



Fire Rating Design

Wood by nature is a flammable material. Engineers and architects design a building to meet fire safety standards in accordance to the International Building Codes. However, in the United States, building codes defer from state to state. There are passive and active fire protection design elements that are considered in a building's design. Active elements are those which are response activated and consist of installation of a sprinkler system, and fire-extinguishers. Passive fire protection design are those that consist of components and systems which help to contain fires and/or slow down the spread of fires. Passive fire design takes whole system assemblies into consideration such as that between ceiling and floor, and floor and wall. Section 804 of the International Building Codes mentions the specification requirements for interior floor finishes. The requirement specifies that finished floors be tested in accordance with the NFPA 253, also known as, the ASTM E648: The Critical Radiant Flux.

The two most popular tests for fire rated flooring products are the ASTM E84, and the ASTM E648. These two tests are described in greater detail below. The ASTM E84 test is currently only used for ceiling and wall building materials, and has been retired as an accepted flooring fire test. Flooring is the last material to be ignited during a building fire and therefore does not require the highest flame resistance. The air near the floor is the coolest portion of a room; heat rises. The areas of public buildings that are regulated in accordance to flame spread ratings are: exits, public corridors, elevator cars, and service spaces.

Fire Rating Tests

ASTM E84: *Standard Test Method for Surface Burning Characteristics of Building Materials (Also Known As The Steiner Tunnel Test)*

Method: The test method requires a 10 minute exposure to determine flame spread on the surface of the material being tested in a tunnel that is 25' length x 17 3/4" width x 12" height. There are two gas burners in one end of the tunnel and with a controlled air flow, the flames are spread across the surface of the material. The tunnel is calibrated to an index of 0 for non-combustible materials and 100 for red oak flooring plank.

Class A : Flame Spread Index 0 – 25 – Allowed in Enclosed vertical exits

Smoke Developed Index 0-450

Class B : Flame Spread Index 26- 75 – Allowed in Exit access corridors

Smoke Developed Index 0-450

Class C : Flame Spread Index 76-200 – Allowed in Other rooms and areas

Smoke Developed Index 0-450

ASTM E648: *Standard Test Method for Critical Radiant Flux of Floor-Covering Systems Using a Radiant Heat Energy Source (Also Known As The Smoke Density Test)*

Method: The test method requires a flooring product be mounted horizontally and exposed to a flame while being exposed to radiant heat energy from a panel mounted at 30° horizontally. The critical radiant flux (CRF) ranges from 1.04 W/cm² at 100 mm to 0.10 W/cm² at 900mm.

Class I : $\geq 0.45 \text{ W/cm}^2$

Class II : $0.22 \text{ W/cm}^2 \leq 0.45 \text{ W/cm}^2$

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European vs American Fire Rating Standards

Swedish Standard – NT Fire 007

- Also known as the Nordic method. The objective of this test is to measure the flooring material ability to withstand flame spread and the smoke development. The test method involves in an enclosed chamber and the flooring material with underlayment is inclined at 30°. The test lasts 15 minutes or until the flame extinguishes itself or the flame reaches the end of the specimen.
- Similar to: Danish DS/INSTA 413, Norwegian NS-INSTA 413, Finnish SFS 4194 & ENV 1187-2
- Floors in Europe are built to a Class C or higher.

http://www.vtt.fi/inf/julkaisut/muut/2009/SP_Report_2008_29%5B1%5D.pdf

European EN ISO 13501-1

- EN ISO 13501-1 is set by the European Commission. Flooring materials are classified separate from other materials used in building construction.
- Each class level is tested according to different requirements as follows:
 - Class F & Class E are tested in accordance to EN ISO 11925-2: Reaction to fire tests – Ignitability of building products subjected to direct impingement of flame – Part 2: Single-flame source test
 - Classes D, C, & B are tested in accordance to EN ISO 11925-2, as well as, EN ISO 9239-1: Reaction to fire tests for floorings. Part 1: Determination of the burning behaviour using a radiant heat source
 - Class A2 & Class A1 are tested in accordance to EN ISO 1182: Reaction to fire tests for building products. Non-combustibility test, as well as, EN ISO 1716: Reaction to fire tests for building products. Determination of the heat of combustion

https://www.peroni.com/lang_UK/_download/EN_Reaction_to_Fire_Classification.pdf

Comparable Standards:

Europe: EN ISO 9239-1/EN 13501-1

USA: NFPA 253/ASTM E648

Method: Flooring radiant panel

Different Species of Wood Reaction to Fire

The table below was taken from the American Wood Council's Flame Spread Performance of Wood Products guide. The table describes the flame spread and smoke development of different species of wood, to show the differing characteristics of the most popular species of wood used in construction.

American Wood Council (2010). Design for Code Compliance: Flame Spread Performance of Wood Products.

Fire Rated Finishes

A Class A flame retardant finish does not exist for interior hardwood flooring. The flame retardant finish cannot be wet, which would cause blushing. Class B fire rated hardwood floor finishes exist.

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Definition	Classification according to European Standard EN 13501-1				
	Construction products			Floorings	
non-combustible materials	A1			A1 _f	
	A2 - s1 d0 A2 - s2 d0 A2 - s3 d0	A2 - s1 d1 A2 - s2 d1 A2 - s3 d1	A2 - s1 d2 A2 - s2 d2 A2 - s3 d2	A2 _f - s1	A2 _f - s2
combustible materials - very limited contribution to fire	B - s1 d0 B - s2 d0 B - s3 d0	B - s1 d1 B - s2 d1 B - s3 d1	B - s1 d2 B - s2 d2 B - s3 d2	B _f - s1	B _f - s2
combustible materials - limited contribution to fire	C - s1 d0 C - s2 d0 C - s3 d0	C - s1 d1 C - s2 d1 C - s3 d1	C - s1 d2 C - s2 d2 C - s3 d2	C _f - s1	C _f - s1
combustible materials - medium contribution to fire	D - s1 d0 D - s2 d0 D - s3 d0	D - s1 d1 D - s2 d1 D - s3 d1	D - s1 d2 D - s2 d2 D - s3 d2	D _f - s1	D _f - s1
combustible materials - highly contribution to fire	E		E - d2	E _f	
combustible materials - easily flammable	F			F _f	

Table 1 Reported Flame Spread Indices of Solid Wood Products

Material ¹	ASTM E84 Flame Spread Index	Flame Spread Class	ASTM E84 Smoke Developed Index	Source ²
Alder	80	C	165	HPVA T-14189 (2013)
Birch, Yellow	NA ⁴	C ⁴	NA	UL527 (1971)
Cedar, Alaska Yellow	50	B	115	HPVA T-12704 (2008)
Cedar, Port Orford	60	B	150	HPVA T-12694 (2008)
Cedar, Western Red	65	B	150	HPVA T-14388 and T-14495 (2014)
Cottonwood	NA ⁴	C ⁴	NA	UL527 (1971)
Cypress	NA ⁴	C ⁴	NA	UL527 (1971)
Douglas-fir	70	B	80	HPVA T-14253 (2013)
Gum, Red	NA ⁴	C ⁴	NA	UL527 (1971)
Hem-Fir Species Group ³	60	B	70	HPVA T-10602 (2001)
Maple (flooring)	NA ⁴	C ⁴	155	CWC FP-6 (1973)
Oak, Red or White	NA ⁴	C ⁴	NA	UL527 (1971)
Pine, Eastern White	70	B	110	HPVA T-14186 (2013)
Pine, Idaho White	NA ⁴	B ⁴	125	HPVA T-592 (1974)
Pine, Lodgepole	NA ⁴	C ⁴	210	CWC FP-6 (1973)
Pine, Ponderosa	NA ⁴	C ⁴	NA	UL527 (1971)
Pine, Red	NA ⁴	C ⁴	230	CWC FP-6 (1973)
Pine, Southern Yellow	70	B	165	HPVA T-14254 (2013)
Pine, Western White	NA ⁴	B ⁴	NA	UL527 (1971)
Poplar, Yellow	125	C	125	HPVA T-14512 (2014)
Redwood	55	B	135	HPVA T-14185 and T-14243 (2013)
Spruce, Black	45	B	250	HPVA T-14053 (2013)
Spruce, Black (4" thick, 3 layers of cross laminations)	35	B	55	HPVA T-14054 (2013)
Spruce, White	NA ⁴	B ⁴	NA	CWC FP-6 (1973)
Walnut	NA ⁴	C ⁴	NA	UL527 (1971)

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Table 1 Footnotes

- 1 Thickness of material tested is one-inch nominal except where indicated.
- 2 Sources: CWC – Canadian Wood Council; HPVA – Hardwood Plywood Veneer Association; UL – Underwriters’ Laboratories. Test report numbers and year of test are indicated.
- 3 The Hem-Fir Species Group represents six species: Californian Red Fir, Grand Fir, Noble Fir, Pacific Silver Fir, Western Hemlock, and White Fir. The reported flame spread index represents a product containing a mixture of these species. When lumber is from a single species refer to the specific species flame spread index.
- 4 Flame spread index cannot be directly determined from the referenced source, however, the reported Flame Spread Class is deemed to be a reasonable estimate based on changes to the analysis method of test results as reported within the referenced source.

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