Fire Retardant Treated Wood (FRTW) For Commercial and Residential Structures

via06b
An AIA Continuing Education Program
Credit for this course is
1 AIA HSW CE Hour
In this course, we will gain insight into the growing need for and use of fire retardant treated wood (FRTW). We will explore both interior and exterior FRTW and discuss treatment options. Through a review of applications, codes and standards, the design professional will have a better understanding of how to incorporate FRTW into their next project.
By completing this course, the design professional will be able to:

1. Describe the fire retardant features of FRT wood, and the difference between fire resistance and flame spread
2. List the various types of FRTW and their specific applications
3. Explain what the model building codes require, and how FRTW is specified
4. Describe how FRT wood is manufactured, tested and certified
Introduction
US Fire History

- Chicago Fire, 1871
  --> 300 lives lost, over 100,000 left homeless, destroyed 4 square miles of downtown Chicago

- Triangle Shirtwaist Factory NYC, 1911- loss of 146 lives; led to regulatory safeguards and the creation of OSHA and increased regulation on worker safety.
Three Components for a Fire

- For a fire to start, it must have fuel, oxygen and a heat source (temperature)

- Fire Retardant Treated Wood (FRTW) reduces risks
Fire Prevention – Remove the Fuel

• To prevent a fire, a fire retardant must remove one or more of the elements in the fire triangle

• Through a combination of physical and chemical mechanisms, fire retardants effectively remove the fuel (wood) from the triangle
The Combustion Cycle

- Heat produces flammable gases from wood components (cellulose and lignin)

- When the gases combine with oxygen, they ignite and burn

- That creates more intense heat which generates more flammable gases from the wood and leads to a “combustion cycle”

Wood: cellulose and lignin
FRTW Protection
Reasons for FRT Wood Specification

Meet building codes with an acceptable substitute for noncombustible material

There is one overriding reason for specification of FRT wood – which is to meet the codes designed to increase safety in public buildings. However, other non-code-driven reasons exist why a building owner might desire greater fire protection:

• To reduce personal injury and property damage from fires
  – Permits egress from a burning building
  – Slows destruction, increasing time for help to arrive
• Reduces and/or slows the spread of flame and smoke development
  – Smoke inhalation and toxic poisoning are primary causes of death in residential fires
• Protect valuable contents of buildings (e.g. art, horses, etc.)
• Lower insurance premiums
Reasons for FRT Wood Specification

Meet building codes with an acceptable substitute for noncombustible material

- Reduce sprinkler requirements
- Add fire protection to light construction
- Keep fire contained within a unit - apartments/condos/malls
- Lower installed cost compared to other non-combustible materials
How Does FRT Wood Work?

- Converts combustible gases and tars to carbon char at temperatures below 550ºF
- Releases carbon dioxide and water vapor which dilute the combustible gases
- However, treatment does not make wood a non-combustible material

Charring insulates underlying wood and slows destruction.
Types of Treatments

- **Interior FRT Wood**
  - Pressure Treated
  - Most commonly used
  - FRTW treatment is water soluble
    - Must be shielded from direct precipitation and moisture

- **Exterior FRT Wood**
  (newer, but more common in CA due to wildfires)
  - Pressure-treated
  - Can be exposed to weather
  - Useful for meeting California Fire Wildland-Urban Interface building code requirements
Applicable Types of Projects

• Institutional
  – Schools
  – Hospitals
  – Airports
  – Museums

• Commercial
  – Shopping centers
  – Restaurants
  – Sports stadiums

• Residential
  – Multi-family homes
  – Military housing
FRT Wood Used in Today’s Buildings

Products and applications are increasing.

- Interior Sheathing and Lumber
  - New Construction - roof and sidewall
  - Remodeling of Existing Buildings

- California Fire Wildland-Urban Interface Building code requirements have also increased the use of FRT wood

- New opportunities with engineered wood products (EWPs)
Common Applications – Interior FRTW

- Trusses
- Roof sheathing
- Wall sheathing
- Interior framing
- Backing for mechanical panels
- Blocking for hand rails, wall fixtures
- Stairwell construction

*Interior FRT wood should not be exposed to continual wetting*
Common Applications – Exterior FRTW

- Exterior decks
- Balconies
- Stairways
- Shakes & shingles
- Siding
- Trim & molding
- Open-air roof systems
- Soffit & fascia
- Construction staging
- Scaffolding

Exterior FRT wood should not be used in attic space environments or in ground contact.
FRTW in Non-combustible Application

• FRT wood is not classified as noncombustible, but often can be used in specific components and/or locations as an alternative for noncombustible materials

• Limited Use Permitted in Type 1 and Type 2 Construction

• Model codes permit use of FRT wood in cases where combustible materials are not permitted
Type IV Heavy Timber (HT) construction permits untreated wood of sufficient dimensions – there are applications where untreated wood can meet codes, as long as members are large enough.

**TABLE 602.4**

**WOOD MEMBER SIZE EQUIVALENCIES**

<table>
<thead>
<tr>
<th>MINIMUM NOMINAL SOLID SAWN SIZE</th>
<th>MINIMUM GLUED-LAMINATED NET SIZE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Width, inch</strong></td>
<td><strong>Depth, inch</strong></td>
</tr>
<tr>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>6</td>
<td>10</td>
</tr>
<tr>
<td>6</td>
<td>8</td>
</tr>
<tr>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>4</td>
<td>6</td>
</tr>
</tbody>
</table>

For SI: 1 inch = 25.4 mm.  

Table is from IBC 2012, Section 6.
Recognized by Respected Organizations

- Underwriters Laboratories® (UL®)
  - FR-S

- American Wood Protection Association (AWPA)
  - Standard P49, P50 Fire Retardant Formulations
  - Standard U1, UCFA

- Code evaluation organizations
  - ICC Evaluation Service

- Factory Mutual
Pressure Treated Interior FRTW Model Code Requirements

IBC 2303.2 (2012):
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. In addition, the flame front shall not progress more than 10.5 feet (3200 mm) beyond the centerline of the burners at any time during the test.

Note: Third-party inspection agencies must be an accredited organization to be acceptable
Pressure Treated Interior FRTW Model Code Requirements

- Pressure-impregnated
- Kiln dried after treatment (KDAT) – ensures treatment characteristics are locked in
- Strength-tested at high temperatures such as what exists in an enclosed attic space
- Production QC monitored by third-party agency
Pressure Treated Exterior FRTW
Model Code Requirements

• Exterior FRTW has the same requirements, plus high-temp. testing (must pass fire tests after undergoing 800-inch rain test to verify protection lasts in weather)

• 2012 IBC 2303.2.4
  “For fire-retardant-treated wood exposed to weather, damp or wet locations, include the words ‘No increase in the listed classification when subjected to the Standard Rain Test’ (ASTM D 2898).”
Treatment and Standards
Flame Spread vs. Fire Resistance

- There can often be confusion between flame spread and fire resistance. They ARE different.

- FRT wood has a flame spread rating.

- FRT wood does not, by itself, have an hourly fire resistance rating, however:
  - If assembly has been tested with untreated wood, you can substitute FRT wood & get same resistance rating without re-testing
  - Some assemblies would meet requirements for fire resistance, but can’t be used because they contain combustible materials – FRT wood can sometimes qualify the assembly
Flame Spread:
How quickly flame travels across the surface of a material

- Determined by tunnel test of surface-burning characteristics
- ASTM E84 is a 10 minute test which extended to 30 minutes
- There is a new ASTM test, E2768, adopted in 2011 which is the same as E84, but it is 30 minutes by default (not part of the code requirements)
Flame Spread vs. Fire Resistance

- **Fire Resistance**
  Hourly fire endurance rating of assemblies, such as doors, walls, ceilings, and floors

- There are other agencies and tests for fire ratings of assemblies.
  - ASTM E 119 and E 136 tests

- Many codes accept the Component Additive Method (CAM) Determined by ASTM
Using CAM

Example:

<table>
<thead>
<tr>
<th>Component</th>
<th>Time/Min.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Studs 16” on center</td>
<td>20</td>
</tr>
<tr>
<td>5/8” plywood – interior</td>
<td>15</td>
</tr>
<tr>
<td>Rockwool or slag mineral wool batts weighing not less than 1/4 lb./sq. ft. of wall surface</td>
<td>15</td>
</tr>
<tr>
<td>1/2” gypsum board</td>
<td>15</td>
</tr>
</tbody>
</table>

Assembly Total 1 hour 5 min.

Details on CAM available from American Wood Council and others.
AWC website: www.awc.org
The Steiner Tunnel Test

• The heart of qualifying as FRT wood is the Tunnel Test, which determines flame spread and smoke development

• Part of three similar testing protocols:
  – ASTM E 84, UL 723, NFPA 255

• Test: Wood placed in tunnel; visual determination of flame spread; sensors measure density of smoke.
Interior of Tunnel During Burn Test
Flame spread number is an index – a comparison to results from asbestos cement board (rated zero) and untreated red oak (rated 100).
Below are the results of tests for various species. Most accurate testing would be to use species likely to be treated and used in field, and not just species with low flame spread characteristics.

Materials are classified as Class A, B, C, depending on flame spread in tunnel test lasting 10 minutes.

### Examples of untreated wood:
- Southern pine: 130-195
- Ponderosa Pine: 105
- Maple: 104
- Douglas Fir: 70-100
- Western Red Cedar: 69
- Engelmann Spruce: 55

Wood must be Class A and pass 30-minute tunnel test to substitute for noncombustible materials.
All wood is not the same in its natural burning characteristics.

- Class A: 0-25
  - FRTW
- Class B: 26-75
  - White Spruce
- Class C: 76-200
  - Plywood, oriented strand board (OSB) and composite panels
FRT Wood Increases Design Flexibility

There are instances when FRT wood provides designers with more choices. For example, the use of FRT wood may reduce the need for sprinklers. This option may be useful in places housing artwork or electronic equipment, where potential exists for significant damage by activation of sprinklers.

**Sprinklers:**

**Section 8.15.1.2.11 of NFPA 13 Standard:**

Concealed spaces in which the exposed materials are constructed entirely of fire-retardant treated wood as defined by NFPA 703 ... shall not require sprinkler protection.

Codes often require fire walls in multi-family buildings to extend through roof.

Using FRT panels on roof on both sides of common walls may eliminate requirement for parapets, leading to a less commercial appearance and fewer roof penetrations.

**Parapets:**

**IBC 2012 706.6 & IRC 2012 302.2.2**

In Type III, IV, and V construction of R-3 dwellings, parapet not required if FRT panels extend 4’ on both sides of fire wall.

Allows for unbroken, continuous roof line.
Production of Pressure-Treated Wood

There are wood treating plants throughout the country at which wood is impregnated with preservative for decks and backyard projects, or for poles and piling. The treatment process for FRT wood is similar.

At a wood-treating plant, all types of lumber, timbers, and plywood are loaded onto trams and pushed into a large horizontal treating cylinder.
A High-tech Wood Treating Plant

Treating equipment is costly and highly capital-intensive.
Inside the Treating Cylinder

**Step 1**
Dry wood is loaded into cylinder

**Step 2**
Initial vacuum pulls out air

**Step 3**
Liquid preservative fills cylinder
Inside the Treating Cylinder

*Step 4*
Pressure forces preservative into wood

*Step 5*
Remaining liquid emptied for later use

*Step 6*
Final vacuum removes excess chemical

Treatment chemicals are captured, used again, and then properly disposed of at end of useful life.
Lumber and Plywood Sizes

Treatable sizes are limited only by treating plant’s ability to treat, dry, and handle.
Several species of trees can meet FRTW treating requirements
Typically only one or two are available in any particular area
A list of accepted species appears in AWPA standards & code evaluation reports
### Treatable Species

Treatable species vary by region, chemical manufacturer, and by plywood / lumber. A species certified for lumber may not be so for plywood, for example.

<table>
<thead>
<tr>
<th>Common name</th>
<th>Botanical name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ponderosa pine</td>
<td><em>Pinus ponderosa</em></td>
</tr>
<tr>
<td>Southern pines</td>
<td><em>Pinus spp.</em></td>
</tr>
<tr>
<td>Red pine</td>
<td><em>Pinus resinosa</em></td>
</tr>
<tr>
<td>Pine</td>
<td><em>Pinus caribea</em></td>
</tr>
<tr>
<td>Radiata pine</td>
<td><em>Pinus radiata</em></td>
</tr>
<tr>
<td>Lodgepole pine</td>
<td><em>Pinus contorta</em></td>
</tr>
<tr>
<td>Eastern white pine</td>
<td><em>Pinus strobos</em></td>
</tr>
<tr>
<td>Patula pine</td>
<td><em>Pinus patula</em></td>
</tr>
<tr>
<td>Jack pine</td>
<td><em>Pinus banksiana</em></td>
</tr>
<tr>
<td>Western Hemlock</td>
<td><em>Tsuga canadensis</em></td>
</tr>
<tr>
<td>Douglas fir</td>
<td><em>Pseudostuga menziesii</em></td>
</tr>
<tr>
<td>Alpine fir</td>
<td><em>Abies lasiocarpa</em></td>
</tr>
<tr>
<td>Hem fir/ Hem fir- North</td>
<td><em>Tsuga heterophylla</em></td>
</tr>
<tr>
<td>Englemann spruce</td>
<td><em>Picea englemanni</em></td>
</tr>
<tr>
<td>White fir</td>
<td><em>Abies concolor</em></td>
</tr>
<tr>
<td>White spruce</td>
<td><em>Picea glauca</em></td>
</tr>
<tr>
<td>Red spruce</td>
<td><em>Picea rubens</em></td>
</tr>
<tr>
<td>Black spruce</td>
<td><em>Picea mariana</em></td>
</tr>
<tr>
<td>Balsam fir</td>
<td><em>Abies balsamea</em></td>
</tr>
<tr>
<td>Spruce-pine-fir</td>
<td>SPF</td>
</tr>
<tr>
<td>Basswood</td>
<td><em>Tilia spp.</em></td>
</tr>
<tr>
<td>Red oak</td>
<td><em>Quercus rubra</em></td>
</tr>
</tbody>
</table>
Plywood for sheathing applications.

- Southern pine
- Red pine
- Douglas fir
- Lauan
Codes require drying after treatment to a maximum moisture content.

This is especially important for exterior FRT wood — heat needed to lock chemical into wood cells.

Treating process saturates wood with liquid. Re-drying: 19% for lumber, 15% for plywood.
• KDAT = Kiln Dried After Treatment
• Sticks (thin pieces of wood) are placed between layers to ensure air flow
• Like the treating process, the KD process is monitored by third party
• The drying temperature is controlled to avoid damage to wood – because of differences in strength values, it’s best to check values with manufacturers before designing with FRT wood or allowing a brand substitution
Dried After Treatment

- Kiln Dry After Treatment (KDAT) process is third-party monitored.
- Strength values may differ for different brands (check with manufacturer).
- Consult Evaluation Service Reports for strength adjustment factors.

![Table 1 - Strength Design Adjustment Factors](image)
Inside FRTW Kilns

Large, sealable kilns are used to dry FRTW for approximately 48 hours after treatment to reach the required moisture content levels.
Quality Control Programs

• Fire retardant chemical manufacturers maintain QC programs
  – Compliance with qualified third-party program
  – Highest quality of fire retardant chemicals

• FRT wood treaters
  – Check retention, penetration, and drying schedules
Quality Control Programs

All treaters hire a third-party inspection service to ensure products are made to specifications. These inspection agencies:

- Monitor production process
- Inspections are code required
- Underwriters Labs, Timber Products Inspection (TP), Southern Pine Inspection Bureau (SPIB). SPIB is a rules writing agency.
Quality Stamps

Finished FRTW is stamped with applicable quality marks.

Monitored by:
[Inspection Agency Name] (AA-XXX)
ASTM E84/AWPA U1, UCFA, P50 FR-2
Interior Type A, (HT), KDAT

[Wood Species] Treated Lumber
Flame Spread [ ]
Smoke Developed [ ]
[Treating Company Name]
[Location]

ICC-ESR
Quality Stamps

Examples of quality stamps:
Use & Handling

- The chemicals used for FRTW are not considered hazardous materials.

- Proper Storage
  - Protect from physical damage
  - Shield wood from precipitation

- Proper Disposal
  - Dispose in accordance with regulations
  - Typically, FRT wood is not considered a hazardous material and can be disposed of by typical means, in accordance with local waste management policies.
Use & Handling

• The usual precautions in using and working with wood apply.

• Proper Handling
  – FRT wood & wood dust are no more hazardous than untreated wood

• Proper Use
  – Should not be used in ground contact
  – Exterior types should not be installed in attic environments

• Material Safety Data Sheets
Material Safety Data Sheet

Material Name: Fire Retardant, Pressure Treated Wood

*** Section 1 - Chemical Product and Company Identification ***

Synonyms: Fire Retardant, Pressure Treated Wood (Phospho-Ammonium-Boron Complex)

*** Section 2 - Hazards Identification ***

Emergency Overview
Product is a light to dark brown solid. Acute or prolonged exposure may cause irritation of the eyes, skin, gastrointestinal tract and respiratory tract. Product may form explosive dust/air mixtures if high concentration of product dust is suspended in air.

Potential Health Effects: Eyes
This product may cause mechanical irritation to the eyes.

Potential Health Effects: Skin
Prolonged and/or repeated skin contact with this product may cause irritation/dermatitis.

Potential Health Effects: Ingestion
Spray-On Fire Retardants Do Not Meet Code Requirements for FRTW

Wood Products with painted or sprayed-on fire retardants do not meet building code requirements for fire retardant treated wood and should never be used in lieu of code-compliant, pressure impregnated, fire retardant treated wood.

FRTW products must meet the requirements as defined by the International Code Council (ICC) or the National Fire Protection Association (NFPA).

Some painted wood products with spray-on or brush applied topical coatings have been promoted in ways that encourage their misuse in structural applications.

The building codes do not permit wood products painted with “fire retardant” coatings to be used as substitutes for pressure impregnated fire retardant treated wood.

Confusing, ambiguous, and misleading statements and claims in print and on the web may give the impression that some of these painted products are code-compliant and safe for building construction.

As a specifier, builder, contractor or owner, you can be liable for the problems that occur from the use of these products if substituted for fire retardant wood.

Coatings may have been mistakenly accepted as FRTW by building officials, fire marshals, architects and contractors when they are not aware of the differences between pressure impregnated fire retardant treatments and surface-applied coatings.
FRT Wood & The Environment

- FRTW and Green Building claims
- Basic material is wood, a sustainable natural resource
- Plentiful acreage is grown on managed timberlands
- Low-energy requirements for production
- Absorption and sequestering of carbon – reduced generation of greenhouse gases
- Insulation value – thermal, acoustical, electrical
Green Building Rating Systems

• Currently no credits for treatment, unless treated wood is accepted as an Innovative Product
• Can be specified to be certified wood
• Other credits possible for wood attributes, particularly in Green Globes® and National Green Building Standard™
Specification and FAQs
The following considerations can influence the specification of FRT wood:

- Building code requirements
- Architectural details, such as avoidance of sprinklers, parapets
- Strength values
- Material & installation costs
- Ease of job site modification & later repair/remodeling
The following points can and should be included in a specification of FRT wood:

- Application, interior or exterior
- Qualification tests & ratings
- Quality control monitoring
- Species
- Warranty

*Three-part model specs available on Internet from manufacturers*
Good Sources for 3-Part Specs

3-part specifications are available online at these sites and at manufacturers’ websites.
Will FRT Wood Burn?

- If a suitable heat source and oxygen is present, FRT wood will eventually burn.
- The important fact to remember is that FRT wood will not support a fire.
What is the difference between flame spread vs. fire resistance?

- Flame spread is how quickly a fire travels across the surface.
- Fire resistance is how fast a fire burns through the cross section.
- For calculating the fire resistance rating for an assembly, refer to the Component Additive Method (CAM).
Does a Class A rating require the extended 30-minute test?

- To qualify for Class A, a material must have a Flame Spread index of 0-25 and a Smoke Developed index of 0-450 in the 10-minute tunnel test. It does NOT have to undergo the 30-minute test.

- However, to meet model code requirements for FRT wood, a material must pass Class A and not exhibit progressive combustion in the extended 30-minute test.
What is a UL FR-S rating?

- To qualify for an FR-S rating the flame spread index and smoke developed index must both be less than or equal to 25 in a 30 minute ASTM E 84 or UL 723 tunnel test.
Can FRTW be painted or stained?

- Yes. Follow the same procedures you would for painting or staining untreated wood. However, flammability of the finish should be considered before application, and in most cases may void the FRTW warranty due to uncertainty about its flammability. Follow manufacturers’ recommendations.
FRT Wood FAQs

Is there a reduction in strength compared to untreated wood?

- Pressure-treatment and drying processes may cause a reduction in FRTW strength that will vary with treatment, species of wood, applications, and specific properties of the chemicals used. Consult manufacturers’ literature for specific details.
What type of fasteners should be used with FRT wood?

- Always follow the code requirements.

- Hot dip galvanized steel hardware is generally recommended. Although the FRT treatment does not increase the corrosion of bare steel, the galvanizing process provides an extra margin of safety, particularly in wet environments such as with exterior FRT wood.
Can I cut FRT wood?

- Yes. Cutting lengths, drilling holes, and light sanding are permissible. It is not necessary to field-treat cut ends to maintain the flame spread rating.
- Most species of FRT lumber should not be ripped or milled.
- Pressure-treated FRT plywood can be ripped or cross-cut.
What if Interior FRTW is exposed to rain on the job site?

- All precautions should be taken to keep the material dry. Testing has shown that incidental exposure to rain during construction will not affect performance of interior FRTW.
- If significant wetting occurs interior FRTW must be dried to 19% for lumber and 15% for plywood before being covered or enclosed.
Now, the design professional will be able to:

1. Describe the fire retardant features of FRT wood, and the difference between fire resistance and flame spread
2. Describe the various types of FRTW and their specific applications
3. Describe what the model building codes require, and how FRTW is specified
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