The Code Corner

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Openings – Part 1

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"The act or an instance of becoming open or being made to open." "An open space serving as a passage or gap." "An unfilled job or position; a vacancy." "A breach or aperture."[1]

The word "opening" has many meanings, as indicated above. However, with its many specific code-related definitions, it is surprising that the *International Building Code* (IBC)[2] does not provide its own definition of "opening." So, in the absence of a code-specific definition, the latter definition from the above list is very apt when referring to doors, windows, and other "breaches" in fire-resistance-rated assemblies.

Fire-resistance-rated assemblies (*i.e.* fire walls, fire barriers, fire partitions, smoke barriers, and horizontal assemblies) have been tested to restrict the spread of fire; but openings, such as doors and windows, located in these assemblies, introduce points of weakness. Therefore, openings in a fire-resistance-rated assembly must afford some protection to maintain a minimum level of fire resistance throughout the extent of the assembly. The IBC establishes requirements for openings in Chapter 7 in three locations. The first location is Section 705.8 for openings in exterior walls; the second location is Section 712.8 for floor doors in horizontal assemblies; and finally, the third location is Section 715, which is titled "Opening Protectives"—the primary location for opening requirements.

Standards for Openings

In order for an opening to be used in a fire-resistance-rated assembly, the opening must be tested in accordance with the standards indicated in the IBC based on type of opening. The IBC defines three types of openings: the fire door assembly, the fire window assembly, and the floor fire door assembly, which is used only in the horizontal position. The use of the word "assembly" with each of these terms indicates that it includes all components necessary for a complete opening, such as frames, hardware, glazing, and other accessories.

For side-hinged and pivoted swinging doors, the applicable test standards are National Fire Protection Agency's (NFPA) 252, *Standard Methods of Fire Tests of Door Assemblies*, or Underwriters Laboratories (UL) 10C, *Positive Pressure Fire Tests of Door Assemblies*. Other doors are required to be tested in accordance with either NFPA 252 or UL 10B, *Fire Tests of Door Assemblies*.

The positive pressure requirement for fire door assemblies was introduced in the 1997 Uniform Building Code after much debate and has remained a requirement in the IBC. It was expected that the hose stream requirement for fire doors would be eliminated from test standards if positive pressure was incorporated, but the hose stream test (discussed in the next paragraph) has remained in U.S. fire door test standards. UL 10C integrates the positive pressure requirements into the test standard; however, NFPA 252 does not, so the IBC requires that the neutral pressure plane be moved to 40 in. or less above the sill after 5 minutes into the test. The positive pressure requirement provides a more realistic condition experienced by fire door assemblies during an actual fire event (See Figure 1).

[1] The American Heritage Dictionary of the English Language, Fourth Edition, 2000, Houghton Mifflin Company.
[2] References to the IBC in this article are for the 2009 Edition.

The hose stream portions of the UL 10C and NFPA 252 tests are not indicative of an assembly's ability to withstand firefighting operations, but to test the structural durability of the assembly through thermal shock from the cool water and the impact and scouring effect of the water blast against the assembly. Fire door assemblies in walls of corridors and smoke barriers are not required to pass the hose stream test of either standard.

An exception to the tests above are those doors that have been tested in accordance with UL 10A, UL 14B, and UL 14C. The doors applicable to these standards are tin-clad fire doors usually constructed of a wood core with sheet metal applied to faces and edges. Historically, tin-clad doors were often associated with old warehouses, and may be of the swinging, horizontally sliding, or vertically sliding types. Even so, some manufacturers continue today to fabricate doors of this type.

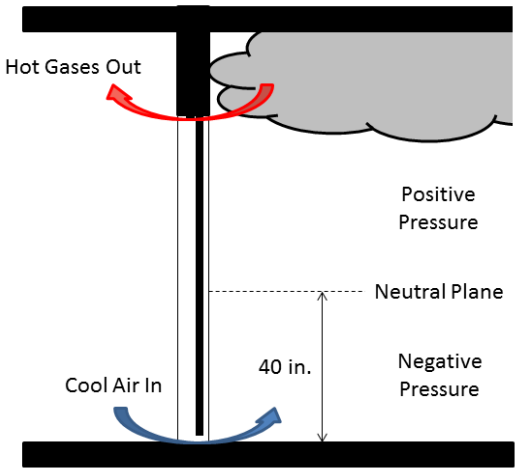

Figure 1 - Positive Pressure Requirement

Another exception to the door testing requirements is for floor fire door assemblies. Doors of this type are required to be tested in accordance with NFPA 288, *Standard Methods of Fire Tests of Floor Fire Door Assemblies Installed Horizontally in Fire Resistance-Rated Floor Systems*. Where openings are needed in a fire-resistance-rated horizontal assembly, the floor fire door can be a solution. Floor doors are subject to fire exposure that is different from that experienced by standard vertical fire doors, such as the lack of differential pressure along the plane of the door surface and exposure to higher temperatures from the rising heat.

For fire window assemblies, the required tests are either NFPA 257, *Standard on Fire Tests for Window and Glass Block Assemblies*, or UL 9, *Fire Tests of Window Assemblies*. The only exceptions to these standards are wired glass and glazing complying with the requirements of ASTM E 119, *Standard Test Methods for Fire Tests of Building Construction and Materials*, or UL 263, *Fire Tests of Building Construction and Materials*. The latter exception will be addressed in detail in Part 2 of this article. Like fire door assemblies, fire window assemblies are also required to be tested under positive pressure, but only within 10 minutes of test start and at a height that leaves two-thirds of the window above the neutral plane.

Fire Door Assemblies

The required fire protection rating of a fire door assembly is based upon both the rating and the type of fire-resistive assembly in which the fire door assembly is located. Like fire-resistive assemblies, the fire protection ratings for fire door assemblies are also given in hours. Fire protection ratings are provided in Table 715.4 of the IBC.

Fire door assemblies, at a minimum, must be provided with a label complying with the requirements of NFPA 80, *Standard for Fire Doors and Other Opening Protectives*, and shall bear the name of the manufacturer or the manufacturer's traceable identification number, the name or trademark of the third party inspection agency, and the fire protection rating (See Figure 2). Frames for fire door assemblies are also required to have a label, but it is not required that the fire protection rating be included.

In addition to controlling the spread of fire, fire door assemblies must also control drafts and the passage of smoke. To measure a fire door assembly's performance in these areas, the assembly shall be tested in accordance with UL 1784, *Air Leakage Tests of Door Assemblies*. New in the 2009 edition of the IBC is the basic acceptable performance level with which fire door assemblies must comply. Doors complying with the smoke and draft control requirements shall be identified with an "S" on the required label.

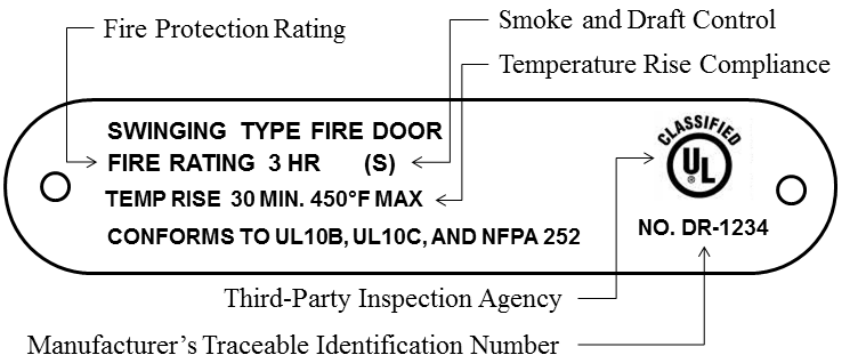

Figure 2 - Fire Door Label Example

If a door that requires a fire protection rating is larger than the fire door assembly that was tested, then the required label mentioned earlier will need to indicate the door is oversized. Another option is to have an approved testing agency provide a certificate of inspection attesting to the fact that the door is constructed in the same manner as the tested fire door assembly.

Fire door assemblies located in exit enclosures and exit passageways are required to minimize the transmission of heat from the exposed side through the door to the unexposed side, thus reducing the amount of radiant heat occupants may experience while egressing through the exits. The IBC requires that the temperature rise on the unexposed surface of the fire door assembly cannot exceed 450°F above the ambient temperature at the end of a 30 minute period. Fire door assemblies that are required to comply with this requirement must have that shown on the required labels (See Figure 2). Further, if glazing in the fire door assembly exceeds 100 in.^{2}, then the glazing must also pass the temperature rise criteria. Buildings that are equipped throughout with an automatic sprinkler system in accordance with either NFPA 13 or NFPA 13R are not required to comply with either temperature rise provision.

For obvious reasons, the IBC precludes the use of louvers in fire doors. However, UL provides listings for fire door louvers used in fire doors with fire protection ratings up to 1½-hour. The UL requires that such louvers be tested in accordance with UL 10B or UL 10C—the same tests to which fire door assemblies are subjected. With regard to the specific prohibition in the IBC, designers should obtain approval from the building official before incorporating a UL-listed louver into a fire door assembly.

In fire walls, the area of fire door assembly openings is limited to 156 ft.^{2} unless the buildings on each side of the fire wall are sprinklered throughout in accordance with NFPA 13—NFPA 13R systems are not allowed that exception. Additionally, the aggregate width of openings on any floor level cannot exceed 25% of the overall length of the fire wall.

Glazing in fire door assemblies is permitted, but some restrictions do apply. According to NFPA 80, glazing is permitted when tested as part of the fire door assembly. The IBC indicates that glazing shall

have a fire protection rating equal to the rating required for the fire door assembly. The size of glazing in a fire door assembly is limited by NFPA 80 and the IBC. NFPA 80 limits the area of glazing to that tested as part of the fire door assembly. However, ¾-hour doors are limited to a maximum area of 1296 in.^{2} with a maximum dimension not exceeding 54 in. Additionally, in 3-hour doors, NFPA 80 limits the glazed area to a maximum of 100 in.^{2}. The IBC further restricts glazing to 100 in.^{2} in 1½-hour fire door assemblies that are installed in fire barriers.

Glazing used in fire door assemblies shall be permanently labeled with a four-part identification code. The first part of the identification code is the letter "D," which indicates that the glazing is suitable for a fire door application and has been tested in accordance with NFPA 252. The second part is either an "H" or "NH," which indicates that the glazing has passed or not passed, respectively, the hose stream requirements of NFPA 252. The third part is either a "T" or "NT," which indicates the glazing complies or does not comply, respectively, with the temperature rise requirements of the IBC. And finally, the fourth part is the fire protection rating in minutes. Thus, an identification code such as "D—H—NT—120" translates into glazing suitable for a 2-hour fire door that has passed the hose stream test, but has not passed, or was not tested for, the temperature rise requirement.

Glazing utilized in fire door assemblies must also comply with the safety glazing requirements of the IBC. Chapter 24 of the IBC requires that glazing in doors comply with the requirements for Category I glazing as established by test in accordance with the Consumer Product Safety Commission (CPSC) 16 CFR 1201, *Safety Standard for Architectural Glazing Material*. Category I safety glazing will withstand a 100 pound weight swung from a pendulum at a distance of 18 in. from the glass surface. If the area of glazing exceeds 9 ft.^{2}, then the glazing must comply with Category II requirements, which increases the distance of the weight in the test to 48 in. from the glass surface.

A discussion on fire door assemblies would not be complete without addressing door hardware. A fire door assembly is required to have a latch that will secure the door when closed, preventing passage of smoke and fire into the unexposed side. But a latch would be useless if the fire door assembly is allowed to remain open, therefore IBC Section 715.4.8 requires that fire door assemblies be provided with closers that are either automatic- or self-closing, unless they are installed in walls separating sleeping units in Group R-1 occupancies.

Generally, "self-closing" requires the use of standard door closers that will close and latch the door when released. "Automatic-closing" usually includes devices such as magnetic door holders that release doors when triggered by an alarm situation. However, Section 715.4.8.2 states that automatic-closing fire door assemblies "shall be self-closing in accordance with NFPA 80." Therefore, the language of the IBC seems to limit all fire door assemblies to the "self-closing" type, even though NFPA 80 permits the use of "automatic-closing" fire door assemblies.

But Section 715.4.8.3 identifies where smoke-activated, automatic-closing fire door assemblies may be installed. These locations include doors across corridors; doors in smoke barriers, fire walls, fire partitions, and shaft enclosures; as well as in other locations. The actuation of the closer is limited to a 10-second delay after being triggered by a smoke detector or loss of power to the smoke detector or hold-open device. Overhead sliding or rolling fire door assemblies are permitted to be actuated by either heat-sensitive devices, such as a heat detector or fusible link, or smoke detectors connected to the building alarm system.

Transoms and sidelights that are a part of the frame for a fire door assembly are permitted provided the fire protection rating of the assembly is ¾-hour or less. For fire door assemblies exceeding a ¾-hour rating, transoms and sidelights must comply with either ASTM E 119 or UL 263. Glazed units that are not part of a fire door assembly shall comply with requirements for fire window assemblies.

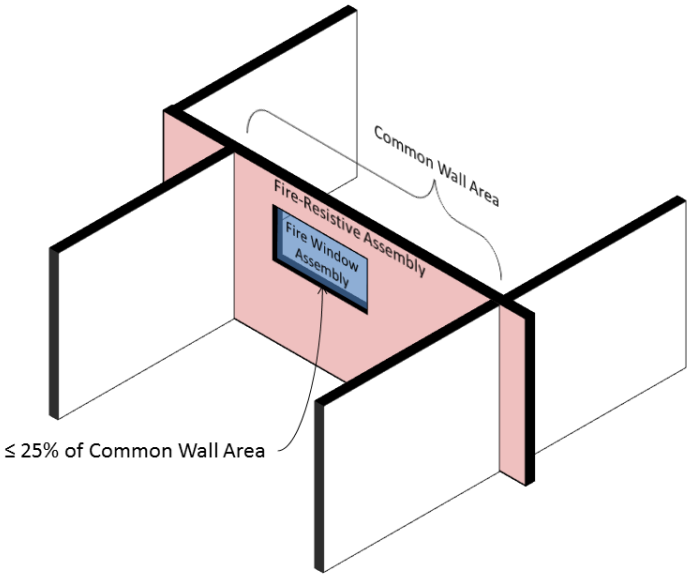

Figure 3 - Common Wall Area Determination

Fire Window Assemblies

The required fire protection ratings of fire window assemblies are provided in IBC Table 715.5 and are based on the type and rating of fire-resistive assembly in which the windows are installed. For interior construction, fire windows are limited to fire-resistive assemblies that have ratings of 1 hour or less. Therefore, all fire walls and fire barriers with ratings of 2 hours or more are not permitted to have fire window assemblies. In all cases where fire window assemblies are permitted, the area of a fire window assembly cannot exceed 25% of the common wall area in any room (See Figure 3).

The size of a single pane of glazing in a fire window assembly is limited to 1296 in.^{2} with no dimension exceeding 54 in. unless tested to a larger size, dimension, or both.

Wired glass assemblies are one of the exceptions to the testing requirements for fire window assemblies. Wired glass that is ¼-inch thick set in steel frames having a metal thickness not less than 0.125 in. are considered to meet the requirements for a ¾-hour fire window assembly. The maximum area of wired glass permitted under this exception is an absolute 1296 in.^{2} with no dimension exceeding 54 in. Wired glass assemblies that have been tested in accordance with the standards for fire window assemblies are permitted to have larger glazed areas and dimensions if tested at those larger sizes.

Like glazing in fire door assemblies, glazing in fire window assemblies are also required to be of safety glazing if located in areas identified in Chapter 24. The only exception is that glazing in fire window assemblies may be tested in accordance with the recently updated ANSI Z97.1, *Safety Glazing Materials Used in Buildings—Safety Performance Specifications and Methods of Test*, in lieu of the CPSC 16 CFR 1201 standard.

Fire-protection-rated glazing used in fire window assemblies must also be permanently marked with a label or other identification that provides the name of the manufacturer, the test standard, and a two-part identification code. The first part of the identification code is "OH," which indicates that the glazing is suitable for an opening and has passed the hose stream test. The second part of the identification code is the fire protection rating in minutes. Therefore, fire-protection-rated glazing with the identification code "OH—45" indicates the ¾-hour glazing is suitable for openings and has passed the hose stream test.

Installation

Fire door and fire window assemblies are required to be installed in accordance with NFPA 80. Doors required for smoke and draft control must be installed in accordance with NFPA 105, *Standard for the installation of Smoke Door Assemblies*. NFPA 80 limits the clearance at the bottom of a fire door to a maximum of ¾ in. above the floor and the clearance between the top and vertical edges of the door and door frame is ⅛ in. (± 1/16 in.) for steel doors and a maximum ⅛ in. for wood doors.

Openings—Part 2

Part 2 of this article will address openings in exterior walls, including calculating allowable area of protected and unprotected openings based on fire separation distance. Also included will be information on alternate methods used to determine fire protection ratings of openings. Part 2 will wrap up with a brief discussion on when a window is not considered an opening.

To comment on this article, suggest other topics, or submit a question regarding codes, contact the author at ron@specsandcodes.com.

About the Author: Ronald L. Geren, AIA, CSI, CCS, CCCA, SCIP, is an ICC Certified Building Plans Examiner, and is the principal of RLGA Technical Services located in Scottsdale, Arizona, which provides specifications and code consulting services to architects, engineers, owners, and product manufacturers. A 1984 graduate of the University of Arizona, Ron has over 26 years of experience with military, public, and private agencies.