3.0 Importance of Land Use Planning

Aviation is a nearly $50 billion national industry that provides a vital transportation and economic element to our country. However, this essential service is continually threatened by the perpetual encroachment of incompatible land uses. The increased demand for developable properties is a national issue facing facilities from large international airports in metropolitan areas to small general aviation airports in rural communities.

> ✈ *Incompatible land uses include a multitude of developments ranging from noise-sensitive residential developments to areas of standing water acting as bird attractants.*

Incompatible land uses include a multitude of developments ranging from noise-sensitive residential developments to areas of standing water acting as bird attractants. The common denominator with all incompatible land uses is their effect on the safety of the airport and safety of the citizens in close proximity to the airport. These various issues are discussed below to further define their importance regarding compatible land use issues.

Issues of compatible land use safety are complex and can be defined in various ways. For example, when asked to describe an airport safety-related issue, many people would reference perimeter fencing or possibly the security checkpoint at an air carrier airport. Seldom does the average citizen recognize that cell towers and residential developments, or even wetlands, pose a hazard to the safety of the airport and those who use it.

There are predominately two issues that must be considered when planning for airport land use compatibility: safety and noise impacts. Each of these issues has their own individual areas of focus yet relate to one another based upon their proximity to the airport environs. These areas are discussed in greater detail below to provide a comprehensive understanding of their role in developing compatible land uses.

3.1 Safety

A primary concern in achieving airport land use compatibility involves safety at and around an airport. It is important to identify those safety risks associated with air transportation in order to minimize the consequences of accident potential. Also, specific areas near airports are exposed to various levels of accident potential. Identifying and protecting these specific areas through effective land use controls is essential for the safe and efficient operation of an airport. It also protects the public from the impacts of a potential aircraft accident. Areas around the airport should be free of development that could pose a hazard to pilots operating aircraft in the airport environs.

> ✈ *The common denominator with all incompatible land uses is their effect on the safety of the airport and safety of the citizens in close proximity to the airport.*

3.1a. Safety Statistics

Safety issues are a significant consideration for pilots, airports, and land uses surrounding airports. There are several factors that determine from a safety perspective, which areas around an airport need to be protected. These factors include: the phase of operation during which aircraft accidents most often occur, the cause of these accidents, and the location of these accidents relative to the airport. Data from the National Transportation Safety Board (NTSB) regarding these factors are available to determine these areas.

The NTSB maintains extensive data on air carrier and general aviation accidents and their causes. The most current data available are from 1996-97. **Table 3-1** shows the number of commercial and general aviation aircraft accidents that occurred during each portion of flight. From an off-airport land use planning perspective, the characteristics of accidents near airports are of the greatest concern.

Table 3-1: Number of Accidents by Phase of Aircraft Operation in 1996-1997

Phase of Operation	Commercial (1996)	General Aviation (1997)
Cruise	2	311
Takeoff	3	392
Landing	4	488
Approach	0	233
Maneuvering	0	254
Taxi	0	55
Climb	1	60
Descent	1	42

Source: National Transportation Safety Board, Annual Review of Aircraft Accident Data, 1996/97

The conclusion that most of the risk involved with air transportation is associated with the takeoff and landing portions of flight is supported by these statistics. The critical areas at an airport that need to be secured and protected from a land use compatibility standpoint include the approach paths and departure paths to the runways. To enhance airport safety, it is important to maintain obstruction-free airport airspace and a reasonable amount of vacant land at both ends of each runway. Areas to be maintained and the dimensions of these areas are dependent upon the type of aircraft that operate at the airport. Information on these areas is on page 3-8 and in Chapter 7.

In addition to knowing the phase of operation during which aircraft accidents are most likely to occur, the most frequent causes of aircraft accidents should be identified. Identifying the cause of accidents as it relates to development activities is important to land use compatibility planning. **Tables 3-2** and **3-3** identify the causes of aircraft accidents that occurred in 1996-97.

✈ The environment, which includes weather, light conditions, objects (trees, wires, etc.), terrain, and runway conditions was the second leading cause of both commercial service and general aviation accidents.

In some cases, more than one factor contributed to an accident. Data presented in **Table 3-2** indicates that commercial aviation aircraft accidents are most often attributed to pilot error. **Table 3-3** indicates that general aviation aircraft accidents are also related to the terrain and obstructions surrounding an airport. A pilot's preoccupation with the terrain and structures immediately surrounding an airport can contribute to accidents. Structures in the approach path of a runway also contribute to aircraft accidents. Clearly, for the safety of both air travelers and the general public, it is best to maintain obstruction-free airspace as part of compatible land use planning for the area around each airport. One may note that assignment of cause can be to some degree subjective.

Table 3-2: Most Common Causes of Commercial Service Accidents

Cause/ Factor	Part 121		Part 135		Non-Sch. Part 135		Total Accidents	
	Non-fatal Accidents	Fatal Accidents	Non-fatal Accidents	Fatal Accidents	Non-fatal Accidents	Fatal Accidents	Non-fatal Accidents	Fatal Accidents
Personnel [1]	24	2	6	1	70	20	100	23
Environment [2]	16	0	3	1	50	12	69	13
Aircraft [3]	11	3	4	0	34	10	49	13
Other [4]	0	0	0	0	0	0	0	0

Source: Tables 13, 33 & 51 of NTSB Report: PB99-156374, NTSB/ACR-99/01

Notes:

Personnel:[1] Pilot, others (aboard), others (not aboard)
Environment:[2] Weather, light conditions, objects (trees, wires, etc.) airport, airways facilities and aids, terrain/runway conditions
Aircraft:[3] Propulsion systems and controls, flight control systems, landing gear, system/equipment/instruments
Other:[4] All other factors

Table 3-3: Most Common Causes of General Aviation Accidents

Cause/Factor	Non-Fatal Accidents	Fatal Accidents	Total Accidents
Personnel [1]	1,409	283	1,692
Environment [2]	790	136	926
Aircraft [3]	571	75	646
Other [4]	192	48	240

Source: Tables 13, 33 & 51 of NTSB Report: PB99-156374, NTSB/ACR-99/01

Notes:

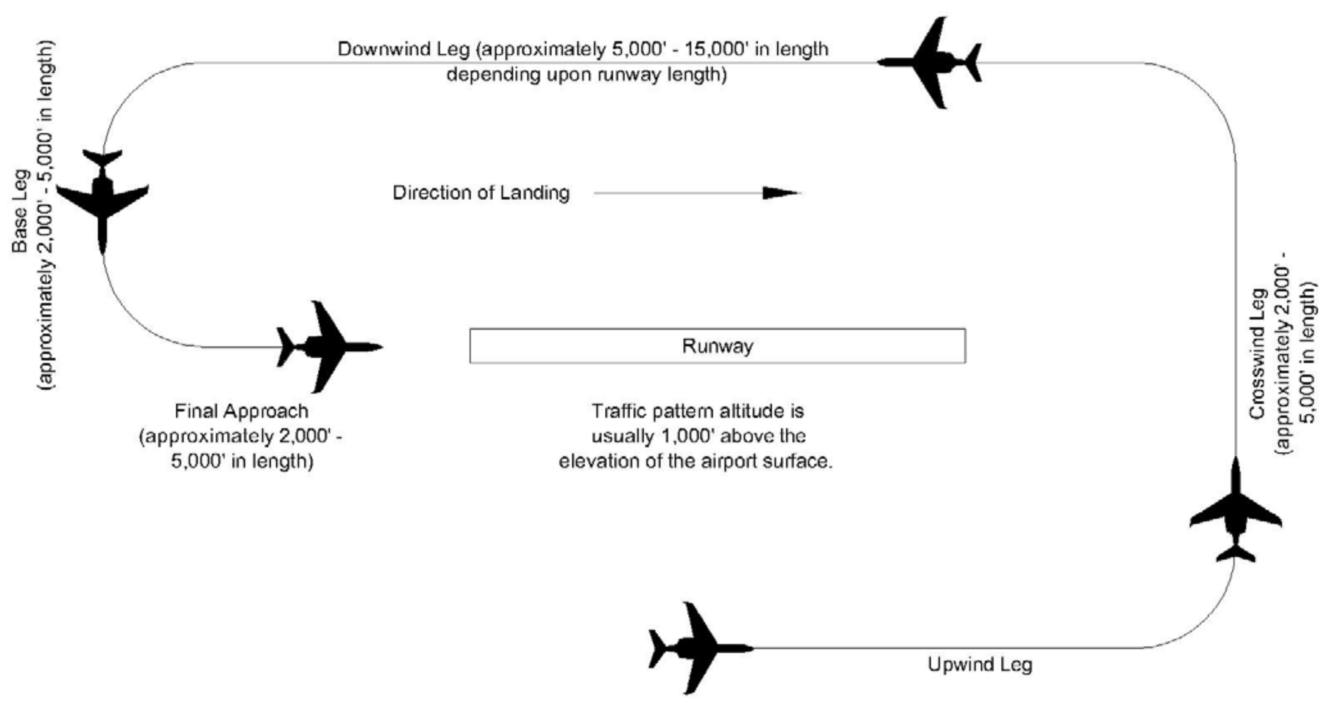
Personnel:[1] Pilot, others (aboard), others (not aboard)
Environment:[2] Weather, light conditions, objects (trees, wires, etc.), airport, airways facilities and aids, terrain/runway conditions
Aircraft:[3] Propulsion systems and controls, flight control systems, landing gear, system/equipment/instruments
Other:[4] All other factors

Perhaps the most critical factor in determining which areas around an airport should be protected, is knowing where aircraft accidents occur. Data compiled by the NTSB indicate that the largest number of aircraft accidents occur on airport property. Specific data regarding the location of general aviation aircraft accidents, relative to the airports' location, are also available from the NTSB. With regard to general aviation aircraft accidents, data from the NTSB indicate that roughly 45 percent of all aircraft accidents occurred on airport property, while 15 percent occurred within one mile of the airport, and 40 percent occurred beyond one mile of the airport. Considering the general aviation aircraft accidents that occurred within one mile of the airport, 33 percent of these occurred within one-quarter mile of the airport and 29 percent occurred in the airport traffic pattern. The remaining 38 percent occurred within one mile of the airport. This data suggests that three geographic areas should be considered when addressing incompatible land use: land use under the airport traffic pattern, within one-quarter mile of an airport, and off the approach ends to the runways. The areas within ¼ mile of the runway and the approach ends of the runway will be discussed later in this chapter, while the airport traffic pattern is discussed below.

✈ *Data compiled by the NTSB indicate that the largest number of aircraft accidents occur on airport property.*

A typical airport traffic pattern, as depicted in Exhibit 3-1, is rectangular in shape. It has a footprint of approximately 230 to 1720 acres of land, depending upon the runway length and type of aircraft using the airport. The base and crosswind legs are flown approximately 1,000 to 2,000 feet perpendicular to the runway and are approximately 2,000 to 5,000 feet in length. The downwind leg parallels the runway at a distance of 2,000 to 5,000 feet and extends approximately 1,000 to 2,000 feet beyond the end length of the runway in each direction to meet either the crosswind or base legs. The typical altitude for the pattern is 1,000 feet above the airport elevation. A typical airport traffic pattern, depicted in **Exhibit 3.1**, can be between 2,000 and 5,000 feet depending on the type of aircraft, number of aircraft in the pattern and a pilot's own individual flying techniques.

Exhibit 3-1: Typical Airport Traffic Pattern



3.1b. FAA Required Surfaces

Specific areas to be considered at and around an airport are defined by two major Federal Aviation Administration criteria: Federal Aviation Regulation (FAR) Part 77 - Objects Affecting Navigable Airspace and FAA Advisory Circular 150/5300-13 Airport Design Standards. These two primary documents provide the foundation for delineating the limits of the environs affected by aircraft near airports.

b.1 FAR Part 77 Surfaces

FAR Part 77 establishes standards for determining which structures pose potential obstructions to air navigation. It does this by establishing standards for defining obstructions to navigable airspace. These airspace areas are referred to as "Imaginary Surfaces." Objects affected include existing or proposed objects of natural growth, terrain, or permanent or temporary construction including equipment that is permanent or temporary in character. The imaginary surfaces outlined in FAR Part 77 include:

- ✈ Primary Surface
- ✈ Transitional Surface
- ✈ Horizontal Surface
- ✈ Conical Surface
- ✈ Approach Surface

✈ Dimensions of FAR Part 77 surfaces vary depending on the type of runway approach.

FAR Part 77 surfaces are designed to protect specific airspace areas, while design standards are intended to protect specific ground areas. Accident data presented earlier reveals that most aircraft accidents occur during the landing or takeoff portion of flight. It is, therefore, important to protect the approach and departure ends of each runway. Dimensions of FAR Part 77 surfaces vary depending on the type of runway approach. There are three types of runway approaches: visual, non-precision, and precision.

A visual approach runway is one with no instrument approach capabilities or where the existing or planned instrument approach is a circling, rather than a straight-in approach. A circling approach requires the pilot to have visual contact with the runway while aligning the aircraft with the runway for landing.

A non-precision instrument runway utilizes air navigational facilities with only horizontal guidance to aircraft, aligning them with the runway for straight-in approaches.

A precision instrument runway has approaches that use an Instrument Landing System (ILS), a Precision Approach Radar (PAR), or a Microwave Landing System (MLS). These approach systems provide both vertical and horizontal alignment of aircraft to a particular runway. Airports with scheduled commercial passenger traffic and heavily-used general aviation airports normally have existing or planned precision approaches.

Definitions for the FAR Part 77 surfaces are as follows:

✈ Primary Surface: The primary surface is longitudinally centered on a runway. When the runway has a specially prepared hard surface, the primary surface extends 200 feet beyond each end of that runway. When the runway has no specially prepared hard surface, or planned hard surface, the primary surface terminates at each end of the runway. The width of a primary surface ranges from 250 feet to 1,000 feet depending on the existing or planned approach and runway type (i.e., visual, non-precision, or precision). **Exhibits 3-2 and 3-3** depict the dimensional requirements of the primary surface.

- ✈ Transitional Surface: Transitional surfaces extend outward and upward at right angles to the runway centerline and are extended at a slope of seven (7) feet horizontally for each foot vertically (7:1) from the sides of the primary and approach surfaces. The transitional surfaces extend to where they intercept the horizontal surface at a height of 150 feet above the runway elevation. For precision approach surfaces, which project through and beyond the limits of the conical surface, the transitional surface also extends a distance of 5,000 feet measured horizontally from the edge of the approach surface and at right angles to the runway centerline. **Exhibits 3-2 and 3-3** depict the dimensional requirements of the transitional surface.

- ✈ Horizontal Surface: The horizontal surface is a horizontal plane located 150 feet above the established airport elevation, covering an area from the transitional surface to the conical surface. The perimeter is constructed by swinging arcs from the center of each end of the primary surface and connecting the adjacent arcs by lines tangent to those areas. The radius of each arc is 5,000 feet for all runway ends designated as utility or visual, or 10,000 feet for all other runway ends**. Exhibits 3-2 and 3-3** depict the dimensional requirements of the horizontal surface.

- ✈ Conical Surface: The conical surface is a surface extending upward and outward from the periphery of the horizontal surface at a slope of one foot for every 20 feet (20:1) for a horizontal distance of 4,000 feet.

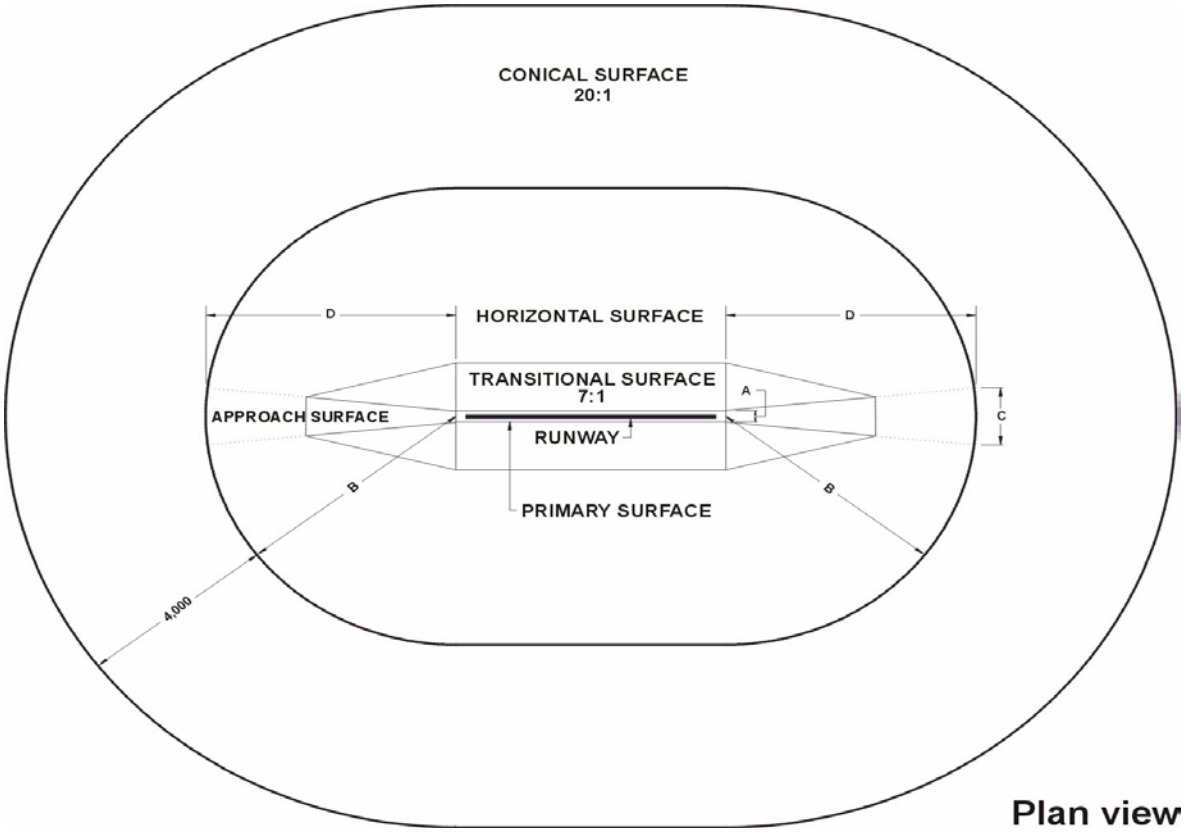
- ✈ Approach Surface: Longitudinally centered on the extended runway centerline, the approach surface extends outward and upward from the end of the primary surface. An approach surface is applied to each end of each runway based upon the type of approach. The approach slope of a runway is a ratio of 20:1, 34:1, or 50:1, depending on the sophistication of the approach. The length of the approach surface varies, ranging from 5,000 feet to 50,000 feet. The inner edge of the approach surface is the same width as the primary surface and expands uniformly to a width ranging from 1,250 feet to 16,000 feet depending on the type of runway and approach. **Exhibits 3-2 and 3-3** depict the dimensional requirements of the approach surface.

As previously noted, Exhibits 3-2 and 3-3 illustrate the FAR Part 77 "Imaginary Surfaces" in both plan view and profile view representations. The dimensional requirements for each of the FAR Part 77 surfaces described previously are also presented. A visual approach runway has relatively small imaginary surfaces with approach and horizontal surfaces extending 5,000 feet from the primary surface, at an approach slope of 20:1. For a non-precision approach runway, both the approach and the horizontal surfaces extend either 5,000 or 10,000 feet from the primary surface, depending on the design category of the runway. The imaginary surfaces for precision approach runways are similar to those for non-precision runways except that the approach surface extends 50,000 feet from the primary surface and horizontal surfaces extend 10,000 feet from the primary surface.

> ✈ *The FAA is not authorized to regulate the height of structures. This responsibility falls to the state and local authorities.*

Although the FAA can determine which structures are obstructions to air navigation, the FAA is not authorized to regulate tall structures. Under FAR Part 77, an aeronautical study can be undertaken by the FAA to determine whether the structure in question would be a hazard to air navigation. However, there is no specific authorization in any statute that permits the FAA to limit structure heights or determine which structures should be lighted or marked. In fact, in every aeronautical study determination, the FAA acknowledges that state or local authorities have control over the appropriate use of property beneath an airport's airspace.

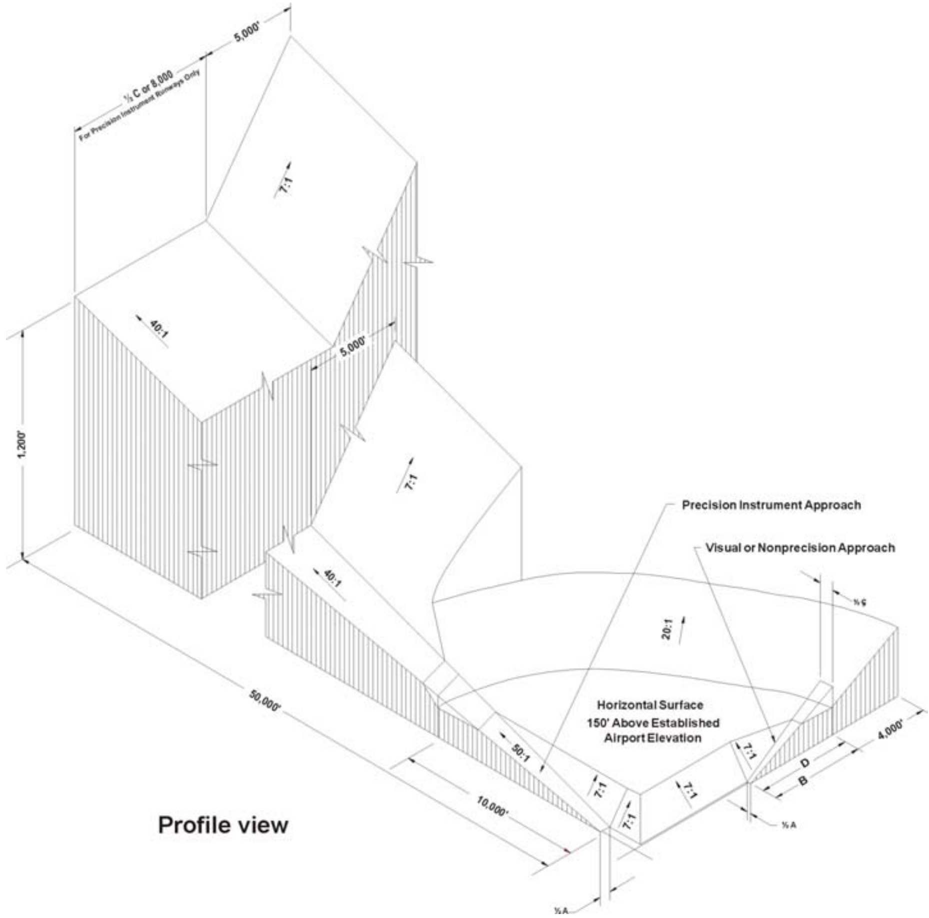
Exhibit 3-2: FAR Part 77 Surfaces – Plan View and Dimension Requirements



Dim	Item	Dimensional Standards (Feet)					
		Visual Runway		Non-Precision Instrument Runway			Precision Instrument Runway
		A	B	A	B		
					C	D	
A	Width of Primary Surface and Approach Surface Width at Inner End	250	500	500	500	1,000	1,000
B	Radius of Horizontal Surface	5,000	5,000	5,000	10,000	10,000	10,000
C	Approach Surface Width at End	1,250	1,500	2,000	3,500	4,000	16,000
D	Approach Surface Length	5,000	5,000	5,000	10,000	10,000	*
E	Approach Slope	20:1	20:1	20:1	34:1	34:1	*

A – Utility Runways
B – Runways Larger than Utility
C – Visibility Minimums Greater than ¾ Mile
D – Visibility Minimums as Low as ¾ Mile
* – Precision Instrument Approach Slope is 50:1 for Inner 10,000 feet and 40:1 for an Additional 40,000 feet

Exhibit 3-3: FAR Part 77 Surfaces - Profile View



The State of Oregon exercises its authority to control obstructions to air navigation. Oregon Administrative Rule Chapter 738, Division 70 Physical Hazards to Air Navigation (OAR 738-70) authorizes the ODA to adopt rules defining physical hazards to air navigation within the State of Oregon. These hazards include existing and proposed manmade objects, objects of natural growth, mobile objects, and terrain. OAR 738-70 also determines whether such objects or structures shall be marked and lighted; and determines the responsibility of such marking and lighting. While FAR Part 77 recommends mitigation measures for objects that deviate from Part 77 imaginary surfaces, OAR 738-70 requires marking and lighting for objects that are obstructions.

✈ ODA exercises its authority to regulate obstruction to air navigation through OAR 738, Division 70.

b.2 FAA Design Standards

Safety areas are defined by FAA airport design criteria standards to allow for the safe and efficient operation of an airport. These safety areas include:

- ✈ **Runway Protection Zone:** Runway Protection Zones, formerly clear zones, were originally established to define land areas underneath aircraft approach paths. Allowing control of these areas by airport operators was desirable to prevent the creation of airport hazards or the development of incompatible land use. A 1952 report by the President's Airport Commission, entitled "The Airport and Its Neighbors," recommended the establishment of clear areas beyond runway ends. Provision of these clear areas was intended not only to preclude obstructions potentially hazardous to aircraft, but also to control building construction as protection to people on the ground. The Department of Commerce concurred with the recommendation on the basis that this area was "primarily for the purpose of safety for people on the ground." The FAA adopted clear zones with dimensional standards to implement the Commission's recommendation. Guidelines were developed recommending that clear zones be kept free of structures and any development that would create a place of public assembly. Today, clear zones are referred to as Runway Protection Zones, whose function remains to protect people and property on the ground.

✈ Design standards are defined and explained by the FAA Advisory Circular 150/5300-13, Airport Design.

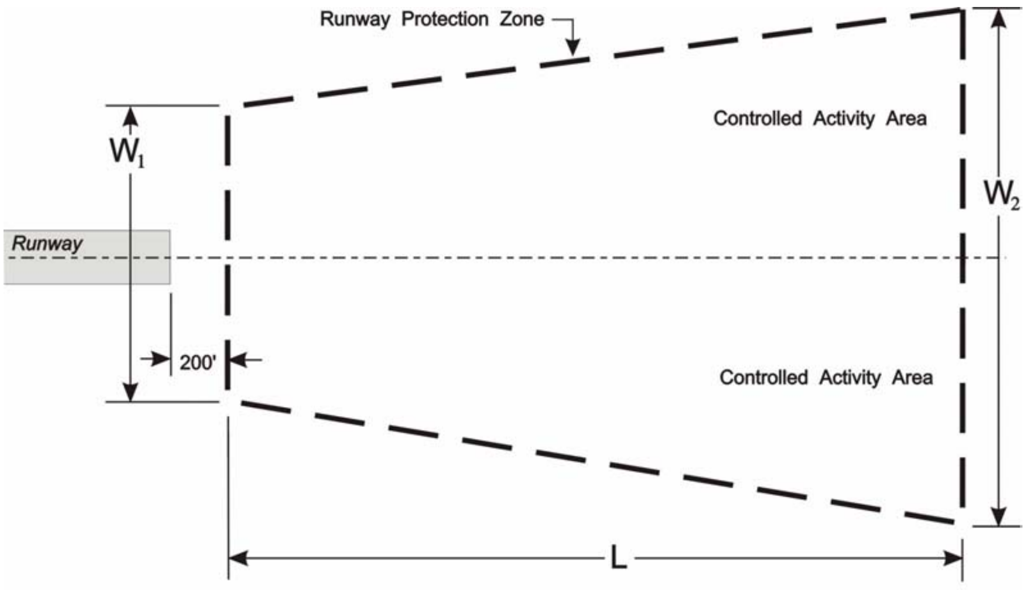
A Runway Protection Zone (RPZ) is an area that begins at a point 200 feet beyond the end of the runway. The length of the RPZ extends 1,000, 1,700, or 2,500 feet depending on the category of runway and type of approach (visual, non-precision or precision). The inner width of a RPZ is located closest to the end of the runway. Opposite this end is the outer width, which is the wider end. The inner width of a RPZ varies from 250 feet to 1,000 feet. The outer width of a RPZ varies from 450 feet to 1,750 feet. As with the length of the RPZ, the inner and outer widths of a RPZ are dependent on the runway category and approach type. **Exhibit 3-4** depicts a schematic of the RPZ and presents its required dimensions by runway category and runway approach type.

- **Runway Safety Area:** The Runway Safety Area (RSA) is a critical surface surrounding the runway. RSAs should be cleared and graded and free of potentially hazardous surface variations. The RSAs should be properly drained and capable of supporting snow removal, aircraft rescue and fire fighting (ARFF) equipment, or an aircraft (without causing damage to the aircraft). The size of the RSA is dependent upon the runway design category and approach type (visual, non-precision, or precision). Taxiways also have similar safety area requirements.

- **Runway Object Free Area:** The runway Object Free Area (OFA) is a two-dimensional ground area surrounding the runway. FAA standards prohibit parked aircraft and objects from locating within the OFA. The runway OFA extends beyond the runway end at lengths that vary from 240 feet to 1,000 feet, depending on the runway design category and the approach type. There are also taxiway OFAs.

These safety zones (RSAs and OFAs) are almost always contained within airport property. The RPZs, however, can extend beyond airport property. Therefore, from an off-airport land use compatibility perspective, the critical safety zone for land use compatibility planning is the RPZ. The FAA recommends that the entire RPZ should be owned by the airport whenever possible.

Exhibit 3-4: Runway Protection Zone and Dimension Requirements



Runway Protection Zone Dimension Requirements

Approach Visibility Minimums [1]	Facilities Expected to Serve	Dimensions: Length (L)	Dimensions: Inner Width (W_1)	Dimensions: Outer Width (W_2)	Dimensions: RPZ (acres)
Visual and Not lower than 1 Mile	Small Aircraft Exclusively	1,000	250	450	8.035
	Aircraft Approach Categories A & B	1,000	500	700	13.770
	Aircraft Approach Categories C & D	1,700	500	1,010	29.465
Not lower than ¾ Mile	All Aircraft	1,700	1,000	1,510	48.978
Lower than ¾ Mile	All Aircraft	2,500	1,000	1,750	78.914

All dimensions in feet unless otherwise noted.

Source: FAA Advisory Circular 150/5300-13, Airport Design

Note:

[1]The RPZ dimensional standards are for the runway end with the specified approach visibility minimums. The departure RPZ dimensional standards are equal to or less than the approach RPZ dimensional standards. When a RPZ begins other than 200 feet beyond the runway end, separate approach and departure RPZs should be provided. Refer to appendix 14 of FAA Advisory Circular 150/5300-13, *Airport Design*, for approach and departure RPZs.

3.2 Compatibility Concerns

✈ Compatibility concerns can take many forms: from the level of density to wildlife attractants and each has associated safety issues.

There are basic categories of concern when discussing compatible land uses. The following outlines the top priority items that need to be addressed as part of a land use compatibility program. Some factors to consider include the density of developments and the height of structures. Other conditions to consider when planning for safe airport environs include distracting lights, reflective glare, smoke, dust, induced fog, electronic interference, and bird attractants. These conditions can distract the pilot and interfere with their safe approach and departure from an airport. Land uses that can lead to, or contribute to, these conditions should be discouraged in the airport environs. In particular, proposed development should not be permitted beneath the approach surface of a runway if that development generates any of the potentially hazardous conditions described in the following paragraphs. This is by no means an inclusive list, however, it illustrates the diverse types of land uses that a planner needs to be cognizant of when developing an airport land use plan.

3.2a. Density Development

A primary means of limiting the risks of damage or injury to persons or property on the ground due to near-airport aircraft accidents is to limit the density of land use development in these areas. The question of where to set these limits is dependent upon both the probability of an accident and the degree of risk that the community finds acceptable. From the previous sections, it is clear that accident probabilities increase with closer proximity to runway ends both because of greater concentration of aircraft over that area and because aircraft are flying at low altitude.

The areas where aircraft regularly fly less than 500 feet above the ground are regarded as the most critical. Low flight altitudes present the greatest risks because they offer pilots less opportunity to recover from unexpected occurrences. Because aircraft are turning to follow the traffic pattern, this area encompasses more than just the area beneath the FAR Part 77 approach surface. Turns mostly take place between 2,000 and 5,000 feet from the runway end, depending upon the aircraft type, the number in the traffic pattern, and the pilot's flying techniques.

These points raise the question of the degree of risk to which adjacent uses will be subjected. Perhaps the best measure of development density in this context is the number of persons per acre. Because the risks differ inside a building versus outside, different standards are often applied for each condition. Some airports and local communities have set development density limitations ranging from 25 to 100 people for various parts of a runway approach corridor. Shopping centers are likely to average about 75 people per acre and restaurants are often over 100. In general, high density residential development and places of public assembly should not be permitted in the airport's approach corridors.

3.2b. Open Areas

✈ RPZs and approach areas are often the most critical areas that must be protected from incompatible land use.

Another facet of the safety/density issue is how to reduce the risks for the occupants of an aircraft in the event that an emergency landing cannot be avoided. Given that aircraft are normally controllable during an emergency descent, pilots will head for the best available open space if they cannot reach the airport. An open area does not have to be very large to enable a successful landing for the occupants to survive the accident with limited injury. Because the pilot's discretion in selecting an emergency landing site is reduced as the aircraft's altitude decreases, open areas should preferably be spaced more closely in those locations that aircraft can over-fly.

3.2c. Height of Structures

As indicated in the previous section, Part 77 of the Federal Aviation Regulation provides basic guidance regarding the airport-vicinity airspace that should be protected from tall structures. The most critical locations with regard to height are beneath the airport approach surfaces. Tall objects in the approach corridors may pose risks even though they do not penetrate the defined Part 77 surfaces. Such objects can adversely affect minimum instrument approach altitudes. As such, the siting of multi-story facilities and communication towers should be carefully considered in relation to airport activities.

3.2d. Lights
Lights that shine upward are potentially hazardous since they can detract from a pilot's ability to identify an airport at night. A pilot may perceive such lights from adjacent land uses as part of the airport and/or runway lights.

3.2e. Glare
Reflective surfaces can produce a blinding glare, distracting pilots. Water surfaces and building materials also need to be considered with regards to glare.

3.2f. Smoke
Smoke generated by nearby business, industry, or field burning operations can create severe visual difficulties when a pilot is either looking for an airport or preparing to take-off or land. An extensive amount of smoke can drastically curtail airport operations. Dust, fog, and steam, that all contribute to reduced visibility can limit the effectiveness of an airport.

3.2g. Electronic Interference
Land uses that generate electronic transmissions should not be permitted near airports. Such uses can interfere with aviation navigational signals and radio communications.

3.2h. Bird Attractants
Water impoundments, garbage dumps, sanitary landfills, sewage treatment plants and certain species of flora and fauna often attract birds. Increased numbers of birds around airports increase the possibility of collisions between birds and aircraft. Damage to an aircraft and its occupants from a bird strike can be devastating. *FAA Order 5200.5, Guidance Concerning Sanitary Landfills On or Near Airports*, states that sanitary landfills, because of their bird attractive qualities, are considered to be an incompatible land use if located within specified distances as cited by the FAA. Advisory Circular 150/5200-33, *Hazardous Wildlife Attractants on or Near Airports* discusses the various incompatible land uses, and bird attractants are included in this list. It is stated in *FAA Order 5050.4A, Airport Environmental Handbook*, that the FAA advises against locating such facilities within 5,000 feet of all runways accommodating or planned to accommodate piston-type aircraft, and within 10,000 feet of all runways accommodating or planned to accommodate turbine (jet) powered aircraft. Oregon State solid waste management rules dictate specific operating criteria for municipal and non-municipal solid waste landfill sites that encourage compatible land uses around airports. For example, the State's rules on landfill site location requirements relative to airports, coincide with the requirements set forth in *FAA Order 5050.4A*. In addition, the State requires that landfill sites be periodically covered with earth material to minimize bird attraction.[1]

> ✈ *Wildlife attractants, specifically bird attractants, are a concern to airports since wildlife can collide with aircraft in the air and on the ground. This can cause loss of life and damage to property.*

Other potentially hazardous conditions should be recognized when planning compatible land use in the airport environs. In general, places of public assembly; distracting lights, glare, smoke, electronic interference; and bird attractors should not be within runway protection zones, approach zones, transitional zones, or beneath the airport traffic pattern. Additionally, sources emitting electronic interference and bird attractors are not acceptable forms of land use within the horizontal and conical zones.

[1] Oregon Department of Environmental Quality, Administrative Rules, Solid Waste Management, Division 340-94-040(10) and Division 340-95-020(22), March 1993.

Table 3-4 identifies land uses that are generally compatible or incompatible within airport safety areas and Part 77 surfaces. There are specific types of development that are usually compatible with an airport. In general, these include most agriculture, commercial, and industrial land uses. Other types of development, such as residential and places of public assembly are typically considered to be incompatible with an airport. If residential development is planned near an airport, it should be low density. Guidelines presented in this table need to be verified on a case-by-case basis.

3.3 Noise Related Concerns

✈ *Noise related issues are often hard to address because many concerns are based upon perceived impacts.*

Noise is defined in Webster's dictionary as "any sound that is undesired or interferes with one's hearing of something." Aircraft sounds are perceived differently by various individuals. However, concerns about aircraft noise are often reflections of the degree to which aircraft noise intrudes on existing background noise. In general, where ambient noise is low, aircraft noise is perceived as a problem. For example, in an urban area, noise generated by aircraft is muffled by noise produced by cars, trucks, and industry. In quiet, less developed areas, noise generated by a small aircraft could be annoying to the nearby resident. Each community must decide whether noise-related land use controls around their airport should be limited to substantially noise-impacted areas, or if they see a need to control land use in areas impacted by more moderate noise levels.

Historically, airports were constructed on the outskirts of communities. Aircraft noise was not a problem since the airport was located at a significant distance from developed areas. Through the years, development has often expanded toward the airport. As communities have expanded toward an airport, land uses that are sensitive to noise have developed closer to the airport. In fact, in Oregon, residential development and other high density development is now occurring near many of the airports. Coupled with increases in air traffic volumes, the potential for noise problems related to land use in the airport environs has intensified in recent years. Inappropriate development near airports increases the perceived impact of aircraft noise.

3.3a. Noise Impacts

Noise impacts around an airport are greatly influenced by various factors. Factors affecting an airport's noise impact include the number of aircraft operations and the type of aircraft using the airport. In addition, each airport is different in geographical location, size, role, airfield layout, and its patterns of surrounding land use. Thus, each airport may have its own particular noise problem that requires solutions tailored to that specific airport site.

✈ *The industry standard for noise modeling is the FAA Integrated Noise Model (INM).*

Noise impact areas for an airport are identified by noise contours. The basic methodology employed to define aircraft noise levels involves the use of a mathematical model: the Federal Aviation Administration's (FAA) Integrated Noise Model (INM). The INM contains a database that relates slant range distance and engine thrust to noise levels related to each specific type of aircraft. On an irregular grid around the airport, the Model computes the associated noise exposure level for the specific aircraft and engine thrust used at that point along the aircraft route of flight. The individual noise exposure levels are summed for each grid location. Equal noise levels are then indicated by a series of contour lines superimposed on a map of the airport and its environs. Although lines on a map tend to be viewed as definitive, it should be emphasized that the Model is only a planning tool. By developing a set of noise contours for an airport, a planner can identify areas that are most likely to be impacted by aircraft noise, and plan accordingly. A later section of this report provides noise contour examples for airports with varying activity levels.

Table 3-4: Compatible Land Uses per FAR Part 77 Surfaces and FAA Safety Areas

Legend:
C Generally compatible land use
NC Incompatible Land Use
• Not clearly compatible or incompatible, requires specific study

Criteria for Compatibility:
1. Does not exceed height standards
2. Does not attract large concentrations of people
3. Does not create a bird attractant
4. Does not cause a distracting light/glare
5. Does not cause a source of smoke
6. Does not cause an electrical interference
7. Does meet compatible DNL sound levels

Land Uses	Primary Surface	Transitional Surface	Horizontal Surface	Conical Surface	Approach Surface	Runway Protection Zone
Residential						
Residential, other than those listed below	NC	NC	•	C	•	NC
Mobile home parks	NC	NC	•	C	•	NC
Transient lodgings	NC	NC	•	C	•	NC
Public Use						
Places of public assembly (schools, hospitals, churches, auditoriums)	NC	NC	•	C	NC	NC
Government services	NC	•	C	C	•	NC
Transportation (parking, highways, terminals)	NC	•	C	C	•	•
Commercial Use						
Offices, business and professional	NC	•	C	C	•	NC
Wholesale & retail - building materials, hardware and farm equipment	•	•	C	C	•	NC
Retail trade - general	NC	•	C	C	•	NC
Utilities	NC	•	•	•	•	•
Communication	NC	•	•	•	•	NC
Manufacturing & production						
Manufacturing - general	NC	•	•	•	•	NC
Agricultural (except livestock) and forestry	•	•	C	C	•	•
Livestock farming and breeding	NC	•	•	C	•	NC
Mining and fishing, resource production and extraction	NC	NC	•	•	•	NC
Recreational						
Outdoor sports arenas and spectator sports	NC	NC	•	C	NC	NC
Nature exhibits and zoos	NC	NC	•	C	NC	NC
Amusement parks, resorts and camps	NC	NC	C	C	NC	NC
Golf courses	NC	NC	C	C	NC	NC
Parks	NC	•	•	•	•	•

The Federal Aviation Administration (FAA) is the federal agency involved with providing guidance for developing local plans and zoning ordinances for areas affected by aircraft noise. Federal Aviation Regulations (FARs) pertaining to aircraft noise include: FAR Part 150 - Airport Noise Compatibility Planning, FAR Part 36 - Noise Standards, FAR Part 91 - Transition to all Stage 3 fleet operating in the 48 contiguous United States and the District of Columbia, and FAR Part 161 - Notice and approval of airport noise and access restrictions

✈ Appendix J provides information regarding measuring aircraft noise.

✈ **FAR Part 150** contains many regulations in the "Aviation Safety and Noise Abatement Act, 1979." Under FAR Part 150, local jurisdictions can prepare and submit to the FAA a Noise Exposure Map (NEM) for the airports environs and a Noise Compatibility Plan (NCP), if desired. This voluntary program applies to all publicly owned, public use airports that are included in the National Plan of Integrated Airport Systems (NPIAS). The NPIAS identifies the type and estimated costs of airport development eligible for FAA Airport Improvement Program (AIP) funds. The NPIAS is considered the planning document while the AIP is the implementing program. The FAR Part 150 regulation does not apply to privately owned airports (unless they are included in the NPIAS), heliports, or military facilities.

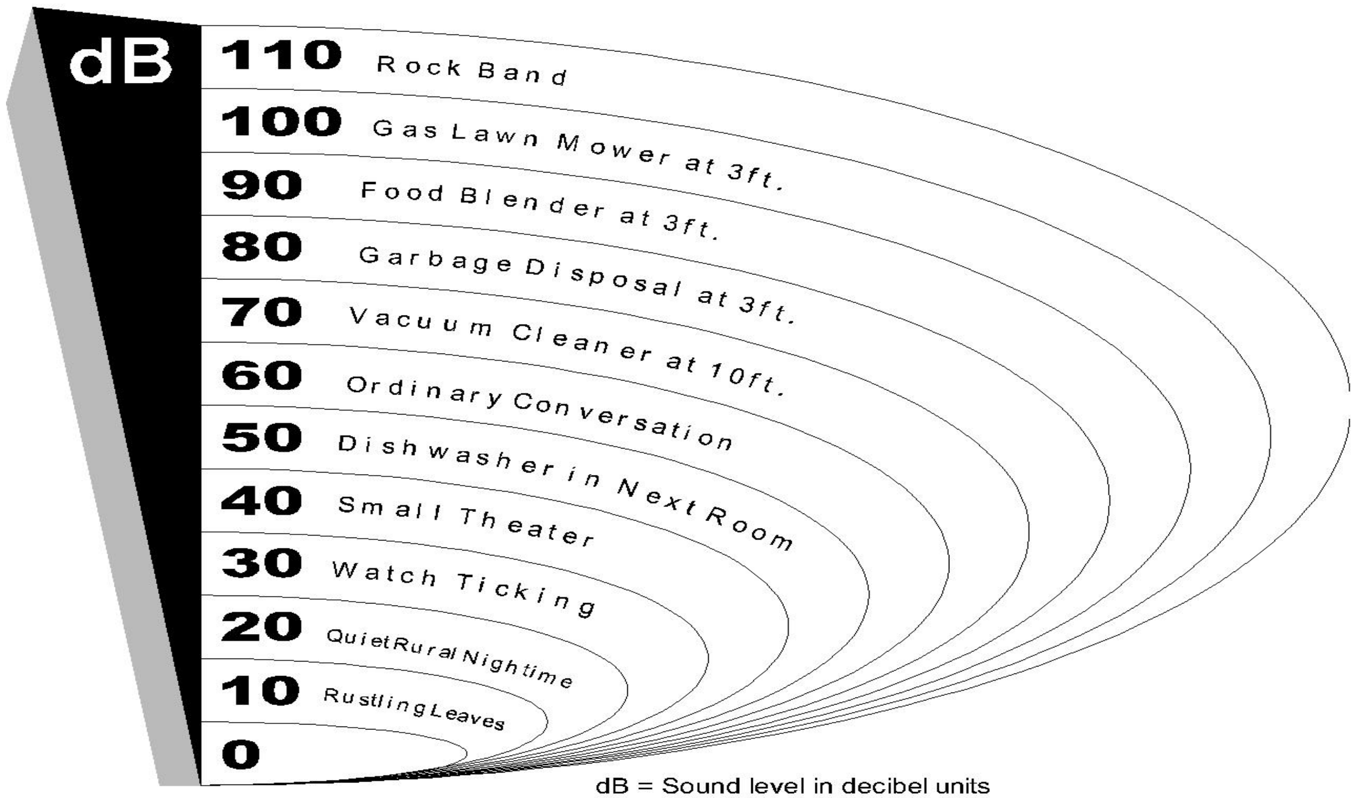
Other provisions established by FAR Part 150 include:

- ✓ Making the decibel (dBA) the universal noise measurement tool
- ✓ Making the DNL the universal Noise Contour measure
- ✓ Defining land uses which are acceptable for areas within each DNL Noise Contour

Noise is measured in decibels (dB). Aircraft sound levels are measured using the A-weighted decibel scale (dBA). FAR Part 150 approves the decibel (dBA) unit as the universal noise measurement tool. The A-weighted decibel unit most closely approximates the manner in which the human ear responds to sound. **Exhibit 3-5** depicts common sounds and their associated noise levels while **Table 3-5** presents estimated noise levels associated with various aircraft types at maximum gross takeoff weight.

Many studies have been done to measure how much noise an aircraft generates. Although several noise measures have been developed, the Environmental Protection Agency (EPA) and the FAA use a method called the day-night average sound level (DNL) noise contour method as the primary measure for defining noise around an airport. DNL is defined as the average A-weighted sound level, measured in decibels, for a 24-hour period. This level is obtained after a 10-decibel penalty is applied to noise events occurring between the nighttime hours of 10:00 p.m. to 7:00 a.m., local time. The 10-decibel penalty applied to noise events occurring at night represents the differences in perception of sound levels between day and night. DNL is a summation metric that allows more objective analysis; it describes noise exposure comprehensively over a large area.

Exhibit 3-5: Common Sounds and Their Noise Levels



Source: Oregon Department of Transportation, Aeronautics Section, Technical Report, Airport Land Use Compatibility Guidelines, November, 1994

Table 3-5: Estimated Part 36 A–Weighted Sound Levels		
Manufacturer	**Airplane**	**Estimated dBA**
Boeing	B-747-200	99
Boeing	B-727-200	88
Boeing	B-737-200	87
McDonnell Douglas	DC 9-30	85
Learjet	23	84
Sabreliner	Sabre 60	84
Gulfstream	G-II	84
Boeing	B-767-300	80
Learjet	240	80
McDonnell Douglas	MD-80	78
Fokker	F-27-200	78
Dassault Brequet	Falcon 20	77
Airbus	A-300B1	76
Boeing	B-757-200	74
Cessna	207	74
Learjet	Learjet 24E	73
Fokker	Fokker 100	72
Cessna	210	71
Learjet	Learjet 35A	71
Beech	B36TC Bonanza	71
Embraer	EMB 110-P2	71
Cessna	Citation III	70
Piper	PA-42 Cheyenne	70
Dehavilland	DHC-7	69
Fairchild	SA 226-AC Metro III	69
Beech	Super King Air 200	68
Learjet	Learjet 55	67
Gulfstream	G-IV	66
Dornier	D-228	66
Beech	65 Queen Air	65
Saab Fairchild	SF 340	65
Mooney	M 20C	65
BAE	Jetstream 31	63
Piper	PA-44-180	62
Gulfstream	GA-5A	60
Beech	A-23	58
Piper	PA-30 Twin Comanche	58

Source: FAA AC 36-3F; noise level estimates are provided in FAR Part 36 (estimates reflect noise levels at 6,500 meters from start of takeoff roll)

After DNL noise contours are developed for an airport area, three basic noise impact areas can be identified. These major impact areas, referred to as noise corridor zones, can be defined as a "severe" noise impact area, a "substantial" noise impact area, or a "moderate" noise impact area. The severe noise impact area includes "those areas contained within the 70 DNL contour and above." The substantial noise impact category is defined by the areas of land impacted by the 65 DNL to the 70 DNL contour. Areas impacted by the 55 DNL up to the 65 DNL contour are within the moderate noise impact category. Areas exposed to 55 DNL or less are not considered to be seriously impacted, from a noise perspective.

✈ *The FAA acknowledges the 65 DNL noise contour as the limit of impact from aircraft noise, whereas at the state level, the 55 DNL noise contour is recognized by the State Department of Environmental Quality within OAR Chapter 340, Division 35.*

FAA Part 150 describes acceptable types of land use for each DNL sound level. It is desirable that areas impacted by the 70 DNL contour or greater be acquired by the airport owner. Typically this level of noise impact beyond airport property is associated with large, high activity airports. For airports with low activity, noise contours of 70 DNL and above are usually contained within airport property. For small airports, the 65 DNL will often fall within the existing airport property line. For larger airports, the 65 DNL contour may extend off airport property. Land uses that should not be located within areas exposed to 65 DNL and above include all residential development. When public institutions such as schools, hospitals, and churches are constructed within noise contours of 65 DNL or higher, measures should be taken to achieve reduced noise levels. Most land uses are compatible in areas impacted by noise levels less than 65 DNL.

The State of Oregon accepts the DNL Noise Contour method as the primary measurement defining noise around an airport. Although the FAA regards 65 DNL contours and above as significant, the State of Oregon regards 60 DNL and 55 DNL contours as significant. The State recognizes that, in some instances, land use controls and restrictions that apply to the 65 DNL may be appropriate for applications to areas impacted by 55 DNL and 60 DNL. For example, a rural area exposed to 55 DNL to 65 DNL noise levels may be more affected by these levels than an urban area. This is because there is typically a higher level of background noise associated with an urban area. **Table 3-6** depicts FAA accepted land uses for each DNL sound level.

On the State level, the Oregon Department of Environmental Quality (DEQ) finds that noise pollution associated with Oregon airports threatens the public health and welfare of residents living near these airports. The Environmental Quality Commission (EQC) states that a coordinated statewide program is needed to ensure that noise abatement programs are developed which effectively mitigate airport noise impacts where needed. Therefore, the DEQ has adopted Oregon Administrative Rule Chapter 340, Division 35 - "Noise Control Regulations" and an "Airport Noise Control Procedure Manual." The manual and OAR 340-35-045 - Noise Control Regulation for Airports establish procedures for an airport sponsor to use when a noise contour map or airport land use plan is needed. They also establish 55 DNL as a study boundary for planning and zoning measures and recommend specific mitigation for that area with noise impacts greater than 65 DNL. There are additional Federal Aviation Regulations that have positive impacts on airport land use compatibility. These regulations include Part 36, Part 91, and Part 161.

Table 3-6: Land Use Compatibility with Yearly Day-Night Average Sound Levels

Legend:

Y (Yes) - Land use and related structures compatible without restrictions

N (No) - Land use and related structures are not compatible and should be prohibited

NLR - Noise Level Reduction (outdoor to indoor) to be achieved through incorporation of noise attenuation into the design and construction of the structure

DNL - Average Day-Night Sound Level

25, 30, 35 - Land use and related structures generally compatible; measures to achieve NLR of 25, 30, 35 dB must be incorporated into design and construction of structure.

Land Use	Below 65	65-70	70-75	75-80	85-85	Over 85
Residential						
Residential, other than mobile homes and transient lodging	Y	N (1)	N (1)	N	N	N
Mobile home parks	Y	N	N	N	N	N
Transient lodgings	Y	N (1)	N (1)	N (1)	N	N
Public						
Schools	Y	N (1)	N (1)	N	N	N
Hospitals and nursing homes	Y	25	30	N	N	N
Churches, auditoriums, and concert halls	Y	25	30	N	N	N
Government services	Y	Y	25	30	N	N
Transportation	Y	Y	Y (2)	Y (3)	Y (4)	Y (4)
Parking	Y	Y	Y (2)	Y (3)	Y (4)	N
Commercial						
Offices, business and professional	Y	Y	25	30	N	N
Wholesale and retail - building materials, hardware and farm equipment	Y	Y	Y (2)	Y (3)	Y (4)	N
Retail trade - general	Y	Y	25	30	N	N
Utilities	Y	Y	Y (2)	Y (3)	Y (4)	N
Communication	Y	Y	25	30	N	N

Table 3-6: (Continued)

Land Use	Below 65	65-70	70-75	75-80	80-85	Over 85
Manufacturing & Production						
Manufacturing - general	Y	Y	Y (2)	Y (3)	Y (4)	N
Photographic and optical	Y	Y	25	30	N	N
Agricultural (except livestock) and forestry	Y	Y (6)	Y (7)	Y (8)	Y (8)	Y (8)
Livestock farming and breeding	Y	Y (6)	Y (7)	N	N	N
Mining and fishing, resource production and extraction	Y	Y	Y	Y	Y	Y
Recreational						
Outdoor sports arenas and spectator sports	Y	Y (5)	Y (5)	N	N	N
Outdoor music shells, amphitheaters	Y	N	N	N	N	N
Nature exhibits and zoos	Y	Y	N	N	N	N
Amusement parks, resorts and camps	Y	Y	Y	N	N	N
Riding stables and water recreation	Y	Y	25	30	N	N

Source: FAR Part 150, Appendix A, Table 1

Notes:

1. When the community determines that residential or school uses must be allowed, measures to achieve an outdoor to indoor NLR of at least 25 dB and 30 dB should be incorporated into building codes and be considered in individual approvals. Normal residential construction can be expected to provide a NLR of 20 dB, thus, the reduction requirements are often stated as 5,10 or 15 dB over standard construction and normally assume mechanical ventilation and closed windows year round. The use of NLR criteria will not, however, eliminate outdoor noise problems.
2. Measures to achieve NLR of 25 dB must be incorporated into the design and construction of portions of these buildings where the public is received, office areas, noise-sensitive areas, or where the normal noise level is low.
3. Measures to achieve NLR of 30 dB must be incorporated into the design and construction of portions of these buildings where the public is received, office areas, noise-sensitive areas, or where the normal noise level is low.
4. Measures to achieve NLR of 35 dB must be incorporated into the design and construction of portions of these buildings where the public is received, office areas, noise-sensitive areas, or where the normal noise level is low.
5. Land use is compatible provided special sound reinforcement systems are installed.
6. Residential buildings require an NLR of 25 dB.
7. Residential buildings require an NLR of 30 dB.
8. Residential buildings are not permitted.

- **FAR Part 36** categorizes aircraft by the level of noise the aircraft generates. The categories are termed Stage 1 (the loudest), Stage 2, and Stage 3 (the quietest). Those aircraft meeting Stage 1 noise levels have already been retired and are no longer operating in the U.S. commercial fleet. As of January 1989, approximately 65 percent of the U.S. airline fleet was comprised of Stage 2 aircraft, while the remaining aircraft met Stage 3 noise levels. FAR Part 36 dictates that all aircraft currently being produced comply with Stage 3 noise levels.

- **FAR Part 91** further mandates a deadline of December 31, 1999 for the retirement of all Stage 2 aircraft. Waivers authorizing Stage 2 aircraft operations may be granted under special circumstances as indicated by FAR Part 91-873. However, under no circumstances will Stage 2 aircraft be permitted to operate after Dec. 31, 2003. In other words, as of January 1, 2004, the U.S. commercial airline fleet will be comprised completely of Stage 3 aircraft. This transition to a quieter fleet mix will result in smaller noise contours, thus reducing the noise impact area surrounding many airports.

- **FAR Part 161** implements the Airport Noise and Capacity Act of 1990. This regulation defines requirements and procedures for airport proprietors to follow when implementing Stage 3 aircraft noise and access restrictions. Under this regulation, airport proprietors can impose limitations on Stage 2 or Stage 3 aircraft utilized by commercial carriers, for the purpose of controlling airport noise. Such restrictions include, but are not limited to:

  - ✓ limiting noise generated on either a single-event or cumulative basis
  - ✓ limiting the total number of Stage 2 or Stage 3 aircraft operations
  - ✓ implementing a noise budget or noise allocation program that includes Stage 2 or Stage 3 aircraft
  - ✓ limiting the number of hours of Stage 2 or Stage 3 aircraft operations
  - ✓ implementing a program of airport-use charges that has the direct or indirect effect of controlling airport noise.

> ✈ *The best approach to reducing noise related concerns is to keep noise-sensitive developments from the approach areas.*

Before the above described restrictions are adopted, the airport proprietor must inform the public of the proposed restriction, its anticipated or actual costs and benefits, an alternative restriction and comparison of the two. The proprietor must allow the public to comment on the proposed restriction. The airport proprietor then submits an application to the FAA for approval of the proposed noise or access restrictions. A written agreement between the airport proprietor and the commercial operators affected by the proposed restriction must be in effect within 180 days prior to the date of the proposed restriction. FAR Part 161 provides for improved airport land use compatibility by permitting the airport proprietor to implement noise and access restrictions at the airport.

The basic approach to enhancing noise compatibility is to minimize the extent to which noise impacts disrupt human activities or otherwise create an annoyance. In general, the best approach is to allow as few people to occupy highly noise impacted areas as possible. When this approach is not practical, the alternatives include:

- ✓ shielding people from the noise,
- ✓ increasing awareness of noise issues through education programs, and
- ✓ allowing land uses which have relatively high ambient noise levels, or are otherwise not particularly noise-sensitive.

This section has provided resource and background data, which is important for understanding the Federal and State regulations that prescribe and influence planning for compatible land use in the airport environs. Information on the location and the physical dimensions of areas to be protected to meet both safety and noise related planning goals, has also been provided. A subsequent section of these guidelines, Planning for Compatible Land Use, provides information that can be used by planners to examine, on a concurrent basis, areas that should be planned for to meet the various safety and noise related objectives described in this section. There are a number of strategies that can be considered by planners to promote compatible land use in the airport environs. These can be categorized as being "preventive" or "corrective" in their nature. These strategies are described in Chapter 6 of the guide.

3.4 Summary

Airports will continue to be an important component of the global economy, as well as the local community, and need to be protected through legislation and regulation of surrounding land uses. Preserving the economic vitality of the aviation system is directly related to the preservation of viable airports and compatible land uses. The various methods outlined in this document are available for use in ensuring the development of compatible land uses, where possible.