

METHODS FOR DETERMINING CONCENTRATIONS OF PEOPLE

INTRODUCTION

The underlying safety compatibility criteria utilized in this *Compatibility Plan* is “usage intensity”—the maximum number of people per acre that can be present in a given area at any one time. If a proposed use exceeds the maximum intensity, it is considered incompatible and inconsistent with the compatibility planning policies. The usage intensity concept is identified in the *California Airport Land Use Planning Handbook* as the measure best suited for assessment of land use safety compatibility with airports. The *Handbook* is published by the California Division of Aeronautics and is required under state law to be used as a guide in preparation of airport land use compatibility plans.

It is recognized, though, that “people per acre” is not a common measure in other facets of land use planning. This *Compatibility Plan* therefore also utilizes the more common measure of floor area ratio (FAR) as a means of implementing the usage intensity criteria on the local level. This appendix both provides guidance on how the usage intensity determination can be made and defines the relationships between this measure, FAR, and other measures found in land use planning. For a discussion of the rationale for use of people per acre as a measure of risk exposure, see Appendix C.

COUNTING PEOPLE

The most difficult part about calculating land use intensity is estimating the number of people expected to use a particular facility under normal circumstances. All people—not just employees, but also customers and visitors—who may be on the property at any single point in time, whether indoors or outdoors, must be counted. The only exceptions are for rare special events, such as an air show at an airport, for which a facility is not designed and normally not used and for which extra safety precautions can be taken as appropriate.

Ideally, the actual number of people for which the facility is designed would be known. For example, the number of seats in a proposed movie theater can be determined with high accuracy once the theater size is decided. Other buildings, though, may be built as a shell and the eventual number of occupants not known until a specific tenant is found. Furthermore, even then, the number of occupants can change as future tenants change. Even greater uncertainty is involved with relatively open uses not having fixed seating—retail stores or sports parks, for example.

When a clear number of measurable occupancy does not exist, other sources must be relied upon to estimate the number of people in a proposed development.

Survey of Similar Uses

A survey of similar uses already in existence is one option, however gathering data can be time-consuming and costly. Also, unless the survey sample is sufficiently large enough and conducted at

various times, inconsistent numbers may result. Except for uncommon uses for which occupancy levels cannot be estimated through other means, surveys may not be appropriate.

Maximum Occupancy

A second option for estimating the number of people who will be on a site is to rely upon data indicating the maximum occupancy of a building measured in terms of occupancy load factors—the number of square feet per occupant. The number of people on the site, assuming limited outdoor or peripheral uses, can be calculated by dividing the total floor area of a proposed use by the occupancy load factor. The challenge of this methodology lies in establishing realistic figures for square feet per occupant. The number varies greatly from one use to another and, for some uses, occupancy load factors can change over time as well.

A commonly used source of maximum occupancy data is the standards set in the California Building Code (CBC). The chart reproduced as Table D1 indicates the occupancy load factors for various types of uses. The CBC is intended primarily for purposes of structural design, fire and safety and represents a legal maximum occupancy in most jurisdictions. A CBC-based methodology consequently results in occupancy numbers that are higher than normal maximum usage in most instances. The numbers also are based upon usable floor area and do not take into account corridors, stairs, building equipment rooms, and other functions that are part of a building's gross square footage. Surveys of actual occupancy load factors conducted by various agencies have indicated that many retail and office uses are generally occupied at no more than 50% of their maximum occupancy levels, even at the busiest times of day. Therefore, the *Handbook* indicates that the number of people calculated for office and retail uses can usually be divided in half to reflect the actual occupancy levels before making the final people-per-acre determination. Even with this adjustment, the CBC-based methodology typically produces intensities at the high end of the likely range.

Another source of data on square footage per occupant comes from the facility management industry. The data is used to help businesses determine how much building space they need to build or lease and thus tends to be more generous than the CBC standards. The numbers vary not only by the type of facility, as with the CBC, but also by type of industry. The following are selected examples of square footage per *employee* gathered from a variety of sources.

→ Call centers	150 – 175
→ Typical offices	180 – 250
→ Law, finance, real estate offices	300 – 325
→ Research & development, light industry	300 – 500
→ Health services	500

The numbers above do not take into account the customers who may also be present for certain uses. For retail business, dining establishments, theaters, and other uses where customers outnumber employees, either direct measures of occupancy—the number of seats, for example—or other methodologies must be used to estimate the potential number of people on the site.

Parking Space Requirements

For many jurisdictions and a wide variety of uses, the number of people present on a site can be calculated based upon the number of automobile parking spaces that are required. Certain limitations and assumptions must be considered when applying this methodology, however. An obvious limitation is that parking space requirements can be correlated with occupancy numbers only where nearly all

users arrive by private vehicle rather than by public transportation, walking, or other method. Secondly, the jurisdiction needs to have a well-defined parking ordinance that lists parking space requirements for a wide range of land uses. For most uses, these requirements are typically stated in terms of the number of parking spaces that must be provided per 1,000 square feet of gross building size or a similar ratio. Lastly, assumptions must be made with regard to the average number of people who will arrive in each car.

Both of the critical ratios associated with this methodology—parking spaces to building size and occupants to vehicles—vary from one jurisdiction to another even for the same types of uses. Research of local ordinances and other sources, though, indicates that the following ratios are typical.

➔ **Parking Space Ratios**—These examples of required parking space requirements are typical of those found in ordinances adopted by urban and suburban jurisdictions. The numbers are ratios of spaces required per 1,000 square feet of gross floor area. Gross floor area is normally measured to the outside surfaces of a building and includes all floor levels as well as stairways, elevators, storage, and mechanical rooms.

- Small Restaurants 10.0
- Medical Offices 4.0 – 5.7
- Shopping Centers 4.0 – 5.0
- Health Clubs 3.3 – 5.0
- Business Professional Offices 3.3 – 4.0
- Retail Stores 3.0 – 3.5
- Research & Development 2.5 – 4.0
- Manufacturing 2.0 – 2.5
- Furniture, Building Supply Stores 0.7 – 1.0

➔ **Vehicle Occupancy**—Data indicating the average number of people occupying each vehicle parking at a particular business or other land use can be found in various transportation surveys. The numbers vary both from one community or region to another and over time, thus current local data is best if available. The following data represent typical vehicle occupancy for different trip purposes.

- Work 1.05 – 1.2
- Education 1.2 – 2.0
- Medical 1.5 – 1.7
- Shopping 1.5 – 1.8
- Dining, Social, Recreational 1.7 – 2.3

USAGE INTENSITY RELATIONSHIP TO OTHER DEVELOPMENT MEASURES

Calculating Usage Intensities

Once the number of people expected in a particular development—both over the entire site and within individual buildings—has been estimated, the usage intensity can be calculated. The criteria in Chapter 2 of this *Compatibility Plan* are measured in terms of the average intensity over the entire project site.

The average intensity is calculated by dividing the total number of people on the site by the site size. A 10-acre site expected to be occupied by as many as 1,000 people at a time, thus would have an average intensity of 100 people per acre. The site size equals the total size of the parcel or parcels to be developed.

Having calculated the usage intensities of a proposed development, a comparison can be made with the criteria set forth in the *Compatibility Plan* to determine whether the proposal is consistent or inconsistent with the policies.

Comparison with Floor Area Ratio

As noted earlier, usage intensity or people per acre is not a common metric in land use planning. Floor area ratio or FAR—the gross square footage of the buildings on a site divided by the site size—is a more common measure in land use planning. Some counties and cities adopt explicit FAR limits in their zoning ordinance or other policies. Those that do not set FAR limits often have other requirements such as, a maximum number of floors a building can have, minimum setback distances from the property line, and minimum number of parking spaces. These requirements effectively limit the floor area ratio as well.

To facilitate local jurisdiction implementation, the Safety Compatibility Criteria table in Chapter 2 has been structured around FAR measures to determine usage intensity limits for many types of nonresidential land use development. To utilize FAR in this manner, a critical additional piece of information is necessary to overcome the major shortcoming of FAR as a safety compatibility measure. The problem with FAR is that it does not directly correlate with risks to people because different types of buildings with the same FAR can have vastly different numbers of people inside—a low-intensity warehouse versus a high-intensity restaurant, for example. For FAR to be applied as a factor in setting development limitations, assumptions must be made as to how much space each person (employees and others) in the building will occupy. The Safety Compatibility Criteria table therefore indicates the assumed occupancy load factor for various land uses. Mathematically, the relationship between usage intensity and FAR is:

$$\text{FAR} = \frac{\text{(allowable usage intensity)} \times \text{(occupancy load factor)}}{43,560}$$

Where *usage intensity* is measured in terms of people per acre and *occupancy load factor* as square feet per person.

Selection of the usage intensity, occupancy level, and FAR numbers that appear in the Safety Compatibility Criteria table was done in an iterative manner that considered each of the components both separately and together. Usage intensities were initially set with respect to guidelines provided in the *California Airport Land Use Planning Handbook* (see Appendix C of this *Compatibility Plan*). Occupancy levels were derived from the CBC, but were adjusted based upon additional research from both local and national sources in the manner discussed earlier in this appendix. The FAR limits were initially calculated from these other two numbers using the formula above.

Comparison with Parking Space Requirements

As discussed above, many jurisdictions have adopted parking space requirements that vary from one land use type to another. Factoring in an estimated vehicle occupancy rate for various land uses as described earlier, the occupancy load factor can be calculated. For example, a typical parking space requirement for office uses is 4.0 spaces per 1,000 square feet or 1 space per 250 square feet. If each

vehicle is assumed to be occupied by 1.1 persons, the equivalent occupancy load factor would be 1 person per 227 square feet. This number falls squarely within the range noted above that was found through separate research of norms used by the facility management industry.

As an added note, the occupancy load factor of 215 square feet per person indicated in the Safety Compatibility Criteria table for office uses is slightly more conservative than the above calculation produces. This means that, for a given usage intensity standard, the FAR limit in the table is slightly more restrictive than would result from a higher occupancy load factor.

Table D1

Occupant Load Factors

California Building Code

<i>Use</i>	<i>Minimum Square Feet per Occupant</i>
1. Aircraft Hangars (no repair)	500
2. Auction Rooms	7
3. Assembly Areas, Concentrated Use (without fixed seats)	7
Auditoriums	
Churches and Chapels	
Dance Floors	
Lobby Accessory to Assembly Occupancy	
Lodge Rooms	
Reviewing Stands	
Stadiums	
Waiting Areas	3
4. Assembly Areas, Less Concentrated Use	15
Conference Rooms	
Dining Rooms	
Drinking Establishments	
Exhibit Rooms	
Gymnasiums	
Lounges	
Stages	
Gaming	11
5. Bowling Alley (assume no occupant load for bowling lanes)	4
6. Children's Homes and Homes for the Aged	80
7. Classrooms	20
8. Congregate Residences	200
9. Courtrooms	40
10. Dormitories	50
11. Dwellings	300
12. Exercising Rooms	50
13. Garage, Parking	200
14. Health-Care Facilities	80
Sleeping Rooms	120
Treatment Rooms	240
15. Hotels and Apartments	200
16. Kitchen – Commercial	200
17. Library Reading Room	50
Stack Areas	100
18. Locker Rooms	50
19. Malls	Varies
20. Manufacturing Areas	200
21. Mechanical Equipment Room	300
22. Nurseries for Children (Daycare)	35
23. Offices	100
24. School Shops and Vocational Rooms	50
25. Skating Rinks	50 on the skating area; 15 on the deck
26. Storage and Stock Rooms	300
27. Stores – Retail Sales Rooms	
Basements and Ground Floors	30
Upper Floors	60
28. Swimming Pools	50 for the pool area; 15 on the deck
29. Warehouses	500
30. All Others	100

Source: California Building Code (2001), Table 10-A