall panels.
 - 3.1.3. Fastener requirements for use with FRTW, other than metal connector plates.
- 3.2. Any code compliance issues not specifically addressed in this section are outside the scope of this evaluation.

4. Applications:

4.1. General Requirements

- 4.1.1. This research report provides guidance on the use of FRTW products in trusses and wall panels in above ground applications where allowed by code.
- 4.1.2. All truss and wall assembly components shall be approved, installed, and inspected in accordance with the applicable building code, approved construction documents, manufacturer installation instructions, and good practice.

4.2. Terminology

- 4.2.1. **Fire-retardant-treated wood (FRTW)** - Wood products that, when impregnated with chemicals by a pressure process or other means during manufacture, exhibit reduced surface-burning characteristics and resist propagation of fire.
- 4.2.2. **Treated Wood** – Wood products that are conditioned to enhance fire-retardant or preservative properties.

5. Code Compliance

5.1. Allowable Uses

- 5.1.1. The *IBC* distinguishes several construction types based on the required combustibility level of the building materials used. [IBC Chapter 6](#) details how FRTW products can be included in each building type.

DrJ Research Report

- 5.1.2. Types I and II construction have the strictest fire resistance requirements; buildings must be built with non-combustible materials in both the exterior and interior walls. Although FRTW products are not considered non-combustible, [IBC Section 603.1](#) includes a provision for FRTW to be used in several locations in Type I and II construction:

603.1 Allowable materials. Combustible materials shall be permitted in buildings of Type I or II construction in the following applications and in accordance with Sections 603.1.1 through 603.1.3:

1. Fire-retardant-treated wood shall be permitted in:

- 1.1. Nonbearing partitions where the required fire-resistance rating is 2 hours or less.
- 1.2. Nonbearing exterior walls where fire-resistance rated construction is not required.
- 1.3. Roof construction, including girders, trusses, framing and decking.

Exception: In buildings of Type IA construction exceeding two stories above grade plane, fire-retardant-treated wood is not permitted in roof construction when the vertical distance from the upper floor to the roof is less than 20 feet (6096 mm).

- 5.1.3. Type III construction requires exterior walls to be of noncombustible materials, but provides that FRTW framing complying with [IBC Section 2303.2](#) is permitted within exterior wall assemblies of a 2-hour rating or less. ([IBC Section 602.3](#))
- 5.1.4. Type IV construction (Heavy Timber) requires exterior walls to be of noncombustible materials, but like Type III, FRTW framing is permitted within exterior walls of 2-hour rating or less.
- 5.1.5. Type V construction allows both exterior and interior walls to be of any materials permitted by code.

5.2. Treatment

- 5.2.1. [IBC Section 2303.2.1-4](#) and [IRC Section R802.1.3.1-4](#) give identical guidelines on the treatment process, testing (where required), and labeling of FRTW products. [IBC Section 2303.2](#) and [IRC Section R802.1.3](#) both describe FRTW as:

2303.2 Fire-retardant-treated wood Fire-retardant-treated-wood is any wood product which, when impregnated with chemicals by a pressure process or other means during manufacture, shall have, when tested in accordance with ASTM E 84 or UL 723, a listed flame spread index of 25 or less and show no evidence of significant progressive combustion when the test is continued for an additional 20-minute period. Additionally, the flame front shall not progress more than 10 ½ feet (3200 mm) beyond the centerline of the burners at any time during the test.

- 5.2.1.1. There are three methods of compliance with this section.

5.2.1.1.1. One method states that the FRTW may be treated using a pressure process, as described in [IBC Section 2303.2.1](#) and [IRC Section R802.1.3.1](#).

5.2.1.1.2. A second method states that wood products treated in other ways are allowable, so long as the treatment is “an integral part of the manufacturing process of the wood product” and provides “permanent protection to all surfaces of the wood product” ([IBC Section 2303.2.2](#) / [IRC Section R802.1.3.2](#)). Also, wood products treated by means other than a pressure process, must be tested on all sides as described in [IBC Section 2303.2](#) / [IRC Section R802.1.3](#) and meet the same performance requirements as wood treated by a pressure process.

5.2.1.1.3. A third way of meeting the requirement is via an alternate material, in accordance with the alternative means and methods provision of [IBC Section 104.11](#), provided the product meets the same performance requirements as FRTW. An alternative product would not be FRTW by definition (not impregnated) but would serve as an alternative to FRTW.

5.3. Drying

- 5.3.1. The humidity experienced by the wood during both treatment and in service can have an effect on both the structural and fire performance of the wood. [IBC Section 2303.2.6](#) / [IRC Section R802.1.3.6](#) states that FRTW in wet or damp locations must be identified as “Exterior” to indicate there is no increase in the listed flame spread index when subjected to ASTM D 2898, Standard Practice for Accelerated Weathering of Fire-Retardant-Treated Wood for Fire Testing.

- 5.3.1.1. FRTW in interior locations must be tested in accordance with ASTM D 3201 and must have a maximum moisture content of 28%

DrJ Research Report

5.3.1.2. The FRTW shall be dried to a moisture content of 19% or less for lumber and 15% or less for Wood Structural Panels (WSP) before use.

5.3.1.3. For wood kiln-dried after treatment (KDAT), the kiln temperatures shall not exceed those used in kiln drying the lumber and plywood submitted for the tests described in [IBC Section 2303.2.5.1/ IRC Section R802.1.3.5.1](#) for plywood and [IBC Section 2303.2.5.2/ IRC R802.1.3.5.2](#) for lumber.

5.3.1.4. ANSI/TPI 1 Section 6.4.9.1 is similar.

6.4.9.1 Fire Retardant Treated (FRT) Lumber². All FRT lumber used in Trusses shall be re-dried after treatment to 19 percent maximum moisture content at temperatures not to exceed 160°F (71°C). FRT lumber design values shall be developed from approved test methods and procedures that consider potential strength-reduction characteristics, including effects of elevated temperature and moisture. Design values shall be approved by the authorities having Jurisdiction.

5.4. Labeling

5.4.1. FRTW products must be labeled with the following items per [IBC Section 2303.2.4](#) / [IRC Section R802.1.3.4](#), which states

[2303.2.4 Labeling](#) Fire-retardant-treated lumber and wood structural panels shall be labeled. The *label* shall contain the following items:

1. The identification mark of an approved agency in accordance with Section 1703.5.
2. Identification of the treating manufacturer.
3. The name of the fire-retardant treatment.
4. The species of wood treated.
5. Flame spread and smoke-developed index.
6. Method of drying after treatment.
7. Conformance with appropriate standards in accordance with Sections 2303.2.5 through 2303.2.8.
8. For *fire-retardant-treated wood* exposed to weather, damp or wet locations, include the word "No increase in the listed classification when subjected to the Standard Rain Test" (ASTM D 2898).

5.4.2. ANSI/TPI 1 Chapter 3 requires that FRTW lumber must be clearly identified and marked:

3.4.5 Fire Retardant Identification – Lumber Impregnated with fire retardant chemicals shall be identified by the quality mark of, or a certificate of inspection from, an approved inspection agency and shall be identified by a label affixed to the package.

5.4.3. The Commentary for Chapter 3 explains the reasoning behind requiring a mark on FRTW lumber:

§3.4.5 Fire Retardant Identification. The marking by an approved inspection agency is specified to assure that lumber processing during the treatment process, and subsequent processes such as kiln-drying, are conducted in accordance with the processes employed during the evaluation of the treatment's effects. Approval of an inspection agency for treated lumber is typically the authority of the local Building Official. Inspection agencies may be accredited for inspection of pressure treated wood products by the American Lumber Standard Committee, Inc. (ALSC, see www.alsc.org), the International Accreditation Service, Inc. (IAS, see www.iasonline.org), or other accrediting services

5.5. Fastener Use

5.5.1. Fastener requirements for use in contact with FRTW are discussed in [IBC Section 2304.9.5.3](#) and [IRC Section R317.3.3](#) (for exterior or wet or damp applications) and [IBC Section 2304.9.5.4](#) and [IRC Section R317.3.4](#) (for interior applications).

5.5.1.1. [IBC Section 2304.9.5.3](#) states that fasteners, including nuts and washers, used in exterior applications or wet or damp locations shall be of hot-dipped zinc-coated galvanized steel stainless steel, silicon bronze, or copper. There is an exception made for fasteners other than nails, timber rivets, wood screws and lag screws, which are permitted to be of mechanically deposited zinc-coated steel. [IRC Section R317.3.3](#) is identical, although the IRC does not include wood screws and lag screws in the exception.

5.5.1.2. [IBC Section 2304.9.5.4](#) states that fasteners used in interior applications shall follow the manufacturer's recommendations, or in their absence, to follow the guidelines for exterior applications

² 2014 ANSI/TPI 1 Section 6.4.9.1

DrJ Research Report

found in [IBC Section 2304.9.5.3](#). [IRC Section R317.3.4](#) is identical, except references [IRC Section R317.3.3](#).

5.6. Design Adjustments

5.6.1. Lumber and WSP FRTW Products

5.6.1.1. Adjustments to untreated wood design values must be made when using FRTW in structural applications, including in the design of trusses or wall panels. The code does not specify adjustment factors, but states that the adjustments shall be based on an approved method and must take into consideration the effects of temperature and humidity exposures from the treatment and redrying process. ([IBC Section 2303.2.5](#) / [IRC Section R802.1.3.5.2](#)) The approved methods for WSP and lumber respectively are found in [IBC Section 2303.2.5.1](#) / [IRC Section R802.1.3.5.1](#) and [Section 2303.2.5.2](#) / [Section R802.1.3.5.2](#):

2303.2.5.1 Wood structural panels. The effect of treatment and the method of redrying after treatment, and exposure to high temperatures and high humidities on the flexure properties of fire-retardant-treated softwood plywood shall be determined in accordance with ASTM D 5516. The test data developed by ASTM D 5516 shall be used to develop adjustment factors, maximum loads and spans, or both, for untreated plywood design values in accordance with ASTM D 6305. Each manufacturer shall publish the allowable maximum loads and spans for service as floor and roof sheathing for its treatment.

2303.2.5.2 Lumber. For each species of wood that is treated, the effects of the treatment, the method of redrying after treatment and exposure to high temperatures and high humidities on the allowable design properties of fire-retardant-treated lumber shall be determined in accordance with ASTM D 5664. The test data developed by ASTM D 5664 shall be used to develop modification factors for use at or near room temperature and at elevated temperatures and humidity in accordance with ASTM D 6841. Each manufacturer shall publish the modification factors for service at temperatures of not less than 80°F (27°C) and for roof framing. The roof framing modification factors shall take into consideration the climatological location.

5.6.2. Treated wood stress adjustments are discussed in [IBC Section 2306.1.3](#). The code restates here what is found in [IBC Section 2303](#), but also notes that other adjustments are applicable except that the impact load duration shall not apply.

5.7. Metal Connector Plates used with FRTW

5.7.1. The *IRC* and *IBC* do not provide any guidance on the use of Metal Connector plates used with FRTW materials. However, *ANSI/TPI 1* Chapter 6 discusses this topic. 6.4.9.2 Metal Connector Plates Installed in FRT Metal Connector Plates installed in lumber pressure-impregnated with fire retardant chemicals shall have the reductions for lateral resistance values specified by the FRT chemical manufacturer. The quality mark shall indicate that the design value adjustments are in accordance with either the FRT manufacturer's specifications or based upon an approved method of investigation which takes into consideration the effects of the anticipated temperature and humidity to which the FRT will be subjected.

5.7.2. The commentary for chapter 6 further states: §6.4.9.2 Metal Connector Plates Installed in FRTW. Metal Connector Plate design values shall be adjusted per recommendations by the chemical manufacturer.

5.8. LRFD Design

5.8.1. *ANSI/ TPI 1* Chapter 6 notes in Table 6.4-7 Time Effect Factors, λ (LRFD Only) Footnote ** states:

**Time effect factors greater than 1.0 shall not apply to connections or to structural members pressure-treated with water-borne preservatives or fire retardant chemicals.

6. Test and Engineering Substantiating Data:

- 6.1.** 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.
- 6.2.** 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.
- 6.3.** DrJ's responsibility for data provided by approved sources is in accordance with professional engineering law.

DrJ Research Report

- 6.4. 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.

7. Findings:

- 7.1. Fire retardant treated materials can be incorporated into buildings to reduce the ability of lumber and lumber products to contribute to a fire. *IBC* and *IRC* requirements dictate where, and under what circumstances, fire retardant materials are appropriate.
- 7.2. When designing trusses with fire retardant lumber, *ANSI/TPI 1* should be followed as a guide for the appropriate drying conditions for the lumber after treatment. In addition, appropriate design values reductions for the lumber or metal connector plate should be taken following the FRT manufacturer's specifications.
- 7.3. [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 not less than 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 why the alternative was not *approved*.³
- 7.4. 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:
- 7.4.1. No known variations.
- 7.5. 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.

8. Conditions of Use:

- 8.1. 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.
- 8.2. Any generally accepted engineering calculations needed to show compliance with this DRR shall be submitted to the code official for review and approval.
- 8.3. Or design loads shall be determined in accordance with the building code adopted by the jurisdiction in which the project is to be constructed.
- 8.4. Design
- 8.4.1. Building Designer Responsibility
- 8.4.1.1. 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](#).
- 8.4.1.2. 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](#).
- 8.4.2. Construction Documents

³ The last sentence is adopted language in the 2015 codes.

DrJ Research Report

8.4.2.1. When required, 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.

8.5. Responsibilities

- 8.5.1.** 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.
- 8.5.2.** DrJ research reports provide an assessment of only those attributes specifically addressed in the Products Evaluated or Code Compliance Process Evaluated section.
- 8.5.3.** The engineering evaluation was performed on the dates provided in this DRR, within DrJ's professional scope of work.
- 8.5.4.** The actual design, suitability and use of this research report for any particular building is the responsibility of the Owner or the Owner's authorized agent, and the report shall be reviewed for code compliance by the Building Official.
- 8.5.5.** The use of this DRR 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.

9. Review Schedule:

- 9.1.** This research report is subject to periodic review and revision. For the most recent version of this report, visit drjengineering.org.
- 9.2.** For information on the current status of this report, contact [DrJ Engineering](#).