CHAPTER

7

FIRE AND SMOKE PROTECTION FEATURES

The types of construction and the fire-resistance requirements of the *International Building Code*® (IBC®) are based on the concept of fire endurance. Fire endurance is the length of time during which a fire-resistive construction assembly will confine a fire to a given area, or continue to perform structurally once exposed to fire, or both. In the IBC, the fire endurance of an assembly is usually expressed as a "___-hour fire-resistance-rated assembly." Chapter 7 prescribes test criteria for the determination of the fire-resistance rating of construction assemblies and components, details of construction of many assemblies and components that have already been tested, and other information necessary to secure the intent of the code as far as the fire resistance and the fire endurance of construction assemblies and components are concerned. Additionally, Chapter 7 addresses other construction items that must be incorporated into a building's design in order to safeguard against the spread of fire and smoke.

Section 703 *Fire-Resistance Ratings and Fire Tests*

It is the intent of the IBC that materials and methods used for fire-resistance purposes are limited to those specified in this chapter. Materials and assemblies tested in accordance with ASTM E 119 or UL 263 are considered to be in full compliance with the code, as are building components whose fire-resistance rating has been achieved by one of the alternative methods specified in Section 703.3.

703.2 Fire-resistance ratings. This section indicates that building elements are considered to have a fire-resistance rating when tested in accordance with the procedures of ASTM E 119 or UL 263. Figures 703-1 through 703-5 depict the fundamental testing requirements of the two standards. The intent of the IBC is that any material or assembly that successfully passes the end-point criteria depicted for the specified time period shall have its fire-endurance rating accepted and the assembly classified in accordance with the time during which the assembly successfully withstood the test.

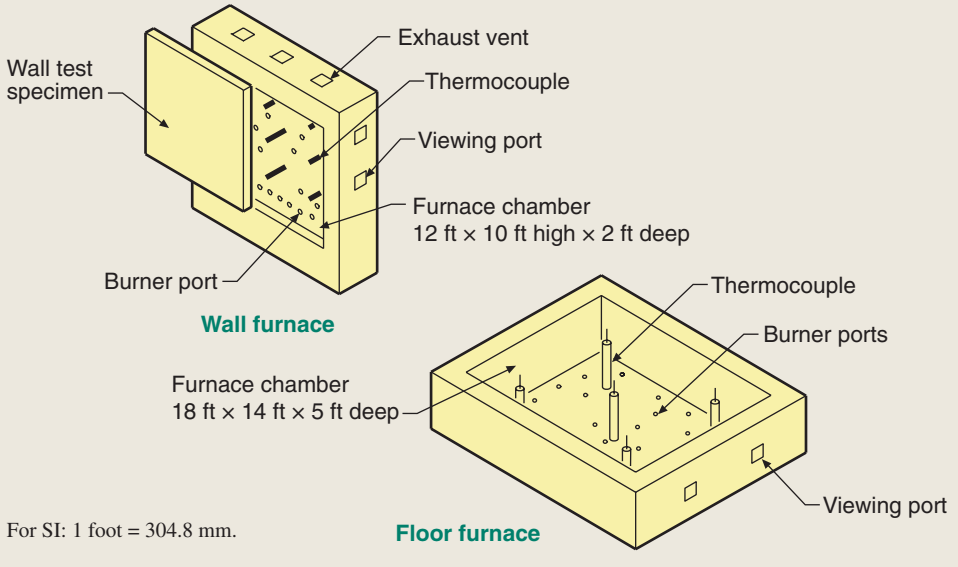

Figure 703-1
Test furnaces.

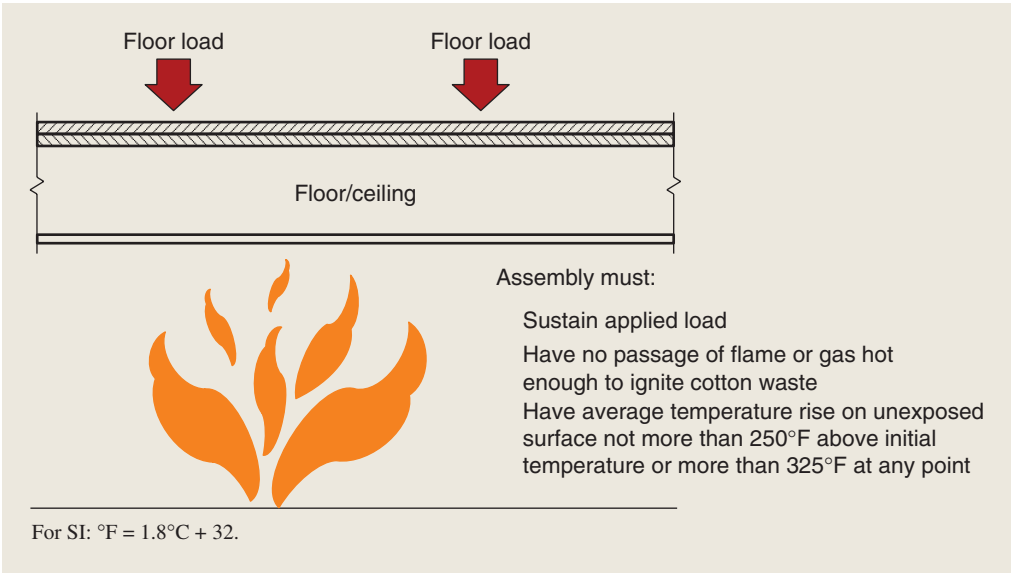

Figure 703-2
Floor assembly fire test.

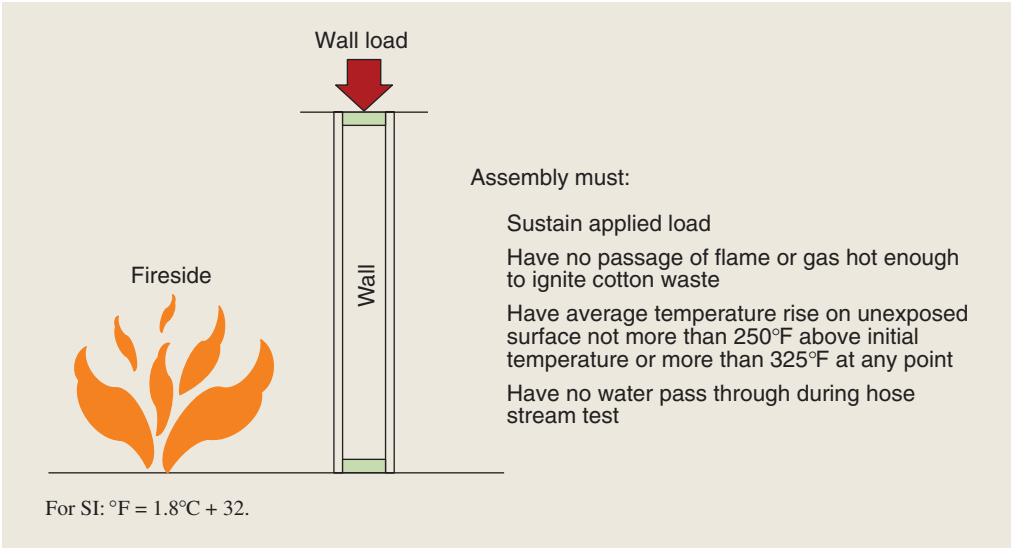

Figure 703-3
Conditions of acceptance—wall fire test.

Although early fire testing in the United States began as long ago as the 1890s, the standard fire-endurance test procedure using a standard time-temperature curve and specifying fire-endurance ratings in hours was developed in 1918. The significance of 1918 and later standards is the fact that they were and are intended to be reproducible so that the test conducted at Underwriters Laboratories (UL) can be compared with the test of the same assembly conducted at the University of California, Ohio State University, or other testing facility. An often-expressed criticism of a standard such as ASTM E 119 or UL 263 is that "it does not represent the real world." This is true in many cases, and for that reason it should not be thought of as representing the absolute behavior of a fire-resistance-rated assembly under most actual fires in buildings. There are too many variables that affect the fire endurance of an assembly during an actual fire, such as fuel load, room size, rate of oxygen supply, and restraint, to consider that the test establishes absolute values of the real-world fire endurance of an assembly. However, it is a severe test of the fire-resistive qualities of a material or an assembly, and because of its reproducibility, it provides a means of comparing assemblies.

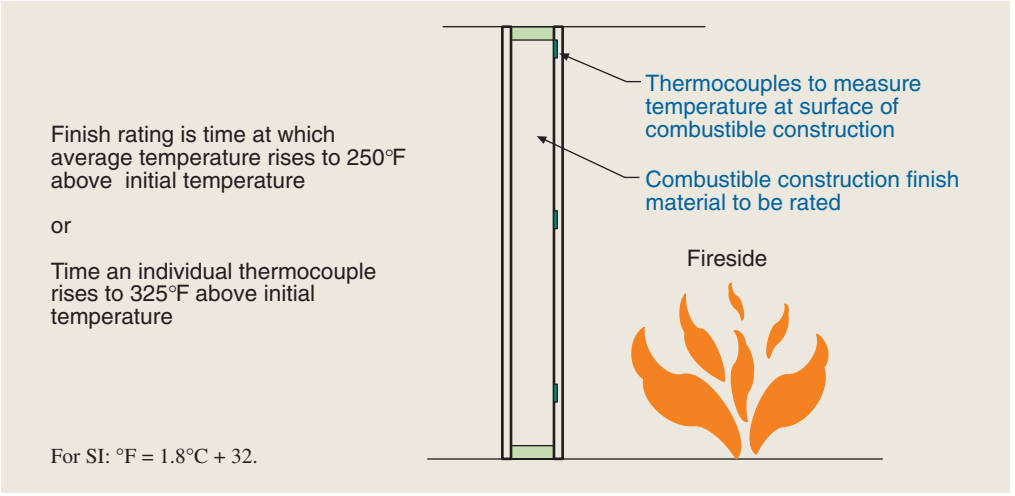

Figure 703-4
Combustible assembly for determining finish rating.

In addition to the fire-endurance fire ratings obtained from the standard fire tests of ASTM E 119 and UL 263, it is also possible to obtain, as expressed in the standard, the protective membrane performance for walls, partitions, and floor or roof assemblies. In the case of combustible walls or floor or roof assemblies, it is also referred to as the finish rating. Although the test standard does not limit the determination of the protective membrane performance to combustible assemblies, its greatest significance is with combustible assemblies.

The end-point criteria for determining the finish rating are that the average temperature at the surface of the protected materials shall not be greater than 250°F (121°C) above the beginning temperature. Furthermore, the maximum temperature at any measured point shall not be greater than 325°F (163°C) above the beginning temperature. These temperatures relate to the lower limit of ignition temperatures for wood. Figure 703-4 illustrates the determination of the finish rating for a wall assembly, which is usually determined during a fire-endurance test of the assembly.

The condition of acceptance, also referred to as failure criteria and end-point criteria, of fire-resistance-rated assemblies are as follows:

1. For load-bearing assemblies, the applied load must be successfully sustained during the time period for which classification is desired. There shall be no passage of flame or gases hot enough to ignite cotton waste on the unexposed surfaces.
2. The average temperature rise on the unexposed surface shall not be more than 250°F (121°C) above the initial temperature during the time period of the test.
3. The maximum temperature on the unexposed surface shall not be more than 325°F (163°C) above the initial temperature during the time period of the test.
4. Walls or partitions shall withstand the hose-stream test without passage of flame or gases hot enough to ignite cotton waste on the unexposed side or the projection of water from the hose stream beyond the unexposed surface.

In addition to the conditions of acceptance just described, load-carrying structural members in roof and floor assemblies are subject to special end-point temperatures for:

1. Structural steel beams and girders—1,100°F (593°C) average at any cross section and 1,300°F (704°C) for any individual thermocouple, for unrestrained assemblies.
2. Reinforcing steel in cast-in-place reinforced concrete beams and girders—1,100°F (593°C) average at any section.

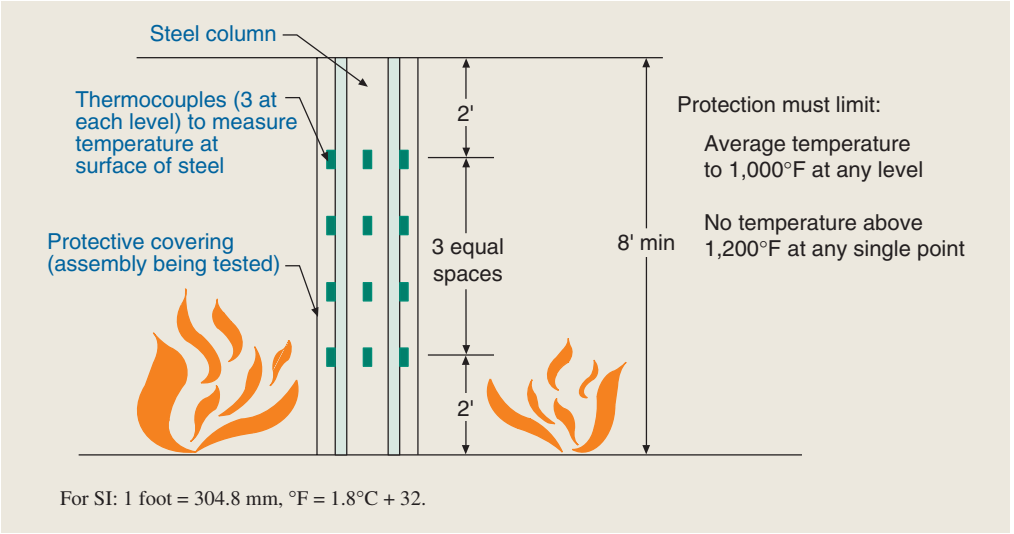

Figure 703-5
Alternative fire test of steel column protection.

3. Prestressing steel in prestressed concrete beams and girders—800°F (427°C) average at any section.
4. Steel deck floor and roof units—1,100°F (593°C) average on any one span.

As columns are exposed to fire on all surfaces, the standard has special temperature and testing criteria for these members:

1. The column is loaded so as to develop (as nearly as practicable) the working stresses contemplated by the structural design. The condition of acceptance is simply that the column sustain the load for the duration of the test period for which a classification is desired.
2. Alternatively, a steel column may be tested without load, and the column will be tested in the furnace to determine the adequacy of the protection on the steel column. The test and end points are depicted in Figure 703-5.

The exception to this section is intended to modify the acceptance criteria for exterior bearing walls so that the walls will receive a rating based on which of the two following sets of criteria occurs first during the test:

1. Heat transmission or flame and hot gases transmission for nonbearing walls.
2. Structural failure or hose-stream application failure.

The first set of end points measures the wall's ability to prevent the spread of fire from one side to the opposite side. It is considered overly restrictive to require that exterior bearing walls comply with this first set of end points for a longer time than would be required for a nonbearing wall located at the same distance from the lot line if it is still structurally capable of carrying the superimposed loads.

Nonsymmetrical wall construction. At times, an interior wall or partition is constructed nonsymmetrically as far as its fire protection is concerned, with the membrane on one side of the wall differing from that on the opposing side. Where the wall is to be fire-resistance rated, it must be tested from both sides in order to determine the fire-resistance rating to be assigned to the assembly. Based on the two tests, the shortest time period is determined to be the wall's rating. An assembly tested from only one side may be approved by the building official, provided there is adequate evidence furnished to show that the wall was tested with the least fire-resistive side exposed to the furnace. The provisions for exterior walls of nonsymmetrical construction differ somewhat from those addressing interior walls and are regulated by Section 705.5. **703.2.1**