

Allowable Building Area - Part 2

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Last month we discussed the intricacies of calculating allowable floor area for buildings under the *International Building Code* (IBC) using the “nonseparated use” method. But, if using the nonseparated use method is too restrictive for your building, you can always revert to the “separated use” method.

The separated use method has been in the building codes for many years, and it requires that the various occupancy groups within a building be separated from each other by fire-resistance-rated assemblies. As a benefit of this “compartmentation,” the building code allows a building floor area to be determined based on the sum of the ratios of actual floor areas to allowable floor areas. In all cases, this sum of ratios cannot exceed 1.0.

We’ll look at this separated use method using the fire station example used in previous articles. However, our owner has again decided to modify the building’s programmed use by making this facility also the site of their fire department headquarters with the following increases:

<u>Space</u>	<u>Actual Area</u>
<u>First Floor</u>	
Office Area - Station (B)	7,200 sf
Office Area - HQ (B)	30,000 sf
Auditorium (A-3)	1,400 sf
<u>Apparatus Bays (S-2)</u>	<u>16,800 sf</u>
Total	55,400 sf
<u>Second Floor</u>	
Sleeping Area (R-2)	3,600 sf
Day Room (A-3)	2,000 sf
<u>Training Room (A-3)</u>	<u>1,600 sf</u>
Total	7,200 sf

In last month’s article, we determined that using the “nonseparated use” method for this project would provide an allowable floor area of 52,325 square feet based on Type IIIA construction and on the A-3 occupancy, which was determined to be the most restrictive. This allowable floor area included increases for fire sprinkler and frontage. Now that the building area has increased, the permissible frontage increase would likely be reduced (unless more land was acquired), thereby causing the previously calculated allowable floor to decrease, as well. Additionally, the owner and designer want to see if the building could be constructed using Type IIIB construction.

Regardless, the first floor area has increased beyond what was allowed for a nonseparated use, so we have to look at the other alternatives available to designer: either increase the construction type (either Type IIA or IB) or utilize the separated use method. And since the construction type is to be reduced to Type IIIB, the separated use method is the only choice. Now, some of you familiar with the code are probably yelling “add a fire wall to separate the two buildings!” Well, yeah, but that wouldn’t illustrate the separated use method, now would it? (This is another example of how the building code provides the designer options; the key is in knowing how to use them and when).

To use the separated use method, the various occupancy groups in the building will need to be separated by fire barriers (Section 706) and horizontal assemblies (Section 711) that have fire-resistance ratings as established in Table 302.3.2. According to that Table, our occupancies in the fire station will need to have assemblies with the following fire-resistance ratings between them:

- B and A-3: 2 hours
- B and S-2: 2 hours
- B and R-2: 2 hours
- S-2 and A-3: 2 hours
- S-2 and R-2: 2 hours
- R-2 and A-3: 2 hours

Fortunately, the IBC allows a reduction in fire-resistance ratings by one hour since this building has a sprinkler system installed throughout (Section 302.3.2). Therefore, the required minimum fire-resistance rating for the fire stations fire barriers can be reduced to 1 hour.

The next step is to determine the allowable floor area for each occupancy group using the same equation introduced in the previous article. However, since the first floor is the largest floor area and the R-2 occupancy is only located on the second floor, there is no need to calculate for that occupancy group.

$$A_a = A_t + \left[\frac{A_t I_f}{100} \right] + \left[\frac{A_t I_s}{100} \right]$$

Whereas:

A_a = Allowable area per floor

A_t = Tabular floor area per Table 503 (B=19,000 sf; A-3=9,500 sf; S-2=26,000 sf)

I_f = Increase due to frontage

I_s = Increase due sprinkler installation

The fire sprinkler increase will remain at 200% for multiple stories, and, to save a little time, we'll assume the frontage increase was reduced to 70% (down from 73.75% in the previous article). With that information at the ready, we can now calculate each allowable floor area:

B Occupancy:

$$A_a = 19,000sf + \left[\frac{19,000sf \times 70}{100} \right] + \left[\frac{19,000sf \times 200}{100} \right] = 70,300sf$$

A-3 Occupancy:

$$A_a = 9,500sf + \left[\frac{9,500sf \times 70}{100} \right] + \left[\frac{9,500sf \times 200}{100} \right] = 35,150sf$$

S-2 Occupancy:

$$A_a = 26,000sf + \left[\frac{26,000sf \times 70}{100} \right] + \left[\frac{26,000sf \times 200}{100} \right] = 96,200sf$$

Now that we've calculated the allowable floor areas for each of the first floor occupancy groups, we can add up the ratios to see if the sum is less than 1.0:

$$\frac{37,200sf}{70,300sf} + \frac{1,400sf}{35,150sf} + \frac{16,800sf}{96,200sf} = 0.529 + 0.040 + 0.175 = 0.744 < 1.0 \therefore \textit{okay}$$

The sum of the ratios is less than 1.0; therefore, the project can be built as a Type IIIB building with separated uses. But, the owner states that every fire station needs a pole from the second floor, so a 1-hour rated horizontal assembly at the floor just isn't going to work. He also wants the sleeping area to be open to the day room without a fire-rated door. This is a situation where using a combination of separated and nonseparated use methods can be considered.

By doing so, the station's office space on the first floor, the sleeping area, day room, and training room, which are located above the station's office area, are all now considered a part of the same fire area. Therefore, the most restrictive requirements will apply to the entire fire area. Again, the A-3 occupancy of the day room becomes the restrictive occupancy since its allowable area is less than all the other occupancies involved. As a result, the ratio calculation we completed above will now have to be redone, moving the fire station's office floor area from the B occupancy ratio to the A-3 occupancy ratio since it is now part of the A-3 fire area.

$$\frac{30,000sf}{70,300sf} + \frac{8,600sf}{35,150sf} + \frac{16,800sf}{96,200sf} = 0.427 + 0.245 + 0.175 = 0.847 < 1.0 \therefore \textit{okay}$$

As you can see, by adjusting the project to the owner's requirements, we were able to remain in compliance with the building code. The second floor, which has a total area of 7,200 square feet, is less than the 35,150 square feet allowed for an A-3 occupancy, so all spaces on the second floor can be nonseparated (except where they adjoin the S-2 occupancy of the apparatus bay).

There are some cases where a building is in such a low fire-risk situation, that the allowable area can be considered unlimited without having to build the structure using Type I construction. Section 507 sets provisions that allow certain buildings to have unlimited area with the more common applications listed below:

1. Nonsprinklered, One Story Buildings: Any Group F-2 and S-2 building surrounded by yards or public ways that are immediately adjacent to the building with distances of 60 feet or greater.
2. Sprinklered, One Story Buildings: Any Group B, F, M, or S building that is sprinklered throughout (that means the entire building), and is surrounded by yards or public ways that are immediately adjacent to the building with distances of 60 feet or greater. Any Group A-4 building that isn't of Type V construction, complying with the same minimum sprinkler and yard requirements.

3. Two Story Buildings: Any Group B, F, M, or S building that is sprinklered throughout, and is surrounded by yards or public ways that are immediately adjacent to the building with distances of 60 feet or greater.
4. One Story, Group A-3 Buildings: A building used as a church, community hall, dance hall, exhibition hall, gymnasium, lecture hall, indoor swimming pool or tennis court of Type I or II construction provided it has no stage or platform, is equipped with a sprinkler throughout, has an assembly floor within 21 inches of street or grade level (with ramps to the grade or street level), and is surrounded by yards or public ways that are immediately adjacent to the building with distances of 60 feet or greater.
5. One Story, Group E Buildings: A building constructed of Type II, IIIA, or IV construction provided it has two means of egress from each classroom with one having direct access to the outside of the building, equipped with a sprinkler throughout, and is surrounded by yards or public ways that are immediately adjacent to the building with distances of 60 feet or greater.

For items 1, 2 and 3 listed above, the 60-foot yard or public way requirement may be reduced to 40 feet as long as the reduced open space applies to no more than 75% of the building's perimeter, and the exterior walls and openings facing the reduced open space have a fire-resistance rating of 3 hours.

As I just demonstrated in this article, the building code is there to be used as a tool during the design process. Understanding the building code's many provisions will open the door to its flexibility. With this knowledge, the designer can make critical decisions early in the design process, long before the project reaches the building official for plan review.

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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