The Code Corner

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Calculating Plumbing Fixture Counts

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In 2005, New York City's legislature unanimously passed the Women's Restroom Equity Bill, which essentially requires that in assembly-type buildings, female toilets shall be provided at a ratio of 2 to 1 when compared to male toilets and urinals. Restroom ratios have been an issue for some time, as evidenced by the first state legislative actions on this issue taken by California and Virginia in 1989. In 1990, an article published in *The National Law Journal* by George Washington University Law School professor John F. Banzhaf III, otherwise known as the "Father of Potty Parity," stressed the need to provide equity in public restrooms—not based on floor area, but on number of fixtures. Titled "Final Frontier for the Law?," Banzhaf's article asked the questions:

> Can women truly be said to be liberated when they often stand on interminable lines at the theater, concerts, some restaurants, and in other public places to perform a necessary and often compelling biological function that men usually accomplish with virtually no wait? Does this problem, which certainly can be corrected by adding additional toilet facilities, amount to unfair discrimination?

This is a situation that can easily be handled via the building code without separate legislation, even though past model building codes had an obviously poor track record for providing toilet fixture equity. Individual laws fragment building requirements, making compliance difficult if the separate laws are not incorporated by amendments during the local building code adoption process.

The Legacy Codes

Prior to the introduction of the International Codes in 2000, the three legacy model codes had provisions for regulating the number of fixtures, but the methods were different and generally did not provide the higher fixture counts required by states enacting restroom equity laws. For example, jurisdictions that adopted the 1994 or 1997 *Uniform Building Code* (UBC) also needed to specifically adopt Appendix Chapter 29, which included a table that assigned number of fixtures for males and females based on occupant loads; otherwise, the UBC set forth very little in the way of minimum fixture count requirements.

UBC editions earlier than the 1994 edition had no plumbing requirements, let alone requirements for minimum number of fixtures. To cover the minimum fixture gap created by the building code, the UBC's companion plumbing code at the time, the *Uniform Plumbing Code* (UPC), included a "recommended" list of minimum fixtures, but "recommended" did not mean "required."

Interestingly, in the UBC, occupant loads determined for plumbing fixtures count, were different than the occupant loads determined for means of egress. Thus, for some assembly occupancies, the occupant load required for plumbing fixtures could be from 1/2 to less than 1/4 of the means of egress occupant load, depending on the egress occupant load factor used. This could have little to great impact on the minimum number of fixtures required depending on the specific situation.

The International Building Code

"Potty parity" laws aside, the *International Building Code* (IBC)* does provide some fairness in plumbing fixture distribution between males and females. Unlike the UBC, the IBC incorporates the

* Specific code references used in this article are from the 2009 edition of the IBC unless otherwise indicated.

minimum fixture table in the main body of the code. Therefore, when the IBC is adopted by a jurisdiction, the table (Table 2902.1) is automatically a part of the requirements (unless amended by the jurisdiction) without specifically identifying it in the adopting ordinance like an appendix. It should be pointed out that the plumbing systems chapter in the IBC is actually maintained by the International Plumbing Code Development Committee, and the content provided in the IBC is replicated in the *International Plumbing Code* (IPC). Therefore, if the IBC and IPC are adopted and if Chapter 29 is amended in the IBC, then identical amendments will be necessary for Chapter 4 of the IPC.

In addition to water closets (plumbing parlance for "toilets") and urinals, the IBC also establishes requirements for lavatories, bathtubs and showers, drinking fountains, service sinks, kitchen sinks, and automatic clothes washer connections. Calculating the number of plumbing fixtures for each type of fixture is not a difficult task, but prior to the 2009 IBC, there were some gray areas that caused some confusion among design professionals—namely the determination of fixture counts for mixed occupancies. Fortunately, that problem was clarified in the 2009 IBC. But before addressing mixed uses, let us proceed with a basic review of calculating fixture counts and the variations based on uses with different occupancy groups.

Basic Fixture Count Calculations

Before you can calculate the number of plumbing fixtures, you have to determine what the occupant load is for the occupancy group. To minimize duplication of work effort, the IBC requires the use of the occupant load determined for the means of egress. Now, here is the important question: *what determines the number of males and females?* That is rather simple; you just divide the total occupant load in half. The IBC does not address how to handle odd number occupant loads. For this situation, you can use the fractional number for each sex (See Example 2) or round the occupant load for each sex up to the next whole number.

Regarding number of occupants for each sex, the IBC does provide an exception that allows the adjustment of male and female occupant distribution if statistical data supports a ratio other than 50 percent of each sex. Of course, this must be approved by the building official prior to proceeding with an alternate male to female ratio.

The two examples below illustrate two types of simple ratios used in the IBC. Example 1 shows a simple ratio that is applied equally to both males and females, and Example 2 uses separate ratios for males and females. Where a simple ratio is applied equally to males and females, calculations can be determined by dividing the total occupant load in half and applying the ratio to each male and female load, or by applying the ratio to the total occupant load and dividing the number of fixtures evenly between males and females. The latter method is used Example 1. Please note that fixture count numbers are rounded up to the next whole number per footnote "a" of Table 2902.1.

Example 1 - Group M store with 2,000 total occupants

Water Closets: ratio 1 per 500

2,000 x 1/500 = 4 water closets
4 x 50% = 2
2 water closets for males
2 water closets for females

Drinking Fountains: ratio 1 per 1000

2,000 x 1/1000 = 2 drinking fountains

Lavatories: ratio 1 per 750

2,000 x 1/750 = 2.66
2.66 x 50% = 1.33 = 2
2 lavatories for males
2 lavatories for females

Example 2 - Group A-1 theater with 1,155 total occupants

1,155 x 50% = 577.5
577.5 males
577.5 females

Water Closets: ratios 1 per 125 (males) and 1 per 65 (females)

Males: 577.5 x 1/125 = 4.62 = 5 water closets
Females: 577.5 x 1/65 = 8.88 = 9 water closets

Lavatories: ratio 1 per 200

Males: 577.5 x 1/200 = 2.89 = 3 lavatories
Females: 577.5 x 1/200 = 2.89 = 3 lavatories

Drinking Fountains: ratio 1 per 500

1,155 x 1/500 = 2.31 = 3 drinking fountains

Another method of calculation used by the IBC to determine fixture counts is the graduated ratio. This method uses one ratio for an initial number of occupants and another ratio for the remaining number of occupants. In Example 3 below, the graduated method is used for the water closets and lavatories.

Example 3 - Group B office building with 250 total occupants

Water Closets: ratios 1 per 25 for first 50 and 1 per 50 for remainder exceeding 50

50 x 1/25 = 2 water closets
(250-50) x 1/50 = 4 water closets
2 + 4 = 6 water closets
6 x 50% = 3 (3 water closets for males and 3 water closets for females)

Lavatories: ratio 1 per 40 for first 80 and 1 per 80 for remainder exceeding 80

80 x 1/40 = 2 water closets
(250-80) x 1/80 = 2.13 water closets
2 + 2.13 = 4.13 water closets
4.13 x 50% = 2.06 = 3 (3 water closets for males and 3 water closets for females)

Drinking Fountains: ratio 1 per 100

250 x 1/100 = 2.5 = 3 drinking fountains

Fixture Count Calculations for Mixed Occupancies

As mentioned earlier, editions of the IBC prior to the 2009 edition did not explain how to determine fixture count calculations for buildings with mixed occupancies. The confusion centers on how to sum up the fixtures to determine the total number of fixtures for a building. The typical method used by design professionals is to sum the rounded fixture numbers for each occupancy group to obtain a total fixture count for the building. Fortunately, that was not the intent.

By summing the rounded fixture count numbers, the total fixture count may include additional fixtures that are not required. Although, from a building department's and the public's points of view, this is not a problem; from an owner's and a design professional's perspective it could be a problem—additional fixtures cost money and require additional space. It is important that design professionals understand the code's intent so they are not misdirected to provide more fixtures than what the code requires, unless requested by the owner to do so.

The 2006 *IBC Code and Commentary* provided some guidance to help with mixed occupancy situations; however, the code provisions in the 2006 IBC did not change. So, without a copy of the *Commentary* at hand, many design professionals continued to do things the way they always had. During the 2006-2007 code development cycle a proposal was introduced to add content that would explain how to handle fractional numbers for fixture counts in buildings with multiple occupancies. This was approved and included in the 2009 IBC in section 2902.1.1 as follows:

> Fractional numbers resulting from applying the fixture ratios of Table 2902.1 shall be rounded up to the next whole number. For calculations involving multiple occupancies, such fractional numbers for each occupancy shall first be summed and then rounded up to the next whole number.

Thus, the rounding only occurs after summing the fractional fixture counts for each occupancy group, keeping the total fixture count as low as permissible. Example 4 illustrates how to calculate the number of plumbing fixtures for a mixed occupancy building.

Fixture Count Calculations Not Based on Occupant Load

There are a few occupancy groups that do not use occupant loads as a basis for determining the number of plumbing fixtures. These include I-2, I-3, R-1, R-2, and R-3. Plumbing fixtures for those occupancy groups are based on the number of rooms, cells, sleeping units, or dwelling units and are not assigned to either sex. Example 4 includes an application for a Group R-1.

Example 4 - Hotel Building with Groups A-3, B, M, and R-1

Group A-3 with 500 total occupants

500 x 50% = 250 (250 males and 250 females)

Water Closets: ratios 1 per 125 (males) and 1 per 65 (females)

Males: 250 x 1/125 = 2 water closets
Females: 250 x 1/65 = 3.8 water closets

Lavatories: ratio 1 per 200

Males: 250 x 1/200 = 1.25 lavatories
Females: 250 x 1/200 = 1.25 lavatories

Drinking Fountains: ratio 1 per 500

500 x 1/500 = 1 drinking fountain

Group B with 75 total occupants

Water Closets: ratios 1 per 25 for first 50 and 1 per 50 for remainder exceeding 50

50 x 1/25 = 2 water closets
(75-50) x 1/50 = 0.5 water closets
2 + 0.5 = 2.5 water closets
2.5 x 50% = 1.25 (1.25 water closets for males and 1.25 water closets for females)

Lavatories: ratio 1 per 40 for first 80 and 1 per 80 for remainder exceeding 80

75 x 1/40 = 1.88 lavatories
1.88 x 50% = 0.94 (0.94 lavatories for males and 0.94 lavatories for females)

Drinking Fountains: ratio 1 per 100

75 x 1/100 = 0.75 drinking fountains

Group M with 50 total occupants

Water Closets: ratio 1 per 500

50 x 1/500 = 0.1 water closets
0.1 x 50% = 0.05 (0.05 water closets for males and 0.05 water closets for females)

Lavatories: ratio 1 per 750

50 x 1/750 = 0.06 lavatories
0.06 x 50% = 0.03 (0.03 lavatories for males and 0.03 lavatories for females)

Drinking Fountains: ratio 1 per 1000

50 x 1/1000 = 0.05 drinking fountains

Group R-1 with 150 sleeping units

Water Closets: ratio 1 per sleeping unit = 150

Lavatories: ratio 1 per sleeping unit = 150

Bathtubs or Showers: ratio 1 per sleeping unit = 150

Drinking Fountains: Not applicable

Summary

Water Closets:

Males: 2 + 1.25 + 0.05 = 3.3 = 4
Females: 3.8 + 1.25 + 0.05 = 5.1 = 6
Sleeping Units: 150

Lavatories:

Males: 1.25 + 0.94 + 0.03 = 2.22 = 3
Females: 1.25 + 0.94 + 0.03= 2.22 = 3
Sleeping Units: 150

Drinking Fountains: 1 + 0.75 + 0.05 = 1.8 = 2

Service Sink: 1 per building

The service sink is another fixture that is also not based on occupant load, but can be a conumdrum for the design professional. For most occupancy groups, Table 2902.1 indicates one service sink. The *Commentary* states "that except for hospitals and nursing homes, one service sink is all that the code

intends to require in a building where all potential users of the fixture have access to it." However, this is not clearly reflected in the IBC provisions, thereby leaving it open for building official interpretation.

Urinal Substitution

Table 2902.1 directs the code user to Section 419.2 of the IPC for substitution of water closets with urinals. The IPC allows up to 67% of the water closets in assembly and educational occupancies to be substituted and up to 50% in all other occupancies. The substitution is limited to the fixtures within a toilet room or bathroom and not for overall fixtures. Therefore, if 9 water closets are required, up to 6 may be converted to urinals if they are all located in a single toilet room; but if two toilet rooms are provided, one cannot have 6 urinals and the other with 3 water closets. See Example 5 for some typical substitution applications. Make note that in the case of urinal substitutions, fractional numbers are rounded down, not up; otherwise the percentage would exceed that permitted.

Example 5 - Urinal Substitutions

Assembly Occupancy: 12 water closets required

Arrangement #1: Single toilet room

12 x 67% = 8.04 = 8
4 water closets
8 urinals

Arrangement #2: Multiple toilet rooms

Toilet Room A: 8 fixtures

8 x 67% = 5.36 = 5
3 water closets
5 urinals

Toilet Room B: 4 fixtures

4 x 67% = 2.68 = 2
2 water closets
2 urinals

Notice that only a total of 7 urinals are allowed under this arrangement

Business Occupancy: 7 water closets required

Arrangement #1: Single toilet room

7 x 50% = 3.5
4 water closets
3 urinals

Arrangement #2: Multiple toilet rooms

Toilet Room A: 4 fixtures

4 x 50% = 2
2 water closets
2 urinals

Toilet Room B: 3 fixtures

3 x 50% = 1.5
2 water closets
1 urinal

Surprisingly, the IPC does not limit the substitution to male toilet rooms or bathrooms only. Therefore, in international locations where they are used—if the IPC is adopted—or when they become more popular in the US, the substitution provision may be applicable to female urinals, as well. Also, in response to the movement towards sustainable buildings, the 2009 IPC now references ASME A112.19.19, *Vitreous China Nonwater Urinals*, (*i.e.* waterless urinals) as an acceptable fixture.

Distribution of Plumbing Fixtures

Required plumbing fixtures cannot be lumped into a single toilet room or be separated into a series of unisex toilet rooms. Separate facilities for males and females must be provided with the number of fixtures as determined by the calculations covered above. Exceptions to those requirements include structures or tenant spaces that do not have more than 15 occupants (includes customers and employees) and mercantile occupancies that do not have more than 50 occupants.

Furthermore, plumbing fixtures must be located where occupants can reasonably access them. Customers, patrons and visitors must have access to toilet facilities in buildings intended for public use and must include the required plumbing fixtures calculated. Thus, if it is determined that an assembly

occupancy is required to have 20 fixtures, those 20 fixtures need to be accessible to the assembly occupants. Toilet facilities for employees may be separate or combined with public toilet facilities.

The path of travel to a toilet facility cannot exceed 500 feet, or 300 feet for covered mall buildings. The distance for covered malls is measured from the entrance of a store or tenant space to the central toilet facility; but if employee facilities are not provided, then the distance is measured from the employee work area. Further, in multi-story buildings, a story that is required to have access to toilet facilities must not have those facilities located more than one story above or below.

For covered mall buildings, the IBC also mentions that required toilet facilities "shall be based on total square footage." However, there are no details on how this is to be applied and the *Commentary* provides no additional insight as to the intent of that statement. However, it is this author's opinion that the intent was to ensure proportionate distribution of the toilet facilities, and the number of fixtures in each, throughout the mall based on the area served. It other words, it was meant to prohibit the intentional location of all but a few of the plumbing fixtures in one location and place the remaining few fixtures at locations just to comply with the path of travel distance, even though the number of occupants in those areas would demand more fixtures.

Family or assisted-use toilets and bathing rooms (formally called "unisex" toilet and bathing rooms in earlier IBC editions) required by Section 1109.2.1 for mercantile and assembly occupancies are permitted to be included in the total count of required fixtures. A fixture in such a toilet or bathing room can be considered one of the fixtures required for males or females, but not both. Family or assisted-use toilets are limited to a single water closet and a single lavatory. Family or assisted-use bathing rooms are also limited to that required for toilet rooms, but may also include a single bathtub or shower.

Continual Improvement

When it comes to building codes, it would be much simpler if people would use common sense, thus minimizing the intrusiveness of building regulations. But, as history has shown, people tend not to do something if they are not required to do it. As demonstrated through code development, the early codes with their "recommendations" were not sufficient to provide the number of fixtures to make the call of nature more convenient for women; so the "recommendations" became "requirements" and have been marginally revised ever since.

Although the process for determining the required number of plumbing fixtures has improved to the point where "potty parity" is on the verge of achievement, some people may argue that building codes still have a way to go to achieve that elusory equity; and as a result, states and municipalities will continue to legislate toilet distribution among women and men. Hopefully, there will be a point in time when codes and individual laws converge to a happy middle ground, and a single source for regulating minimum fixtures lies somewhere between the covers of the building code.

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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