

APPENDIX B

Airport Land Use Compatibility Concepts

Introduction

The information provided in this appendix addresses concepts and rationale used during the development of the compatibility policies and figures presented in Chapters 2 and 3 of this CLUP. The foundation for these policies and the concepts behind them derive from the *California Airport Land Use Compatibility Handbook* (Caltrans, January 2002).

As outlined in the *Handbook* and this CLUP, the policies regarding airport land use compatibility are focused into four concepts categories:

1. **Noise** – As defined by cumulative noise exposure contours depicting noise from aircraft operations near an airport.
2. **Safety** – This addresses minimizing risks of aircraft accidents beyond the runway environment, and their potential impacts to the general public in the airport’s vicinity.
3. **Airspace Protection** – This is accomplished by placing limits on the height of man-made structures and other objects in the airport vicinity, and restrictions on other uses that potentially pose hazards to flight.
4. **Overflight** – The impacts of aircraft flight over a community.

Noise

Noise is one of the most basic airport land use compatibility concerns. Moreover, at major airline airports, many busy general aviation airports, and most military airfields, noise is often the most recognized impact by the general public.

Compatibility Objective

The purpose of noise compatibility policies is to reduce the number of people exposed to frequent and/ or high levels of airport noise. This is often accomplished by avoiding the establishment of new, noise-sensitive land uses in areas that are exposed to significant levels of aircraft noise.

Measurement

For the purpose of airport land use compatibility planning, noise generated by the operation of aircraft to, from, and around an airport is primarily measured in terms of the cumulative noise levels of all aircraft operations. In California, the cumulative noise level metric established by state regulations, including for airport noise, is the Community Noise Equivalent Level (CNEL). This metric provides a single measure of the average sound level in decibels (dB) to which any point near an airport is exposed.

To reflect assumed greater community sensitivity to nighttime and evening noise, events during these periods are counted as being louder than actually measured due to the fact fewer ambient noises exist as during the daytime. Cumulative noise levels are usually illustrated on airport area maps as contour lines connecting points of equal noise exposure. Mapped noise contours primarily show areas of significant noise exposures – ones affected by high concentrations of aircraft takeoffs and landings.

Calculating cumulative noise levels requires several inputs, including the number, type, and time of day of aircraft operations, the location of flight tracks as well as other data. Airports with air traffic control towers can often provide recorded data, and in most metropolitan areas, noise monitoring and radar flight tracking data is available. An important point to be stressed is that, despite the availability of a multitude of data, the location of noise contours is not necessarily precise. In the best of situations, where extensive noise monitoring and flight track data is available, current contours can be accurate to within ± 1 dB. In locations where less data is available, the level of accuracy has generally been found to be ± 3 dB.

Compatibility Strategies

The basic strategy for achieving noise compatibility in the vicinity of an airport is to limit development of land uses which are particularly sensitive to noise. Given the effect that varying levels of noise can have on people (see Table B-1), the most acceptable land uses are ones which either involve few people, or generate significant noise levels themselves (such as other transportation facilities or some industrial uses).

On occasion, local considerations outweigh noise impacts and result in decisions by local land use jurisdictions or even ALUCs to allow residential development in locations where this type of use would normally be considered incompatible. In these situations, approval of development should be conditioned upon the dedication of avigation easement and requirements for sufficient acoustic insulation of structures to assure that aircraft noise is reduced to an interior noise level of 45 dB CNEL or less.

**TABLE B-1
SUMMARY OF EFFECTS OF NOISE ON PEOPLE**

Day-Night Average Sound Level (Decibels)	Effects ¹			
	Hearing Loss (Qualitative Description)	Annoyance ² (Percentage of Population Highly Annoyed) ³	Average Community Reaction ⁴	General Community Attitude Toward Area
≥75	May begin to occur	37%	Very severe	Noise is likely to be the most important of all adverse aspects of the community environment.
70	Will not likely occur	22%	Severe	Noise is one of the most important adverse aspects of the community environment.
65	Will not occur	12%	Significant	Noise is one of the important adverse aspects of the community environment.
60	Will not occur	7%	Moderate to Slight	Noise may be considered an adverse aspect of the community environment.
≤55	Will not occur	3%		Noise considered no more important than various other environmental factors.

¹ All data is drawn from National Academy of Science 1977 report *Guidelines for Preparing Environmental Impact Statements on Noise*, Report of Working Group 69 on Evaluation of Environmental Impact of Noise.

² A summary measure of the general adverse reaction of people to living in noisy environments that cause speech interference; sleep disturbance; desire for tranquil environment; and the inability to use the telephone, radio or television satisfactorily.

³ The percentage of people reporting annoyance to lesser extents are higher in each case. An unknown small percentage of people will report being "highly annoyed" even in the quietest surroundings. One reason is the difficulty all people have in integrating annoyance over a very long time. USAF Update with 400 points (Finegold et al. 1992)

⁴ Attitudes or other non-acoustic factors can modify this. Noise at low levels can still be an important problem, particularly when it intrudes into a quiet environment.

NOTE:
Research implicates noise as a factor producing stress-related health effects such as heart disease, high blood pressure and stroke, ulcers and other digestive disorders. The relationships between noise and these effects, however, have not as yet been conclusively demonstrated. (Thompson 1981; Thompson et al. 1989; CHABA 1981; CHABA 1982; Hattis et al. 1980; and U.S. EPA 1981)

Source: Federal Interagency Committee on Noise (1992)

Source: Caltrans, *California Airport Land Use Planning Handbook*, January 2002.

Basis for Setting Criteria

Compatibility criteria related to cumulative noise levels are well-established in federal and state laws and regulations. The basic state criterion sets a CNEL of 65 dB as the maximum noise level normally compatible with urban residential land uses, though local jurisdictions can institute a lower maximum CNEL for residential land uses. A process called “normalization” is one means of adjusting the criteria to reflect ambient sound levels, the community’s previous exposure to noise, and any other local characteristics. This process helps to determine what CNEL is of significance to that particular community. Once the baseline maximum CNEL for residential uses is established, criteria for other land uses can be set in a manner consistent with this starting point.

Safety

In comparison to noise, safety is in many respects a more difficult concern to address in airport land use compatibility policies. The primary reason for this difference is that safety policies address uncertain events which *may occur* with *occasional* aircraft operations, whereas noise policies deal with known, quantifiable, and more or less predictable events which *do occur* with *every* aircraft operation. Because aircraft accidents happen infrequently and the time, place, and consequences of their occurrence cannot be predicted, the concept of “risk” is central to the assessment of safety compatibility. From the standpoint of land use planning, two variables determine the degree of risk posed by potential aircraft accidents:

1. *Accident Frequency* – Where and when aircraft accidents occur in the vicinity of the airport; and
2. *Accident Consequences* – Land uses and land use characteristics which affect the severity of an accident when one occurs.

Compatibility Objective

The main objective of safety compatibility criteria is to simply minimize the risks associated with potential aircraft accidents. This task is made up of two components; 1) safety on the ground; and 2) safety for aircraft occupants. The fundamental objective for providing safety on the ground is to protect people and property in the event of an aircraft accident near an airport. Safety for aircraft occupants involves trying to find ways in which to enhance the chances of survival of occupants of an aircraft involved in an accident beyond the runway environment.

Measurement

Measuring the degree of safety concerns around an airport involves a determination of frequency, or in other words, assessing the potential for an accident to occur. This task includes determining two elements: *where* aircraft accidents are expected to occur, and *when* an accident might happen. Of these two elements, the *where*, or “spatial” element is most meaningful to land use

compatibility planning for a given airport. Looking at nationwide accident data, it is possible to perceive the possible location of aircraft accidents based upon the frequency of occurrence. In contrast, the *when*, or “time” element, is not very useful for land use compatibility planning due to the fact that there are too many unknowns in determining when an aircraft accident might occur.

While the historical number of aircraft accidents nationwide has varied over the years, future trends can nevertheless be predicted with a fair degree of accuracy. Even with respect to specific classes of aviation (air carrier, general aviation, and military) or types of aircraft (business jets, helicopters, etc.), the frequency of accident occurrence is fairly constant and predictable. The difficulty with prediction arises when the focus is on a single airport rather than nationwide data. The *Handbook* presents a set of diagrams indicating where accidents are most likely to occur around general aviation airports. Figure B-2 and 3 show the spatial distribution of general aviation aircraft accidents. (These charts show accident data for *all* general aviation airports. Data on accidents associated with varying runway lengths can be found in the *Handbook*, and was used for the purpose of developing safety criteria for this CLUP.)

From these two charts, several important facts are revealed:

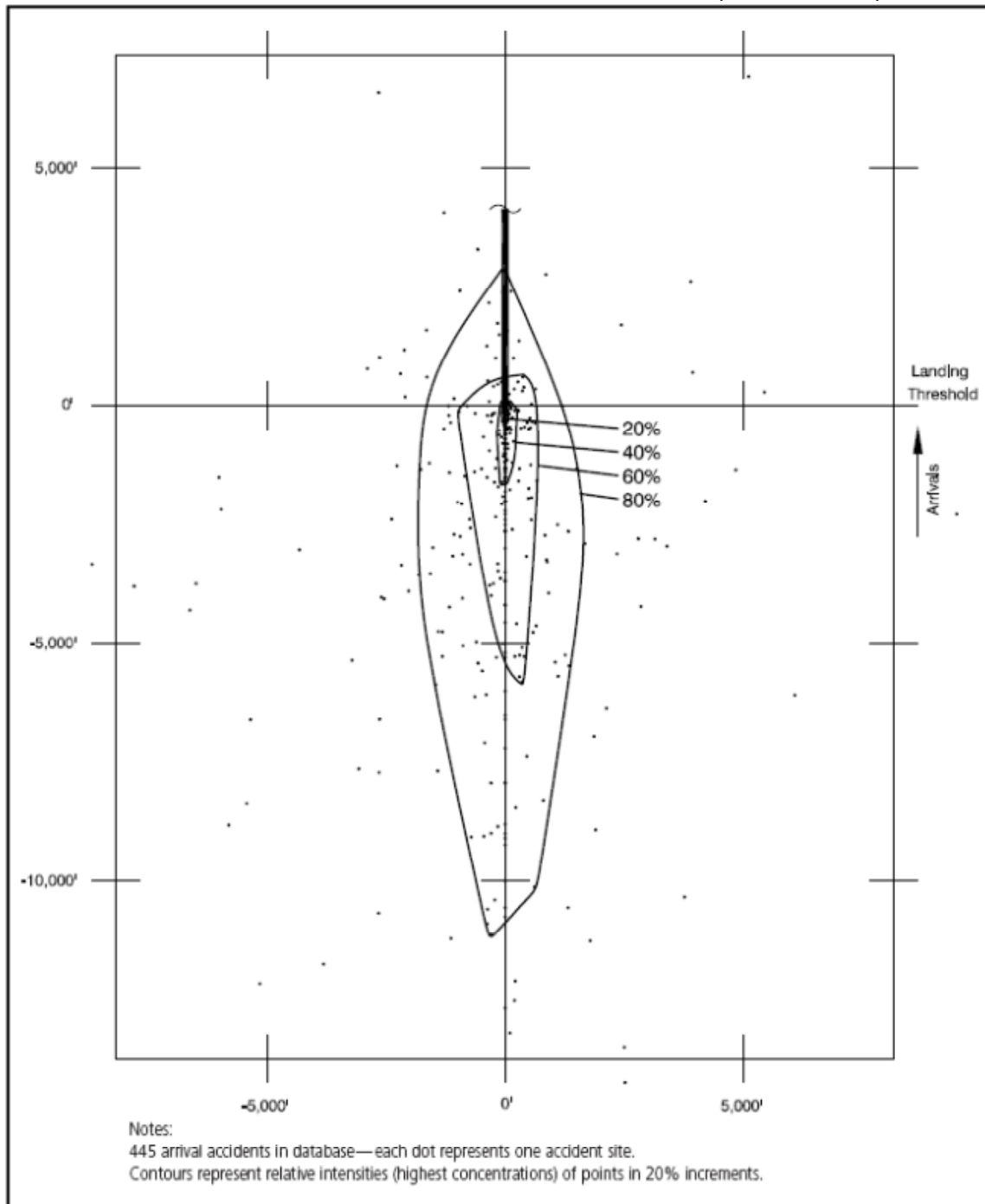
Arrival Accident Patterns

- Arrival accident sites tend to be located close to the extended runway centerline.
- Some 40% fall within a narrow strip, approximately 500-feet-wide and extending some 2,000 feet from the runway end.
- Over 80% of the arrival accident sites are concentrated within just 2,000 feet laterally from the extended runway centerline, but extending outward to approximately 11,000 feet (about 2.0 miles) of the runway end.

Departure Accident Patterns

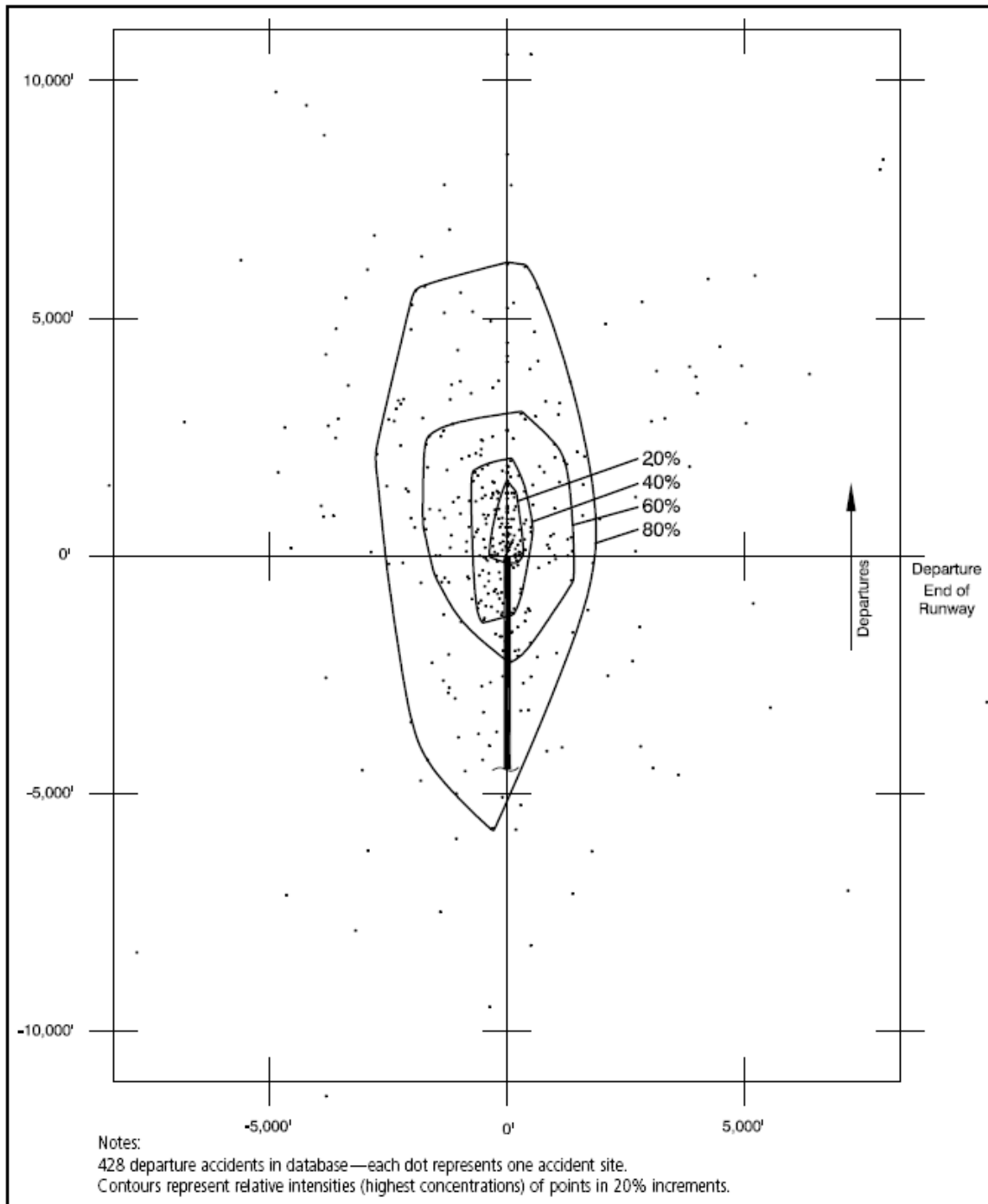
- Departure accident sites also tend to be clustered near the runway end, but are not as concentrated close to the runway centerline as are the arrival accident sites.
- The most tightly bunched 40% of the points lie within an area 1,500 feet wide, extending approximately 2,000 feet beyond the runway end, but also adjacent to the edges of the runway.
- The 80% contour extends some 6,000 feet beyond the runway end plus along the sides of the runway and spreads laterally approximately 2,000 feet from the runway centerline.

FIGURE B-2
GENERAL AVIATION ACCIDENT DISTRIBUTION CONTOURS (ALL ARRIVALS)



Source: Caltrans, *California Airport Land Use Planning Handbook*, January 2002.

FIGURE B-3
GENERAL AVIATION ACCIDENT DISTRIBUTION CONTOURS (ALL DEPARTURES)



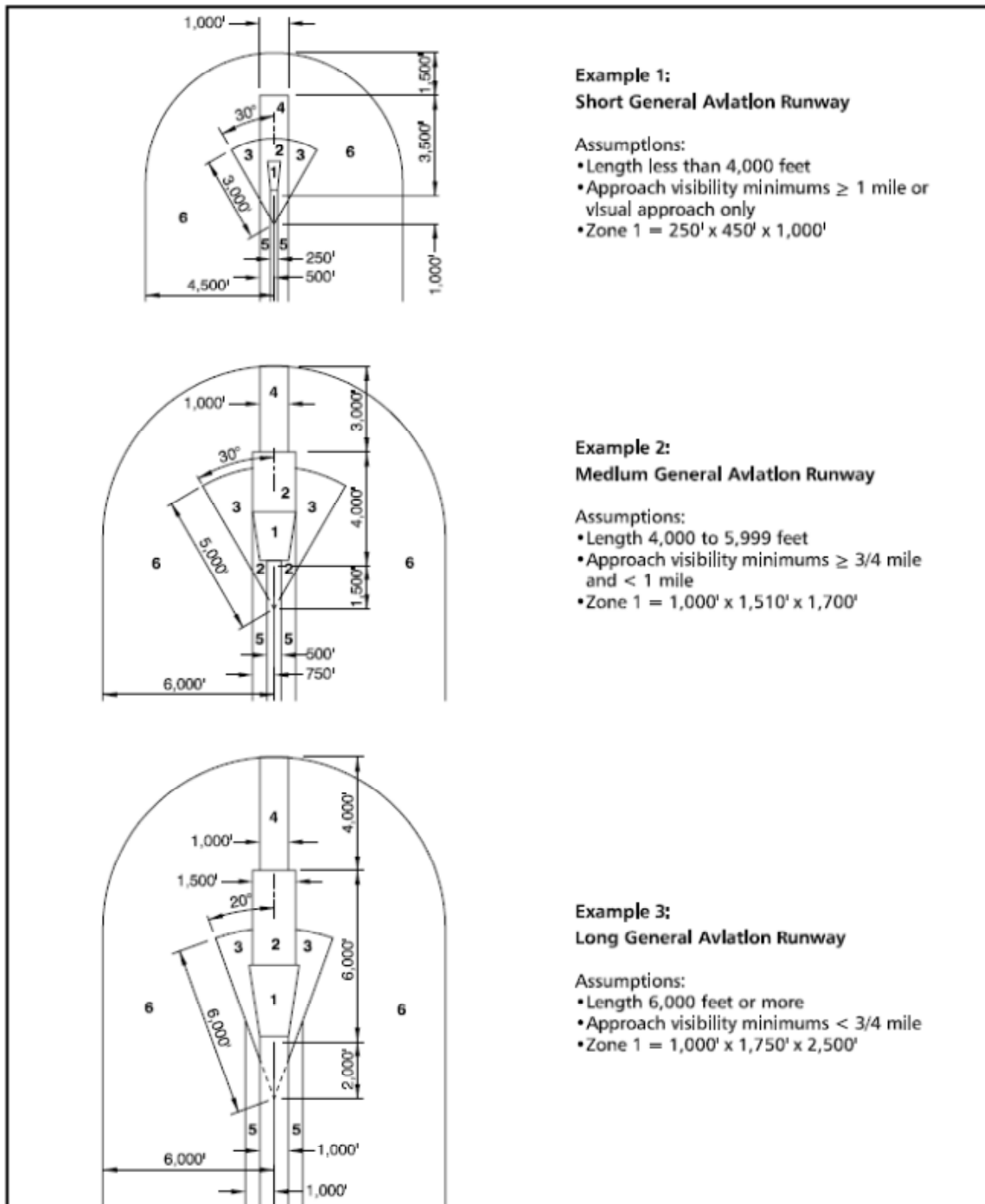
Source: Caltrans, *California Airport Land Use Planning Handbook*, January 2002.

- Two factors account for the substantial number of departure accident sites lateral to the runway.
 1. As defined for the purposes of the database, departing aircraft which crash while attempting to return to the runway are counted as departure accidents unless the aircraft became established in the traffic pattern or on final approach; and
 2. On long runways, aircraft may begin to turn before reaching the far end of the runway.

The next step in taking the accident data provided above and making it applicable to a specific airport is the creation of safety zones. Within safety zones, it is possible for ALUCs to define safety compatibility policies. Safety zones are created to match runways of varying lengths and the approach patterns of a specific airport. The shapes of these zones reflect not just the accident distribution data, but also the ways in which different aircraft operations create various accident risk characteristics close to an airport. For most airports, the *Handbook* suggests creating six safety zones. The locations and typical dimensions of safety zones for both general aviation airports and air carrier airports are depicted in Figures B-4 and 5. In general, the level of risk associated with each safety zone is as follows:

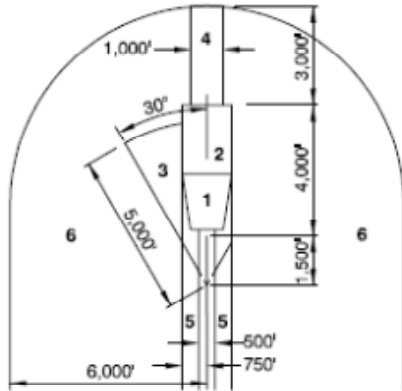
- Zone 1 (Runway Protection Zone) – The risk is greatest in this zone. The dimensions of the RPZ are defined by FAA, which encourages airport ownership of this area and designates specific land use standards when it *is* owned by the airport. Where the land is not owned by the airport, FAA standards serve as recommendations.
- Zone 2 (Inner Approach/Departure Zones) – This zone extends beyond Zone 1, and has a significant degree of risk.
- Zone 3 (Inner Turning Zones) – The risk in this zone is less than in Zones 1 and 2, but greater than 4, 5, and 6. This area encompasses locations where aircraft typically turn at low altitudes while approaching or departing the runway.
- Zone 4 (Outer Approach/Departure Zones) – This zone extends along the runway centerline beyond Zone 2. The degree of significance of this zone depends on whether or not an airport has a straight-in instrument approach procedure.
- Zone 5 (Sideline Zone) – This zone lies adjacent to the runway, and is usually located on airport property. The risk associated with this area is similar to Zone 4.
- Zone 6 (Traffic Pattern Zone) – This zone contains the aircraft traffic pattern. While a high percentage of accidents occur in this zone, the size of the zone reduces the risk level as compared to the other zones.

**FIGURE B-4
SAFETY COMPATIBILITY ZONES FOR GENERAL AVIATION RUNWAYS**



Source: Caltrans, *California Airport Land Use Planning Handbook*, January 2002.

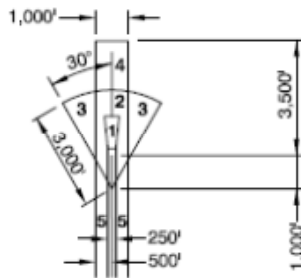
**FIGURE B-4 (CONT.)
SAFETY COMPATIBILITY ZONE EXAMPLES FOR GENERAL AVIATION RUNWAYS**



**Example 4:
General Aviation Runway with
Single-Sided Traffic Pattern**

Assumptions:

- No traffic pattern on right
- Length 4,000 to 5,999 feet
- Approach visibility minimums \geq 3/4 mile and $<$ 1 mile
- Zone 1 = 1,000' x 1,510' x 1,700'



**Example 5:
Low-Activity General Aviation Runway**

Assumptions:

- Less than 2,000 takeoffs and landings per year at individual runway end.
- Length less than 4,000 feet
- Approach visibility minimums \geq 1 mile or visual approach only
- Zone 1 = 250' x 450' x 1,000'

Legend

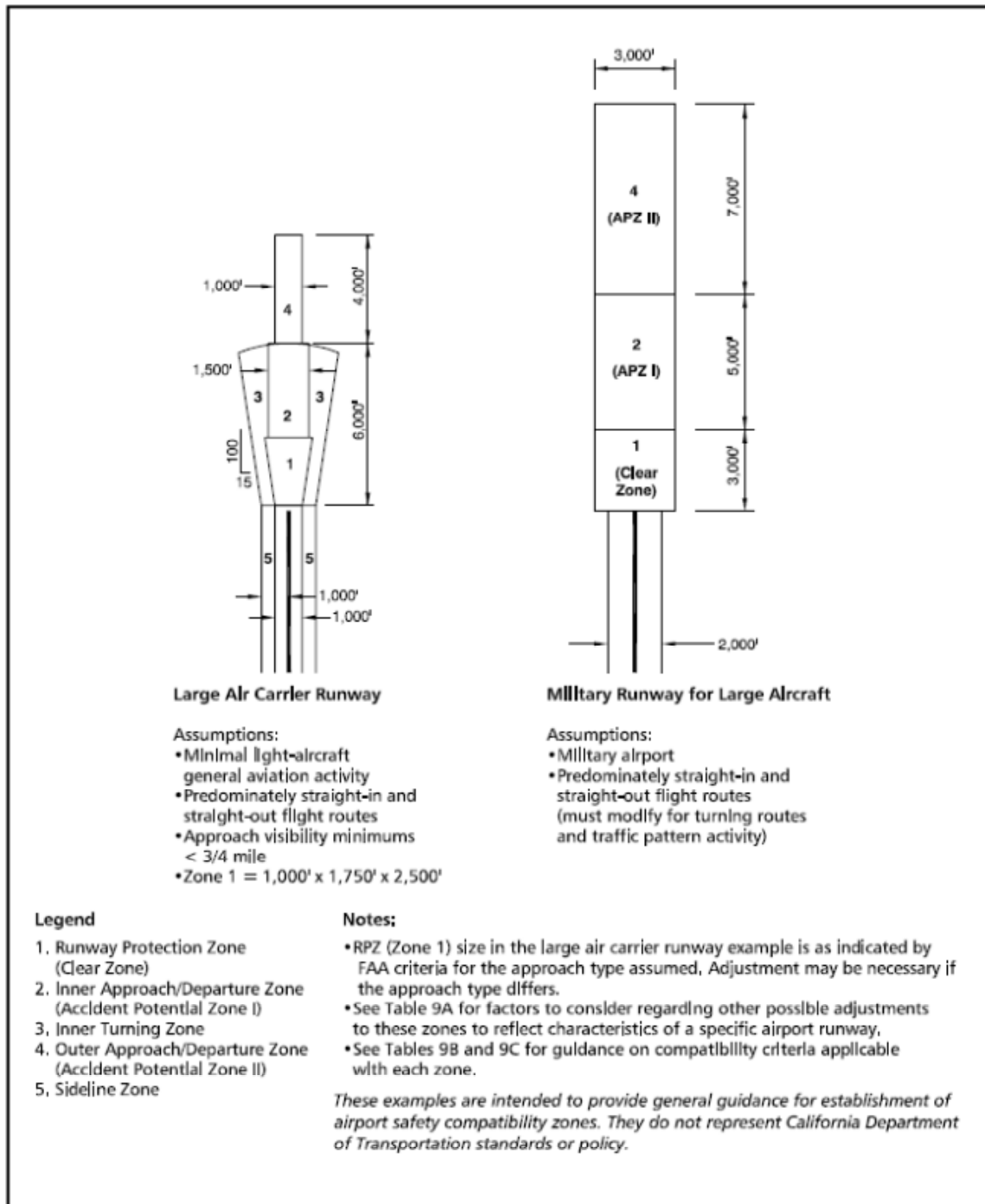
1. Runway Protection Zone
2. Inner Approach/Departure Zone
3. Inner Turning Zone
4. Outer Approach/Departure Zone
5. Sideline Zone
6. Traffic Pattern Zone

Notes:

- RPZ (Zone 1) size in each example is as indicated by FAA criteria for the approach type assumed. Adjustment may be necessary if the approach type differs.
- See Table 9A for factors to consider regarding other possible adjustments to these zones to reflect characteristics of a specific airport runway.
- See Tables 9B and 9C for guidance on compatibility criteria applicable with each zone.

These examples are intended to provide general guidance for establishment of airport safety compatibility zones. They do not represent California Department of Transportation standards or policy.

**FIGURE B-5
LARGE AIR CARRIER AND MILITARY RUNWAYS**



Source: Caltrans, *California Airport Land Use Planning Handbook*, January 2002.

Compatibility Strategies

Safety compatibility strategies focus on the *consequences* component of risk assessment. Essentially, the question that any ALUC or local jurisdiction should ask when making land use decisions in an airport AIA is: what land use planning measure can be taken to reduce the severity of an aircraft accident if one occurs in a particular location near an airport? Although there is a significant overlap, specific strategies must consider both components of the safety compatibility objective: protecting people and property on the ground; and enhancing safety for aircraft occupants. In each case, the primary strategy is to limit the intensity of use (the number of people concentrated on the site) in locations most susceptible to an off-airport aircraft accident. This is accomplished in several ways:

- *Density and Intensity Limitations*: Establishment of criteria limiting the maximum number of dwellings or people in areas close to the airport is the most direct method of reducing the potential severity of an aircraft accident.
- *Open Land Requirements*: Creation of requirements for open land near an airport addresses the objective of enhancing safety for the occupants of an aircraft forced to make an emergency landing away from a runway.
- *Highly Risk-Sensitive Uses*: Certain critical types of land uses – particularly schools, hospitals, and other uses in which the mobility of occupants is effectively limited – should be avoided in the vicinity of an airport regardless of the number of people involved.

Basis of Setting Criteria

Setting safety compatibility criteria presents the fundamental question of what is safe, or rather, what is an *acceptable* risk? In one respect, it may seem ideal to reduce risks to a minimum by prohibiting most types of land use development from areas near airports. However, there are usually costs associated with such high degree of restrictiveness. In practice, safety criteria are set on a progressive scale with the greatest restrictions established in locations with the greatest potential for aircraft accidents. The following resources can and should be utilized in order to develop safety criteria:

- *Established Guidance*: Little established guidance is available to ALUCs regarding how restrictive to make safety criteria for various parts of an airport's environs. Unlike noise, there are no formal federal or state laws or regulations which set safety criteria for airport area land uses for civilian airport except within runway protection zones (and with regard to airspace obstructions as described separately under *airspace protection*). FAA safety criteria primarily are focused on the runway and its immediate environment. Runway protection zones (also known as "clear areas"), were originally established mostly for the purpose of protecting the occupants of aircraft which overrun or land short of a runway.

Now, they are defined by FAA as intended to enhance the protection of people and property on the ground.

- *New Research*: To provide a better foundation for establishment of safety criteria in other portions of the airport environs, extensive research into the distribution of general aviation accident locations was conducted in conjunction with the 1993 edition of the *Handbook* and expanded as an initial step in preparation of the present edition. For this reason, the *Handbook* serves as the primary guide for the development of safety compatibility criteria. Although this document is not regulatory by nature, state law requires ALUCs to “be guided by” the information provided in the *Handbook*.

Airspace Protection

Relatively few aircraft accidents are caused by land use conditions which are hazards to flight. The potential exists, however, and protecting against it is essential to airport land use safety compatibility.

Compatibility Objective

Because airspace protection is in effect a safety factor, its object can likewise be thought of in terms of risk. Specifically, the objective is to avoid development of land use conditions which, by posing hazards to flight, can increase the risk of an accident occurring. The particular hazards of concern are:

- Airspace obstructions;
- Wildlife hazards, particularly bird strikes; and
- Land use characteristics which pose other potential hazards to flight by creating visual, unseen, or electronic interference with air navigation.

Measurement

The measurement of requirements for airspace protection around an airport is a function of several variables including: the dimensions and layout of the runway system; the type of operating procedures established for the airport; and, indirectly, the performance capabilities of aircraft operated at the airport.

- *Airspace Obstructions*: Whether a particular object constitutes an airspace obstruction depends upon the height of the object relative to the runway elevation and its proximity to the airport. The acceptable height of objects near an airport is most commonly determined by application of standards set forth in Federal Aviation Regulation Part 77: *Objects Affecting Navigable Airspace*. These regulations establish a three-dimensional space in the air above an airport. Any object which penetrates this volume of airspace is considered to be an obstruction and may affect the aeronautical use of the airspace.

- *Wildlife and Other Hazards to Flight*: The significance of other potential hazards to flight is principally measured in terms of a hazard's specific characteristics and its distance from the airport and/ or its normal traffic patterns.

Compatibility Strategies

Compatibility strategies for the protection of airport airspace are relatively simple and are directly associated with these types of hazards:

- *Airspace Obstructions*: Buildings, antennas, other types of structures, and trees should be limited in height so as not to pose a potential hazard to flight.
- *Wildlife and Other Hazards to Flight*: Land uses which may create other types of hazards to flight near an airport should be avoided or modified so as not to include the offending characteristic. This could include, but would not be limited to land uses which create habitat for wildlife potentially hazardous to aircraft operations, industrial uses which create smoke, steam, or thermal plumes, and utility uses like electrical substations which could cause electrical interference.

Basis for Setting Criteria

The criteria for determining airspace obstructions and other hazards to flight have been long-established in FAR Part 77 and other FAA regulations and guidelines. Also, State of California regulation of obstructions under the State Aeronautics Act (Public Utilities Code, Section 21659) is based on FAR Part 77 criteria. (For further information regarding FAR Part 77, please see Appendix C.)

Overflight

Experience at many airports has shown that noise-related concerns do not stop at the boundary of the outermost mapped CNEL contour. Many people are sensitive to the frequent presence of aircraft overhead even at low noise levels. These reactions can be most accurately described in the form of annoyance.

At many airports, particularly air carrier airports, complaints often come from locations beyond any of the defined noise contours. Indeed, heavily used flight corridors to and from metropolitan areas are known to generate noise complaints 50 miles or more from the associated airport. The basis for such complaints may be a desire and expectation that outside noise sources not be intrusive – or, in some circumstances, even distinctly audible – above the quiet, natural background noise level. Elsewhere, especially in locations beneath the traffic patterns of general aviation airports, a fear factor also contributes to some individuals' sensitivity to aircraft overflights.

While these impacts may be important community concerns, the question of importance here is whether any land use planning actions can be taken to avoid or mitigate the impacts or otherwise address the concerns. Commonly, when overflight impacts are under discussion in a community, the focus is on modification of the flight routes. Indeed, some might argue that overflight impacts should be addressed solely through the aviation side of the equation – not only flight route changes, but other modifications to where, when, and how aircraft are operated.

ALUCs are particularly limited in their ability to deal with overflight concerns. For one, they have no authority over aircraft operations. The most they can do to bring about changes is to make requests or recommendations. Even with regard to land use, the authority of ALUCs extends only to proposed new development.

Compatibility Objective

In an idealistic sense, the compatibility objective with respect to overflight is the same as for noise: avoid land use development which can lead to annoyance and complaints. However, given the extensive geographic area over which the impacts may occur, this objective is unrealistic except when relatively close to the airport. A more realistic objective therefore is to promote conditions under which annoyance will be minimized.

Measurement

Determining where to draw boundaries around areas of potentially significant overflight noise exposure is difficult because these locations extend beyond the well-defined CNEL contours which indicate areas of high noise exposure. CNEL contours are not very precise as low noise levels, especially where aircraft flight tracks are widely divergent. The general locations over which aircraft regularly fly as they approach and depart an airport is thus a better indicator of overflight annoyance concerns. For general aviation airports, such locations include areas beneath the standard airport traffic patterns, the portions of the pattern entry and departure routes flown at normal traffic pattern altitude, and perhaps additional places which experience a high concentration of overflights. Also, at all types of airports, common IFR arrival and departure routes can produce overflight concerns, sometimes many miles from the airport.

Compatibility Strategies

As noted above, the ideal land use compatibility strategy with respect to overflight annoyance is to avoid development of residential and other noise-sensitive uses in the affected locations. To the extent that this approach is not practical, three different (but not mutually exclusive) strategies are apparent.

One strategy is to help people with above-average sensitivity to aircraft overflights – people who are highly annoyed by overflights – to avoid living in locations where frequent overflights occur. This strategy involves making people more aware of an airport's proximity and its current and potential aircraft noise impacts on the community before the move to the area. This can be

accomplished through buyer awareness measures such as dedication of avigation or overflight easements, recorded deed notices, and/ or real estate disclosure statements. In new residential developments, posting of signs in the real estate sales office and/ or at key locations in the subdivision itself can serve as additional means of alerting the initial purchasers about the impacts.

A second strategy is to minimize annoyance by reducing the intrusiveness of aircraft noise above normal background noise levels. Because ALUCs and local jurisdictions have no way of regulating aircraft noise levels, the other option is to promote types of residential land uses which tend to mask the intrusive noise. Particularly undesirable are “ranchette” style residential areas consisting of large (about an acre on average) lots. Such developments are dense enough to expose many people to overflight noise, yet sufficiently rural in character that background noise levels are likely to be low.

Finally, for highly noise-sensitive uses, acoustical treatment of the structures, together with dedication of an avigation easement, may be appropriate.

Basis for Setting Criteria

In California, the most definitive guidance on the location of overflight impacts or the appropriate associated action taken in response to an impact comes from a state law which went into effect January 2004. California statutes (Business and Professional Code Section 11010 and Civil Code Sections 1103 and 1353) now require most residential real estate transactions, including all involving subdivisions, to include disclosure of the property’s proximity to a nearby airport. The area encompassed by the disclosure requirement is two miles from the airport, or the AIA as established by the ALUC.