*Durability and Wood Protection*

# Fire Research for Safe and Durable Wood Structures

at the **Forest Products Laboratory**

USDA

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DEPARTMENT OF AGRICULTURE

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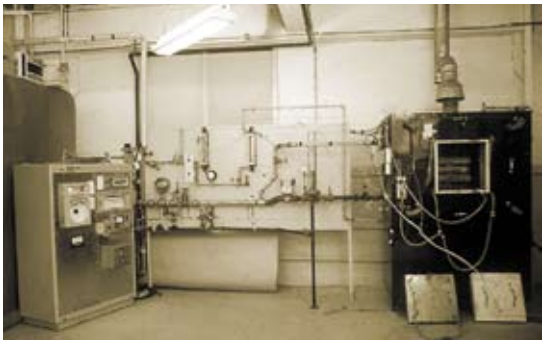
Protecting homes and businesses from fire is a critical issue facing the nation.

- A fire occurs in the United States every 60 seconds.
- Concerns about terrorist activities and homeland security have increased.
- The risk that wildland fires will threaten the survival of homes and other structures near national forests has increased.
- Increased use of composite wood products, which improve wood utilization and provide markets for small-diameter materials, can potentially increase the risk of property damage and loss of life in fires.

Our fire safety research program aims to ensure that wood products and wood-based structures do not contribute to loss of life and property in fires. Research areas include the following:

- Ensuring adequate structural performance of engineered wood products in fires
- Minimizing the contribution of new and innovative forest products to fire growth within buildings
- Using fire-retardant treatments to improve fire performance of wood-based products
- Improving survivability of wood structures in wildland–urban interfaces



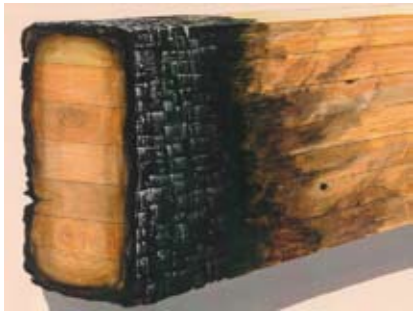
Original FPL heat release rate apparatus.

Present-day cone calorimeter (ASTM E 1354) that uses the oxygen consumption method to measure heat release rate.

## *Scientific approach*

A large portion of our research is conducted in formal or informal cooperation with other parties within the Forest Service and with other government agencies, universities, industry associations, and individual companies. Project researchers are active in the ASTM International Committee E-5 on Fire Standards and Committee D-7 on Wood, Society of Fire Protection Engineers, Forest Products Society, and International Union of Forestry Research Organizations (IUFRO).

# Ensuring adequate structural performance of engineered wood products in fires



Fire resistance is largely a function of rate of charring and dimensions of the member.

Engineered wood products (such as sandwich panels, metal-plate-connected wood trusses, I-joists, laminated veneer lumber, and other composite lumber products) are potential users of small-diameter trees and therefore contribute to Forest Service goals of hazardous fuel reduction. The use of structural wood composite products in wood construction has been rapidly increasing. Engineered wood products provide efficient structural performance and wood utilization, but concerns about fire performance have resulted in efforts to restrict or regulate their use through prescriptive local or state regulations. Work in this problem area is intended to address important fire safety issues that could adversely affect potential markets for products that improve the economics of fuel reduction programs.

## *Recent accomplishments*

**Fire resistance of structural composite lumber products.** Robert H. White. Research Paper FPL–RP–633 (2006). 28 p.

**Fire resistance of engineered wood rim board products.** Robert H. White. Research Paper FPL–RP–610 (2003). 22 p.

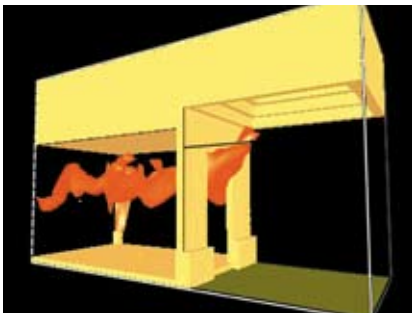
The FPL 1.2- by 1.8-m horizontal furnace and tension apparatus (ASTM E 119 fire-exposure equipment) can be used as (1) a horizontal furnace to test a panel product for fire penetration or (2) a tension apparatus to test a wood member simultaneously exposed to fire and tensile load.

The FPL 510- by 510-mm small vertical furnace used to determine the charring rate of wood products subjected to the standard ASTM E 119 fire exposure.

## *Research highlights*

- Improve fire-resistance models for engineered wood products including trusses, I-joists, and composite lumber products
- Characterize fire performance of adhesives for structural applications
- Characterize improvement obtained by directly applying protection to large timbers
- Assess methods for post-fire evaluation of structural wood members for damage from exposure to elevated temperatures

# Minimizing the contribution of new and innovative forest products to fire growth within buildings



NIST Fire Dynamics Simulator software.

New and innovative forest products are being developed to maximize our utilization of natural resources. Many of these products are used in panels and other applications where they are susceptible to fire. Because the time it takes for people to escape a building and the time required for fire departments to respond to a fire are critical, we are concerned with how building materials contribute to rapid fire growth within a building. In addition to innovations in building products, we are seeing a trend away from current regulatory fire tests and prescriptive codes toward performance-based codes, which creates a new demand for improved material properties and computer fire models.

## *Recent accomplishments*

**Using a quasi-heat-pulse method to determine heat and moisture transfer properties for porous orthotropic wood products or cellular solid materials.** Mark A. Dietenberger. Journal of Thermal Analysis and Calorimetry 83(1):97–106 (2006).

**Comparison of test protocols for the standard room/corner test.** Robert H. White, Mark A. Dietenberger, Hao Tran, Ondrej Grexa, Les Richardson, Kuma Sumathipala, and Marc Janssens. Fire and Materials 23:139–146 (1999).

One of our small-scale tests is the Lateral Ignition Flame-Travel (LIFT) apparatus (ASTM E 1317 or E 1321).

Small-scale tests are used to predict time for flashover in full-scale room/corner test (ASTM E 2257).

## *Research highlights*

- Evaluate the relative flammability of new and innovative forest products and other forest products
- Obtain material properties needed for fire modeling of forest products
- Develop and validate specialized computer algorithms to modify existing fire growth models

# Using fire-retardant treatments to improve the fire performance of wood-based products

Cone calorimeter.

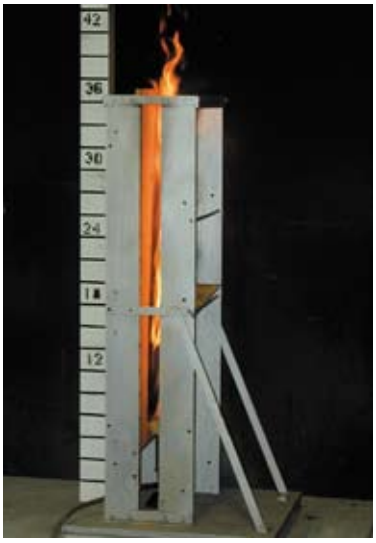
One option for minimizing the contribution of new and innovative forest products to fire growth is treatment with fire-retardant chemicals. The FPL fire research team works with other FPL researchers and outside cooperators to investigate fire-retardant treatments for wood products, primarily using the cone calorimeter. In addition to the cone calorimeter and the LIFT apparatus, FPL equipment used for evaluating fire-retardant treatments includes the critical radiant flux apparatus (ASTM E 648/E 970), mass loss calorimeter (ASTM E 2102), accelerated weathering chamber (ASTM D 2898 Method B), fire tube (ASTM E 69), FPL-modified Schlyter panel, 2-foot tunnel apparatus (ASTM D 3806), and oxygen index (ASTM D 2863). A room/corner test facility is available to conduct full-scale corner tests on treated wood products.

## *Recent accomplishments*

**Cone calorimeter evaluation of wood products.** Robert H. White and Mark A. Dietenberger. In: Proceedings, Fifteenth Annual BCC Conference on Recent Advances in Flame Retardancy, June 6–9, 2004, Stamford, Connecticut.

**Fire performance of oriented strandboard.** Robert H. White and Jerrold E. Winandy. In: Proceedings, Seventeenth Annual BCC Conference on Recent Advances in Flame Retardancy, May 22–24, 2006, Stamford, Connecticut.

Testing a fire-retardant treatment with ASTM E 108 Class C burning brands.

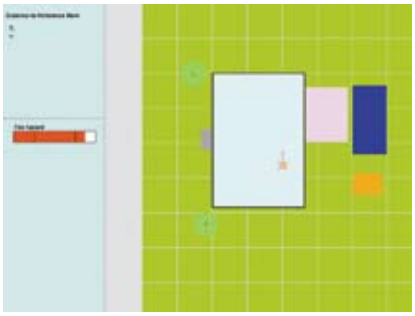



FPL-modified Schlyter panel test apparatus.

## *Research highlights*

- Evaluate the relative flammability of new and innovative forest products (including wood–plastic composites and oriented strandboards) treated with fire-retardant chemicals
- Develop and validate procedures to predict the performance of forest products in the ASTM E 84 tunnel test from data obtained with smaller-scale test methods

# Improving survivability of wood structures in the wildland–urban interface



FPL is cooperating with the Forest Service Pacific Southwest Research Station, Center for Urban Forestry, in improving its web-based software, called EcoSmart, which allows the user to add, prune, or remove vegetation and determine the likelihood of structural ignition.

With increasing urbanization of the countryside and historic levels of forest fires, fire safety of homes in the wildland–urban interface (WUI) is a major problem nationwide. The number of homes simultaneously involved in a single WUI fire makes the survival of any one structure largely dependent on prior efforts of the homeowner to improve the survivability of their own home by local vegetation control and proper building construction. Our goal is to reduce fire hazards in the WUI by improving the quality and flexibility of fire safety recommendations for wood structures. Identification of potential involvement of wood products and vegetation in a fire can lead to guidelines to prevent fires or limit losses. Guidelines must be established for homeowners concerning the use of decking, exterior siding, and roofs and the placement of ornamental plants.

FPL is investigating the potential use of Forest Service emergency tent fabric to provide temporary protection to wood structures such as this ASTM E 108 Class B burning brand on wood shingles.

As part of the EcoSmart project, we have determined the heat release rate of the Class B brand that is used in the ASTM E 108 test for roof coverings.

## *Research highlights*

- Assess relative flammability of ornamental plants and invasive species
- Develop models for assessing likely fire propagation within a structure
- Evaluate new materials used for decking and other exterior applications for fire performance
- Investigate temporary measures that can be used to protect a structure

## *Recent accomplishments*

**Use of the cone calorimeter to detect seasonal differences in selected combustion characteristics of ornamental vegetation.** David R. Weise, Robert H. White, Frank C. Beall, and Matt Etlinger. International Journal of Wildland Fire 14(3):321–338 (2005).

**Ignitability of materials in transitional heating regimes.** Mark A. Dietenberger. In: Proceedings, 5th Wood and Fire Safety International Scientific Conference, April 18–22, 2004, Technical University of Zvolen, Slovak Republic.

# *Durability and Wood Protection*

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## Fire Research Laboratory

Original FPL fire research laboratory (1935).

Fire testing facilities are located in the Fire Research Laboratory (Building 4) on the USDA Forest Products Laboratory campus in Madison, Wisconsin. The original building was constructed in 1935. Two additions have been completed since then, the most recent in 2004.

FPL fire research laboratory today.

### *Publications*

A list of our publications on fire performance of wood and PDF files of these publications are available on the FPL web site (www.fpl.fs.fed.us).

# Forest Products Laboratory

*Our mission*

We use science and technology to conserve and extend our Nation's forest resources. Our mission is to promote healthy forests and forest-based economies through the efficient, sustainable use of our wood resources. Many breakthrough technologies that influence the way we live started at the Forest Products Laboratory (FPL).

*Our role and experience*

Established in 1910 by the U.S. Department of Agriculture Forest Service, the FPL in Madison, Wisconsin, serves the public as the Nation's leading wood research institute. The FPL is recognized both nationally and internationally as an unbiased technical authority on wood science and use. Our research is concentrated in one location to promote an interdisciplinary approach to problem solving. The FPL cooperates with many universities, industries, and federal and state agencies.

*Our areas of expertise*

Today, more than 230 scientists and support staff conduct research on expanded and diverse aspects of wood use. Research concentrates on pulp and paper products, housing and structural uses of wood, wood preservation, wood and fungi identification, and finishing and restoration of wood products.

In addition to traditional lines of research, FPL is responding to environmental pressures on the forest resource by using cutting-edge techniques to meet important future challenges:

- Utilization of small-diameter timber
- Nanotechnology
- Biorefinery/bioenergy
- Advanced wood structures
- Advanced composites

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