

Methods for Determining Concentrations of People

INTRODUCTION

The underlying safety compatibility criterion employed in this *ALUCP* 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 thus inconsistent with 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 *ALUCP* 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. Appendix D2 shows sample calculations.

COUNTING PEOPLE

The most difficult part about calculating a use’s 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 a single point in time, whether indoors or outside, 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 in the future as tenants change. Even greater uncertainty is involved with relatively open uses not having fixed seating—retail stores or sports parks, for example.

Absent clearly measurable occupancy numbers, 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. Gathering data in this manner can be time-consuming and costly, however. Also, unless the survey sample is sufficiently large and conducted at various times, inconsistent numbers may result. Except for uncommon uses for which occupancy levels cannot be estimated through other means, surveys are most appropriate as supplemental information.

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 Factor—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, has changed 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, though, is intended primarily for purposes of structural design and fire 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 Chapters 3 through 6 of this *ALUCP* 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 *ALUCP* 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 in the Basic Compatibility Criteria tables in Chapters 4 through 6 have 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 Basic 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 *ALUCP*). Occupancy levels were de-

rived 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 Basic 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.

Function of Space	Floor area per occupant (sq. ft.)
Accessory storage areas, mechanical equipment room	300 gross
Agricultural building	300 gross
Aircraft hangars	500 gross
Airport terminal	
Baggage claim	20 gross
Baggage handling	300 gross
Concourse	100 gross
Waiting areas	15 gross
Assembly	
Gaming floors (keno, slots, etc.)	11 gross
Assembly with fixed seats	See Section 1004.7
Assembly without fixed seats	
Concentrated (chairs only-not fixed)	15 net
Standing space	5 net
Unconcentrated (tables and chairs)	7 net
Bowling centers, allow 5 persons for each lane including 15 feet of runway, and for additional areas	7 net
Business areas	100 gross
Courtrooms-other than fixed seating areas	40 net
Day care	35 net
Dormitories	50 gross
Educational	
Classroom area	20 net
Shops and other vocational room areas	50 net
Exercise rooms	50 gross
H-5 Fabrication and manufacturing areas	200 gross
Industrial areas	100 gross
Institutional areas	
Inpatient treatment areas	240 gross
Outpatient treatment areas	100 gross
Sleeping areas	120 gross
Kitchens, commercial	200 gross
Laboratory	
Educational	50 net
Laboratories, non-educational	100 net
Laboratory suite	200 gross
Library	
Reading rooms	50 net
Stack area	100 gross
Locker rooms	50 gross
Mercantile	
Areas on other floors	60 gross
Basement and grade floor areas	30 gross
Storage, stock, shipping areas	300 gross
Parking garages	200 gross
Residential	200 gross
Skating rinks, swimming pools	
Rink and pool	50 gross
Decks	15 gross
Stages and platforms	15 net
Warehouses	500 gross

Source: California Building Code (2007), Table 1004.1.1

Table D1

Occupant Load Factors

California Building Code

Example 1

Proposed Development: Two office buildings, each two stories and containing 20,000 square feet of floor area per building. Site size is 3.0 net acres. Counting a portion of the adjacent road, the gross area of the site is 3.5± acres.

A. Calculation Based on Parking Space Requirements

For office uses, assume that a county or city parking ordinance requires 1 parking space for every 300 square feet of floor area. Data from traffic studies or other sources can be used to estimate the average vehicle occupancy. For the purposes of this example, the typical vehicle occupancy is assumed to equal 1.5 people per vehicle.

The average usage intensity would therefore be calculated as follows:

- 1) 40,000 sq. ft. floor area x 1.0 parking space per 300 sq. ft. = 134 required parking spaces
- 2) 134 parking spaces x 1.5 people per space = 201 people maximum on site
- 3) 201 people ÷ 3.5 acres gross site size = 57 people per acre average for the site

B. Calculation Based on Uniform Building Code

Using the UBC (Table D1) as the basis for estimating building occupancy yields the following results for the above example:

- 1) 40,000 sq. ft. bldg. ÷ 100 sq. ft./occupant = 400 people max. bldg. occupancy (under UBC)
- 2) 400 max. bldg. occupancy x 50% adjustment = 200 people maximum on site
- 3) 200 people ÷ 3.5 acres gross site size = 57 people per acre average for the site

C. Calculation of Single Acre Intensity

Assuming that occupancy of each building is relatively equal throughout, but that there is some separation between the buildings and outdoor uses are minimal, the usage intensity for a single acre would be estimated to be:

- 1) 20,000 sq. ft. bldg. ÷ 2 stories = 10,000 sq. ft. bldg. footprint
- 2) 10,000 sq. ft. bldg. footprint ÷ 43,560 sq. ft. per acre = 0.23 acre bldg. footprint
- 3) Building footprint < 1.0 acre; therefore maximum people in 1 acre = bldg. occupancy = 100 people per single acre (i.e., 200 people max. on site ÷ 2 bldgs.)

Conclusions: In this instance, both methodologies yield the same results. The 57 people per average acre and the 100 people per single acre results must be compared with the intensity limits provided in the Basic Compatibility Criteria tables in Chapters 4, 5, and 6. For Auburn Municipal Airport, the proposed use would meet the *Compatibility Zones B2, C1, C2, and D* criteria for maximum usage intensity criteria averaged over the entire site (70, 100, 200, and unlimited people/acre, respectively). The maximum single-acre intensity of 100 people also would meet the criteria for these zones (210, 300, 800, and unlimited, respectively).

Table D2**Sample People-Per-Acre Calculations**

Example 2

Proposed Development: Single-floor furniture store containing 24,000 square feet of floor area on a site of 2.0 gross acres and the net acreage (less internal roadways) is 1.7 acres.

A. Calculation Based on Parking Space Requirements

For furniture stores, assume that a county or city parking ordinance requires 1 parking space per 1,500 square feet of use area. Assuming 1.5 people per automobile results in the following intensity estimates:

The average usage intensity would be:

- 1) 24,000 sq. ft. bldg. x 1.0 parking space per 1,500 sq. ft. = 16 required parking spaces
- 2) 16 parking spaces x 1.5 people per space = 24 people maximum on site
- 3) 24 people ÷ 2.0 acres gross site size = 12 people per acre average for the site

B. Calculation Based on Uniform Building Code

For the purposes of the UBC-based methodology, the furniture store is assumed to consist of 50% retail sales floor (at 30 square feet per occupant) and 50% warehouse (at 500 square feet per occupant). Usage intensities would therefore be estimated as follows:

- 1) 12,000 sq. ft. retail floor area ÷ 30 sq. ft./occupant = 400 people max. occupancy in retail area
- 2) 12,000 sq. ft. warehouse floor area ÷ 500 sq. ft./occupant = 24 people max. occupancy in warehouse area
- 3) Maximum occupancy under UBC assumptions = 400 + 24 = 424 people
- 4) Assuming typical peak occupancy is 50% of UBC numbers = 212 people maximum on site
- 5) 212 people ÷ 2.0 acres = 106 people per acre average for the site

C. Calculation for Single Acre Intensity

With respect to the single-acre intensity criteria, the entire building occupancy would again be within less than 1.0 acre, thus yielding the same intensity of 24 or 212 people per single acre.

Again assuming a relatively balanced occupancy throughout the building and that outdoor uses are minimal, the usage intensity for a single acre would be estimated to be:

- 1) 24,000 sq. ft. bldg. footprint ÷ 43,560 sq. ft. per acre = 0.55 acre bldg. footprint
- 3) Building footprint < 1.0 acre; therefore maximum people in 1 acre = bldg. occupancy = 24 or 212 people per single acre under parking space or UBC methodology, respectively

Conclusions: In this instance, the two methods produce very different results. The occupancy estimate of 30 square feet per person is undoubtedly low for a furniture store even after the 50% adjustment. On the other hand, the 12 people-per-acre estimate using the parking requirement methodology appears low, but is probably closer to being realistic. Unless better data is available from surveys of similar uses, this proposal should reasonably be considered compatible within most compatibility zones, except *Zone A* and possibly *Zone B1*.

Table D2, Continued