

# Basic Fire Door Requirements



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## 1 Introduction

Fire testing of doors and hardware and the resulting labeling authorities granted, is a complex subject that is better understood when basic rules and guidelines are applied.

## 2 Doors

The fire rating classification of the wall into which the door is installed dictates the required fire rating of the door. The location of the wall in the building and prevailing building code establish the wall's fire rating. The associated door ratings are shown in table 1 below.

### 2.1 Hourly ratings

Steel fire doors are "rated" by time (in minutes or hours) that a door can withstand exposure

to fire test conditions. Hourly ratings include 1-1/2-hours, 1-hour, 3/4-hour, and 1/3-hour, with the maximum rating required of any swinging type fire door being three hours.

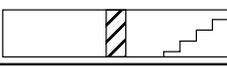
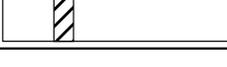
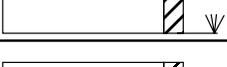
### 2.2 Three-hour (180 minute) doors

A door with a three-hour fire protection rating is usually found in walls that separate buildings or that divide a large building into smaller fire areas. The wall rating is four hours.

### 2.3 1-1/2-hour (90 minute) doors

Doors rated for 1-1/2 hours are found in 2-hour rated walls. These doors are commonly located in stairwells, or other enclosures of vertical communication through a building. They also occur in boiler rooms and in exterior walls that have potential for severe fire exposure from the outside the building.

**Table 1 – Fire door openings**

Opening	Wall Rating	Door and Frame Rating	Description and Use
	4 Hour	3 Hour (180 minutes)	These openings are in walls that separate buildings or divide a single building into designated fire areas.
	2 Hour	1-1/2 Hour (90 minute)	Openings of this type are used in enclosures of vertical communication or egress through buildings. Examples of these types of openings include stairwells and elevator shafts.
	1 Hour	1 Hour (60 minute)	These door and frame assemblies divide occupancies in a building.
	1 Hour	3/4 Hour (45 minute)	For use where there are openings in corridors or room partitions.
	2 Hour	1-1/2 Hour (90 minute)	This opening is in a wall where there is the potential for severe fire exposure from the exterior of the building.
	1 Hour	3/4 Hour (45 minute)	This opening is in an exterior wall that has the potential to be exposed to moderate to light fire from the exterior of the building.
	1 Hour	1/3 Hour (20 minute)	These openings are in corridors where smoke and draft control is required. The minimum wall rating is 1 hour.

## 2.4 One-hour (60 minute) doors

One-hour rated doors are used in walls between rooms, which are also typically one-hour rated.

## 2.5 3/4-hour (45 minute) doors

Doors with 3/4-hour fire protection ratings are used in one-hour walls. A 3/4-hour rated door is found in walls of corridors and room partitions. A door with this rating may also be located in the exterior wall of a building subject to moderate fire exposure from the outside of the building.

## 2.6 1/3-hour (20 minute) doors

One-third-hour or 20 minute doors are used in one-hour walls. These doors are used for corridor applications and in other applications where smoke and draft control is a primary concern.

## 2.7 Twenty-minute doors tested without hose stream

Doors and frames may also be rated as 20 minutes without a hose stream. These doors have successfully passed a 20-minute fire test, with the omission of the hose stream test, and bear a label that specifically states "Twenty-Minute-Rating Tested Without Hose Stream." These doors may be provided with vision lights only limited in size by the door manufacturer's fire labeling procedure authority.

Assemblies identified as "Twenty-Minute-Rating Tested Without Hose Stream" should not be confused with 1/3-hour fire rated doors, which have been tested in accordance with the standard fire test procedure that includes the hose stream test.

## 2.8 Summary

Doors are rated for three-fourths of the rating of the surrounding wall: A 3-hour door is used in a 4-hour rated wall; a 1-1/2-hour fire door is used in a 2-hour rated wall; and a 3/4-hour door is used in a one-hour rated wall. The notable exception is that 1/3-hour rated doors are also used with one-hour rated walls.

However, a door with a higher fire rating than the opening requires may also be used. For example, a door rated for 3 hours may be used in a 1-1/2-hour opening. All requirements

for the 3 hour rating, such as maximum glass size, door size, and other restrictions for the higher rated door must be met.

## 3 Glass

1/4" wire glass and ceramic glass are the most common types of glazing used in fire rated doors. The hourly rating of the door dictates the number and maximum size of the vision lights used in the door. Table 2 shows the limitations of size, area and number of vision lights in a door. Vision lights are not allowed in 3-hour rated fire doors, unless allowed by the local authority having jurisdiction. The vision light kit or window frame must be approved for use in a fire rated door.

## 4 Temperature rise doors

In certain applications, fire doors are required to minimize the transmission of heat from one side of the door to the other, as in the stairwell of a high rise building. If the door can limit the transmission of heat for a period of time, it is possible for people in a burning building to safely pass below the floor of fire origin. These doors are built with a specifically designed core and are referred to as temperature rise doors.

In addition to the hourly rating, the fire door label will also state the temperature rise rating of the door. Temperature rise ratings are 250°F, 450°F, and 650°F, and indicate the maximum rise in temperature above ambient temperature measured on the unexposed surface (non-fire side) of the door during the first 30 minutes of the standard fire test. The 250°F temperature rise designation is the most stringent rating of the three, since it requires the most limiting rise in temperature. A 250°F temperature rise door meets the requirements of specifications calling for a 450°F or 650°F temperature rise rating.

## 5 Louvers

Listed fusible-link type louvers to a maximum size of 24" x 24" are permitted in 1-1/2-hour

Table 2 – Door glazing

<b>1/4" Wire Glass</b>				
<b>Hourly Rating</b>	<b>Maximum Exposed Area ( Sq. In.)</b>	<b>Maximum Width</b>	<b>Maximum Height</b>	<b>Number of Lights</b>
20 min. w/o Hose	2994	35-13/16"	83-5/8"	No Limit
20 and 45 Minutes	1296	36"	54"	No Limit
20 and 45 Minutes*	2856	34"	84"	No Limit
60 and 90 Minutes*	2204	12"	46"	4
90 Minutes	100	12"	33"	No Limit
* Requires use of special Bedding Compound				
<b>Ceramic Glass</b>				
<b>Hourly Rating</b>	<b>Maximum Exposed Area ( Sq. In.)</b>	<b>Maximum Width</b>	<b>Maximum Height</b>	<b>Number of Lights</b>
20 min. w/o Hose	2835	35"	81"	No Limit
20 and 45 Minutes	1296	36"	54"	No Limit
60 Minutes	1296	36"	54"	No Limit
90 Minutes	1296	36"	54"	No Limit
180 Minutes	100	12"	33"	1

and 3/4-hour fire doors, with the louver mounted in the bottom half of the door. Louvers may not be used in 1/3-hour (20 minute) rated doors, or doors of other hourly ratings that may be part of a smoke and draft assembly. Doors with glass lights, or doors equipped with fire exit devices may not have louvers.

## 6 Fire door frames

Fire doors frames are not affected by the exposure ratings and opening classifications that apply to doors. There are *no hourly ratings* for a basic fire door frame unless the labeling on the frame specifically states that the frame is rated for something less than 3 hours. If a frame bears a recognized label qualifying it as a fire door frame, it may support a 3-hour, a 1-1/2-hour, a 3/4-hour, or a 1/3-hour door. Frames used in masonry walls may be used with a maximum 3-hour fire door, while frames used in drywall walls are intended to be used with a maximum 1-1/2-hour fire door.

## 7 Transom and sidelight assemblies

Labeled frames are available with transom areas, sidelight areas, or a combination of both. The transom and sidelight areas can be furnished with listed panel assemblies or listed glass, depending on the desired hourly rating. Frames with solid transom panel and/or side panels may be used in openings rated up to and including 1-1/2-hour. Some manufacturers have the capability to provide frames with solid transom panels that have a 3-hour rating. Frames with labeled glass transom lights and/or sidelights may be used with doors that have up to a one-hour rating. Examples of individual visible glass light areas are shown in table 3. Transom/sidelight frames may also have a rating of twenty minutes without a hose stream. The glass openings allowed are only limited by the individual manufacturer's listing.

The overall size of transom and sidelight frames is limited to the maximum size that a manufacturer has successfully fire tested. Since the size may vary, it is important to

consult the manufacturer when writing specifications.

The label applied to transom sidelight assemblies will state whether panels or glass are to be used in the frame. If the frame contains both panels and glass, the label for glass lights is used since it is the most limiting rating.

## 8 Fire window frames (borrowed light)

Fire window frames are labeled hollow metal glass light frames that are not attached to a door frame. Fire window frames with a maximum 3/4-hour rating may be provided in accordance with the manufacturer's listing. Individual glass openings are not to exceed 1296 square inches; the dimension for width or height shall not exceed 54 inches. Fire window frames with a 20-minute rating tested

without a hose stream are limited in overall size and glass area only by a manufacturer's individual fire test program. Fire window frames are typically used in corridor walls and may be provided for masonry or drywall construction. Consult the frame manufacturer as to the ability to supply fire window frames for drywall walls. Fire window frames may be provided with wired glass not less than 1/4-inch thick, or glass as approved by the labeling agencies.

## 9 Fire door hardware

To understand fire door hardware, you must remember that fire doors serve four main purposes:

1) To serve as a regular door at all times; 2) to provide ready egress during a fire; 3) to keep fire from spreading throughout the building; and 4) to protect life and property.

**Table 3 – Fire window frame and transom/sidelight frame glazing**

<b>1/4" Wire Glass</b>				
<b>Hourly Rating</b>	<b>Maximum Exposed Area ( Sq. In.)</b>	<b>Maximum Width</b>	<b>Maximum Height</b>	<b>Number of Lights</b>
20 min. w/o Hose	5268	109-3/4"	109-3/4"	No Limit
20 and 45 Minutes	1296	54"	54"	No Limit
20 and 45 Minutes*	4704	106"	106"	No Limit
* Requires use of special Bedding Compound				
<b>Ceramic Glass</b>				
<b>Hourly Rating</b>	<b>Maximum Exposed Area ( Sq. In.)</b>	<b>Maximum Width</b>	<b>Maximum Height</b>	<b>Number of Lights</b>
20 min. w/o Hose	3325	95"	95"	No Limit
20 and 45 Minutes	3325	95"	95"	No Limit
60 Minutes	2721	77"	77"	No Limit
<b>Panels</b>				
<b>Hourly Rating</b>	<b>Maximum Exposed Area ( Sq. In.)</b>	<b>Maximum Width</b>	<b>Maximum Height</b>	<b>Number of Lights</b>
90 Minutes <sup>1,2</sup>	2304	48"	48"	No Limit
90 Minutes <sup>1,3</sup>	4608	96"	96"	No Limit
180 Minutes <sup>1,3</sup>	4608	96"	48"	No Limit
<sup>1</sup> Check with individual manufacturer for specific panel size and construction				
<sup>2</sup> 1/2" thick composite panel				
<sup>3</sup> 1-3/4" thick hollow metal panel				

To adequately perform these functions, a fire door must be equipped with fire listed hardware for dependable operation. Proper hardware selections can be verified by consulting the current editions of "Building Materials Directory" published by Underwriters Laboratories Inc., "Directory of Listed Products" published by Intertek Testing Services and "Hardware for Labeled Fire Doors" published by the Door and Hardware Institute. These manuals identify hardware and other products that may be used in fire-rated assemblies.

The National Fire Protection Association's publication, NFPA 80, entitled, "Standard for Fire Doors and Fire Windows" provides guidance for installing fire doors and frames and hardware in the openings of a building.

### 9.1 Hinges

A labeled fire door must be hung on steel bearing-type hinges. The use of steel is necessary since non-ferrous metals become "elastic" at much lower temperatures, which could allow serious dislocation of the door during a fire. There are certain hinge designs made of non-ferrous metals which may be used on fire doors in accordance with the listing information for the particular hinge. These hinges are usually used on doors of lesser fire rating.

The bearing type knuckles on hinges are required in order to provide smooth operation and to minimize wear throughout the lifetime of the opening. Remember, a fire door must close in the event of a fire. Worn hinges will cause the door to sag, effectively preventing the door from closing. Exception: Some manufacturers may provide doors with hinges which are non-bearing type when they are part of a listing assembly.

NFPA 80 allows the use of standard weight (1.34 inches leaf thickness) 4-1/2" hinges on 1-3/4-hour doors up to 4'0" in width and 8'0" in height. Doors over 8' in height shall have heavy weight (.180 inches leaf thickness) 4-1/2" hinges. Some manufacturers have the capability of providing lighter weight hinges on doors over 8' in height as part of a listed assembly. (Consideration should be given to larger hinge sizes for heavy or frequent use doors.)

### 9.2 Latching devices

EVERY SWINGING FIRE DOOR MUST HAVE A LABELED AUTOMATIC LATCHING DEVICE TO ENGAGE THE STRIKE. Deadlocks may be provided in addition to the latch bolt, except on doors used as a means of egress, where interconnected locks may be used which retract the dead bolt with the latch bolt. Dead bolts may not be used in place of latch bolts.

When selecting latching devices, it is important to use the correct length of latch bolt, a requirement that can vary with the door construction and the manufacturer's fire testing program. It is common for a pair of doors to require a longer latch bolt throw than a single door. The minimum latch bolt length that must be used for any given door is indicated on the fire door label.

Some state and city building code authorities allow the use of a "push" and "pull" function on certain fire rated openings. This push/pull function does not include a self-latching device and does not allow a fire door to perform its vital function. Without a latching device the door will not remain closed during a fire. A manufacturer cannot fire label a door prepared only for a push/pull function.

### 9.3 Fire exit hardware

Exit devices may be used on labeled doors provided the door labeling specifically states "Fire Door To Be Used With Fire Exit Hardware." This label indicates that the door has been properly reinforced for fire exit devices. Doors that bear this label must pass a panic loading test in addition to the standard fire test. The panic load test measures the structural capability of the door to allow the hardware to operate in a panic situation.

Care must be taken when selecting exit devices for use on fire rated doors, as some devices have been tested for panic loading only, and not fire tested. In addition, exit devices have size and hourly rating restrictions, and must be properly labeled and identified as fire exit hardware.

### 9.4 Closing devices

A properly sized closing device is the last of the "basic" fire door hardware requirements. A

fire door must be in a closed and latched position to serve as a protective barrier in the event of a fire. For this reason, either spring hinges or a listed door closer is required. When the door is closed, the closer has served its role as a protective device.

### **9.5 Hold open devices**

Mechanical hold-open devices and hold-open arms on door closers should be avoided. Fusible link equipped closers with a hold-open feature are available, but the fusible linkages will not function quickly enough to allow the door to act as a protective barrier to save human lives. Tests and investigations have proven that smoke and toxic gases are the main cause of death in tragic fires. Doors held open by electromagnetic release devices are the only ones which will close quickly enough to prevent the passage of the toxic gases and smoke. These devices are activated by electronic detectors that sense smoke and/or the products of combustion.

## **10 Hardware — Pairs of doors**

Pairs of doors for labeled openings have some unique hardware requirements because of the presence of the inactive leaf.

### **10.1 Hinges and closing devices**

Pairs of doors for labeled openings require steel, bearing-type hinges or a listed continuous hinge. Closing devices are required on both leaves of a pair of doors except on mechanical equipment rooms where the closing device may be omitted from the inactive leaf, if acceptable with the authority having jurisdiction.

### **10.2 Latching hardware**

#### **10.2.1 Active leaf of pairs of doors**

The active leaf of a pair of doors may have either labeled fire-exit hardware, or any labeled latch that shall be opened by one obvious operation from the egress side.

#### **10.2.2 Inactive leaf of pairs of doors**

Where pairs of doors are being used as an entrance to an equipment room or similar situation, manual flush or surface mounted bolts

may be used to secure the inactive leaf. Under these circumstances, the NFPA recommends that the inactive leaf have no knob or other visible hardware.

Labeled fire exit devices are mandatory for exits unless local authorities give specific approval for the use of labeled self-unlatching and latching devices, such as automatic flush bolts on the inactive leaf. The self-unlatching feature must work only when the active leaf is opened.

### **10.3 Double egress pairs**

Double egress pairs of doors should only be provided with vertical rod fire-exit device hardware on both leaves. The vertical rod devices may be either surface mounted or concealed. Double egress doors and frames are part of a listed assembly and only those door designs that are named in a frame manufacturer's published listing may be used.

### **10.4 Astragals**

Astragals may or may not be required on pairs of doors depending upon the individual door manufacturer's labeling capabilities. Pairs of doors that do require an astragal shall have at least one that projects a minimum of 3/4-inch beyond the edge of the door to which the astragal is attached. Pairs of doors that are in a required means of egress may not be equipped with an astragal that inhibits the free use of either leaf. An astragal may not be used on pairs of doors with vertical rod exit devices on both leaves of the pair. Pairs of three hour doors always require an astragal per NFPA 80. Other combinations of fire exit hardware on the active leaf and a vertical rod device on the inactive leaf are acceptable.

In some situations a coordinator may be needed to allow the inactive leaf to close ahead of the active leaf. This ensures proper latching of pairs of doors. Some manufacturers are able to supply labeled pairs of doors with an open-back strike without an astragal, which eliminates the need for a coordinator.

## **11 Label materials and attachment**

There are several materials used for making fire labels that are acceptable to recognized

labeling agencies. These include steel, brass, aluminum, and non-metallic. Metal labels are attached by welding, riveting, pop riveting or with drive screws. Non-metallic labels are either die-slit or tamper proof with an adhesive back. Once applied, if any attempt is made to remove the label it will tear apart indicating tampering. Embossed labels are label markings which are stamped directly into the steel, and are also acceptable to the labeling agencies.

Fire labels on doors and frames are not intended to survive a fire to prove guilt after the fact. The label is there to indicate that the opening is protected by a properly constructed and applied steel door and frame. Adherence to fire protection requirements must be performed before a fire occurs.

## 12 Fire test methods

There are two primary fire test methods that are used to establish the fire ratings of doors. The first is UL 10B and is referred to as neutral pressure; the second is UL 10C, and is referred to as positive pressure.

The difference between the two test methods concerns the location of a neutral pressure plane in the test furnace. In the late 1990's, the test method required in building codes changed to a positive pressure test method. This change was adopted in the Uniform Building Code (UBC) and the International Building Code (IBC) for swinging-type fire doors.

Fire doors required to be tested to either method may be specified by calling out the test method or by indicating that the product must meet a specific section of a model building code.

## 13 Smoke and draft control

Doors that open onto corridors that are used for a means of egress may be required to have a smoke and draft control rating. Smoke and draft control assemblies are tested for both air leakage and fire resistance.

The assembly is tested to determine how much air leaks around the door. The assembly is

tested for air leakage with air that is at room temperature and air that has been heated to 400°F. The amount of air leakage must be below the standards that are set forth in the building code and/or NFPA 105.

An identical assembly is also subjected to a fire test. The unit must at least pass a 20-minute-without-hose-stream fire test to be qualified as a smoke and draft control assembly.

### 13.1 Gaskets

Gaskets are required for doors to pass a smoke and draft control test. The requirement for a gasket also includes the meeting edges of a pair of doors. The gaskets used in a smoke and draft control assembly must be fire rated and be listed for use in a smoke and draft control assembly. A bottom seal is not required for smoke and draft control assemblies.

The UBC code calls for a tight fitting assembly that meets the requirements of UBC 7.2 Part II. The UBC includes the following statement: "Smoke and draft control door assemblies shall be provided with a gasket installed so as to provide a seal where the door meets the stop on both sides and across the top."

### 13.2 Marking

The UBC requires Smoke and Draft Control assemblies to have an identification mark of "S" which appears on the label following the hourly rating.

## 14 References

NFPA 80-1999 "Standard for Fire Doors and Fire Windows"

NFPA 252-1995 "Standard Methods of Fire Tests of Door Assemblies"

Underwriters Laboratories Standard for Safety UL 10B "Fire Tests of Door Assemblies"

Underwriters Laboratories Standard for Safety UL 10C "Positive Pressure Fire Tests of Door Assemblies"

Uniform Building Code Standard 7-2 "Fire Tests of Door Assemblies."

International Building Code 2000

### **Suggested Procedure for the Selection of Swinging Fire Doors and Frames**

- A. Determine the appropriate building code.
- B. Check and fulfill the fire insurance company's requirements for the specific building.
- C. Basic Fire Door Requirements — Use this check list.
  - 1. A fire door must have a label attached.
  - 2. A fire door frame must have either an attached or an embossed label.
  - 3. A fire door must be self-latching.
  - 4. A fire door must be self-closing.
  - 5. If a fire door is held open, it must be equipped with a listed heat responsive device, fusible link or a smoke detection device.
  - 6. A fire door must be free of any obstructions which could prevent the door from operating properly, i.e., wedge door stops, chains, hookbacks, etc.
  - 7. Only listed fire door hardware shall be used.
  - 8. A fire door must have steel bearing-type hinges. (Exception: Non-bearing plain steel hinges may be used if they are part of a listed assembly.)
  - 9. Doors swinging in pairs that require astragals shall have at least one overlapping astragal. Pairs of doors within a means of egress shall not be equipped with an astragal that inhibits the free use of either leaf. A coordinator or open-back strike should be used to ensure proper closing.
  - 10. Fire doors with glass lights:
    - a. The glass frame and glazing bead must be metal.
    - b. The glass must be labeled wire glass not less than  $\frac{1}{4}$ " thick or as permitted by the labeling agency.
  - 11. Fire doors with fusible link louvers:
    - a. Only listed louvers can be used.
    - b. Louvers can be furnished in  $1\text{-}\frac{3}{4}$ " thick doors with a  $1\text{-}\frac{1}{2}$ -hour or a  $\frac{3}{4}$ -hour (no louver and glass light combinations are permitted).
    - c. Maximum louver size is 24" x 24".
    - d. Louvers are not permitted to be installed in doors with fire exit hardware or in stairwells.
- D. For maximum fire protection, Standard Number 80 of the National Fire Protection Association should be used for an installation guide.
- E. Purchase doors from a recognized, responsible manufacturer whose fire doors and frames are produced to conform to Fire Door Procedures and are subject to periodic inspections.