

Fire Engineering®

Construction Concerns: Room Contents vs. Rated Assemblies Article by Gregory Havel

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When firefighters think of a “fire-rated” wall, floor-ceiling assembly, or door and frame, we usually think of a rating in “hours.” Photo 1 shows the labels on a three-hour-rated door and frame in a four-hour-rated masonry wall located between a factory’s office wing and a manufacturing area with hazardous processes.



The “fire rating” is from a test described by ASTM Standard E119 and National Fire Protection Association (NFPA) Standard 251, *Standard Methods of Tests of Fire Resistance of Building Construction and Materials*, 2006 edition. This test was first adopted as a standard in 1918 and has been refined since. The test uses the Standard Temperature-Time curve (Photo 2) from the standards to raise the temperature on one side of the assembly to be rated to the proper level for the proper amount of elapsed time. If the assembly has been raised to a temperature of 1,700° F (927° Celsius) during a period of an hour or more, as shown on the curve, and is undamaged (or receives limited damage as defined by the test), it receives a one-hour rating. If it has been raised to a temperature of 1,850° F (1,010° C) during a period of two hours or more, as shown on the curve, and is undamaged (or receives limited damage as defined by the test), it receives a two-hour rating. Photo 2 shows temperatures and times for up to an eight-hour rating.

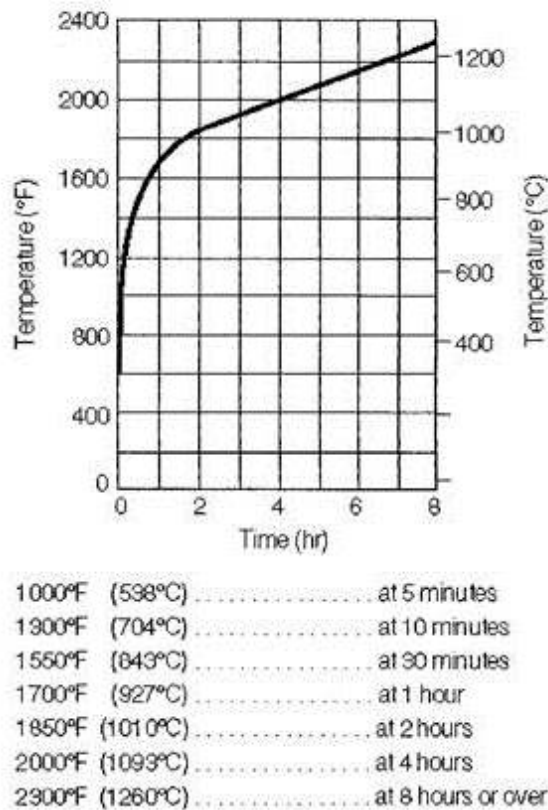


FIGURE 4.1.1
Temperature-Time Curve.

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This Standard Temperature-Time curve is based on the combustion of wood and other cellulose materials with known burning characteristics. Today's test procedure uses gas burners that permit precise regulation of temperature and time, but still uses the same temperature-time curve.

In today's residences, commercial occupancies, warehouses, and factories, much of the fire load is no longer wood or cellulose-based. It is made from petroleum products in the form of plastics, foam plastics, and synthetic fabrics that contain a greater amount of heat energy and burn with a faster rate of heat release at higher temperatures than the wood fire upon which the temperature-time curve is based.

As a result, a rated assembly exposed to a fire of petroleum-based plastics and synthetics (or even a fire of cellulose-based furnishings with the right fuel arrangement and ventilation) may not remain an effective barrier to fire spread for the full time of its rating in hours because exposure to higher temperatures and faster rates of heat release. Today's room contents fires can follow a different temperature-time curve than the one from the standard--a curve that is to the left (faster-burning) and above (hotter) than the curve from the standard.

How long will a rated wall, floor-ceiling assembly or door and frame withstand exposure to one of today's fires? There is no precise answer to this question.

Tests conducted by Underwriters Laboratories (UL) and the National Institute for Standards and Technology (NIST) fire researchers in laboratories, room fire mock-ups, and acquired structures using several types of fuels indicate that the time needed for fire development, the rate of heat release from the fuel, the maximum temperature, and the time from ignition to flashover are dependent upon:

- The heat content of the fuel in British Thermal Units (BTUs) or calories
- The quantity of fuel present
- The rate of heat release of the fuel
- The arrangement (geometry) of the fuel
- The amount of oxygen available to the fire after ignition from air in the room and from ventilation
- Changes in ventilation patterns (and the amount of oxygen available) because of opening of doors and failure of window glass

It is unlikely that the Standard Temperature-Time Curve will be modified or that a new test will be developed because of the variables noted above that affect a fire in most types of fuels, including wood and other cellulose materials, under most conditions. The "standard" is precisely that: a fire of a specific type of fuel in a specific arrangement for a specified length of time and temperature that produces similar or identical results in repeated trials.

As firefighters, we must not assume that a one-hour assembly will protect the rest of the building, or our operating position, for one hour. We should assume that the assembly is more fire-resistant than other types of assemblies and that it can be used as a defensive position to protect building occupants, firefighters, and property. We must never assume that the rated assembly will protect our position and ourselves for the full period of its rating.

We can assume that the proportions between assemblies of different hour-ratings will remain true: a two-hour-rated assembly will resist exposure to the fire for about twice as long as a one-hour-rated assembly; but only about half as long as a four-hour-rated assembly.

We can easily counter the effects of today's hotter, faster-burning fires and the possible failure of fire-rated assemblies in a shorter time than that with which they are rated. We can ensure that the commercial and larger residential structures (and even single-family residences) in our jurisdiction are protected with automatic fire sprinkler systems, which have a long history of success in controlling or extinguishing fires with the discharge of a small number of sprinkler heads. This results in the protection of building occupants and firefighters; reduced temperature and amount of heat released by the fire; reduced property loss; and a fire that is still manageable upon the arrival of the fire department. At the same time, sprinklers can extend the time that a fire-rated assembly will resist exposure to the fire by reducing the size of, and heat released by the fire.

To ensure reliability, automatic fire sprinkler systems should be installed and maintained using the NFPA 13 series of standard as the minimum:

- NFPA Standard 13, *Standard on Installation of Sprinkler Systems*
- NFPA Standard 13D *Standard on Installation of Sprinkler Systems in One- and Two-Family Dwellings and Manufactured Homes*
- NFPA Standard 13R *Standard on Installation of Sprinkler Systems in Low-Rise Residential Occupancies*

The 2013 editions of these three standards are the most current; although our state or municipality may cite an older edition in its building and fire codes.



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