

Egress Width

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“The inability of the exits to handle all of the occupants in the short time available for this fast growing fire contributed directly to the large loss of life.”

That is a quote from the NIST’s (National Institute of Standards and Technology) 2005 final report on The Station Nightclub fire that occurred on February 20, 2003, killing 100 people. Although the estimated 458 occupants within the building that night did not exceed the calculated maximum occupant load of 585 based on floor area per the 2003 *International Building Code* (IBC), the one of the most significant limiting factor was the lack of capacity of the egress system, and the improper distribution of exit width.

The Station Nightclub had four exits, one more than what is required by the IBC¹. However, the capacity of those exits to handle the number of occupants present was limited by the exits’ widths. The capacity of the nightclub’s exits was calculated to handle only 420 occupants, a little more than 71% of the building’s calculated occupant load, and 91% of the occupants in attendance that night. Had the exits been sized for the maximum occupant capacity of the building, the tragic result of the fire would have been significantly reduced, if not eliminated². Therefore, it is critically important to understand the egress width requirements of the building code, and apply them properly to new and existing buildings.

The best way to visualize a building’s egress system is to look at your city’s freeway system during the morning rush hour. Cars will work their way onto the freeway from their neighborhoods via side streets, and, as you move toward the city, more cars enter the freeway. And if your department of transportation put a little thought into their freeway planning, the number of lanes will increase as you make your way to the city center.

A building’s egress system is very similar, but instead of cars we have people making their way from the various spaces in a building via aisles and access doors to a corridor, that may connect to other corridors, and which will eventually lead to an exit. And along that path, as the number of people increase, the width of corridors and doors will typically get wider. But how do you know how wide to make those components? Like the department of transportation needing to know how many cars to expect on their freeway, you need to determine how many people will be exiting the building; commonly referred to as the building’s “occupant load.”

Calculating occupant load is covered in Section 1004 of the IBC³. It is based on an area per occupant according to the space’s function as provided in Table 1004.1.1. If a space is 700 square feet in area and the area per occupant is 100 square feet, the occupant load is 7. If accessory spaces egress through an adjoining space, such as a private office exiting through an open office area, then the adjoining space’s occupant load will be a combination of the occupants in the space plus the occupants exiting through the space. A new addition to the 2006 IBC is the provision that, upon approval by the building official, the actual occupant load may be used—even if it is less than the calculated occupant load.

Once the occupant load is calculated, the overall required exit width can now be determined. Section 1005 of the IBC establishes the provisions for calculating the egress width. To do so, two pieces of

information will be needed: whether or not a fire sprinkler system will be installed throughout the building and the occupancy classification. With those two pieces of information, utilize Table 1005.1 to obtain the egress width per occupant and multiply that number by the number of occupants.

For example, if a sprinklered, 4-story office building has 600 occupants per floor, the width per occupant for stairways is 0.2 inches, which calculates to be 120 inches (10 feet) of overall egress width for stairs. For all other egress components (doors, ramps, aisles, corridors, passageways, etc.) the width per occupant is 0.15 inches, or 90 inches (7'-6") overall. These dimensions seem quite large, but they'll be distributed among the number of exits required, which leads us to the next step.

Using the occupant load calculated, the number of required exits can now be determined. Per the IBC, at least two exits will be required from each room, space or floor. However, individual spaces are permitted to have a single exit in accordance with Table 1015.1. For example, spaces in business occupancies with less than 50 occupants need only have one exit. Buildings, under certain conditions, are also permitted to have only one exit in accordance with Table 1019.2. As an example, a building classified as a business occupancy can have one exit if it's a single story with no more than 49 occupants, and the travel distance from the farthest space to the exit does not exceed 75 feet.

The exit width should be as evenly distributed as possible among the required exits. At no time should the loss of one egress path diminish the egress capacity by 50%. Therefore, with buildings requiring only two exits, each exit must handle 50% or more of the occupants. For buildings requiring three exits, the egress width of any two exits must handle 50% or more of the occupants.

Let's return to our 4-story office building example. Since each floor has 600 occupants, three exits will be required per story in accordance with Table 1019.1. Therefore, we divide the required exit widths by three to determine the width of the three main exits. For each stair, the width would be 40 inches (120 inches divided by 3) and all other egress components would have a width of 30 inches. However, exit components cannot have a width less than that specified elsewhere. So, according to Section 1009.1, stairways with occupant loads of 50 or greater must have a minimum required width of 44 inches (or 48 inches if the stairway is part of an accessible means of egress); and, other components will have the following minimum widths:

- **Doors:** Clear width of 32 inches in accordance with Section 1008.1.1. It should be clarified that the clear width of a door is measured between the stop on the latch side and the face of the door on the hinge side when the door is open at 90 degrees. With that in mind, a standard 36-inch-wide door will have a clear width of approximately 33 inches.
- **Aisles:** 36 inches for B and M occupancies (Section 1014.4.1), and 23 to 48 inches in A occupancies (Section 1025.9.1) depending on number and arrangement of seating; however, aisle widths in A occupancies are not subject to the width requirements of Section 1005.
- **Corridors:** 44 inches in accordance with Section 1017.2 if occupant load is greater than 49; 36 inches otherwise.
- **Exit Passageways:** 44 inches in accordance with Section 1021.2 if occupant load is greater than 49; 36 inches otherwise.
- **Egress Courts:** 44 inches in accordance with Section 1024.5.1.

Therefore, our example office building will require three stairways having a minimum width of 44 inches; and the doors into and exiting from those stairways will need to be 32 inches wide. The first floor can exit directly to the exterior through three, 32-inch-wide doors. The corridors connecting these exits will need to have a width of not less than 44 inches; however, like the freeway adding lanes when the number of cars increases, if there's a point in any corridor that would handle more than 294 occupants (the capacity of a 44-inch-wide corridor), then the corridor width will need to be increased by the factors in Table 1005.1 for each occupant over the 294 maximum.

The freeway analogy also applies to stairways...even more so. There are two locations in the IBC that touch on this matter. The first location is Section 1003.6, which states, "The required capacity of a means of egress system shall not be diminished along the path of egress travel." The second location is Section 1004.4, and it states:

Where exits serve more than one floor, only the occupant load of each floor considered individually shall be used in computing the required capacity of the exits at that floor, provided that the exit capacity shall not decrease in the direction of egress travel.

The first provision is fairly self-explanatory; however, the second one may need some explaining. In older editions of the *Uniform Building Code* (1988 and earlier), the stairway widths were based on the occupant load of the floor they served plus specified percentages of the occupant loads from the two floors above. This created a rather complex calculation. Later editions of the UBC, and now the IBC, have simplified it considerably by requiring the stairway widths to be determined by the floor they're currently serving, provided it doesn't reduce the width of the stairway from the floor above.

To illustrate this, let's go back to our 4-story office building. If the third floor had an occupant load of 800 instead of 600, then each of the three stairways for that floor would need to be about 54 inches wide (800×0.2 , divided by 3 exits) and doors, leading into the stairway and exiting from the stairway at the first floor, will need to be 40 inches wide (800×0.15 , divided by 3 exits). Since the fourth floor has an occupant load of 600, the stairway can still be 44 inches wide from the fourth floor to the third floor. But once the stairway reaches the third floor, it will need to increase to 54 inches wide, and remain that way to the first floor, even though the second floor, which has 600 occupants, only requires a 44-inch-wide stairway.

Additionally, per Section 1004.5, if two floors converge at an intermediate level or floor, then the exit width will be based on the sum of the occupant loads. For instance, we'll add a basement to our 4-story office building; and because it houses mechanical and some storage spaces, the occupant load will only be 250. The exit widths for stairs and other components are 50 inches and 37.5 inches, respectively.

Since the occupant load of the basement is less than 501, there only needs to be two exits per Table 1019.1. So, we divide the widths by two to determine the required width for each exit. However, the widths will be less than the minimums previously stated, so the stairs need to be 44 inches wide, doors at 32 inches wide, and corridors at 44 inches wide. For efficiency, we'll use two of the stairs serving the other floors of the building to serve the basement.

In this example, the occupant loads of the basement and second floor will converge at the first floor. For that reason, the width of the door exiting the stair enclosure will be based on the sum of the occupant loads of those two floors for each of those stairs. Since the 600 occupants are distributed evenly among the three exits, each stair will handle 200 occupants. Therefore, each stair serving the basement will have

200 occupants from the second floor and 125 from the basement for a total of 350 occupants converging at the first floor exit discharge door from the stairway. At 350 occupants each, the doors will need to be 52.5 inches wide.

This brings us to another dilemma: a single door leaf cannot have a width greater than 48 inches. Overcoming this problem is simple...provide a double-wide door with two leaves: one having the minimum 32-inch-wide clear opening and the other making up the difference. However, if a mullion is used, then both leaves will need to provide a 32-inch-wide clear opening (See Section 1008.1.1).

And finally, it should be clearly understood that the required exit widths as determined above are not necessarily clear widths; some encroachment into these required widths is permitted. For example, doors can open into the egress path provided that the required width is not reduced by more than half at any point in the door's swing; and when fully open, the door cannot project more than 7 inches into the required width. Additionally, handrails on stairways and ramps cannot project more than 4.5 inches at or below the handrail height.

Having the capability to handle the number of occupants in a building quickly and safely is paramount in an egress system. It is even more critical in assembly occupancies where large numbers of people are gathered in a relatively small area. For that reason, the IBC provides a special egress section just for assembly occupancies. One of the key elements of that section is the "main exit." Since most people don't utilize the same assembly building on a regular basis, they aren't as familiar with the egress system as they would their work place or local grocery store. Therefore, in times of emergency, most people will exit the way they entered--through the main exit. Due to this typical human response, the building code requires that the main exit be sized to handle at least 50% of the occupant load when the occupant load is greater than 300.

The lack of a main exit complying with the requirements of the IBC was probably the single most building condition that led to the high number of deaths at the scene of The Station Nightclub fire. Forty of the victims were found at or near the main exit. Although the exterior door of the vestibule had a clear width of 68 inches and could handle 340 occupants, the interior vestibule door had only a clear width of 36 inches that could only handle 180 occupants...a little more than 39% of the people in attendance that night, and only 30% of the people it should have been designed to handle. Because of that bottle neck, the flow of panic-stricken people eventually stopped--just like that morning rush hour--and they were only inches away from safety.

There are many examples in fire history, beside The Station Nightclub, that suffered loss of life as a result of inadequate exiting. The NIST report identifies at least 13 events, going back as far as 1876, that experienced "crowd crush" at the exits. The building code requirements for minimal exit width are founded on this experience, as well as detailed research by organizations such as the NIST and the National Fire Protection Association (NFPA). It is not just enough to understand the need to provide a means of egress for building occupants, but to also understand the need to size them properly to ensure that all occupants can exit quickly and safely without overloading the exits.

¹ Per Table 1018.1, an occupant load between 501 and 1000 requires three exits.

² There were other factors in addition to occupant load and egress that contributed to the tragic loss, such as lack of fire sprinklers, improper use of finish materials, and use of pyrotechnics.

³ Although the NIST report used the 2003 IBC in its research, the published code edition at the time, this article will use the 2006 IBC, which was publicly released earlier this year. Therefore, some of the code section references will be different than those in the 2003 IBC.

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

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