CALCULATING OCCUPANT LOAD FOR AN ASSEMBLY OCCUPANCY
USING THE 2000 NFPA LIFE SAFETY CODE

Illinois OSFM Division of Technical Services

The Illinois Office of the State Fire Marshal (OSFM) has adopted the National Fire Protection Association's *Life Safety Code* - 2000 edition (also referred to in this document as the "Code") as the statewide standards for fire prevention and safety. The Life Safety Code is a comprehensive code that addresses many issues relevant to fire and life safety in new and existing occupancies (e.g., the need for fire alarm or fire suppression systems, exit lighting, emergency lighting, the number of exits, the width of exits, the type of interior finish that is allowed in the building, etc.).

The Life Safety Code applies different requirements for different types of occupancies. Therefore, an assembly occupancy is required to meet different requirements than a business office building, a hotel, or a storage occupancy, etc. This document limits its discussion to the review of the Code's methods for determining occupant loads and necessary exit capacity of an assembly occupancy. This document will not discuss the method of calculation for other occupancy classifications, which follow the same procedures but apply different occupant load factors or capacity factors and therefore, the associated math is different for other occupancy classifications.

The steps used to determine occupancy load can be broken down as follows:

1. Determine proper occupant load factor to be used
2. Determine "net" or "gross" floor area
3. Calculated expected occupant load
4. Determine egress capacity needed for the calculated occupant load
5. Determine minimum width requirements for aisles and aisle accessways located within seating arrangement
6. Determine minimum number of means of egress, based on occupant load
7. Determine main entrance/exit requirements
8. Other considerations and requirements

STEP #1 - DETERMINE PROPER OCCUPANT LOAD FACTOR TO BE USED

First, the Code defines what is called an "occupant load factor" for a building or space within a building. The occupant load factor to be applied to a building or space is prescribed in Table 7.3.1.2 of the Life Safety Code and is based upon the use of the building or space being calculated, and not the occupancy classification of the overall building. For example, when applying the prescriptive requirements of the Code a meeting room for fewer than 50 people within a business occupancy would be considered ancillary use of the business occupancy and have business occupancy chapter requirements applied to the room. However, for the specific purpose of calculating the occupant load and choosing an "occupant load factor" from Table 7.3.1.2 it is the actual use of the room that must be taken into consideration and therefore, in such a case the factors applying to an "assembly use" would be applied to the room.

The occupant load factor is a number that describes how many square feet per person should be considered when determining the occupant load. For example, in assembly occupancies, the two most commonly used occupant load factors are 7 net ft^2/person and 15 net ft^2/person. The "7" factor is used for "concentrated use" assembly occupancies such as the nightclubs, dance floors or multipurpose rooms where portable chairs are placed in rows for meetings, film viewing or lectures.

The "15" factor would be used in less concentrated use assembly occupancies that do not have fixed seating where a certain amount of space is occupied by furniture such as restaurant dining tables. In assembly occupancies with fixed seating, an occupant load is calculated as the number of fixed seats, taking into account also available egress capacity and minimum widths of aisle and aisle accessways, all of which is discussed later in this document.

In assembly occupancies with bench-type seating, such as religious pews or booths at a dining table, the Life Safety Code prescribes an occupant load factor of 1 person/18 inches of linear bench. In kitchen spaces that may be associated with assembly occupancies, the Code prescribes an occupant load factor of 100 ft^2/person. Occupant load factors for specialty use areas including swimming pool decks, exercise equipment rooms, stages, casinos and skating rinks are all addressed separately by the Life Safety Code.

STEP #2 - DETERMINE NET OR GROSS FLOOR AREA

Once the occupant load factor is determined, the area of a space or building must be determined. It is also important to note that some occupancies in Table 7.3.1.2 of the Life Safety Code allow the "net" area of a space or building to be used in conducting calculations (this is allowed for assembly occupancies). Other occupancy classifications must use the "gross" area of the building when determining occupant loads. When the Life Safety Code designates that "net area" can be applied, this means that permanent objects that take up space where people cannot sit or stand are subtracted from the total area of the room or building. (For example, space taken up by a bar, or fixed booths, pool tables, storage rooms, or columns in the building would be subtracted from the total area because people cannot stand or normally occupy these places).

STEP #3 - CALCULATE EXPECTED OCCUPANT LOAD

Once the total area of the building or space in question is known (using the prescribed "gross" or "net" areas as addressed above) then this area is divided by the previously identified occupant load factor to obtain an "occupant load".

For example, if you measured the area of an assembly building that is used as a night club to be 11,000 ft^2 in area and then you found that 1,000 ft^2 of space is not occupiable, you would have a "net" occupiable area of 11,000 – 1,000 = 10,000 ft^2. From Table 7.3.1.2 of the Life Safety Code you would apply the 7 person/ft^2 occupancy factor because it will be a "concentrated use" occupancy. Then the calculated occupant load would be:

$$10{,}000 \div 7 = 1{,}428 \text{ occupants. (This is the "occupant load")}$$

STEP #4 - DETERMINE EGRESS CAPACITY NEEDED FOR THE CALCULATED OCCUPANT LOAD

Once this "occupant load" is known, the Code prescribes a method of calculating just how much exit width is needed to safely egress this many occupants from the building. This involves the application of a "capacity factor" prescribed in Life Safety Code Table 7.3.3.1. For all assembly occupancies, the capacity factor for level components or egress (meaning doorways and ramps, but not stairs) is 0.2 inches/person and the capacity factor for stairways is 0.3 inches/person. The capacity factor is multiplied by the total number of occupants to obtain the "number of inches of exit width" that must be provided to safely egress the occupants from the space or building being calculated.

If the occupants are traveling straight out of the building on the same level (in other words, walking out doors, or walking on ramps and not negotiating stairs to get out) then the Code prescribes taking the occupant load and multiplying it by 0.2. In the above example, this would mean 1,428 x 0.2 = 285.7. This number is the number of "inches of exit width" that must be provided for the building to safely exit the 1,428 occupants that were calculated above. The facility, for example, could provide 8 doors that are each 36 inches in clear width for a total of 8 x 36 = 288 inches of exiting width to comply with the requirement.

If the occupants need to travel up or down stairs to exit, then the Code-prescribed factor of 0.3 must be used to calculate the exit width. Again, for the above example this would mean:

1,428 x 0.3 = 428.4 inches of stairway width.

Note that the total required egress width of stairs is larger than the total egress width resulting from calculating level paths of egress such as doors (428 inches compared to 285 inches) because the Code recognizes that the biomechanics of walking down stairs causes side-to-side swaying which prevents people from walking shoulder to shoulder as they would on a level plane and therefore more exiting width is needed when stairs are in the egress path.

STEP #5 - DETERMINE MINIMUM WIDTH REQUIREMENTS FOR AISLES AND AISLE ACCESSWAYS LOCATED WITHIN SEATING ARRANGEMENT

The Code requires that minimum widths be provided for seating aisles and seating aisle accessways (the walking space between rows of seating or rows of tables/chairs). These minimum widths could be a criteria that may limit the occupancy load of a space. The user should reference Section 12.2.5 for "new assembly occupancies" or 13.2.5 for "existing assembly occupancies" in the Code for the specific requirements.

STEP #6 - DETERMINE MINIMUM NUMBER OF MEANS OF EGRESS BASED ON OCCUPANT LOAD

Most buildings are required to have a minimum of two means of egress, remotely located from each other. Therefore, even though the calculated width of necessary exits may be able to be achieved with the installation of a single door, there would still be a requirement to provide a second door as the second means of egress. Occupancy owners often find that the "width of provided exits" far exceeds the Code-required minimum because they must provide the minimum "number of exits". The minimum number of exits becomes even more critical in larger-area occupancies, especially assembly occupancies. The Code requires that if 50 to 500 people occupy the building or space, then at least two exits are needed. If 501- 1000 occupants are calculated then a minimum of three exits are needed. Lastly, if more than 1000 occupants are calculated then a minimum of 4 exits are required to be provided.

STEP #7 - DETERMINE MAIN ENTRANCE/EXIT REQUIREMENTS

The Code recognizes an important characteristic about the occupants of assembly occupancies. Most occupants tend to attempt to exit a building via the door or stairway which they used to enter the building. This is usually the main entrance/exit to the room or building. Therefore, the Code requires that no matter how many different exit paths are provided, the "main entrance/exit" must be able to handle one-half of the calculated occupant load. The remaining exits provided must be able to handle the remaining 50% of the required egress capacity.

STEP #8 - OTHER CONSIDERATIONS AND REQUIREMENTS

The calculated occupant load using this process DOES NOT establish an absolute maximum number of occupants that can be in an assembly occupancy. This point is often misunderstood by code officials and building owners. What this calculation process does do, is establish the minimum amount of egress (exit) width that must be provided to ensure safe egress for the calculated number of occupants that the Life Safety Code believes will be occupying the given space. Occupancies that provide more than the prescribed number of exits (and thus greater than the code prescribed number of inches of exits) may have additional occupants in the room or space. However, there is a point when no matter how many exit doors or inches of exit width are provided, occupants are simply too packed into an occupancy to allow efficient exiting. The Code defines this as not less than 3 ft^2/person in waiting spaces, not less than 5 ft^2/person in occupancies with areas of less than 10,000 ft^2, and not less than 7 ft^2/person in occupancies with areas in excess of 10,000 ft^2.

Also, it is important to note that even if a building or room is provided with a sufficient number and width of egress routes to comply with the above calculation methods, other requirements of the Life Safety Code associated with the means of egress may cause the building to be in noncompliance with the LSC's requirements. For example:

- Exits, even if of sufficient width, cannot be credited as part of the total exit width from an occupancy unless all exiting requirements of the Life Safety Code are met. This means that amongst other requirements:
  - the exits must be marked with code-complying exit marking signs;
  - the exits cannot be obscured by draperies, mirrors or other items that might confuse exiting occupants;
  - exit paths must be kept clear, combustible material cannot be stored in the exit paths;
  - interior finish material (the material affixed to walls, floors and ceilings) must comply with code requirements for flame spread and smoke developed ratings.

- Prescribed travel distances to reach the closest exit from any point in the occupancy must be met regardless of the total number of exits provided to the occupants.

- Doors serving more than 50 occupants must swing in the direction of exit travel.

- Doors serving more than 100 occupants and capable of locking or latching must have approved panic or fire exit hardware.

- Every room constituting an assembly occupancy and not having fixed seats must have the occupant load of the room posted in a conspicuous place near the main exit from the room. Approved signs must be maintained in a legible manner by the owner or authorized agent. The signs must be durable and indicate the number of occupants permitted for each room use.