Fire Inspector I

CHAPTER SEVEN

OCCUPANCY SAFETY AND EMERGENCY PLANS

Slide 1	Welcome to the Chapter 7 Occupancy Safety and Emergency Plans. This Chapter is divided into three Parts. In part one, we will discuss: • Occupant loads: how to calculate them and factors affecting them • Two types of occupant load calculations -Design Occupant loads and Maximum Occupant Loads • Calculating occupant loads based on Gross floor area and net floor area • Means of Egress • Travel distance to an exit • Exit width • Dead end corridors
Slide 2	If you are following us in Jones and Bartlett's Fire Inspector Principals and Practices, First Edition Revised, you will note that the introduction deals with the adoption and use of building and fire codes and other fire safety documents. As these have been covered extensively in Chapter 1 and repeated in Chapter 5 Part 1, we will not be addressing them here.
Slide 3	One of the functions of the model codes is to help building designers, building officials, plans examiners and fire inspectors determine the number of people who can safely occupy the building or area. The term occupant load refers to the total number of people the means of egress of a building or portion thereof is designed for. Many code requirements are dependent upon the occupant load of the room or space in question. For example, the building code requires exit doors from a room or suite of assembly occupancy to be equipped with panic hardware if the occupant load is more than 100 people. The occupant load is normally established by the designer and verified by the plans examiner based on the floor area or part of the floor area based on: • The number of fixed seats in an assembly occupancy • Two persons per sleeping room or sleeping area in a dwelling unit or suite, or • The number of persons for which the area is designed, • Or from a table in the applicable building code. Reference NBC 3.4.6.16 (panic hardware)
Slide 4	There are two types of occupant loads; design occupant load, and maximum permissible occupant load. Design occupant loads are addressed in subsection 3.1.17 of the Building Code and are intended to indicate the approximate number of people

	which can be expected to occupy the space. Based on that number, the designer can determine further code requirements that may be applicable such as: • The minimum number of exits required • Fire safety systems that are required, such as sprinkler systems or fire alarms • Other things like the number of sanitary facilities required The design occupant load is considered a minimum occupant load but is not intended to limit the number of people that can safely occupy a room or building. If the designer designs the building or room for an occupant load different than that shown in the building code table, a sign indicating the occupant load must be posted in a conspicuous location. During the plan review process, the design occupant loads should be checked for accuracy as designers can make mistakes. This occupant load is critical in determining the egress requirements, distribution of exits, and travel distances. Along with other life safety equipment.
Slide 5	Article 2.7.1.3 of the fire code addresses the maximum number of people that are permitted to enter a room or area. This number is based on either .4m² per person or the capacity of the means of egress that is provided. The lowest figure (fewest people) calculated is used to establish the maximum occupant load. The maximum permissible occupant load using the .4m² fire code calculation cannot exceed the number of people that can safely be accommodated by the means of egress. For example: A room has an area of 200m². The maximum occupant load permitted by the fire code would be 200m² ÷ .4m² per person which equals 500 people. However, the available exiting, which is calculated using article 3.4.3.2 of the building code, only provides for 258 people. So the maximum occupant load for the room would be the lessor of the two figures or 258 people. In the majority of cases, the exit width will be the maximum occupant load limiting factor when using the calculations provided in the fire code.
Slide 6	2.7.1.3 of the fire code has an appendix note that says in part: “Assuming that the exit capacity is sufficient, the value of .4m² per person ensures that a crowd of people will be able to move steadily toward the exits.”

	This note goes on to say "Table 3.1.17.1 of Division B of the building code should not be used to determine the maximum permissible occupant load for rooms or spaces in existing buildings. Table 3.1.17.1 is intended to allow the building designer to calculate a minimum occupant load for the purposes of designing certain building features, such as means of egress and fire alarm systems." In all likelihood, the fire code calculation of maximum occupant load will be much higher than the design occupant load.
Slide 7	As we have talked about before, the National Fire and Building Codes are model codes, and the adopting jurisdiction can make changes as they see appropriate. When it comes to occupant load calculations some jurisdictions have made significant changes that fire inspectors working in that jurisdiction must be aware of.
Slide 8	In some cases, it is possible to have multiple occupant loads for the same space based on the use at the time. Often two occupant load signs may be posted depending on the configuration of the room. For example a banquet room with non-fixed seats and tables will accommodate less people than the same space with non-fixed seats but without the tables. The designer or building official may have provided several occupant load signs. During site visits and inspections the fire inspector should verify the maximum occupant load. This is especially important when there is an occupancy classification change or the room or area has been altered in a way that may affect exiting. A change in occupancy classification or alteration to the room or area should initiate a plan review. Any increase in occupant load should be verified as a change in exiting may also be required.
Slide 9	If you are asked to provide an occupant load calculation make sure you do so in conformance with your organizations policies. Many Provincial organizations provide guidance on occupant load calculations, some of which can be found in the Additional Resources section of this Chapter. Changing the maximum occupant load may require the owner to install a fire alarm system or other fire protection measures that were not required in the original design. For example, you are asked to calculate the occupant load for a church hall. Under the design calculation in the building code, the space for non fixed seats and tables was used, and the occupant load was established at 166 people based on a floor area of 150m^2.

	They would like to accommodate more people and think they have the room to do it. Using the fire code, you calculate the maximum occupant based on net floor area. After deducting the space taken up by tables and chairs, you determine the net floor area to be 125m². Dividing 125m² by .4m² per person, you determine the maximum occupant load to be 312 people. If the occupant load is increased above 300 a fire alarm system will be required by the building code which could be a costly installation for the church and may be beyond their means. Reference: NBC A-2..7.1.3.(1)
Slide 10	The net floor area is the gross floor area minus unoccupied accessory areas such as lobbies, corridors, stairways, washrooms, mechanical, electrical, closets, storage rooms, and furniture. In this case a washroom has been added that is 5m X 5m for a total of 25m2. The net floor area is the gross floor area of 600 m2 minus the 25m2 taken up by washrooms so the net floor area of 575 m2. Gross and Net floor area definitions may vary depending on the defining agency so fire inspectors should be familiar with the definitions used by their agency. Net floor area should be used when calculating the total number of occupants permitted.
Slide 11	There are limits for which occupants can safely travel to reach an exit, so the building code establishes maximum travel distances to exits based on the size and use of the building and the number of exits. For example, in a non-sprinklered building that has one exit, the maximum travel distance to the exit in an assembly occupancy is 15m and in a business and personal service occupancy travel distance increases to 25m. The travel distance is usually increased significantly if the building is sprinkler protected. If, during an inspection the travel distance to the exit seems to far, it should be checked for compliance which may necessitate a review of the approved building plans. Compliance may be as simple as rearranging the layout of the contents of the room. If compliance cannot be obtained remodeling or alterations to the building may be required. References BCBC 1.4.1.2 (2018) NBC Table 3.4.2.1 http://codes-guides.nrc.ca/IA/05NFC/intentframe.html
Slide 12	Lets now look at an example of a school classroom. The design occupant load for the classrooms, based on the building code is 33 people. There

	are many other factors however that determine the occupant load including the size and number of exits, door widths, stairs, distance to the exit, and obstructions. For example, the building code requires the classroom door to be a minimum width of 800mm which may allow for a much larger maximum occupant load than the 33 people in the design occupant load. The capacity of the exit is calculated on the basis of: 6.1 mm (0.24 in) per person for doorways, corridors and passageways and 8mm (0.31 inches) for stairs per the building code. So if the classroom door is 800mm, and no stairs are involved, the width of the door being 800mm is divided by 6.1mm per person, so the door could accommodate 131 people. Reference NBC Division B Table 3.4.3.2.-A classroom door width Sentence 3.4.3.2 (1)]
Slide 13	The fire code uses two criteria to determine the maximum permissible occupant load in existing buildings: the exit capacity which we already calculated at 131 people, and the net floor area based on 0.4 m^2 person which ensures that a crowd of people will be able to move steadily toward the exits. The classroom has a net floor area of 62.17m^2 which is divided by the fire code value of .4m^2 per person which provides for an occupant load of 155 people. The lower of the two calculations, 131 people based on available exiting, determines the maximum occupant load for the classroom. Obviously, that is not practical for a school classroom and there are other limiting factors. For example, the number of exits from the room contributes to the total occupant load. If the room has only one egress door, the building code limits the occupant load to 60 people. So the maximum occupant load for the classroom would be limited to 60 people. Reference NBC 3.3.1.5 (1)(b) OL limited to 60 & OFC Occupant load bulletin
Slide 14	Now that you know the number of people that the classroom can hold, you still need to consider means of egress. The occupants need a means of egress to a safe area. You will have to assess the path of travel to the exit including, distance to the exit, width of the exit, and whether it involves stairs or other obstructions.

	The means of exit must be sized to accommodate all the people occupying the area. Lets assume the occupants of the classroom have to walk out of the classroom, along a corridor, down a flight of stairs, and then through another door to get outside the building. Each of these points, the door, corridor, stairs, and outside door, form part of the means of egress so occupant load factors need to be applied to each point to determine if they are sufficient for the occupant load of the classroom. Reference [NBC3.3.1.5 (1)(b)]. & BC-OFC Occupant load bulletin
Slide 15	Video.
Slide 16	The minimum required width of exits serving floor areas intended for assembly, residential, business and personal services, mercantile, and industrial occupancies is determined by multiplying the occupant load of the area served by 6.1 mm per person for most ramps, doorways, corridors, and 8mm per person for most stairs. Considering this, what would be the capacity of the access to exit corridor if it is 1800mm wide? Answer 1800mm ÷ 6.1 mm = 295 What would be the capacity of the stairs if they were 1800mm wide? Answer 1800mm ÷ 8mm = 225 What would be the capacity of the exit discharge doors if each leaf was 800mm wide? Answer 800 ÷ 6.1 = 131 times 2 doors = 262 So, remembering that the lesser number applies, the maximum occupant load that can be served by the access to exit, stairs, and the exit discharge is restricted to 225 people by the capacity of the stairs.
Slide 17	The building code also requires exits to be spaced apart from one another. The minimum distance between 2 exits from a floor area must be one half the diagonal dimension of the floor area but need not be more than 9m. Spatial separation between exits is required to minimize the chance that a fire could block both exits from a floor area. Remembering way back to school days, the formula for determining the diagonal distance of a rectangle is A2 + B2 = C 2.
Slide 18	So in this case, you multiple 6.1m X 6.1m which gives you 37.21. You then multiply 12.2 times 12.2 which gives you 148.84. You then add the two

	together, 37.21 + 148.84 for a total of 186.05. The diagonal dimension of the room is the square root of186.05 which can be calculated using a scientific calculator but we used an online version. The answer provides a diagonal distance of 13.64m which you divide by 2 to determine the minimum separation between exits. The answer is 6.82 meters or approximately 22 feet. This slide was revised on 2022-02-15 JT References: NBC 3.3.1.5.5.2) BCBC3.3.1.5 (1)(b)]. & OFC Occupant load bulletin BCBC 3.4.2.1 Minimum number of exits
Slide 19	Video
Slide 20	When the occupant load is determined, occupant load signs may be required. If the floor area is designed for an occupant load other than that determined by Table 3.1.17.1 of the building code, a permanent sign indicating that occupant load must be posted in a conspicuous location. The fire code requires occupant load signs to be posted when the occupant load of an assembly occupancy exceeds 60 people. This sign is intended to indicate the maximum permissible occupant load determined under article 2.7.1.3. While it is the owner's responsibility to post the required signs, it is recommended that the posting of the sign be done in consultation with the local fire authority. In cases where the layout of an establishment periodically changes, it is possible to have multiple occupant load signs. It is also recommended that the different layouts are documented as part of the fire safety plan's ongoing review and development process. This will help to ensure that the periodic change in layout is compliant with the requirements of the Fire Code. Reference NFC 2.7.1.4
Slide 21	As we have talked about before, the building code establishes the minimum width of Exit Corridors, Passageways, Ramps, Stairs and Doorways based on the occupancy classification of the building. In most cases, it is 1100mm (43.5") for corridors and ramps, 900mm (35.5") for stairs, and 800mm (31.5") for doorways. No fixtures, turnstiles or construction is allowed to project into, or be fixed within, the required width of an exit with the exception of handrails. The building code

	requires handrails in most stairs and if the stairway is less than 1100mm wide one handrail is required but if the stairway is 1100mm or more, handrails must be provided on both sides. Handrails and their supports must not project more than 100 mm (4") into the required width of a means of egress and must be installed between 865mm (34") and 1070mm (42") above floor level. Handrail height limits are base on the body normally being wider at the shoulders and narrower at the hips. In addition the body sway while walking is greater at the shoulders than at the hips particularly on stairs. Reference BCBC Table 3.4.3.2
Slide 22	In case of fire, it's good to have 2 means of exit so the building code limits dead-end corridors to a maximum of 6 m in length. An exception to this is that the building code allows dead-end corridors that are entirely within a suite to be more than 6 meters in length. In this example, the two–storey building is occupied by a variety of Group D Business and Personal Service businesses. The doctor's office has two dead end corridors; one serving the washrooms and two offices and the other serving the patient examination rooms. These dead-end corridors are permissible because they are contained inside the suite. A suite is a defined term in the building code and means "a single room or series of rooms of complementary use, operated under a single tenancy, and includes dwelling units, individual guest rooms in motels, hotels, boarding houses, rooming houses and dormitories as well as individual stores and individual or complementary rooms for business and personal services occupancies. So in this example the doctor's office, law office, and accounting firm are all separate suites. References: NBC 3.3.1.9.7) & BCBC 3.3.1.7 Exception is for dead-end corridors entirely within a suite, or as permitted in Group B care, treatment , detention occupancies and dwelling units.
Slide 23	That is the end of part one. In this Part we discussed: Occupant loads and: • How to calculate the maximum number of people for a given area or room • Two types of occupant loads, design loads per the building code and maximum occupant load per the fire code

	• That design occupant load is considered the minimum occupant load used by designer to estimate the number of people that will normally be using the space • That plan reviewers should check the accuracy of the designer's occupant load calculations • The maximum occupant load is calculated on .4 m² per person or on the exiting provided whichever is less.
Slide 24	• That design occupant loads identified in the building code should not be used to calculate the maximum occupant load • That based on the use of the space there may be more than one occupant load posted. • Changing the design occupant load to the maximum occupant load may require the installation of fire protection systems like fire alarms. • Occupant loads are calculated on gross floor area or net floor area. • Gross floor area is basically the inside perimeter of the outside walls • Net floor area is the gross floor area minus unoccupied area such as lobbies, stairways, washrooms, service rooms etc. • Egress requirements are based on occupant load, exit capacity, and travel distance • The minimum distance between 2 exits must be one-third the maximum diagonal dimension of the floor area • We concluded this part with a discussion about dead-end corridors.