AIR INSTALLATION COMPATIBLE USE ZONE STUDY

Randolph Air Force Base, Texas

April 2008

DEPARTMENT OF THE AIR FORCE
AIR EDUCATION AND TRAINING COMMAND

08 APR 2008

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City Officials and Citizens of the Greater San Antonio Area

This Air Installation Compatible Use Zone (AICUZ) Study is an update of the 2000 Randolph AFB AICUZ Study. This update presents and documents changes to the previous study attributed to anticipated operational changes due to mission restructuring, conversion from the T-37 aircraft to the Joint Primary Aircraft Training System and its T-6 aircraft, and technical improvements to the noise modeling software used to perform the study.

The basic objective of the AICUZ program is to achieve compatible uses of public and private lands in the vicinity of military airfields. This can be accomplished by controlling incompatible development through local regulatory actions. The AICUZ Study provides the information necessary to maximize beneficial use of the land surrounding Randolph AFB while minimizing the potential for degradation of the health and safety of the affected public.

The AICUZ Study contains a description of the area of influence around the base. The report outlines the location of runway clear and accident potential zones, and noise contours; and the report recommends compatible land use for areas in the vicinity of the base. It is our hope this information will be incorporated into your community comprehensive plans, zoning ordinances, subdivision regulations, building codes, and other related documents.

We greatly value the positive relationship Randolph AFB has experienced with its neighbors in the Greater San Antonio area over the years. As a partner in the process, we have attempted to minimize disturbances generated by our aircraft operations in the area. We solicit your cooperation in implementing the recommendations and guidelines presented in this report.

Sincerely

J Van Ovost

JACQUELINE D. VAN OVOST, Colonel, USAF

AIR INSTALLATION COMPATIBLE USE ZONE STUDY

RANDOLPH AIR FORCE BASE, TEXAS

APRIL 2008

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ACRONYMS AND ABBREVIATIONS

12 FTW	12th Flying Training Wing
12 OG	12th Operations Group
AFB	Air Force Base
AFI	Air Force Instruction
AGL	above ground level
AICUZ	Air Installation Compatible Use Zone
APZ	Accident Potential Zone
CZ	Clear Zone
dB	decibel
dBA	A-weighted sound level measured in decibels
DNL	Day-Night Average A-Weighted Sound Level
DoD	Department of Defense
FAA	Federal Aviation Administration
FAR	Federal Aviation Regulations
FTS	Flying Training Squadron
INM	Integrated Noise Model
LZ	landing zone
MSA	Metropolitan Statistical Area
MSL	mean sea level
NLR	Noise Level Reduction
SLUCM	Standard Land Use Coding Manual
the Base	Randolph Air Force Base
UFC	Unified Facilities Criteria
US	United States
USEPA	United States Environmental Protection Agency
VFR	visual flight rules

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SECTION 1
PURPOSE AND NEED

1.1 INTRODUCTION

This study is an update of the 2000 Randolph Air Force Base (AFB), Texas Air Installation Compatible Use Zone (AICUZ) Study. The update presents and documents changes to the AICUZ amendment for the period 2000-2007 and is based on the March 2007 aircraft operations condition. This AICUZ Study reaffirms Air Force policy of assisting local, regional, state, and federal officials in the areas neighboring Randolph AFB by promoting compatible development within the AICUZ area of influence; and protecting Air Force operational capability from the effects of land use that are incompatible with aircraft operations. Specifically, the report documents changes in aircraft operations since the 2000 Study and provides noise contours and compatible use guidelines for land areas neighboring the installation based on the March 2007 operations. This information is provided to assist local communities and to serve as a tool for future planning and zoning activities. Changes that occurred since the 2000 Randolph AFB AICUZ Study include:

- A reduction in the number of aircraft operations at the airfield;
- Addition, elimination, and modification of aircraft flight tracks to correspond to flying operations changes;
- A change in the number of annual days of flying for Randolph AFB aircraft from 245 to 260 days per year;
- Changes in the number and location of aircraft maintenance engine runups;
- Relocation of an engine runup sound suppressor and the addition of a second suppressor; and
- Technical improvements to the NOISEMAP computer modeling program.

1.2 PURPOSE AND NEED

The purpose of the long-standing AICUZ program is to promote compatible land development in areas subject to aircraft noise and accident potential. The Air Force provides the AICUZ Study to all local communities to assist them in preparing local land use plans. As the nearby cities of Universal City, Schertz, Selma, Cibolo, Live Oak, and Converse and Bexar and Guadalupe counties prepare and modify land use development plans, recommendations from this updated AICUZ Study should be included in the planning process to prevent incompatible land use that could compromise the ability of Randolph AFB to fulfill its mission. Accident potential and aircraft noise should be major considerations in the planning process.

Air Force AICUZ guidelines reflect land use recommendations for the Clear Zones (CZ), Accident Potential Zones (APZ) I and II, and four noise zones exposed to noise levels at or above 65 decibels (dB) Day-Night Average A-Weighted Sound Level (DNL). These

guidelines were established on the basis of studies prepared and sponsored by several federal agencies, including the United States Department of Housing and Urban Development, United States Environmental Protection Agency (USEPA), United States Air Force, and state and local agencies. The guidelines recommend land uses that are compatible with airfield operations while allowing maximum beneficial use of adjacent properties. The Air Force has no desire to recommend land use regulations that render property economically useless. It does, however, have an obligation to the inhabitants of the Randolph AFB area of influence and the citizens of the United States to point out ways to protect the public investment in the installation and the people living in areas adjacent to the installation. The AICUZ area of influence includes the area within the DNL 65 dB and greater noise exposure area and the area within the CZs and APZs.

1.3 PROCESS, PROCEDURE, AND NOISE METRICS

Preparation and presentation of this update to Randolph AFB's AICUZ Study is part of the continuing Air Force participation in the local planning process. Guidance for the Air Force AICUZ program is contained in Air Force Instruction (AFI) 32-7063, *Air Installation Compatible Use Zone Program*, which implements DoD Instruction 4165.57, *Air Installations Compatible Use Zones*.

As local communities prepare land use plans and zoning ordinances, the Air Force recognizes it has the responsibility to provide input on its activities relating to the community. This study is presented in the spirit of mutual cooperation and assistance by Randolph AFB to aid in the land use planning process around the Base.

The AICUZ program uses the latest technology to define noise levels in areas near Air Force installations with a flying mission. Aircraft operational data used in this study were collected at Randolph AFB during the period January-March 2007. The Air Force reviewed and validated the data through a communicative process that was finalized in April 2007. Aircraft flight data were obtained to derive average daily operations by runway and type of aircraft. Analysis of Randolph AFB's flying operations included the types of aircraft, flight patterns utilized, variations in altitude, power settings, number of operations, and hours of operations. These data were supplemented by flight track information (where we fly), flight profile information (how we fly), and ground runup information. After verification for accuracy, the data were input into the NOISEMAP Version 7.3 computer program to produce DNL noise contours. The noise contours for Randolph AFB were plotted on an area map and overlaid with the CZ and APZ areas for the airfield.

A comment at the December 2007 presentation of the October 2007 AICUZ Study led to the discovery that T-6 closed pattern operations data for the west runway (*i.e.*, Runway 14Right/32Left) had been incorrectly entered into the noise model that produced the noise contours for the October 2007 Study. This 2008 AICUZ Study contains noise contours based on noise modeling that reflects corrected T-6 closed pattern operations.

1.4 COMPUTERIZED NOISE EXPOSURE MODELS

The Air Force adopted the NOISEMAP computer program to describe noise impacts created by aircraft operations. NOISEMAP is one of two USEPA-approved computer programs; the other is the Integrated Noise Model (INM) used by the Federal Aviation Administration (FAA) for noise analysis at civil airports. The NOISEMAP and INM programs are similar; however, INM is specifically designed to model aircraft flight operations at civil airports.

NOISEMAP is a suite of computer programs and components developed by the Air Force to predict noise exposure in the vicinity of an airfield due to aircraft flight, maintenance, and ground run-up operations. The components of NOISEMAP are:

- BASEOPS is the input module for NOISEMAP and is used to enter detailed aircraft flight track and profile and ground maintenance operational data.
- NOISEFILE is a comprehensive database of measured military and civil aircraft noise data. Aircraft operational information is matched with the noise measurements in the NOISEFILE after the detailed aircraft flight and ground maintenance operational data has been entered into BASEOPS.
- NMAP is the computational module in NOISEMAP. NMAP takes BASEOPS input and uses the NOISEFILE database to calculate the noise levels caused by aircraft events at specified grid points in the airbase vicinity. The output of NMAP is a series of georeferenced data points, specific grid point locations, and corresponding noise levels.
- NMPLOT is the program for viewing and editing the sets of georeferenced data points. NMPLOT plots the NMAP output in a noise contour grid that can be exported as files that can be used in mapping programs for analyzing the noise impacts.

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SECTION 2
INSTALLATION DESCRIPTION

2.1 DESCRIPTION OF RANDOLPH AIR FORCE BASE

Randolph AFB is located approximately 13 miles northeast of the center of San Antonio on 5,044 acres of land in the northeastern corner of Bexar County (see Figure 2.1). The installation is bounded by the municipalities of Converse to the west, Universal City to the northwest, and Schertz to the north, east, and south. Land under the jurisdiction of Bexar and Guadalupe Counties is interspersed among the neighboring communities. The base is located between Interstate 10 to the south and Interstate 35 to the north. Randolph AFB has two parallel runways, respectively designated as Runway 14Left/32Right, and Runway 14Right/32Left.

2.2 MISSION

The host unit at Randolph AFB is the 12th Flying Training Wing (12 FTW), a subordinate unit of the Air Education and Training Command. Randolph AFB is the only unit in the Air Force that conducts both pilot instructor training and combat systems officer training. In addition, the 12 FTW provides host –base support to more than 30 Department of Defense units, including Air Education and Training Command, Air Force Personnel Center, and Air Force Recruiting Service. The 12 FTW provides command guidance and operational control of the 12th Operations Group (12 OG), 12th Maintenance Directorate, 12th Medical Group, and 12th Mission Support Group, and is directly responsible for several functional areas.

The 99th, 559th, and 560th Flying Training Squadrons (FTS) of the 12 OG conduct Pilot Instructor Training in the T-1, T-6, and T-38 aircraft, respectively. Additionally, the 12 OG's 435th FTS accomplishes Introduction to Fighter Fundamentals training in the T-38 and the 562nd FTS conducts Undergraduate Navigator Training in the T-43 aircraft.

2.3 ECONOMIC IMPACT

As previously mentioned, Randolph AFB is located approximately 13 miles northeast of the center of San Antonio. The Economic Impact Region for Randolph AFB is the geographic area subject to significant base-generated economic influences and is defined as the San Antonio Metropolitan Statistical Area (MSA). In 2003, the Office of Management and Budget reorganized the San Antonio MSA by adding Atascosa, Bandera, Kendall, and Medina Counties to the MSA. The current San Antonio MSA is comprised of Atascosa, Bandera, Bexar, Comal, Guadalupe, Kendall, Medina, and Wilson Counties.

2.3.1 Local Economic Characteristics

As shown in Table 2.1, the San Antonio MSA had an estimated 2005 population of 1.75 million people. The San Antonio MSA is expected to grow in population to over 1.9 million by 2010. This MSA population reflects a nearly 9 percent growth over a ten-year period. San

Antonio grew by 22 percent and Bexar County recorded a population growth of 17 percent from 1990 to 2000. Table 2.1 displays the population for the City of San Antonio, Bexar County, and the San Antonio MSA.

Table 2.1 Historic and Projected Population

Area	1990	2000	2005	2010 projection
San Antonio	935,933	1,144,646	1,256,509	-
Bexar County	1,185,394	1,392,931	1,518,370	1,542,294
San Antonio MSA	1,324,749	1,592,383	1,754,949	1,911,238

Source: US Census Bureau, 2000

In November 2006, the San Antonio MSA had an estimated labor force of 807,600 and an unemployment rate of 4.3 percent. The economy relied heavily on the services industry, which comprised 29.9 percent of nonagricultural employment, while the government sector made up over 18 percent of non-agricultural employment. The 2003 San Antonio MSA per capita personal income was $27,381.

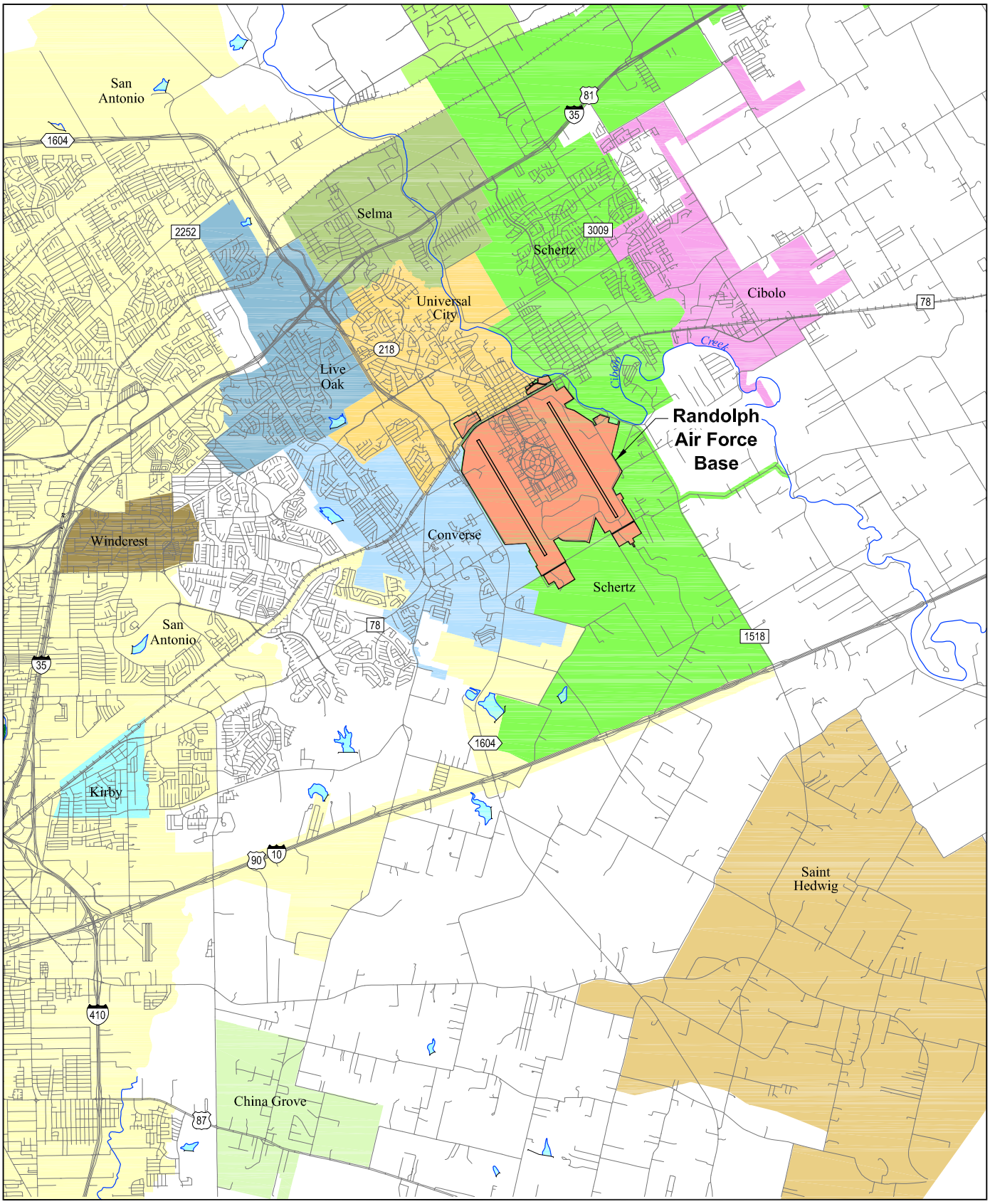
Table 2.2 San Antonio MSA Non-farm Employment Estimates by Industry

Sector	2006 estimate
Natural Res., Mining & Construction	51,600
Manufacturing	47,900
Trade, Transportation., & Utilities	143,400
Information	20,400
Financial Activities	64,200
Professional & Business Services	102,200
Education & Health Services	112,000
Leisure & Hospitality	90,600
Other Services	27,900
Government	147,400
Total	**807,600**

Source: Texas Workforce Commission, Labor Market Information (LMI)

2.3.2 Base Impact

Based on the Fiscal Year 2006 Randolph AFB Economic Impact Report, the Base directly employs 10,233 personnel. As shown in Table 2.3, accounting for military dependents results in a total population of 16,469. The annual payroll of the installation is nearly $650 million (Table 2.4). As a result of payroll expenditures, and the estimated value of indirect jobs in the local area, Randolph AFB has an estimated total economic impact of nearly $1.8 billion on the local economy. The majority of this economic impact was due to the payroll and contracts provided by the installation.



Randolph Air Force Base 2008 AICUZ

LEGEND

Randolph AFB

Roadway

N

0 2

Miles

Randolph AFB Location Map

Figure 2.1

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Table 2.3 Personnel by Classification

Classification	Total
Active Duty Military	3,872
Reserve and Guard	306
Total Military	**4,178**
Appropriated Fund Civilian Employees	4,110
Other Civilian Employees	1,945
Military Dependents	6,236
Total Civilian	**12,291**
Grand Total	**16,469**

Source: Randolph AFB Economic Impact Report FY06

Table 2.4 Annual Economic Impact

Category	($)
Payroll	
Military	409,475,606
Appropriated Fund Civilian Employees	211,529,480
Other Civilian	26,881,055
Total	**647,886,141**
Expenditures	
Base Operations and Maintenance Spending	655,698,375
Base Non-Operations and Maintenance Spending	170,009,817
Other	98,056,027
Total	**923,764,219**
Estimated Value of Indirect Jobs	**223,902,954**
Grand Total	**1,795,553,314**

Source: Randolph AFB Economic Impact Report FY06

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SECTION 3
AIRCRAFT OPERATIONS

3.1 INTRODUCTION

To describe the relationship between aircraft operations and land use at and around the airfield, it is necessary to fully evaluate the exact nature of flying activities. The March 2007 inventory of Randolph AFB aircraft operations included where aircraft fly, how high they fly, how many times they fly over a given area, and the time of day they operate.

Section 3.2 discusses aircraft operations at Randolph AFB. Section 3.3 discusses runway and flight track utilization for all operations by aircraft type. Section 3.4 describes aircraft maintenance activity, Section 3.5 discusses aircraft flight profiles, and Section 3.6 presents climatological data.

3.2 AIRCRAFT OPERATIONS

Over 237,000 annual aircraft operations occurred at Randolph AFB for the period October 2005-September 2006 based on aircraft operations data validated in March 2007. An aircraft operation is defined as one takeoff/departure, one approach/landing, or half a closed pattern. A closed pattern consists of two portions, a takeoff/departure and an approach/landing, *i.e.*, two operations. A sortie is a single military aircraft flight from the initial takeoff through the termination landing. The minimum number of aircraft operations for one sortie is two operations, one takeoff (departure) and one landing (approach).

Table 3.1 summarizes the projected average busy-day aircraft operations for the Randolph AFB airfield based on information provided by Base staff, flying organization, and air traffic control personnel. Aircraft types operating at the Base consist primarily of military aircraft. In addition to the Randolph AFB based aircraft, numerous types of transient military conduct operations at the Base. The table reflects a total of about 803 operations on an average busy-day based on collected operations data. Operations at night (10:00 p.m.-7:00 a.m.) are rare.

Although the number of military and civil aircraft operations at an installation usually varies from day to day, NOISEMAP requires input of the specific numbers of daily flight and aircraft maintenance engine runup operations. The Air Force does not follow the FAA's use of the "average annual day" in which annual operations are averaged over an entire 365-day year. Neither does the Air Force use the "worst-case day" since it typically does not represent the typical noise exposure. Instead, the Air Force uses the "average busy-day" concept in which annual operations for an aircraft type are averaged over the number of flying days per year by that aircraft type. Non-flying days (*e.g.*, weekends or holidays) are not used in computing the "average busy-day" operations. Flying by Randolph AFB flying units occurs 260 days per year. Transient aircraft operations are based on 312 days per year.

Table 3.1 Average Busy-Day Aircraft Operations for 2007

Category/ Aircraft Type	Daily Arrival/ Departure Operations	Daily Closed Pattern Operations	Total Daily Operations
Randolph AFB Aircraft			
T-1	33.00	59.40	92.40
T-6	124.00	379.20	503.20
T-38	104.80	80.51	185.31
T-43	9.31	0.90	10.21
Subtotal	271.11	520.01	791.12
Transient Aircraft			
69 types	11.78	0.00	11.78
Total	**282.89**	**520.01**	**802.90**

Note: An operation is one takeoff/departure or one arrival/landing. A closed pattern consists of two operations, one takeoff and one landing.

3.3 RUNWAY AND FLIGHT TRACK UTILIZATION

Runways 14L/32R and 14R/32L are oriented 144°–324°magnetic. Runway 14L/32R is 8,351 feet long and 200 feet wide. Runway 14R/32L is 200 feet wide and 8,353 feet long. The overruns at the ends of each runway are 1,000 feet long. The airfield elevation is 762 feet above mean sea level (MSL).

Arrival and departure flight tracks at Randolph AFB are influenced by other airports in the area. There are five military and public use airports in the area surrounding Randolph AFB: Martindale Army Airfield is eight miles south-southwest; Stinson Municipal Airport is 16 miles south-southwest; Lackland AFB is 18 miles southwest; San Antonio International Airport is 10 miles west; Twin Oaks airport is 10 miles northwest; and the New Braunfels Airport is 16 miles northeast. Additionally, there are numerous small, private airports around Randolph AFB. The locations of these other airports influence aircraft arrival and departure flight tracks at Randolph AFB. Additionally, regional aircraft routings are developed, to the maximum extent practicable, to establish common aircraft tracks that serve the arrival and departure "flow" for all the airports within the area.

Aircraft operating at Randolph AFB use the following flight patterns:

- Straight-out departure;
- Takeoff patterns routed to avoid overflying populated areas as much as possible;
- Turn out after takeoff;
- Straight-in arrival;
- Overhead closed patterns both east and west of the airfield;
- Radar closed patterns to the east of the airfield;
- Re-entry patterns;

- Alteration of flight tracks to avoid Bracken Cave, located about 10 miles north of the airfield, and other caves along the Balcones Escarpment during periods of bat activity;
- Alteration of flight tracks to avoid overflight of Village Oaks Regional Hospital on Toepperwein Road; and
- Coordination with the FAA to minimize conflict with civilian aircraft operations.

To reduce the affect of noise, Randolph AFB limits transient aircraft to one approach to a full stop landing. Additionally, the Base controls and schedules missions to keep noise levels low, especially at night.

Flight patterns specific to Randolph AFB result from several considerations, including:

- Takeoff patterns routed to avoid noise-sensitive areas as much as possible;
- Arrivals and departures routed to avoid restricted airspace;
- Criteria governing the speed, rate of climb, and turning radius for each type of aircraft;
- Efforts to control and schedule missions to keep noise levels low, especially at night; and
- Coordination with the FAA to minimize conflict with civil aircraft operations.

Planning for the areas surrounding an airfield considers three primary aircraft operational/land-use determinants: (1) aircraft accident potential to land users; (2) aircraft noise; and (3) hazards to operations from land uses (*e.g.*, height of structures). Each of these concerns is addressed in conjunction with mission requirements and safe aircraft operations to determine the optimum flight track for each aircraft type. The flight tracks depicted in Figures 3.1 through 3.3 are the result of such planning and depict the representative flight tracks used for noise modeling. The flight track locations reflect the various types of arrivals, departures, and closed patterns accomplished at Randolph AFB. The location for each track is representative for the specific track and may vary due to air traffic control, weather, and other reasons (*e.g.*, one pilot may fly the track on one side of the depicted track, while another pilot may fly the track slightly to the other side). Approximately 85 percent of the aircraft operations are in a southerly flow (*i.e.*, on Runways 14Left and Right) and 15 percent are in a northerly flow (*i.e.*, on Runways 32Left and Right).

3.4 AIRCRAFT MAINTENANCE RUNUP OPERATIONS

To the maximum extent possible, aircraft maintenance engine runup locations have been established in areas to minimize noise for people in the surrounding communities, as well as for those on base. Aircraft maintenance engine runup operations are accomplished by Randolph AFB-based flying units and their associated maintenance functions.

Average busy-day aircraft maintenance runup operations were calculated similarly to flight operations described in Section 3.1. Weekly, monthly, or annual estimates of runups

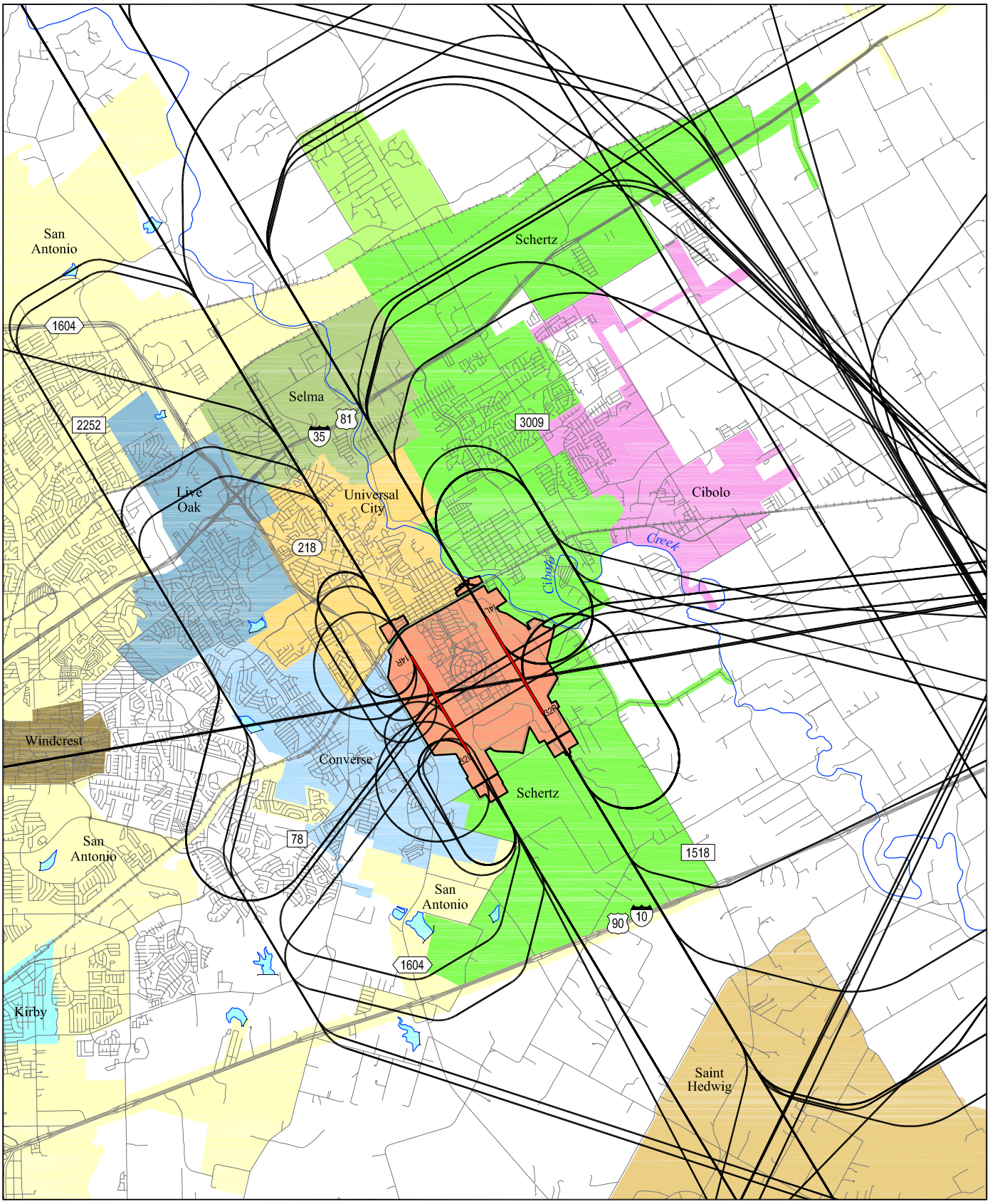
provided by Randolph AFB aircraft maintenance personnel were divided by the typical number of days runups were performed over the respective period. None of the aircraft maintenance runups at Randolph AFB occur during nighttime (10:00 p.m. to 7:00 a.m.).

3.5 AIRCRAFT FLIGHT PROFILES

For purposes of this AICUZ Study, aircraft "flight profiles" denote the aircraft power settings, altitudes above runway level, and airspeeds along each flight track. Aircraft flight profiles for T-1, T-6, T-38, and T-43 aircraft were obtained from Randolph AFB personnel. Generic flight profiles from the BASEOPS database were used to model operations for the other military aircraft types. Noise data from the NOISEFILE database were used to model operations for all aircraft types.

3.6 CLIMATOLOGICAL DATA

Weather conditions, measured by temperature and relative humidity, are an important factor in the propagation of noise. Temperature and relative humidity affect sound absorption. The average temperature and humidity for each month of the year are input into BASEOPS, which then calculates the sound absorption coefficient for each month. Ranking the twelve monthly sound absorption coefficients from smallest to largest, BASEOPS chooses the sixth smallest sound absorption coefficient to represent the typical weather conditions at the installation. The month with the sixth smallest sound absorption coefficient for Randolph AFB is the month with the average monthly temperature of 69 degrees Fahrenheit and 67 percent relative humidity.



Randolph Air Force Base 2008 AICUZ

LEGEND

- Flight Track
- Runway
- Roadway
- Randolph AFB

N

0 10,000 Feet

Arrival Flight Tracks

Figure 3.1

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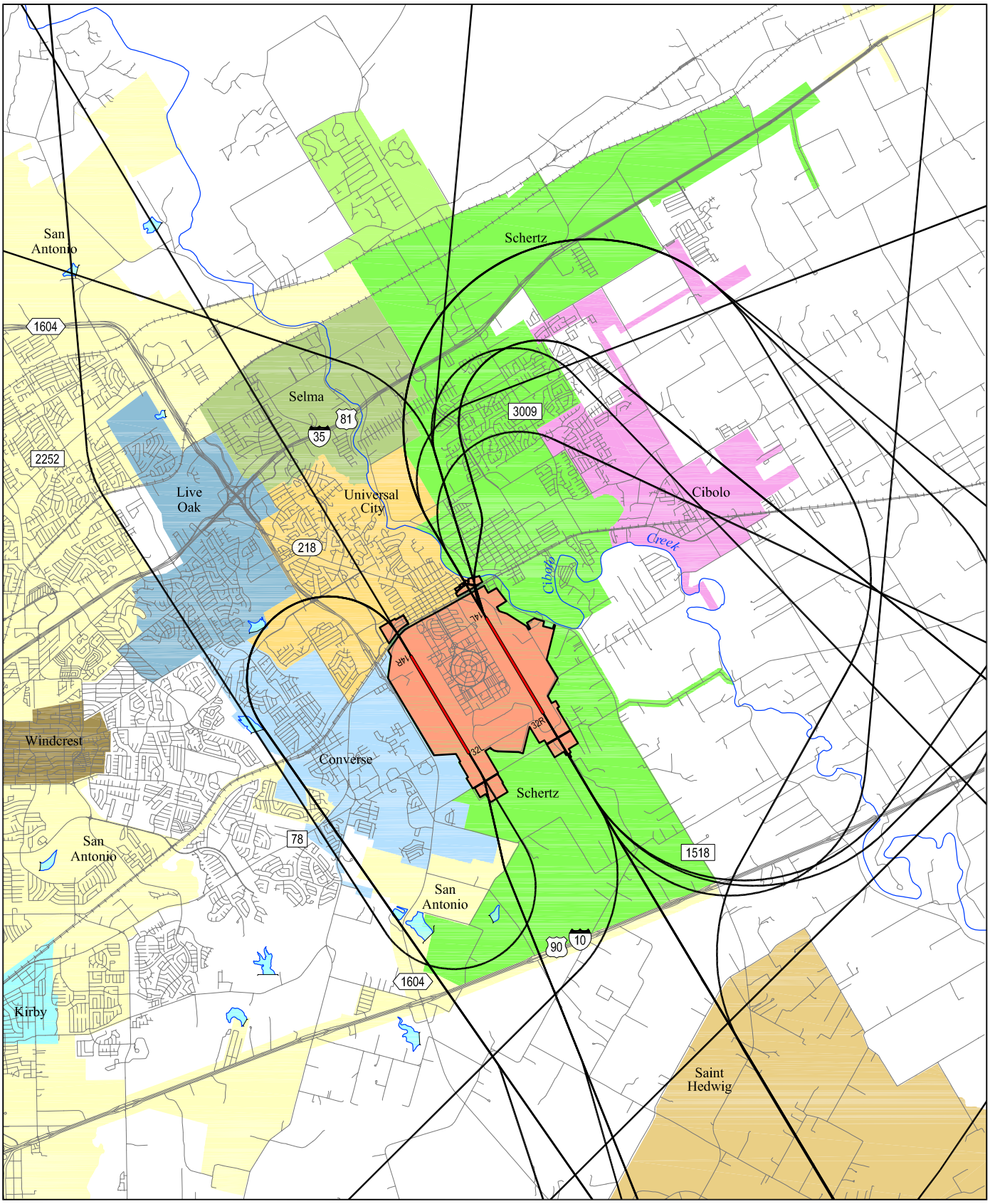

Randolph Air Force Base 2008 AICUZ

LEGEND

- Flight Track
- Runway
- Roadway
- Randolph AFB

N

0 10,000 Feet

Departure Flight Tracks

Figure 3.2

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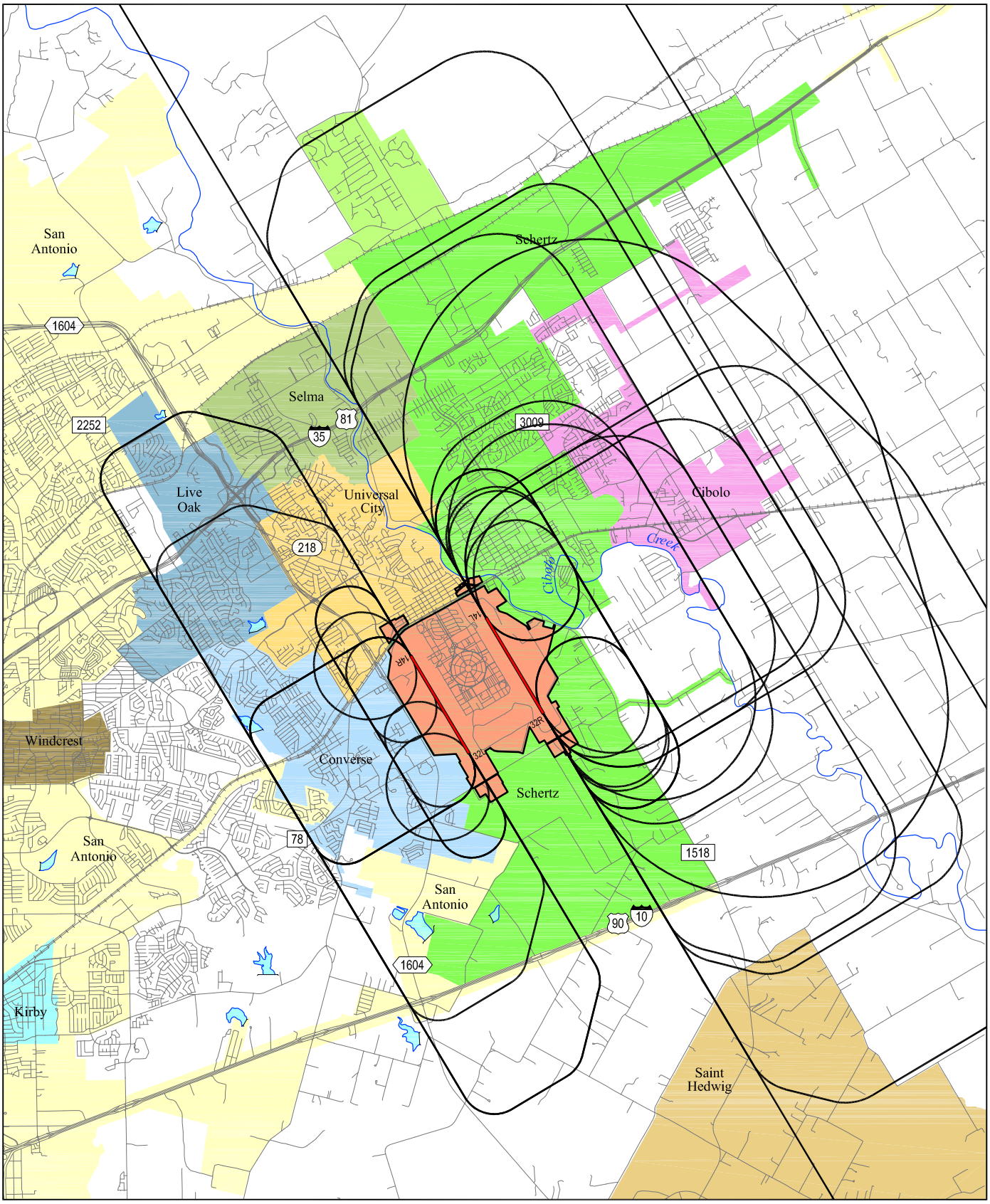

Randolph Air Force Base 2008 AICUZ

LEGEND

- Flight Track
- Runway
- Roadway
- Randolph AFB

N

0 10,000 Feet

Closed Pattern Flight Tracks

Figure 3.3

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SECTION 4
EFFECTS OF AIRCRAFT OPERATIONS

4.1 INTRODUCTION

This section has two purposes. The first is to describe the imaginary surfaces associated with obstructions to air navigation, noise exposure, CZs, and APZs. The second purpose is to present applicable land-use compatibility guidelines and the Air Force's participation in the land-use planning process.

4.2 RUNWAY AIRSPACE IMAGINARY SURFACES

Obstructions to air navigation are considered to be:

- Natural objects or man-made structures that protrude above the planes or imaginary surfaces, and/or;
- Man-made objects that extend more than 500 feet AGL at the site of the structure.

4.2.1 Explanation of Terms

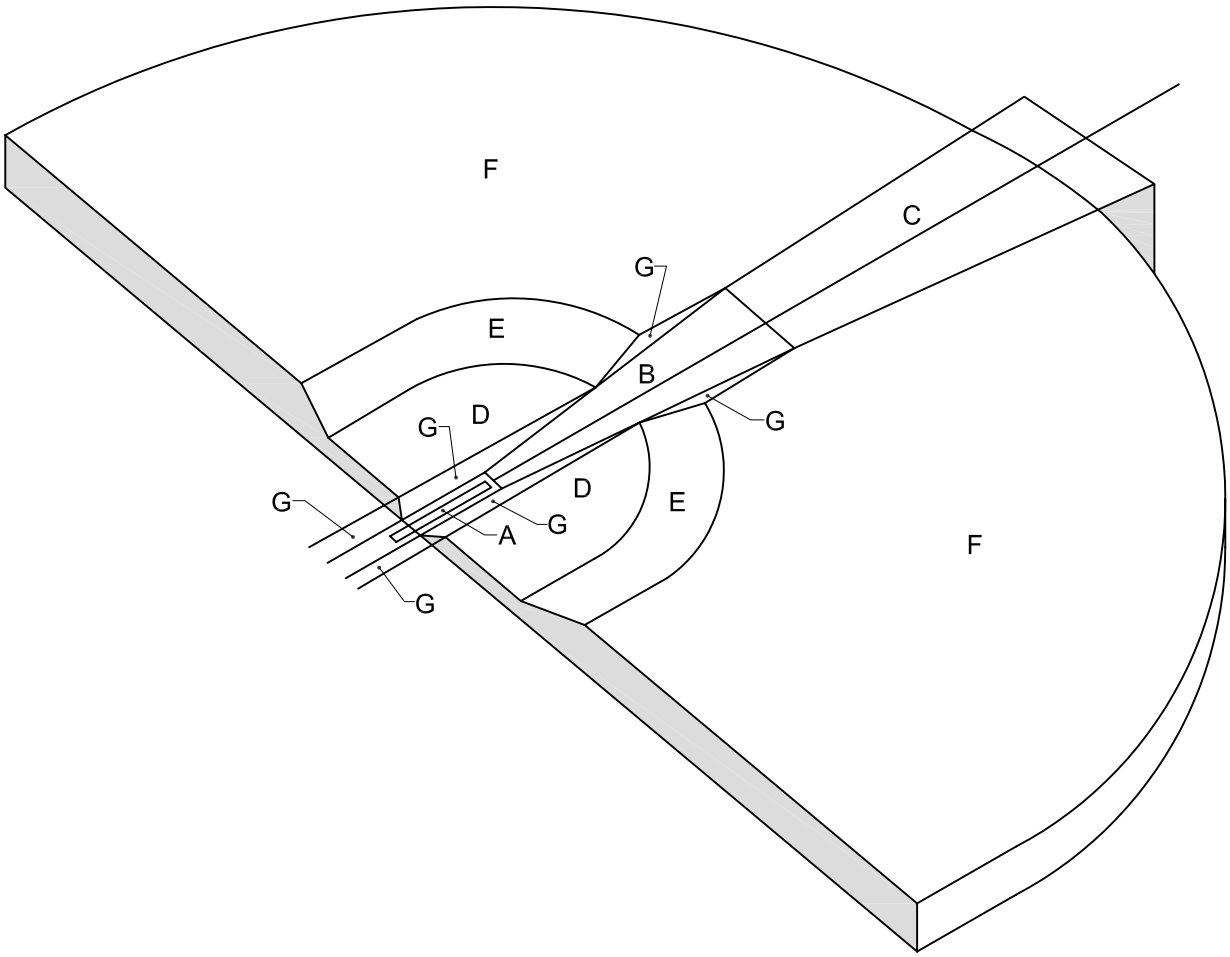
The following elevation, runway length, and dimensional criteria apply:

- Controlling Elevation—Whenever surfaces or planes within the obstruction criteria overlap, the controlling (or governing) elevation becomes that of the lowest surface or plane.
- Runway Length—Randolph AFB has two runways. Runways 14L/32R and 14R/32L are 8,351 and 8,353 feet long, respectively. Both runways are Class B runways that are designed and built for sustained aircraft landings and take-offs:
- Established Airfield Elevation—The established elevation for the Randolph AFB airfield is 762 feet above MSL.
- Dimensions—All dimensions are measured horizontally unless otherwise noted.

4.2.2 Runway Airspace Imaginary Surfaces

Runway airspace imaginary surfaces, in graphical form, are the result of the application of obstruction height criteria to Randolph AFB. Imaginary surfaces are surfaces in space around airfields in relation to runways. The surfaces are designed to define the obstacle-free airspace at and around the airfield. Refer to Unified Facilities Criteria (UFC) 3-260-01, *Airfield and Heliport Planning and Design,* for a more complete description of runway airspace imaginary surfaces for Class B runways. Figure 4.1 depicts the runway airspace imaginary surfaces for the Randolph AFB Class B runways. Air Force obstruction criteria in UFC 3-260-01 are based on those contained in Federal Aviation Regulation (FAR) Part 77, *Objects Affecting Navigable Airspace*, Subpart C. The following paragraphs contain definitions of the runway airspace imaginary surfaces for Air Force class B runways:

- Primary Surface—An imaginary surface symmetrically centered on the runway, extending 200 feet beyond each runway end that defines the limits of the obstruction clearance requirements in the vicinity of the landing area. The width of the primary surface is 2,000 feet, or 1,000 feet on each side of the runway centerline.
- Clear Zone Surface—An obstruction-free surface (except for features essential for aircraft operations) on the ground symmetrically centered on the extended runway centerline beginning at the end of the runway and extending outward 3,000 feet. The CZ width is 3,000 feet (1,500 feet to either side of runway centerline).
- Accident Potential Zone Surfaces—APZ I begins at the outer end of the CZ and is 5,000 feet long and 3,000 feet wide. APZ II begins at the outer end of APZ I and is 7,000 feet long and 3,000 feet wide.
- Approach-Departure Clearance Surface—This imaginary surface is symmetrically centered on the extended runway centerline, beginning as an inclined plane (glide angle) 200 feet beyond each end of the primary surface, and extending for 50,000 feet. The slope of the approach-departure clearance surface is 50:1 until it reaches an elevation of 500 feet above the established airfield elevation. It then continues horizontally at this elevation to a point 50,000 feet from the starting point. The width of this surface at the runway end is 2,000 feet, flaring uniformly to a width of 16,000 feet at the end point.
- Inner Horizontal Surface—This imaginary surface is an oval plane at a height of 150 feet above the established airfield elevation. The inner boundary intersects with the approach-departure clearance surface and the transitional surface. The outer boundary is formed by scribing arcs with a radius 7,500 feet from the centerline of each runway end and interconnecting these arcs with tangents.
- Conical Surface—This is an inclined imaginary surface extending outward and upward from the outer periphery of the inner horizontal surface for a horizontal distance of 7,000 feet to a height of 500 feet above the established airfield elevation. The slope of the conical surface is 20:1. The conical surface connects the inner and outer horizontal surfaces.
- Outer Horizontal Surface—This imaginary surface is located 500 feet above the established airfield elevation and extends outward from the outer periphery of the conical surface for a horizontal distance of 30,000 feet.
- Transitional Surface—This imaginary surface extends outward and upward at right angles to the runway centerline and extended runway centerline at a slope of 7:1. The transitional surface connects the primary and the approach-departure clearance surfaces to the inner horizontal, the conical, and the outer horizontal surfaces.



Note:
The outer edge of the outer horizontal surfaces (F) extends to 44,500 feet from the runway centerline.

LEGEND

- A Primary Surface
- B Approach-Departure Clearance Surface (50:1 Slope Ratio)
- C Approach-Departure Clearance Surface (Horizontal)
- D Inner Horizontal Surface (45.72m [150'] Elevation)
- E Conical Surface (20:1 Slope Ratio)
- F Outer Horizontal Surface (152.40m [500'] Elevation)
- G Transitional Surface (7:1 Slope Ratio)

Class B Air Force Runway Airspace Imaginary Surfaces

Figure 4.1

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4.3 RESTRICTED AND/OR PROHIBITED LAND USES

The land areas outlined by these criteria should be regulated to prevent uses that might otherwise be hazardous to aircraft operations. The following uses should be restricted and/or prohibited:

- Releases into the air of any substance that would impair visibility or otherwise interfere with the operation of aircraft (e.g., steam, dust, or smoke);
- Light emissions, either direct or indirect (reflective), that would interfere with pilot vision;
- Electrical emissions that would interfere with aircraft communications systems or navigational equipment;
- Uses that would attract birds or waterfowl, including but not limited to, operation of sanitary landfills, waste transfer facilities, maintenance of feeding stations, sand and gravel dredging operations, storm water retention ponds, created wetland areas, or the growing of certain vegetation; and
- Structures within 10 feet of aircraft approach-departure and/or transitional surfaces.

4.4 NOISE EXPOSURE

NOISEMAP Version 7.3 was used to calculate and plot the DNL noise contours based on the average busy-day aircraft operations data collected in 2007 and described in Sections 3.1 through 3.6. Figure 4.2 shows the DNL noise contours plotted in 5 dB increments, ranging from DNL 65 dB to DNL at or above 80 dB

Different sounds have different frequency content. When describing sound and its effect on a human population, A-weighted (dB) sound levels are typically used to account for the response of the human ear. The term “A-weighted” refers to a filtering of the sound signal to emphasize frequencies in the middle of the audible spectrum and to de-emphasize low and high frequencies in a manner corresponding to the way the human ear perceives sound. This filtering network has been established by the American National Standards Institute. The A-weighted noise level has been found to correlate well with people’s judgments of the noisiness of different sounds and has been in use for many years as a measure of community noise.

Table 4.1 shows the off-installation noise exposure within the DNL 65 dB and greater noise exposure area for aircraft operations at Randolph AFB in terms of acreage and estimated population. DNL is the measure of the total noise environment. DNL averages the sum of all aircraft noise producing events over a 24-hour period, with a 10 dBA upward adjustment added to the nighttime events (between 10:00 p.m. and 7:00 a.m.). The population data used in preparing this estimate was obtained from the United States Census Bureau 2000 census. To estimate affected population, it was assumed that population was equally distributed within a census tract area. Using this assumption, the total acreage and population in each census tract surrounding Randolph AFB was collected and assessed. Using the noise

contour information, the number of acres of land in each noise zone (*i.e.*, DNL 65-69 dB, 70-74 dB, 75-79 dB, and 80 dB and greater) was divided by the number of acres of land in each census tract to determine what portion of the census tract was contained within each noise zone. The population total in each block-group was then multiplied by this ratio to estimate population exposed to aircraft noise at and above DNL 65 dB.

Table 4.1 Area and Population within DNL 65 dB and Greater Noise Exposure Area (Off-Installation)

DNL Noise Zone	Acres	Population
65–69	2,497	2,385
70–74	687	226
75–79	160	11
80+	0	0
Total	**3,344**	**2,622**

From Table 4.1, a total of 3,344 acres and 2,622 persons are expected to be in the off-installation area within the DNL 65 dB and greater noise exposure area. The largest affected population is within the DNL 65–69 dB noise zone. This area is estimated to contain 2,497 acres in off-installation land area (75 percent of the total) and an estimated population of 2,385 persons (91 percent of the total) based on the calculated population densities for the area.

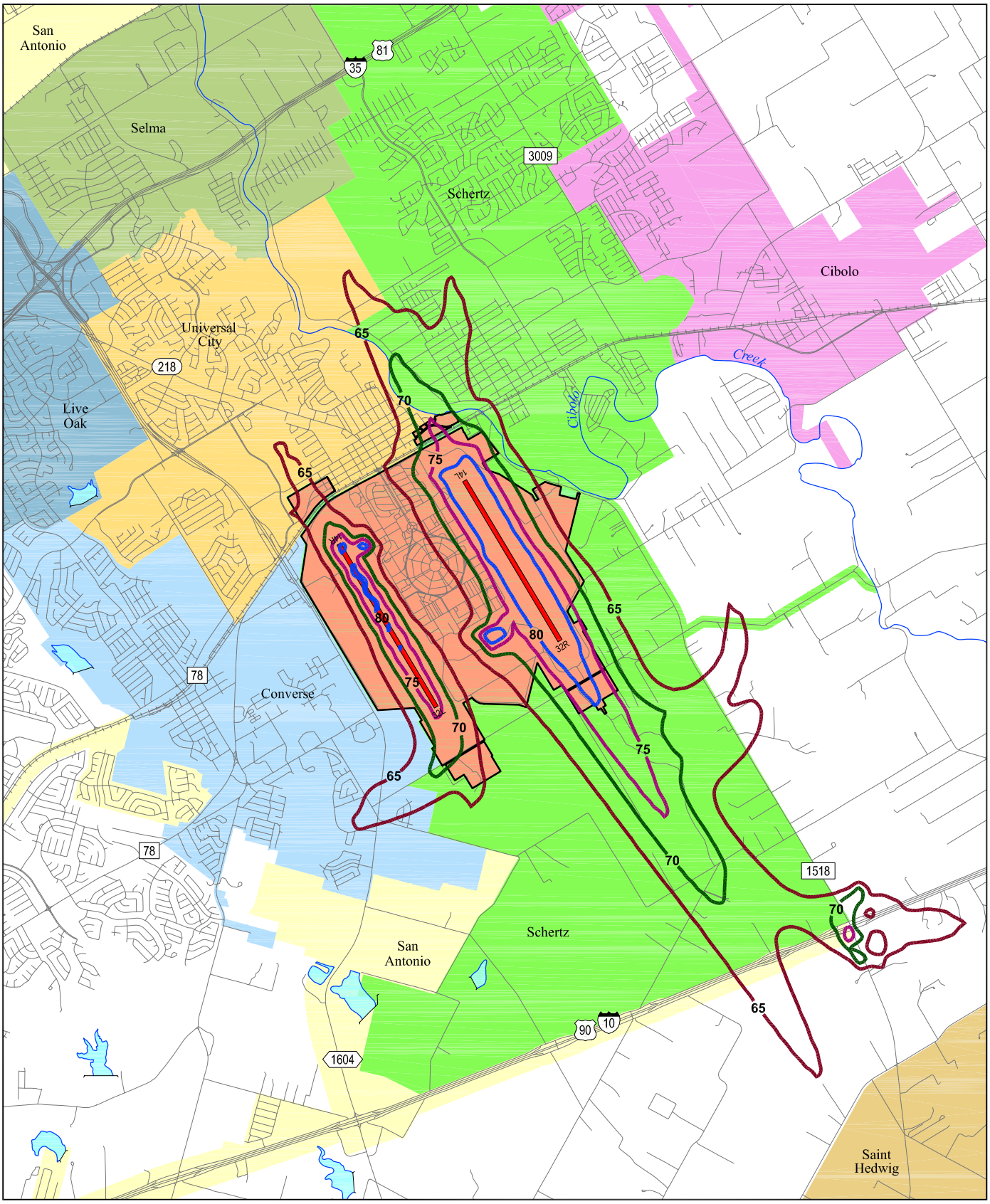
4.5 COMPARISON WITH 2000 AICUZ STUDY

Noise contours presented in this study differ in both shape and extent of coverage when compared to the noise contours in the 2000 AICUZ Study. Figure 4.3 depicts the 2000 AICUZ Study contours and Figure 4.4 compares the 2008 and 2000 contours.

The overall exposure for this AICUZ Study is about 4,001 acres less than the 2000 AICUZ Study. Table 4.2 lists the total noise exposure for the four noise zones in each study. The decrease in noise exposure since the 2000 AICUZ Study is attributed to the decrease in the number of aircraft operations.

Table 4.2 Total Acres within the 2008 and 2000 AICUZ Study Noise Zones

	Acres	
DNL Noise Zone	2008 Study	2000 Study
65–69	3,137	4,677
70–74	1,212	2,592
75–79	627	1,066
80+	407	1,049
Total	**5,383**	**9,384**



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Randolph Air Force Base 2008 AICUZ

LEGEND

- DNL 65 dB Contour
- DNL 70 dB Contour
- DNL 75 dB Contour
- DNL 80 dB Contour
- Runway
- Roadway
- Randolph AFB

N

0 6,000 Feet

Average Busy-Day Noise Contours for 2008

Figure 4.2

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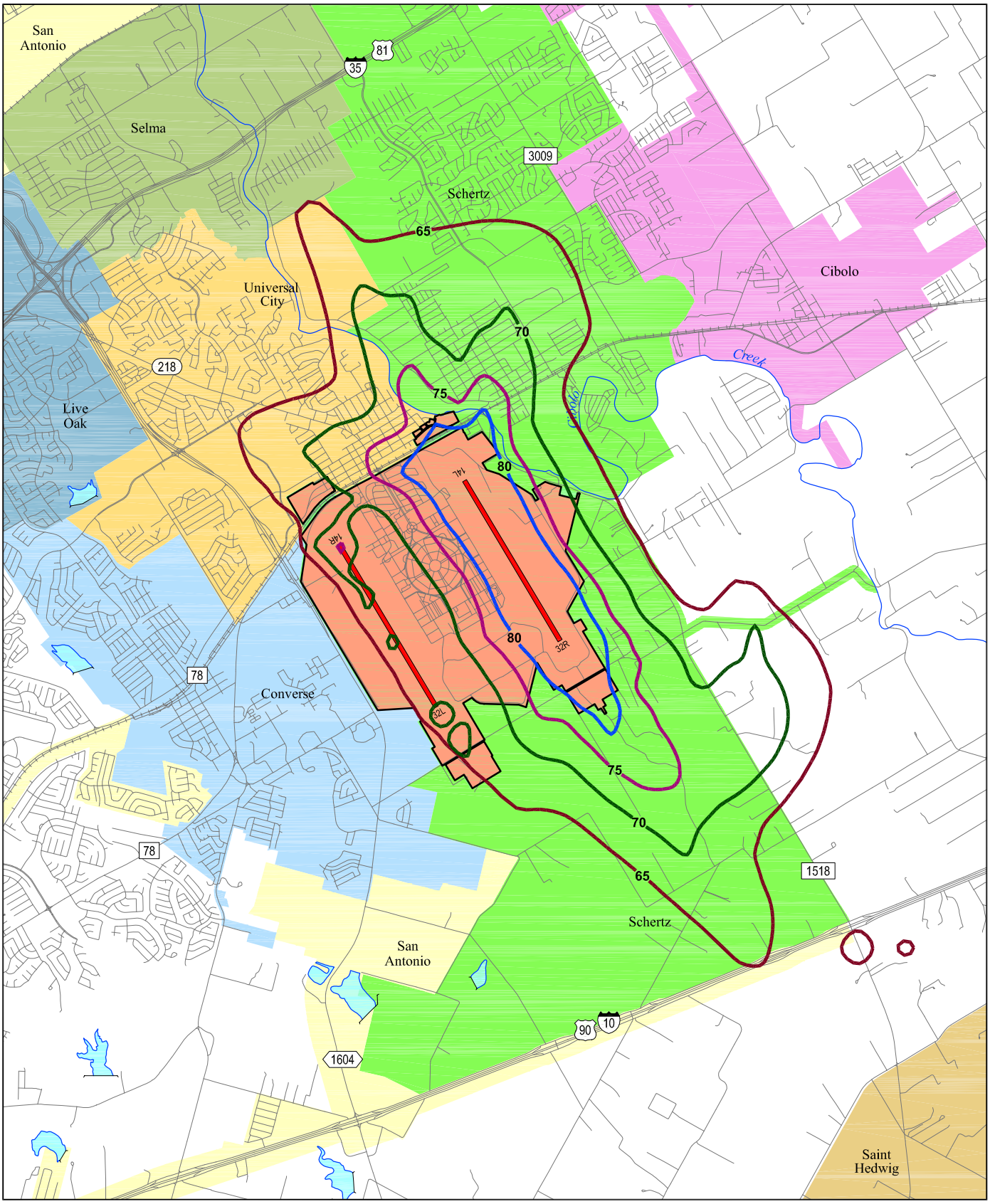

Randolph Air Force Base 2008 AICUZ

LEGEND

- DNL 65 dB Contour
- DNL 70 dB Contour
- DNL 75 dB Contour
- DNL 80 dB Contour
- Runway
- Roadway
- Randolph AFB

N

0 6,000 Feet

2000 AICUZ Study Noise Contours

Figure 4.3

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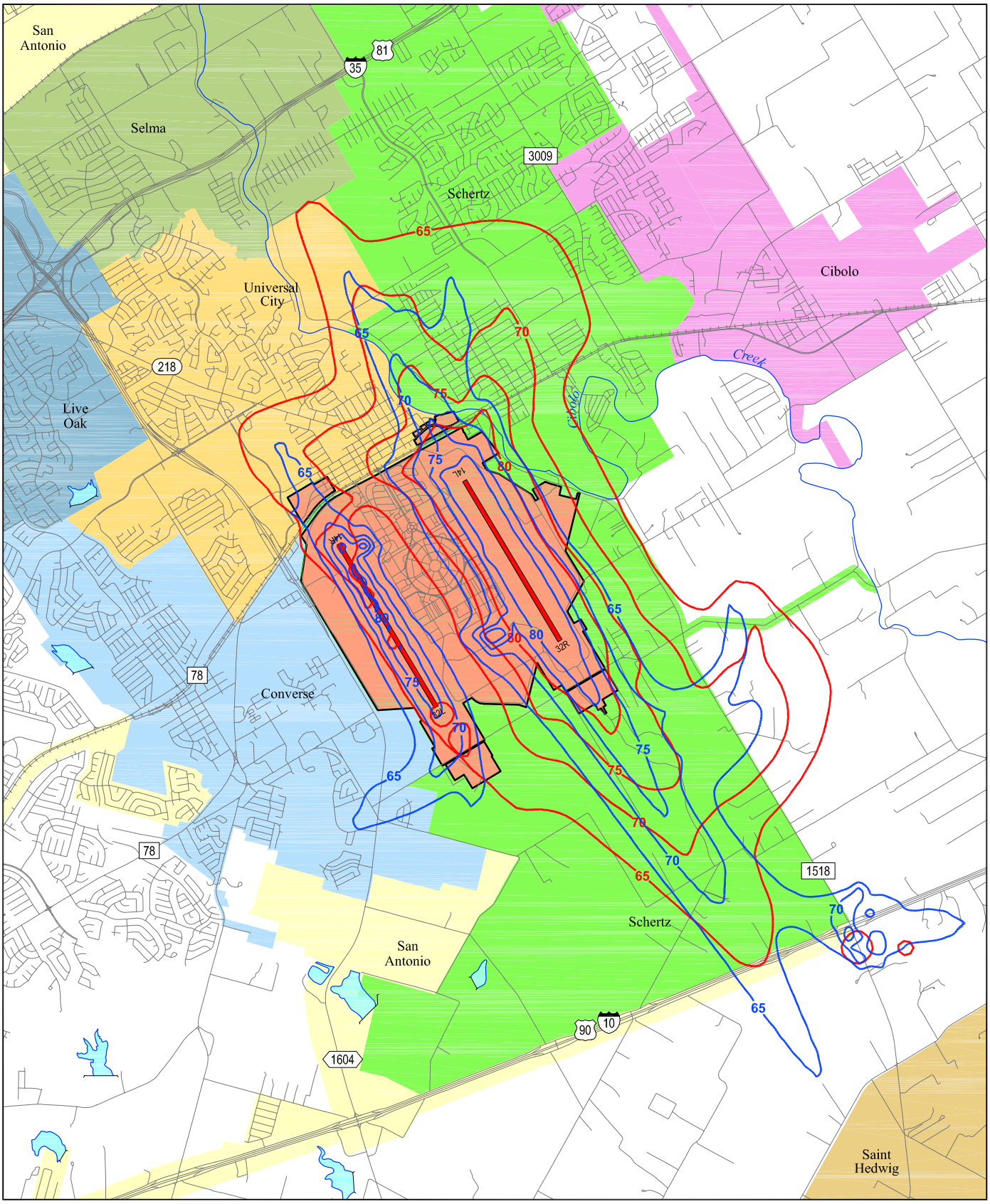

Randolph Air Force Base 2008 AICUZ

LEGEND

- 2000 AICUZ Noise Contours
- 2008 AICUZ Noise Contours
- Runway
- Roadway
- Randolph AFB

N

0 6,000 Feet

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Comparison of 2008 and 2000 AICUZ Study Noise Contours

Figure 4.4

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4.6 CLEAR ZONES AND ACCIDENT POTENTIAL ZONES

The purpose of this section is to describe the basis for CZs and APZs and apply the zones to the Randolph AFB runways.

4.6.1 Basis for Clear Zones and Accident Potential Zones

Areas around airports are exposed to the possibility of aircraft accidents even with well-maintained aircraft and highly trained aircrews. Despite stringent maintenance requirements and countless hours of training, past history makes it clear that accidents may occur.

The risk of people on the ground being killed or injured by aircraft accidents is miniscule. However, an aircraft accident is a high-consequence event and, when a crash does occur, the result is often catastrophic. Because of this, the Air Force does not attempt to base its safety standards on accident probabilities. Instead it approaches this safety issue from a land use-planning perspective. Designation of safety zones around the airfield and restriction of incompatible land uses can reduce the public's exposure to safety hazards.

The AICUZ program includes three safety zones: the CZ, APZ I, and APZ II. These zones were developed from analysis of over 800 major Air Force accidents that occurred within 10 miles of an Air Force installation between 1968 and 1995. Figure B-3 in Appendix B summarizes the location of these accidents.

The CZ has the highest accident potential of the three zones, as 27 percent of accidents studied occurred in this area. Due to the relatively high accident potential, the Air Force adopted a policy of acquiring real estate interests in the CZ through purchase or easement when feasible.

APZ I is an area that possesses somewhat less accident potential than the CZ, with 10 percent of the accidents studied occurring in this zone. APZ II has less accident potential than APZ I, with 6 percent of the accidents studied occurring in this zone. While the potential for aircraft accidents in APZs I and II does not warrant land acquisition by the Air Force, land-use planning and controls are strongly encouraged in these areas for the protection of the public.

4.6.2 Clear Zones and Accident Potential Zones

Figure 4.5 depicts the CZs and APZs for Runways 14L/32R and 14R/32L at Randolph AFB. The Air Force standard CZ for a runway begins at the end of the runway and extends outward 3,000 feet and is 3,000 feet wide (1,500 feet to either side of runway centerline). In accordance with UFC 3-260-01, CZs are authorized to deviate from the standard with individual service approval. The Randolph AFB CZs adhere to the standard 3,000-foot CZ width within the installation boundary. However, the CZs are 2,000 feet wide on property outside of the Randolph AFB boundary (see Figure 4.5). All Randolph AFB CZs extend 3,000 feet outward from the runway ends.

Accident potential in zone I is less critical than the CZ, but still possesses a significant risk factor. This 3,000 foot by 5,000 foot area has land use compatibility guidelines that are sufficiently flexible to allow reasonable economic use of the land, such as industrial/manufacturing, transportation, communication/utilities, wholesale trade, open space, recreation, and agriculture. However, uses that concentrate people in small areas are not acceptable.

Accident potential zone II is less critical than APZ I, but still possesses potential for accidents. Accident potential zone II, also 3,000 feet wide, is 7,000 feet long extending to 15,000 feet from the runway threshold. Acceptable uses include those of APZ I, as well as low density single family residential and those personal and business services and commercial/retail trade uses of low intensity or scale of operation. High density functions such as multi-story buildings, places of assembly (*e.g.*, theaters, churches, schools, restaurants, *etc*.), and high density office uses are not considered appropriate.

High people densities should be limited to the maximum extent possible in APZ II. The optimum density recommended for residential usage (where it does not conflict with noise criteria) in APZ II is one dwelling per acre. For most nonresidential usage, buildings should be limited to one story and the lot coverage should not exceed 20 percent.

4.6.3 Land Use Compatibility Guidelines

Section 4.6.3.1 introduces the AICUZ concept and Section 4.6.3.2 presents the land-use compatibility guidelines applicable to Randolph AFB.

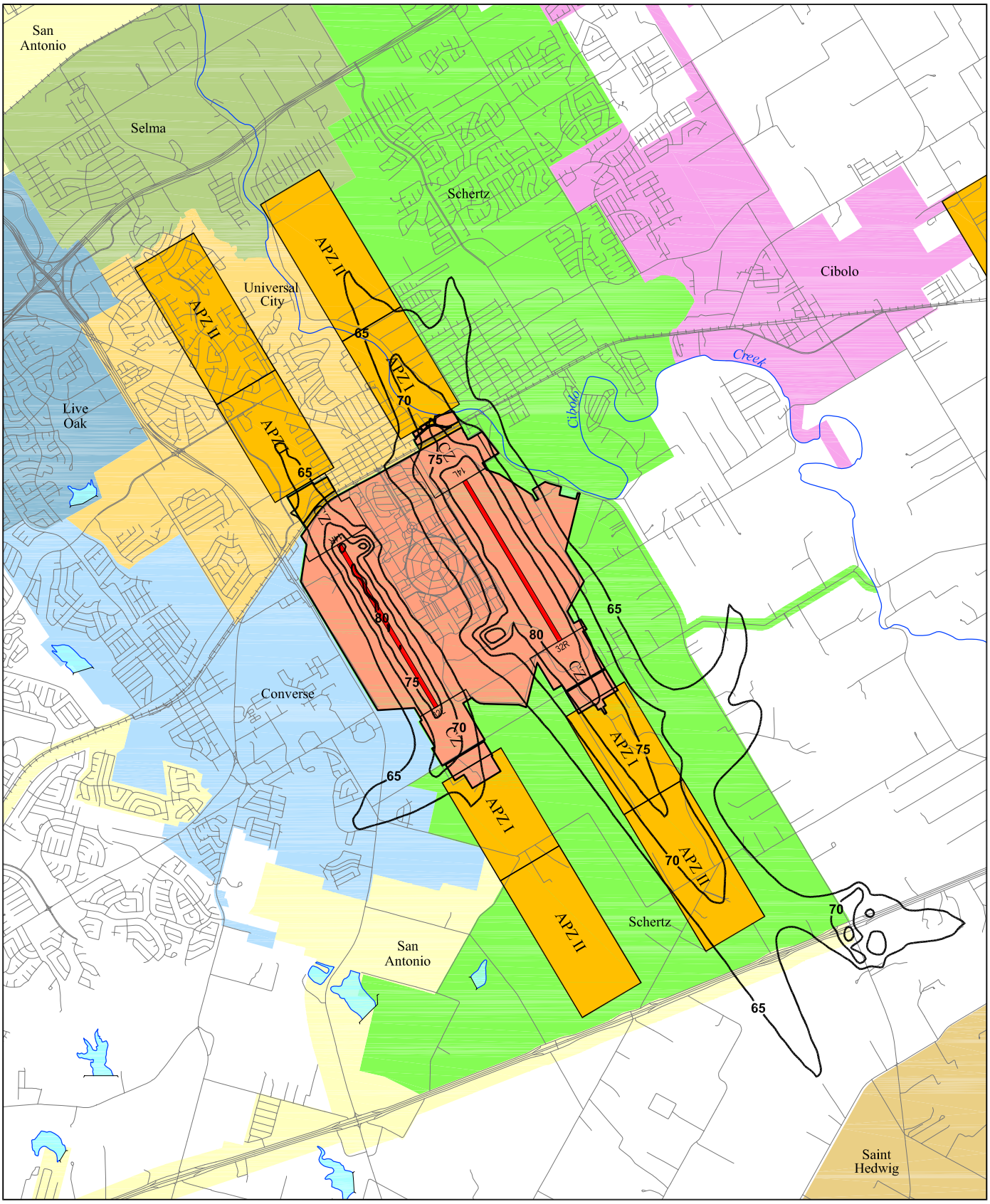
4.6.3.1 Introduction

The DoD developed the AICUZ program for military airfields. Using this program at its installations, the DoD works to protect aircraft operational capabilities and to assist local government officials in protecting and promoting the public's health, safety, and quality of life. The goal is to promote compatible land-use development around military airfields by providing information on aircraft noise exposure and accident potential.

AICUZ reports describe three basic types of constraints that affect, or result from, flight operations. The first constraint involves areas that the FAA and the DoD identified for height limitations (see Section 4.2).

The second constraint involves noise zones based on the DNL metric and the DoD NOISEMAP methodology. Using the NOISEMAP program, which is similar to FAA's INM, the Air Force produces noise contours showing the noise levels generated by aircraft operations. The AICUZ report contains noise contours plotted in 5 dB increments, ranging from DNL 65 dB to 80+ dB.

The third constraint involves CZs and APZs based on statistical analysis of past DoD aircraft accidents. DoD analysis has determined that areas immediately beyond the ends of runways and along the approach and departure flight paths have greater potential for aircraft accidents (see Figure 4.5).



Randolph Air Force Base 2008 AICUZ

LEGEND

- Runway
- Roadway
- Randolph AFB
- CZ Clear Zone
- APZ Accident Potential Zone

N

0 6,000 Feet

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Clear Zones and Accident Potential Zones

Figure 4.5

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4.6.3.2 Land-Use Compatibility Guidelines

Each AICUZ Study contains land-use guidelines. Table 4.3 identifies land uses and possible noise exposure and accident potential combinations for Randolph AFB. These noise guidelines are essentially the same as those published by the Federal Interagency Committee on Urban Noise in the June 1980 publication, *Guidelines for Considering Noise in Land-Use Planning and Control.* The U.S. Department of Transportation publication, *Standard Land Use Coding Manual (SLUCM),* has been used to identify and code land-use activities. The designations are a combination of criteria listed in the Legend and Notes at the end of the table. For example, Y[1] means land use and related structures are compatible without restriction at a suggested maximum density of 1-2 dwelling units per acre, possibly increased under a Planned Unit Development where lot coverage is less than 20 percent.

Table 4.3 Land Use Compatibility Guidelines

Land Use		Accident Potential Zones			Noise Zones in DNL dB			
SLUCM No.	Name	Clear Zone	APZ I	APZ II	65-69	70-74	75-79	80+
10	**Residential**							
11	Household units							
11.11	Single units; detached	N	N	Y[1]	A[11]	B[11]	N	N
11.12	Single units; semidetached	N	N	N	A[11]	B[11]	N	N
11.13	Single units; attached row	N	N	N	A[11]	B[11]	N	N
11.21	Two units; side-by-side	N	N	N	A[11]	B[11]	N	N
11.22	Two units; one above the other	N	N	N	A[11]	B[11]	N	N
11.31	Apartments; walk up	N	N	N	A[11]	B[11]	N	N
11.32	Apartments; elevator	N	N	N	A[11]	B[11]	N	N
12	Group quarters	N	N	N	A[11]	B[11]	N	N
13	Residential hotels	N	N	N	A[11]	B[11]	N	N
14	Mobile home parks or courts	N	N	N	N	N	N	N
15	Transient lodgings	N	N	N	A[11]	B[11]	C[11]	N
16	Other residential	N	N	N[1]	A[11]	B[11]	N	N
20	**Manufacturing**							
21	Food & kindred products; manufacturing	N	N[2]	Y	Y	Y[12]	Y[13]	Y[14]
22	Textile mill products; manufacturing	N	N[2]	Y	Y	Y[12]	Y[13]	Y[14]
23	Apparel and other finished products made from fabrics, leather, and similar materials; manufacturing	N	N	N[2]	Y	Y[12]	Y[13]	Y[14]
24	Lumber and wood products (except furniture); manufacturing	N	Y[2]	Y	Y	Y[12]	Y[13]	Y[14]
25	Furniture and fixtures; manufacturing	N	Y[2]	Y	Y	Y[12]	Y[13]	Y[14]

Table 4.3 Land Use Compatibility Guidelines *(continued)*

Land Use		Accident Potential Zones			Noise Zones			
SLUCM No.	**Name**	**Clear Zone**	**APZ I**	**APZ II**	**65-69**	**70-74**	**75-79**	**80+**
26	Paper & allied products; manufacturing	N	Y[2]	Y	Y	Y[12]	Y[13]	Y[14]
27	Printing, publishing, and allied industries	N	Y[2]	Y	Y	Y[12]	Y[13]	Y[14]
28	Chemicals and allied products; manufacturing	N	N	N[2]	Y	Y[12]	Y[13]	Y[14]
29	Petroleum refining and related industries	N	N	Y	Y	Y[12]	Y[13]	Y[14]
30	**Manufacturing**							
31	Rubber and misc. plastic products, manufacturing	N	N[2]	N[2]	Y	Y[12]	Y[13]	Y[14]
32	Stone, clay and glass products manufacturing	N	N[2]	Y	Y	Y[12]	Y[13]	Y[14]
33	Primary metal industries	N	N[2]	Y	Y	Y[12]	Y[13]	Y[14]
34	Fabricated metal products; manufacturing	N	N[2]	Y	Y	Y[12]	Y[13]	Y[14]
35	Professional, scientific, and controlling instruments; photographic and optical goods; watches and clocks manufacturing	N	N	N[2]	Y	A	B	N
39	Miscellaneous manufacturing	N	Y[2]	Y[2]	Y	Y[12]	Y[13]	Y[14]
40	**Transportation, Communications and Utilities**							
41	Railroad, rapid rail transit and street railroad transportation	N[3]	Y[4]	Y	Y	Y[12]	Y[13]	Y[14]
42	Motor vehicle transportation	N[3]	Y	Y	Y	Y[12]	Y[13]	Y[14]
43	Aircraft transportation	N[3]	Y[4]	Y	Y	Y[12]	Y[13]	Y[14]
44	Marine craft transportation	N[3]	Y[4]	Y	Y	Y[12]	Y[13]	Y[14]
45	Highway & street right-of-way	N[3]	Y	Y	Y	Y[12]	Y[13]	Y[14]
46	Automobile parking	N[3]	Y[4]	Y	Y	Y[12]	Y[13]	Y[14]
47	Communications	N[3]	Y[4]	Y	Y	A[15]	B[15]	N
48	Utilities	N[3]	Y[4]	Y	Y	Y	Y[12]	Y[13]
49	Other transportation communications and utilities	N[3]	Y[4]	Y	Y	A[15]	B[15]	N

Table 4.3 Land Use Compatibility Guidelines *(continued)*

Land Use		Accident Potential Zones			Noise Zones			
SLUCM No.	**Name**	**Clear Zone**	**APZ I**	**APZ II**	**65-69**	**70-74**	**75-79**	**80+**
50	**Trade**							
51	Wholesale trade	N	Y[2]	Y	Y	Y[12]	Y[13]	Y[14]
52	Retail trade-building materials, hardware and farm equipment	N	Y[2]	Y	Y	Y[12]	Y[13]	Y[14]
53	Retail trade-general merchandise	N	N[2]	Y[2]	Y	A	B	N
54	Retail trade-food	N	N[2]	Y[2]	Y	A	B	N
55	Retail trade-automotive, marine craft, aircraft and accessories	N	Y[2]	Y[2]	Y	A	B	N
56	Retail trade-apparel and accessories	N	N[2]	Y[2]	Y	A	B	N
57	Retail trade-furniture, home furnishings and equipment	N	N[2]	Y[2]	Y	A	B	N
58	Retail trade-eating and drinking establishments	N	N	N[2]	Y	A	B	N
59	Other retail trade	N	N[2]	Y[2]	Y	A	B	N
60	**Services**							
61	Finance, insurance and real estate services	N	N	Y[6]	Y	A	B	N
62	Personal services	N	N	Y[6]	Y	A	B	N
62.4	Cemeteries	N	Y[7]	Y[7]	Y	Y[12]	Y[13]	Y[14,21]
63	Business services	N	Y[8]	Y[8]	Y	A	B	N
64	Repair services	N	Y[2]	Y	Y	Y[12]	Y[13]	Y[14]
65	Professional services	N	N	Y[6]	Y	A	B	N
65.1	Hospitals, nursing homes	N	N	N	A*	B*	N	N
65.1	Other medical facilities	N	N	N	Y	A	B	N
66	Contract construction services	N	Y[6]	Y	Y	A	B	N
67	Governmental services	N	N	Y[6]	Y*	A*	B*	N
68	Educational services	N	N	N	A*	B*	N	N
69	Miscellaneous services	N	N[2]	Y[2]	Y	A	B	N

Table 4.3 Land Use Compatibility Guidelines *(continued)*

Land Use		Accident Potential Zones			Noise Zones			
SLUCM No.	**Name**	**Clear Zone**	**APZ I**	**APZ II**	**65-69**	**70-74**	**75-79**	**80+**
70	**Cultural, Entertainment and Recreational**							
71	Cultural activities (including churches)	N	N	N[2]	A*	B*	N	N
71.2	Nature exhibits	N	Y[2]	Y	Y*	N	N	N
72	Public assembly	N	N	N	Y	N	N	N
72.1	Auditoriums, concert halls	N	N	N	A	B	N	N
72.11	Outdoor music shell, amphitheaters	N	N	N	N	N	N	N
72.2	Outdoor sports arenas, spectator sports	N	N	N	Y[17]	Y[17]	N	N
73	Amusements	N	N	Y[8]	Y	Y	N	N
74	Recreational activities (including golf courses, riding stables, water recreation)	N	Y[8,9,10]	Y	Y*	A*	B*	N
75	Resorts and group camps	N	N	N	Y*	Y*	N	N
76	Parks	N	Y[8]	Y[8]	Y*	Y*	N	N
79	Other cultural, entertainment and recreation	N	Y[9]	Y[9]	Y*	Y*	N	N
80	**Resources Production and Extraction**							
81	Agriculture (except livestock)	Y[16]	Y	Y	Y[18]	Y[19]	Y[20]	Y[20,21]
81.5 to 81.7	Livestock farming and animal breeding	N	Y	Y	Y[18]	Y[19]	Y[20]	Y[20,21]
82	Agricultural related activities	N	Y[5]	Y	Y[18]	Y[19]	N	N
83	Forestry activities and related services	N[5]	Y	Y	Y[18]	Y[19]	Y[20]	Y[20,21]
84	Fishing activities and related services	N[5]	Y[5]	Y	Y	Y	Y	Y
85	Mining activities and related services	N	Y[5]	Y	Y	Y	Y	Y
89	Other resources production and extraction	N	Y[5]	Y	Y	Y	Y	Y

LEGEND

SLUCM - Standard Land Use Coding Manual, U.S. Department of Transportation.
Y - (Yes) - Land use and related structures are compatible without restriction.
N - (No) - Land use and related structures are not compatible and should be prohibited.
Y[x] - (yes with restrictions) - Land use and related structures generally compatible; see notes 1-21.
N[x] - (no with exceptions) - See notes 1-21.
NLR - (Noise Level Reduction) - NLR (outdoor to indoor) to be achieved through incorporation of noise attenuation measures into the design and construction of the structures (see Appendix C, section c.4).
A, B, or C - Land use and related structures generally compatible; measures to achieve NLR of A (DNL 25 dB), B (DNL 30 dB), or C (DNL 35 dB) need to be incorporated into the design and construction of structures.
A*, B*, and C* - Land use generally compatible with NLR. However, measures to achieve an overall noise level reduction do not necessarily solve noise difficulties and additional evaluation is warranted. See appropriate footnotes.
***** - The designation of these uses as "compatible" in this zone reflects individual federal agency and program consideration of general cost and feasibility factors, as well as past community experiences and program objectives.

Localities, when evaluating the application of these guidelines to specific situations, may have different concerns or goals to consider.

NOTES

1. Suggested maximum density of 1-2 dwelling units per acre possibly increased under a Planned Unit Development where maximum lot coverage is less than 20 percent.
2. Within each land use category, uses exist where further definition may be needed due to the variation of densities in people and structures. Shopping malls and shopping centers are considered incompatible in any accident potential zone (CZ, APZ I, or APZ II).
3. The placing of structures, buildings, or aboveground utility lines in the clear zone is subject to severe restrictions. In a majority of the clear zones, these items are prohibited. See AFI 32-7063 and UFC 3-260-01 for specific guidance.
4. No passenger terminals and no major aboveground transmission lines in APZ I.
5. Factors to be considered: labor intensity, structural coverage, explosive characteristics, and air pollution.
6. Low-intensity office uses only. Meeting places, auditoriums, etc., are not recommended.
7. Excludes chapels.
8. Facilities must be low intensity.
9. Clubhouse not recommended.
10. Areas for gatherings of people are not recommended.

11A. Although local conditions may require residential use, it is discouraged in DNL 65-69 dB and strongly discouraged in DNL 70-74 dB. An evaluation should be conducted prior to approvals, indicating a demonstrated community need for residential use would not be met if development were prohibited in these zones, and there are no viable alternative locations.

11B. Where the community determines the residential uses must be allowed, measures to achieve outdoor to indoor NLR for DNL 65-69 dB and DNL 70-74 dB should be incorporated into building codes and considered in individual approvals.

11C. NLR criteria will not eliminate outdoor noise problems. However, building location and site planning, and design and use of berms and barriers can help mitigate outdoor exposure, particularly from near ground level sources. Measures that reduce outdoor noise should be used whenever practical in preference to measures which only protect interior spaces.

12. Measures to achieve the same NLR as required for facilities in the DNL 65-69 dB range 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.
13. Measures to achieve the same NLR as required for facilities in the DNL 70-74 dB range 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.
14. Measures to achieve the same NLR as required for facilities in the DNL 75-79 dB range 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.
15. If noise sensitive, use indicated NLR; if not, the use is compatible.
16. No buildings.
17. Land use is compatible provided special sound reinforcement systems are installed.
18. Residential buildings require the same NLR required for facilities in the DNL 65-69 dB range.
19. Residential buildings require the same NLR required for facilities in the DNL 70-74 dB range.
20. Residential buildings are not permitted.
21. Land use is not recommended. If the community decides the use is necessary, personnel should wear hearing protection devices.

4.7 PARTICIPATION IN THE PLANNING PROCESS

The Air Force provides the AICUZ Study to local communities to assist them in preparing their local land use plans. This section discusses how the base participates in the community planning process. Section 6.3 addresses the role played by the local community in enhancing compatible land use.

Airspace obstructions, construction in the APZs, residential development, and the construction of other noise-sensitive uses near the base are of great concern to Randolph AFB. The Air Force is very interested in minimizing increases in incompatible usage and in encouraging voluntary conversion of non-compatible usage to compatible usage. Applying the categories for compatible land use described in Table 4.3, the Base evaluates the impact aircraft operations have on surrounding properties and the effect new development or changes in land use might have on Randolph AFB operational capabilities.

In addition to working with local governing entities and planning professionals, the Randolph AFB Base Public Affairs Office works to address complaints and concerns expressed by off-airfield neighbors.

Randolph AFB conducts active outreach to the community by meeting with various community groups and speaking with individuals as needed. The Randolph AFB Civil Engineer and Public Affairs Offices work together providing public meetings and informational workshops to disseminate information about base operations, forecasts, plans, and mitigation strategies.

SECTION 5
LAND USE ANALYSIS

5.1 INTRODUCTION

Land use planning and control is a dynamic, rather than a static process. The specific characteristics of land use determinants will always reflect, to some degree, the changing conditions of the economic, social, and physical environment of a community, as well as changing public concern. The planning process accommodates this fluidity in which decisions are normally not based on boundary lines, but rather on more generalized area designations.

Randolph AFB was originally established in a relatively undeveloped area in Bexar County, Texas. Since World War II, development has slowly expanded from the center of San Antonio, located southwest of Randolph AFB.

Computer technology has enabled Randolph AFB to more precisely display its flight tracks and noise contours for land use planning purposes. The computer technology has revealed the extent of the Randolph AFB region of impact into the counties and surrounding nearby cities and towns.

For the purpose of this Study, existing and future land uses on the figures in this section are generalized into one of the following six categories:

Residential: This category includes all types of residential activity, such as single and multi-family residences and mobile homes, at a density greater than one dwelling unit per acre.

Commercial: This category includes offices, retail, restaurants and other types of commercial establishments.

Industrial: This category includes manufacturing, warehousing, and other similar uses.

Public/Quasi-Public: This category includes publicly owned lands and/or land to which the public has access, including military reservations and training grounds, public buildings, schools, churches, cemeteries, and hospitals.

Recreational: This category includes land areas designated for recreational activity including parks, wilderness areas and reservations, conservation areas, and areas designated for trails, hikes, camping, etc.

Open/Agricultural/Low Density: This category includes undeveloped land areas, agricultural areas, grazing lands and areas with residential activity at densities less than or equal to one dwelling unit per acre.

5.2 EXISTING LAND USE

Three municipalities, Converse, Schertz, and Universal City, surround Randolph AFB on all sides. Selma, Live Oak, and Cibolo are also located within a few miles of the base boundary and are overflown by aircraft accomplishing operations at Randolph AFB. Land under the jurisdiction of Bexar and Guadalupe Counties is interspersed among the surrounding communities to the south and west of Randolph AFB. Land directly impacted by Randolph AFB operations is predominantly located within the cities of Schertz and Universal City. Land use surrounding Randolph AFB is generally a mix of developed urban to the north and west, and open agricultural or rural residential to the south and east.

5.2.1 Bexar & Guadalupe Counties

Land under the jurisdiction of the City of San Antonio and Bexar and Guadalupe Counties is primarily located to the south and west of Randolph AFB. Development patterns generally consist of small amounts of commercial and rural residential adjacent to roadways. Predominant land uses within the county land are open/agriculture with a few existing low-density single family residential homes.

5.2.2 Converse

Converse has experienced significant residential growth in recent years. The area adjacent to Randolph AFB was formerly undeveloped pastureland, but residential subdivisions are currently under development in Converse directly to the west of the installation. The subdivisions, including Miramar and Hanover Cove, are in varying stages of development. A small number of commercial uses are located along FM 78 and Loop 1604. The majority of medium and high-density development in Converse occurs along the Toepperwein and Seguin Road corridors, where a mix of commercial, industrial, and residential development exists.

5.2.3 Schertz

The City of Schertz contains a significant amount of undeveloped land, especially east and south of Randolph AFB. Residential development exists north of Randolph AFB, just outside APZ I at the northwest end of Runway 14L/32R. Thulemeyer Park, a recreational facility, is located within APZ I at the northwest end of Runway 14L/32R. Recently constructed housing developments exist adjacent to FM 3009 (Roy Richard Drive), northeast of Randolph AFB. Additional subdivisions have recently been developed along Schertz Parkway. Minimal commercial development exists along FM 78 and other road corridors. The land to the south and east of Randolph AFB remains mostly agricultural. A few isolated single family residences and mobile homes are located adjacent to Lower Seguin Drive near the southeast end of Runway 14L/32R.

5.2.4 Universal City

Universal City contains the most development within the Randolph AFB area of influence. Development directly outside the main gate along Pat Booker Road includes

commercial establishments such as diners, pawnshops, and retail stores. Portions of this commercial development are located within APZ I and APZ II off the northwest end of Runway 14R/32L. Residential development also occurs on both sides of Pat Booker Road, beyond the narrow commercial corridor, also located within the APZs. Northlake Business Park is a 178-acre business community located off the northwest end of Runway 14R/32L, predominantly falling within APZ I. The business park has grown significantly in recent years, and is now about 50 percent developed. The development generally consists of light industrial, office-warehouse, professional services, and research and technical labs. A few light industrial uses are scattered throughout the city.

5.2.5 Summary

Figure 5.1 presents the existing land uses for the area that surrounds Randolph AFB and within the DNL 65 dB and greater noise exposure area for the installation. Table 5.1 summarizes the off-installation acreage by land use category exposed to noise levels of DNL 65 dB and greater.

Table 5.1 Generalized Existing Land Use Within DNL 65 dB and Greater Noise Exposure Area (Off Installation)

Category	Acreage
Residential	285
Commercial	83
Industrial	221
Public/Quasi-public	17
Recreational	65
Open/Agricultural/Low Density	2,648
Total	**3,319**

The analysis also includes land use within the Randolph AFB CZs and APZs. Inclusion of the CZs and APZs in the evaluation shows 596 acres of residential land within the Randolph AFB CZs and APZs. Table 5.2 reflects the land use (off-installation areas only) within the Randolph AFB CZs and APZs.

Table 5.2 Generalized Existing Land Use within the Randolph AFB Clear Zones and Accident Potential Zones (Off-Installation)

Category	Acreage
Residential	596
Commercial	133
Industrial	112
Public/Quasi-public	22
Recreational/Open/Agricultural/Low Density	2,429
Total	**3,292**

5.3 CURRENT ZONING

Figure 5.2 overlays the 2008 noise contours and APZs on a map displaying the current generalized zoning in the vicinity of Randolph AFB. All of the surrounding municipalities have adopted standard zoning ordinances and zoning maps to guide and control development. Local governments and planning agencies have developed a strong working relationship with Randolph AFB in matters of development planning. The most influenced municipalities, Schertz and Universal City, have both adopted zoning controls specific to the latest Randolph AFB AICUZ Study recommendations. The zoning classifications identified on Figure 5.2 have been generalized for AICUZ planning purposes.

5.3.1 Bexar & Guadalupe Counties

Land under the jurisdiction of Bexar County, mostly to the southeast of the base, is not zoned and generally remains undeveloped. Guadalupe County land is not zoned and primarily located outside of the Randolph AFB area of influence.

5.3.2 Converse

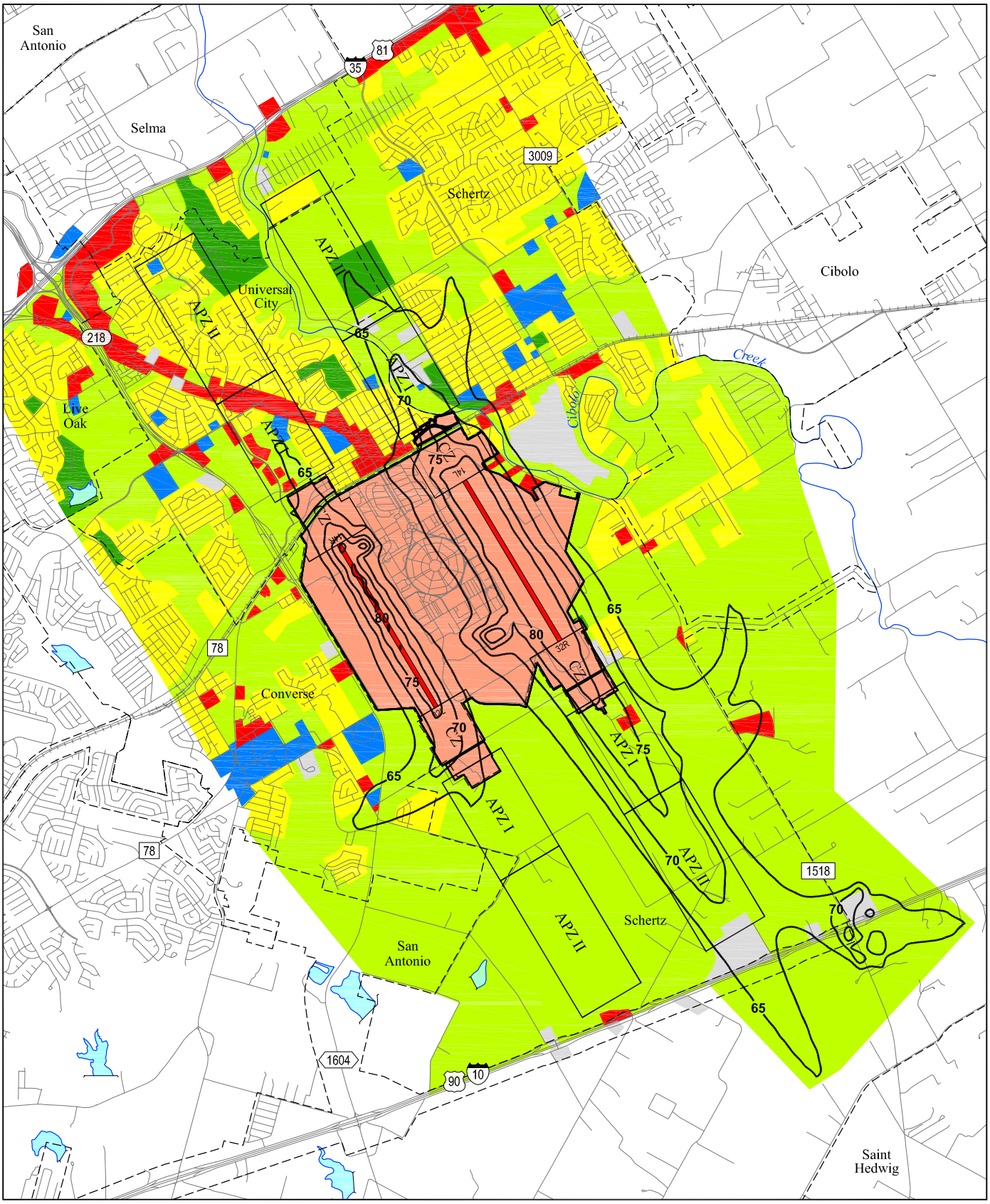
Converse is zoned with a combination of commercial, residential, and industrial uses. The land adjacent to FM Loop 1604, abutting the western boundary of Randolph AFB, is zoned for commercial uses, with residential zoning directly west of this strip commercial zoning. Additional commercial zoning occurs along the majority of the FM Loop 1604 corridor.

5.3.3 Schertz

The portion of Schertz located north of Randolph AFB is primarily zoned for residential uses. Commercially zoned land is located throughout the major road corridors including Interstate 35, FM 78, and FM 1518. A large amount of undeveloped land to the south and east of Randolph AFB is zoned for agriculture and low-density single family residential. A significant area to the southeast is zoned for planned unit development and is depicted as residential on Figure 5.2. To protect the public welfare and to ensure the continued viability of Randolph AFB, Schertz implemented zoning regulations within the Randolph AICUZ noise and accident potential zones. The city's Unified Development Code restricts incompatible development within the overlay district of the most recent Randolph AFB AICUZ study through adoption of a special AICUZ district. The ordinance requires development within noise or accident potential overlay districts to comply with the land use categories identified in Table 4.3 of the AICUZ study. Additionally, developers are required to inform potential homebuyers of the noise levels identified for the prospective building lot.

5.3.4 Selma

Selma is located north of Universal City and is located north and south of Interstate 35. Selma has adopted zoning regulations including a proportional mix of residential and commercially zoned land.



Randolph Air Force Base 2008 AICUZ

LEGEND

- Randolph AFB
- Residential
- Commercial
- Industrial
- Public/Quasi-Public
- Recreational
- Open/Agriculture/Low Density
- Runway
- DNL dB Contours
- City Limits

N

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Generalized Existing Land Use

Figure 5.1

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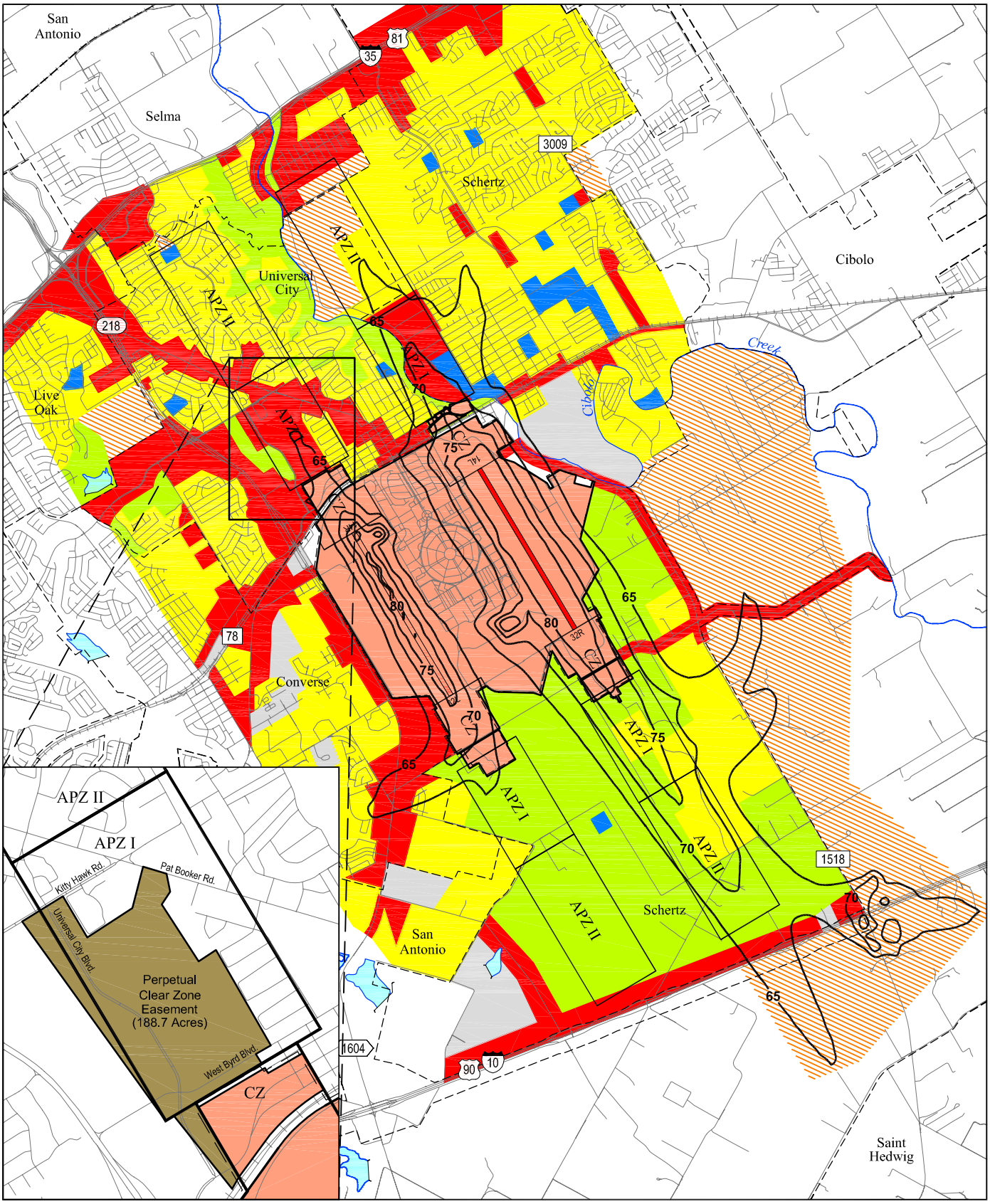

Randolph Air Force Base 2008 AICUZ

LEGEND

- Randolph AFB
- Residential
- Commercial
- Industrial
- Public/Quasi-Public
- Open/Agriculture/Low Density
- Not Zoned
- Runway
- DNL dB Contours
- City Limits

N

0 6,000 Feet

Generalized Zoning

Figure 5.2

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5.3.5 Universal City

Universal City has adopted zoning regulations and a comprehensive plan to guide future development. The updated zoning ordinance was adopted in January 2007. Land on either side of Pat Booker Road is zoned for commercial uses, with the majority of land to the north and east zoned for residential. Land directly north of the Runway 14R CZ is zoned for "highway" commercial uses. Much of the land adjacent to Cibolo Creek is zoned for open space and will remain undeveloped.

In 1989, a Perpetual Clear Zone Easement was adopted which grants a restrictive use area for the operation of aircraft to and from Randolph AFB. As shown on Figure 5.2, the restrictive use easement is comprised of 188 acres located within APZ I of the northwest end of Runway 14R/32L. The western boundary of the easement follows the Runway 14R Approach-Departure Clearance Surface. This easement grants Randolph AFB the right to regulate or prohibit any proposed use that is deemed detrimental to base flying operations. The easement also grants the Air Force the right to prohibit new construction or alteration of any structure that is inconsistent with the AICUZ study for Randolph AFB. All proposed construction requires 60 days advance written notice and grantee certification that the construction is consistent with the AICUZ study recommendation to the Installation Commander of Randolph AFB.

5.3.6 Summary

Analysis of current zoning in the study area was performed to determine the acreage of each zoning designation within the DNL 65dB and greater noise contours. From this analysis, as with the land use analysis, the zoning designations were categorized into residential, commercial, industrial, public/quasi-public, recreational, and open/ agricultural/ low density. Figure 5.2 shows the results of the compilation, and Table 5.3 provides a breakdown of the generalized zoning (areas outside Randolph AFB only, outside CZs and APZs) within the DNL 65 dB and greater noise area.

Table 5.3 Generalized Zoning within DNL 65 dB and Greater Noise Exposure Area (Off-Installation outside CZs and APZs)

Category	Acreage
Residential	506
Commercial	322
Industrial	20
Public/Quasi-public	23
Recreational/Open/Agricultural/Low Density	619
Total	**1,490**

Source: Live Oak, Converse, Schertz, Universal City, San Antonio Zoning Maps

A similar analysis was performed to determine the acreage of each generalized zoning category within the Randolph AFB CZs and APZs and is shown on Table 5.4.

Table 5.4 Generalized Zoning within the Randolph AFB Clear Zones and Accident Potential Zones (Off-Installation)

Category	Acreage
Residential	13
Commercial	522
Industrial	0
Public/Quasi-public	52
Recreational/Open/Agricultural/Low Density	1,424
Total	**3,054**

Source: Live Oak, Converse, Schertz, Universal City, San Antonio Zoning Maps

5.4 FUTURE LAND USE

Figure 5.3 shows generalized future land use predicted for the Randolph AFB environs based on local zoning maps, comprehensive plans, and local development proposals. The following paragraphs discuss the anticipated future land use patterns.

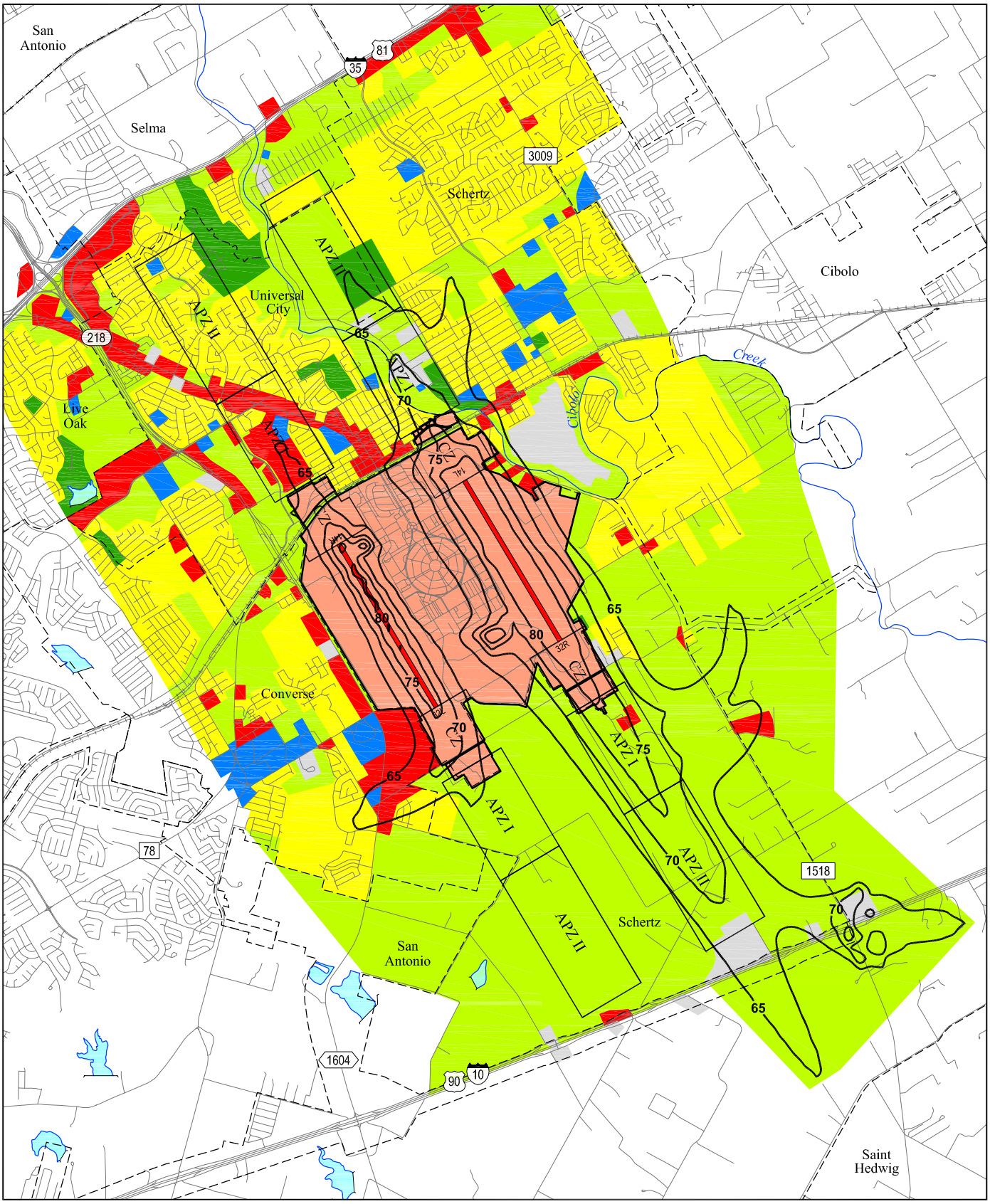
Development in the Randolph AFB AICUZ area of influence is expected to remain consistent with current patterns. The San Antonio MSA is expected to experience steady growth over the next several years. Residential development is expected to see consistent increases in the cities of Schertz, Converse, and Selma. Commercial development is expected to increase slightly to the north and west of the base, primarily along major road corridors including Pat Booker Road, Kitty Hawk Road, Loop 1604, and adjacent to Interstate 35. It is anticipated that Interstate 10 will continue to develop as a major trade corridor, increasing the volume of truck traffic and associated growth.

5.4.1 Bexar & Guadalupe Counties

While significant development is anticipated in the San Antonio area in the coming decade, the majority of growth in the Randolph AFB vicinity will occur within municipalities and extra territorial jurisdiction areas. The majority of non-municipal land within Bexar and Guadalupe Counties, generally located to the extreme south and southeast of Randolph AFB, is not expected to experience significant growth in the next few years.

5.4.2 Converse

The City of Converse will experience moderate growth in both residential and commercial development in the Randolph vicinity. The residential development will continue directly west of the base. Commercial uses are anticipated adjacent to Loop 1604, directly adjacent to the base. Much of the future development will consist of infill as Converse progresses toward a fully developed community. Land in the southern part of Converse is expected to be the last area to be developed.



Randolph Air Force Base 2008 AICUZ

LEGEND

- Randolph AFB
- Residential
- Commercial
- Industrial
- Public/Quasi-Public
- Recreational
- Open/Agriculture/Low Density
- Runway
- DNL dB Contours
- City Limits

N

0 6,000 Feet

Generalized Future Land Use

Figure 5.3

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5.4.3 Schertz

Schertz has recently experienced considerable residential development to the northeast of Randolph AFB. This development trend is expected to continue, with final build out of the residential development occurring along the Schertz Parkway corridor. Most of this development is outside the AICUZ area of influence. Additional commercial development will occur along the Interstate 35 corridor and adjacent to Schertz Parkway. Enforcement of compatible zoning in Schertz should ensure that development within the Runway 14L/32R accident potential zones and adjacent noise zones are compatible with Randolph AFB flying operations. No significant development is expected south of Randolph AFB in the near future, although the Interstate 10 corridor could experience moderate commercial and light industrial development, contingent upon interchange enhancements currently in the early stages of planning. Eventually, increased residential and mixed-use development will occur to the south and east of the base in Schertz.

5.4.4 Selma

Additional commercial development is occurring in the vicinity of Loop 1604 and Interstate 35. A significant subdivision, Trails of Kensington Ranch, is under development in southern Selma along FM 1518. Although this development is located outside of the Randolph AFB noise contours, it does fall within the Runway 14L APZ II. The Selma industrial park, located east of FM 1518, just south of Interstate 35 may see slight commercial/light industrial development over the next several years.

5.4.5 Universal City

Future development in Universal City will mostly consist of infill development. The majority of residentially zoned land within Universal City is fully developed. The North Lake Business Park is expected to continue to develop with light industrial, office-warehouse, professional services, and research/technical labs. The majority of the business park is located within the Runway 14R APZ I and the Perpetual Clear Zone Easement, and as noted on the NLBP Master Plan, is subject to restrictions identified in the most recently released Randolph AFB AICUZ study and FAR Part 77. Additional commercial development will occur along the FM Loop 1604 and Kitty Hawk corridors.

5.4.6 Summary

The land use restrictions discussed in Section 5.3 ensure that significant land use incompatibilities in the Randolph AFB CZs and APZs will be avoided in the future. The positive relationship among Randolph AFB and the area municipalities will continue to minimize the expansion of undeveloped areas surrounding the installation.

5.5 INCOMPATIBLE LAND USES

Table 5.5 shows land use compatibility as it applies to existing land use within the accident potential zones and noise contours DNL 65dB and greater for Randolph AFB. For a

land use area to be considered compatible, it must meet both noise and accident potential criteria shown in Table 4.3. The compatibility guidelines shown in Table 4.3 were combined with the existing land use plan shown in Figure 5.1 to determine land use compatibility associated with aircraft operations at Randolph AFB. Results of this analysis are depicted numerically in Table 5.5 and illustrated in Figure 5.4. The location description of the CZ or APZ in the following incompatible land use discussion describes the position of the CZ or APZ relative to the airfield and runway (*e.g.*, northwest of the airfield).

Table 5.5 Incompatible Land Use for Runways 14Left/32Right and 14Right/32Left at Randolph AFB

Category	Acreage Within CZs and APZs			Acreage Within Noise Zones, Not Included in CZs and APZs				Total
	CLEAR ZONE	APZ I	APZ II	65-69	70-74	75-79	80+	
Residential	0	178	419	208	24	0	0	**829**
Commercial	0	65	•	•	•	•	0	**65**
Industrial	0	•	•	•	•	•	•	**0**
Public/Quasi-public	0	22	9	•	0	0	0	**31**
Recreation/Open/ Agricultural/Low Density	0	•	•	•	•	•	•	**0**
Total	**0**	**265**	**428**	**208**	**24**	**0**	**0**	**925**

• Represents compatible land use

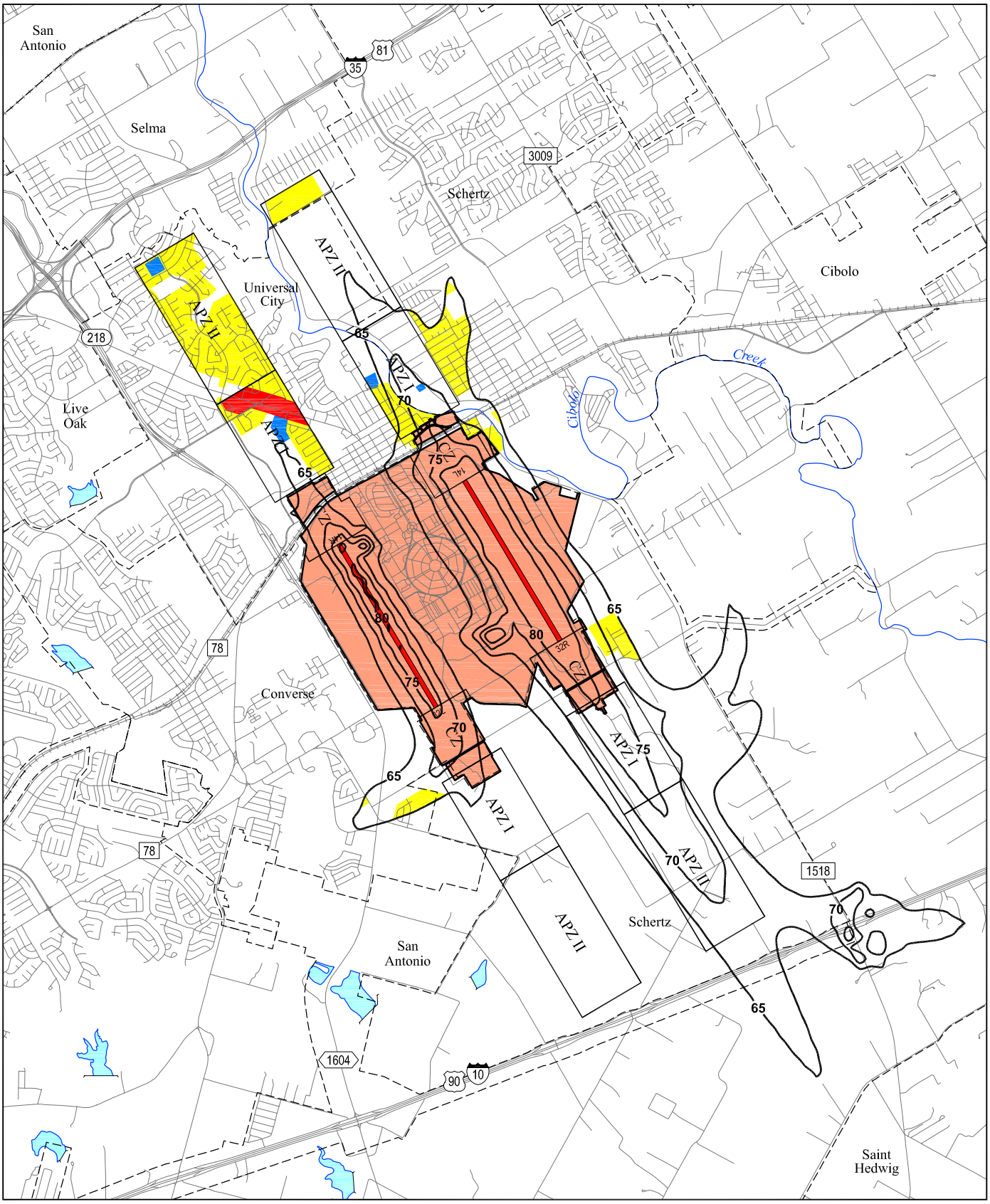
5.5.1 Runways 14Left/32Right Clear Zones and Accident Potential Zones

5.5.1.1 Clear Zone Northeast of the Airfield

Any land uses other than vacant are incompatible with the safety criteria established for a CZ. Two significant roadways, FM 78 and FM 1976 pass through the Northeast CZ and is the only incompatible land use.

5.5.1.2 Accident Potential Zone I Northeast of the Airfield

In general, industrial, recreational, vacant, and agricultural/open land uses are compatible with the safety criteria established for APZ I. Compatibility of commercial uses within APZ I is dependent on densities and intensity of uses. Incompatible uses are located in the Northeast APZ I. Rose Garden Elementary School and a residential development exist in the southwest portion of APZ I in Universal City. A church is located in the northeast portion of the Northeast APZ I in Schertz.



Randolph Air Force Base 2008 AICUZ

LEGEND

- Randolph AFB
- Residential
- Commercial
- Public/Quasi-Public
- Runway
- DNL dB Contours
- City Limits

N

0 6,000 Feet

Incompatible Land Uses

Figure 5.4

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5.5.1.3 Accident Potential Zone II Northeast of the Airfield

Most categories of land use are compatible with the safety criteria established for APZ II with the exception of public/quasi-public and some densities of residential. These land uses generally would be incompatible if residential densities are greater than two dwelling units per acre. The north end of Runway 14L contains land use conflicts, with a residential development exceeding the density limits throughout APZ II.

5.5.1.4 Clear Zone Southeast of the Airfield

All of the land within the CZ is open space compatible with Air Force planning criteria.

5.5.1.5 Accident Potential Zone I Southeast of the Airfield

In general, industrial, recreational, vacant, and agricultural/open land uses are compatible with the safety criteria established for APZ I. Compatibility of commercial uses within APZ I is dependent on densities and intensity of uses. There are no incompatible land uses in APZ I.

5.5.1.6 Potential Zone II Southeast of the Airfield

Most categories of land use are compatible with the safety criteria established for APZ II with the exception of public/quasi-public and some densities of residential. These land uses generally would be incompatible if residential densities are greater than two dwelling units per acre. There are no incompatible land uses in APZ II.

5.5.2 Runways 14Right/32Left Clear Zones and Accident Potential Zones

5.5.2.1 Clear Zone Northwest of the Airfield

Any land uses other than vacant are incompatible with the safety criteria established for a CZ. Two significant roadways, FM 78 and FM 1976 pass through the Northwest CZ and are the only incompatible land use.

5.5.2.2 Accident Potential Zone I Northwest of the Airfield

In general, industrial, recreational, vacant, and agricultural/open land uses are compatible with the safety criteria established for APZ I. Compatibility of commercial uses within APZ I is dependent on densities and intensity of uses. Several incompatible land uses in Universal City conflict with the Northwest APZ I. A mostly single family residential development is located in the eastern half of APZ I, between Pat Booker Road and the base boundary. The Sable Ridge apartment complex and several commercial uses adjacent to Pat Booker Road are incompatibly located in the Northwest APZ I.

5.5.2.3 Accident Potential Zone II Northwest of the Airfield

Most categories of land use are compatible with the safety criteria established for APZ II with the exception of public/quasi-public and some densities of residential. These land uses

generally would be incompatible if residential densities are greater than two dwelling units per acre. Some residential developments exceed the density limits in APZ II. Olympia Elementary School is located at the extreme northwest corner of APZ II.

5.5.2.4 Clear Zone Southwest of the Airfield

All of the land within the CZ is open space compatible with Air Force planning criteria.

5.5.2.5 Accident Potential Zone I Southwest of the Airfield

In general, industrial, recreational, vacant, and agricultural/open land uses are compatible with the safety criteria established for APZ I. Compatibility of commercial uses within APZ I is dependent on densities and intensity of uses. There are no incompatible land uses in APZ I.

5.5.2.6 Accident Potential Zone II Southwest of the Airfield

Most categories of land use are compatible with the safety criteria established for APZ II with the exception of public/quasi-public and some densities of residential. All of the residential areas within APZ II are rural residential, have densities less than two dwelling units per acre, and are compatible with AICUZ guidelines. There are no incompatible land uses in APZ II.

5.6 NOISE ZONES

At noise levels between DNL 65-69 dB, the only incompatible land use type is residential without NLR materials. Residential uses within the DNL 65-69 dB noise zone would be conditionally compatible upon incorporation of the appropriate amount of NLR. Based on the land use compatibility guidelines detailed in Table 4.3, residential use within the DNL 65-74 dB zone is discouraged unless there is a demonstrated community need and there are no viable alternate locations. Residential development exists in the DNL 65-69 dB zone between Maske Road and FM 78 in Schertz. Smaller areas of residential development occur in the DNL 65-74 dB zone along the eastern Randolph AFB boundary in Schertz. Residential development, including a portion of the MacArthur Park subdivision, is located in the DNL 65-69 dB zone to the southwest of Randolph AFB in Converse.

5.7 AIR INSTALLATION COMPATIBLE USE ZONE STUDY UPDATES

AICUZ noise contours describe the noise characteristics of a specific operational environment, and as such, will change if a significant operational change is made. An AICUZ Study should be evaluated for an update if the noise exposure map changes by DNL 2 dB or more in noise sensitive areas when compared to the noise contour map in the last publicly released AICUZ Study. With this in mind, this AICUZ Study updates the 2000 AICUZ Study and provides flight track, accident potential zone and noise zone information in this report which reflects the most accurate picture of the installation's aircraft activities as of March 2007.

SECTION 6
IMPLEMENTATION

6.1 INTRODUCTION

Implementation of the AICUZ Study must be a joint effort between the Air Force and adjacent communities. The role of the Air Force is to minimize impact on the local communities by Randolph AFB aircraft operations. The role of the communities is to ensure that development in the surrounding area is compatible with accepted planning and development principles and practices.

6.2 AIR FORCE RESPONSIBILITIES

In general, the Air Force perceives its AICUZ responsibilities as encompassing the areas of flying safety, noise abatement, and participation in the land use planning process.

Well-maintained aircraft and well-trained aircrews do a great deal to assure that aircraft accidents are avoided. Despite the best aircrew training and aircraft maintenance intentions, however, history clearly shows that accidents do occur. It is imperative flights be routed over sparsely populated areas as regularly as possible to reduce the exposure of lives and property to a potential accident.

Commanders are required by Air Force policy to periodically review existing traffic patterns, instrument approaches, weather minima, and operating practices, and evaluate these factors in relationship to populated areas and other local situations. This requirement is a direct result and expression of Air Force policy that all AICUZ plans must include an analysis of flying and flying-related activities designed to reduce and control the effects of such operations on surrounding land areas. Noise is generated from aircraft both in the air and on the ground. In an effort to reduce the noise effects of Randolph AFB operations on surrounding communities, the installation routes flight tracks to avoid populated areas.

Preparation and presentation of this Randolph AFB AICUZ Study is one phase of continuing Air Force participation in the local planning process. It is recognized that as the local community updates its land use plans, the Air Force must be ready to provide additional input when needed.

It is also recognized that the AICUZ program is an ongoing activity even after compatible development plans are adopted and implemented. Randolph AFB personnel are prepared to participate in the continuing discussion of zoning and other land use matters as they may affect, or may be affected by the Base. Base personnel also are available to provide information, criteria, and guidelines to state, regional, and local planning bodies, civic associations, and similar groups.

Participation in land-use planning can take many forms. The simplest of these forms is straightforward, consistent two-way discussion and information sharing with both professionals and neighbors. Copies of the AICUZ Study, including maps, will be provided

to regional planning departments and zoning administrators. Through this communication process, the Base reviews applications for development or changed use of properties within the noise impact and safety areas, as well as other nearby parcels. The Base coordinates closely with surrounding communities and counties on zoning and land-use issues.

6.3 LOCAL COMMUNITY RESPONSIBILITIES

Residents in the area neighboring Randolph AFB and Base personnel have a long history of working together for mutual benefit of the area around the airfield. Local jurisdictions have taken a proactive approach in incorporating land use regulations into local plans and ordinances which consider the Randolph AFB flying operations when evaluating development proposals. Adoption of the following recommendations will strengthen this relationship, increase the health and safety of the public, and help protect the integrity of the installation's flying mission:

- Incorporate AICUZ policies and guidelines into the comprehensive plans of Converse, Live Oak, San Antonio, and Selma. Use overlay maps of the AICUZ noise contours and Air Force Land Use Compatibility Guidelines to evaluate existing and future land use proposals.
- Continue to incorporate AICUZ policies and guidelines into the comprehensive plans and ordinances of Universal City and Schertz.
- Modify existing zoning ordinances and subdivision regulations to support the compatible land uses outlined in this study.
- Implement height and obstruction ordinances to reflect current Air Force and FAR Part 77 requirements.
- Modify building codes to ensure new construction within the AICUZ area of influence has the recommended noise level reductions incorporated into design and construction codes.
- Continue to inform Randolph AFB of planning and zoning actions that have the potential of affecting base operations. Develop a working group representing city planners, county planners, and base planners to meet at least quarterly to discuss AICUZ concerns and major development proposals that could affect airfield operations.

Appendix A

THE AICUZ CONCEPT, PROGRAM, METHODOLOGY, AND POLICIES

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THE AICUZ CONCEPT, PROGRAM, METHODOLOGY, AND POLICIES

A.1 Concept

Federal legislation, national sentiment, and other external forces, which directly affect the Air Force mission, serve greatly to increase the role of the Air Force in environmental and planning issues. Problems of airfield encroachment from incompatible land uses surrounding installations, as well as air and water pollution and socioeconomic impact, require continued and intensified Air Force involvement. The nature of these problems dictates direct Air Force participation in comprehensive community and land use planning. Effective, coordinated planning that bridges the gap between the federal government and the community requires establishment of good working relationships with local citizens, local planning officials, and state and federal officials. This depends on creating an atmosphere of mutual trust and helpfulness. The AICUZ concept has been developed in an effort to:

- protect local citizens from noise exposure and accident potential associated with flying activities; and
- prevent degradation of the capability of the Air Force to achieve its mission by promoting compatible land use planning.

The land use guidelines developed herein are a composite of a number of other land use compatibility studies that have been refined to fit the Randolph AFB aviation environment.

A.2 Program

Installation commanders establish and maintain active programs to promote the maximum feasible land use compatibility between air installations and neighboring communities. The program requires that all appropriate government bodies and citizens be fully informed whenever AICUZ or other planning matters affecting the installation are under consideration. This includes positive and continuous programs designed to:

- provide information, criteria, and guidelines to federal, state, regional, and local planning bodies, civic associations, and similar groups;
- inform such groups of the requirements of the flying activity, noise exposure, aircraft accident potential, and AICUZ plans;
- describe the noise reduction measures that are being used; and
- ensure that all reasonable, economical, and practical measures are taken to reduce or control the impact of noise-producing activities. These measures include such considerations as proper location of engine test facilities, provision of sound suppressors where necessary, and adjustment of flight patterns and/or techniques to minimize the noise impact on populated areas. This must be done without jeopardizing safety or operational effectiveness.

A.3 Methodology

The AICUZ consists of land areas upon which certain land uses may obstruct the airspace or otherwise be hazardous to aircraft operations, and land areas that are exposed to the health, safety, or welfare hazards of aircraft operations. The AICUZ includes:

- Accident Potential Zones (APZ) and Clear Zones (CZ) based on past Air Force aircraft accidents and installation operational data (see Appendix B);
- Noise zones (NZ) produced by the computerized DNL modeling of the noise created by aircraft flight and maintenance operations (see Section 3 of the Study); and
- The area designated by the FAA and the Air Force for purposes of height limitations in the approach and departure zones of the base (see Section 4 of the Study).

The APZ, CZ, and NZ are the basic building blocks for land use planning with AICUZ data. Compatible land uses are specified for these zones, and recommendations on building materials and standards to reduce interior noise levels inside structures are provided in Appendix C.

As part of the AICUZ Program, the only real property acquisition for which the Air Force has requested and received Congressional authorization, and for which the installation and major commands request appropriation, are the areas designated as the CZ. Randolph AFB either owns or holds restrictive easements on all property in the CZs. Compatible land use controls for the remaining airfield area of influence should be accomplished through the community land use planning processes.

A.4 AICUZ Land Use Development Policies

The basis for any effective land use control system is the development of, and subsequent adherence to, policies which serve as the standard by which all land use planning and control actions are evaluated. Randolph AFB recommends the following policies be considered for incorporation into the comprehensive plans of agencies in the vicinity of the Base's area of influence:

A.4.1 Policy 1

To promote the public health, safety, peace, comfort, convenience, and general welfare of the inhabitants in the airfield area of influence, it is necessary to:

- guide, control, and regulate future growth and development;
- promote orderly and appropriate use of land;
- protect the character and stability of existing land uses;
- prevent destruction or impairment of the airfield and the public investment therein;
- enhance the quality of living in the areas affected; and
- protect the general economic welfare by restricting incompatible land use.

A.4.2 Policy 2

In furtherance of Policy 1, it is appropriate to:

- establish guidelines of land use compatibility;
- restrict or prohibit incompatible land use;
- prevent establishment of any land use which would unreasonably endanger aircraft operations and the continued use of the airfield;
- incorporate the AICUZ concept into community land use plans, modifying them when necessary; and
- adopt appropriate ordinances to implement airfield area of influence land use plans.

A.4.3 Policy 3

Within the boundaries of the CZ, certain land uses are inherently incompatible. The following land uses are not in the public interest and must be restricted or prohibited:

- uses that release into the air any substance, such as steam, dust, or smoke which would impair visibility or otherwise interfere with the operation of aircraft;
- uses that produce light emissions, either direct or indirect (reflective), which would interfere with pilot vision;
- uses that produce electrical emissions which would interfere with aircraft communication systems or navigation equipment;
- uses that attract birds or waterfowl, such as operation of sanitary landfills, maintenance or feeding stations, or growth of certain vegetation; and
- uses that provide for structures within 10 feet of aircraft approach-departure and/or transitional surfaces.

A.4.4 Policy 4

Certain noise levels of varying duration and frequency create hazards to both physical and mental health. A limited, though definite, danger to life exists in certain areas adjacent to airfields. Where these conditions are sufficiently severe, it is not consistent with public health, safety, and welfare to allow the following land uses:

- residential;
- retail business;
- office buildings;
- public buildings (schools, churches, etc.); and
- recreation buildings and structures.

A.4.5 Policy 5

Land areas below takeoff and final approach flight paths are exposed to significant danger of aircraft accidents. The density of development and intensity of use must be limited in such areas.

A.4.6 Policy 6

Different land uses have different sensitivities to noise. Standards of land use acceptability should be adopted, based on these noise sensitivities. In addition, a system of Noise Level Reduction guidelines (Appendix C) for new construction should be implemented to permit certain uses where they would otherwise be prohibited.

A.4.7 Policy 7

Land use planning and zoning in the airfield area of influence cannot be based solely on aircraft-generated effects. Allocation of land used within the AICUZ should be further refined by consideration of:

- physiographic factors;
- climate and hydrology;
- vegetation;
- surface geology;
- soil characteristics;
- intrinsic land use capabilities and constraints;
- existing land use;
- land ownership patterns and values;
- economic and social demands;
- cost and availability of public utilities, transportation, and community facilities; and
- other noise sources.

A.5 Basic Land Use Compatibility

Research on aircraft accident potential, noise, and land use compatibility is ongoing at a number of federal and other agencies. These and all other compatibility guidelines must not be considered inflexible standards. They are the framework within which land use compatibility questions can be addressed and resolved. In each case, full consideration must be given to local conditions such as:

- previous community experience with aircraft accidents and noise;
- local building construction and development practices;

- existing noise environment due to other urban or transportation noise sources;
- time periods of aircraft operations and land use activities;
- specific site analysis; and
- noise buffers, including topography.

These basic guidelines cannot resolve all land use compatibility questions, but they do offer a reasonable framework within which to work.

A.6 Accident Potential

The Air Force standard CZ for a runway begins at the end of the runway and extends outward 3,000 feet and is 3,000 feet wide (1,500 feet to either side of runway centerline). In accordance UFC 3-260-01, CZs are authorized to deviate from the standard with individual service approval. The Randolph AFB CZs adhere to the standard 3,000-foot CZ width within the installation boundary. However, the CZs are 2,000 feet wide on property outside of the Randolph AFB boundary. All Randolph AFB CZs extend 3,000 feet outward from the runway ends.. Accident potential on or adjacent to the runway or within a CZ is so high that the necessary land use restrictions would prohibit reasonable economic use of land. As stated previously, it is Air Force policy to request Congress to authorize and appropriate funds for the necessary real property interests in this area to prevent incompatible land uses.

Accident Potential Zone I is less critical than the CZ, but still possesses a significant risk factor. This 3,000 foot by 5,000 foot area has land use compatibility guidelines which are sufficiently flexible to allow reasonable economic use of the land, such as industrial/manufacturing, transportation, communication/utilities, wholesale trade, open space, recreation, and agriculture. However, uses that concentrate people are not acceptable.

Accident Potential Zone II is less critical than APZ I, but still possesses potential for accidents. Accident potential zone II, also 3,000 feet wide, is 7,000 feet long extending to 15,000 feet from the runway threshold. Acceptable uses include those of APZ I, as well as low density single family residential and those personal and business services and commercial/retail trade uses of low intensity or scale of operation. High density functions such as multistory buildings, places of assembly (theaters, churches, schools, restaurants, *etc*.), and high density office uses are not considered appropriate.

High density populations should be limited to the maximum extent possible. The optimum density recommended for residential usage (where it does not conflict with noise criteria) in APZ II is one dwelling per acre. For most nonresidential usage, buildings should be limited to one story, and the lot coverage should not exceed 20 percent.

Land use guidelines for the two APZs are based on a hazard index system that compares the relationship of accident occurrence for five areas:

- on or adjacent to the runway;
- within the CZ;

- in APZ I;
- in APZ II; and
- in all other areas within a 10 nautical mile radius of the runway.

Accident potential on or adjacent to the runway or within the CZ is so high that few uses are acceptable. The risk outside APZ I and APZ II, but within the 10 nautical mile radius area, is significant, but is acceptable if sound engineering and planning practices are followed.

Land use guidelines for APZs I and II have been developed. The main objective has been to restrict all people-intensive uses because there is greater risk in these areas. The basic guidelines aim at prevention of uses that:

- have high residential density characteristics;
- have high labor intensity;
- involve above-ground explosives, fire, toxic, corrosive, or other hazardous characteristics;
- promote population concentrations;
- involve utilities and services required for area-wide population, where disruption would have an adverse impact (telephone, gas, etc.);
- concentrate people who are unable to respond to emergency situations, such as children, elderly, handicapped, etc.; and
- pose hazards to aircraft operations.

There is no question that these guidelines are relative. Ideally, there should be no people-intensive uses in either of these APZs. The free market and private property systems prevent this where there is a demand for land development. To go beyond these guidelines, however, substantially increases risk by placing more people in areas where there may ultimately be an aircraft accident.

A.7 Noise

Nearly all studies analyzing aircraft noise and residential compatibility recommend no residential uses in noise zones above DNL 75 dB. Usually, no restrictions are recommended below noise zone DNL 65 dB. There is currently no consensus between DNL 65-74 dB. These areas may not qualify for federal mortgage insurance in residential categories according to United States Department of Housing and Urban Development (HUD) Regulation 24 CFR 51B. In many cases, HUD approval requires noise attenuation measures, the Regional Administrator's concurrence, and an Environmental Impact Statement. The United States Department of Veterans Affairs also has airfield noise and accident restrictions which apply to its home loan guarantee program. Whenever possible, residential land use should be located below DNL 65 dB according to Air Force land use recommendations. Residential buildings within the DNL 65-75 dB noise contours should contain noise level reduction in

accordance with the Air Force land use compatibility guidelines in the AICUZ Study, Table 4.3.

Most industrial/manufacturing uses are compatible in the airfield area of influence. Exceptions are uses such as research or scientific activities that require lower noise levels. Noise attenuation measures are recommended for portions of buildings devoted to office use, receiving the public, or where the normal background noise level is low.

The transportation, communications, and utilities categories have a high noise level compatibility because they generally are not people-intensive. When people use land for these purposes, the use is generally very short in duration. Where buildings are required for these uses, additional evaluation is warranted.

The commercial/retail trade and personal and business services categories are compatible without restriction up to DNL 70 dB; however, they are generally incompatible above DNL 80 dB. Between DNLs 70-79 dB, noise level reduction measures should be included in the design and construction of buildings.

The nature of most uses in the public and quasi-public services category requires a quieter environment, and attempts should be made to locate these uses below DNL 65 dB (an Air Force land use recommendation), or else provide adequate noise level reduction.

Although recreational use has often been recommended as compatible with high noise levels, recent research has resulted in a more conservative view. Above DNL 75 dB, noise becomes a factor that limits the ability to enjoy such uses. Where the requirement to hear is a function of the use (*e.g.*, music shell, *etc.*), compatibility is limited. Buildings associated with golf courses and similar uses should be noise attenuated.

With the exception of forestry activities and livestock farming, uses in the resources production, extraction, and open space category are compatible almost without restrictions.

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Appendix B

CLEAR ZONES AND ACCIDENT POTENTIAL ZONES

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CLEAR ZONES AND ACCIDENT POTENTIAL ZONES

B.1 Guidelines for Accident Potential

Areas around airports are exposed to the possibility of aircraft accidents even with well-maintained aircraft and highly trained aircrews. Despite stringent maintenance requirements and countless hours of training, history makes it clear that accidents do happen.

When the AICUZ Program began, there were no current comprehensive studies on accident potential. To support the program, the Air Force completed a study of Air Force aircraft accidents that occurred between 1968 and 1972 within 10 nautical miles of airfields. The study of 369 accidents revealed that 75 percent of aircraft accidents occurred on or adjacent to the runway (1,000 feet to each side of the runway centerline) and in a corridor 3,000 feet (1,500 feet either side of the runway centerline) wide, extending from the runway threshold along the extended runway centerline for a distance of 15,000 feet. The Air Force updated these studies and this information is presented later in this section.

The CZ, APZ I, and APZ II were established based on crash patterns. The CZ starts at the end of the runway and extends outward 3,000 feet. It has the highest accident potential of the three zones. The Air Force adopted a policy of acquiring property rights to areas designated as CZs because of the high accident potential. APZ I extends from the CZ an additional 5,000 feet. It includes an area of reduced accident potential. APZ II extends from APZ I an additional 7,000 feet in an area of further reduced accident potential.

Research in accident potential conducted by the Air Force was the first significant effort in this subject area since 1952 when the President's Airport Commission published "The Airport and Its Neighbors," better known as the "Doolittle Report." The recommendations of this earlier report were influential in the formulation of the APZ concept.

The risk to people on the ground being killed or injured by aircraft accidents is small. However, an aircraft accident is a high consequence event, and when a crash does occur, the result is often catastrophic. Because of this, the Air Force does not attempt to base its safety standards on accident probabilities. Instead, the Air Force approaches this safety issue from a land use planning perspective.

B.2 Guidelines for Accident Potential

Military aircraft accidents differ from commercial air carrier and general aviation accidents because of the variety of aircraft used, the type of missions, and the number of training flights. In 1973, the Air Force performed a service-wide aircraft accident hazard study to identify land near airfields with significant accident potential. Accidents studied occurred within 10 nautical miles of airfields.

The study reviewed 369 major Air Force accidents during 1968-1972, and found that 61 percent of those accidents were related to landing operations, and 39 percent were takeoff

related. It also found that 70 percent occurred in daylight, and that fighter and training aircraft accounted for 80 percent of the accidents.

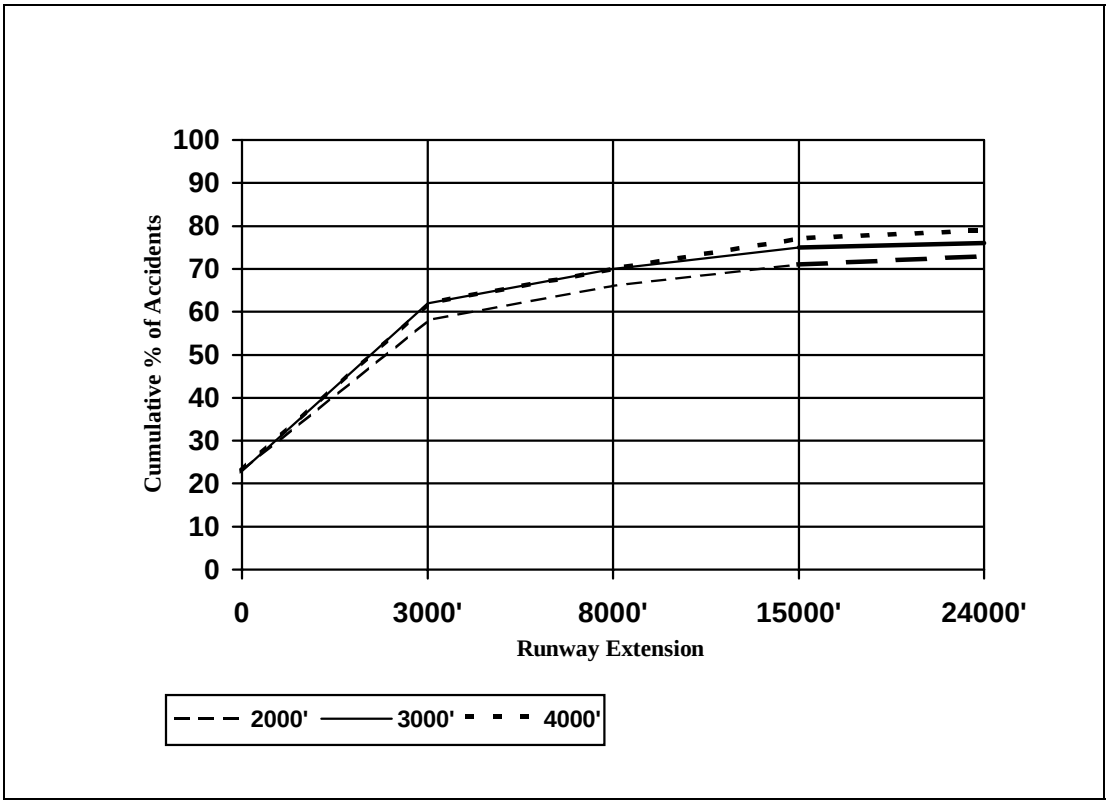
Because the purpose of the study was to identify accident hazards, the study plotted each of the 369 accidents in relation to the airfield. This plotting found that the accidents clustered along the runway and its extended centerline. To further refine this clustering, a tabulation was prepared that described the cumulative frequency of accidents as a function of distance from the runway centerline along the extended centerline. This analysis was done for widths of 2,000, 3,000, and 4,000 total feet. Table B.1 reflects the location analysis.

Table B.1 Location Analysis

	Width of Runway Extension (feet)		
Length From Both Ends of Runway (feet)	**2000**	**3000**	**4000**
Percent of Accidents			
On or Adjacent to Runway (1,000 feet to each side of runway centerline)	23	23	23
0 to 3,000	35	39	39
3,000 to 8,000	8	8	8
8,000 to 15,000	5	5	7
Cumulative Percent of Accidents			
On or Adjacent to Runway (1,000 feet to each side of runway centerline)	23	23	23
0 to 3,000	58	62	62
3,000 to 8,000	66	70	70
8,000 to 15,000	71	75	77

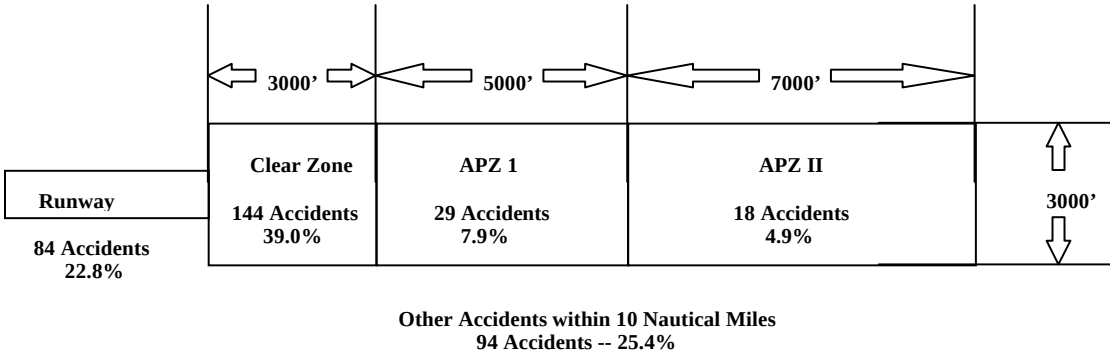
Figure B.1 indicates that the cumulative number of accidents rises rapidly from the end of the runway to 3,000 feet, rises more gradually to 8,000 feet, then continues at about the same rate of increase to 15,000 feet, where it levels off rapidly. The location analysis also indicates 3,000 feet as the optimum runway extension width and the width which includes the maximum percentage of accidents in the smallest area.

Figure B.1 Distribution of Air Force Aircraft Accidents (369 Accidents - 1968 - 1972)



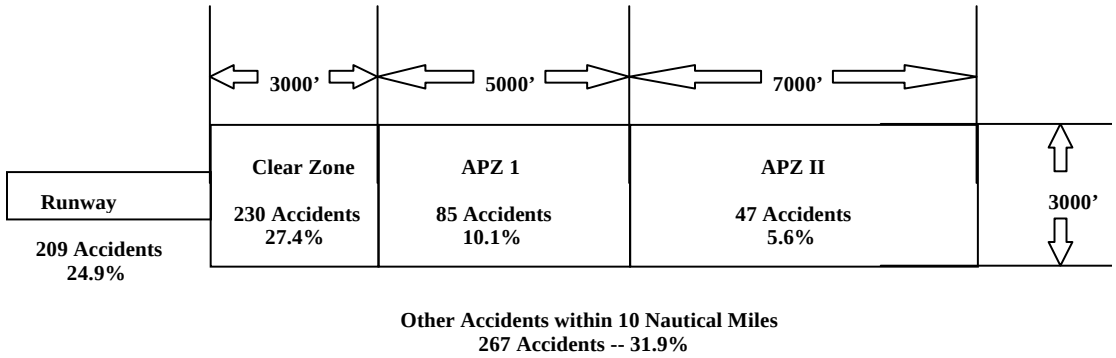
Using the optimum runway extension width, 3,000 feet, and the cumulative distribution of accidents from the end of the runway, zones were established that minimized the land area included and maximized the percentage of accidents included. The zone dimensions and accident statistics for the 1968-1972 study are shown in Figure B.2.

Figure B.2 Air Force Aircraft Accident Data (369 Accidents - 1968 - 1972)



The original study was updated to include accidents through September 1995. This updated study includes 838 accidents during the 1968-1995 period. Using the optimum runway extension width of 3,000 feet, the accident statistics of the updated study are shown in Figure B.3.

Figure B.3 Air Force Aircraft Accident Data (838 Accidents - 1968 - 1995)



Using the designated zones and accident data, it is possible to calculate a ratio of percentage of accidents to percentage of area size. These ratios indicate the CZ, with the smallest area size and the highest number of accidents, has the highest ratio, followed by the runway and adjacent area, APZ I, and then APZ II. Table B.2 reflects this data.

Table B.2 Accident to Area Ratio

Ratio of Percentage of Accidents to Percentage of Area (Air Force Accident Data 1968 - 1995)						
	Area[1] (Acres)	Number[2] Accident	Accident Per Acre	Percent of Total Area	Percent of Total Accidents	Ratio:[3] % Accidents to % Area
Runway Area	487	209	1 Per 2.3 acres	0.183	24.9	136
Clear Zone	413	230	1 Per 1.8 acres	0.155	27.4	177
APZ I	689	85	1 Per 8.1 acres	0.258	10.1	39
APZ II	964	47	1 Per 20.5 acres	0.362	5.6	16
Other Area	264,053	267	1 Per 989 acres	99.042	31.9	0.3

1 Area includes land within 10 nautical miles of runway.
2 Total number of accidents is 838 (through 1995).
3 Percent total accidents divided by percent total area.

Additional accident data for 1986 through July 1995 has been analyzed. Specific location data for some of the 1986-1995 accidents was not available and these were not included in the analysis. Table B.3 compares the 1968-1985 data with the data through July 1995:

Table B.3 Additional Accident Data

	1968-1985		1968-1995	
ZONE	Accidents	% of Total	Accidents	% of Total
On-Runway	197	27.1	209	24.9
Clear Zone	210	28.8	230	27.4
APZ I	57	7.8	85	10.1
APZ II	36	5.0	47	5.7
Other (Within 10 nautical miles)	228	31.3	267	31.9
Total	728	100.0	838	100.0

Analysis has shown that the cumulative changes evident in accident location through July 1995 reconfirm the dimensions of the CZs and APZs.

B.3 Definable Debris Impact Areas

The Air Force also determined which accidents had definable debris impact areas, and in what phase of flight the accident occurred. Overall, 75 percent of the accidents had definable debris impact areas, although they varied in size by type of accident. The Air Force used weighted averages of impact areas, for accidents occurring only in the approach and departure phase, to determine the following average impact areas:

Average Impact Areas for Approach and Departure Accidents

Overall Average Impact Area	5.06 acres
Fighter, Trainer, and Misc. Aircraft	2.73 acres
Heavy Bomber and Tanker Aircraft	8.73 acres

B.4 Findings

Designation of safety zones around the airfield and restriction of incompatible land uses can reduce the public's exposure to safety hazards.

Air Force accident studies have found that aircraft accidents near Air Force installations occurred in the following patterns:

- 61% were related to landing operations.
- 39% were related to takeoff operations.
- 70% occurred in daylight.
- 80% were related to fighter and training aircraft operations.
- 25% occurred on the runway or within an area extending 1,000 feet out from each side of the runway.
- 27% occurred in an area extending from the end of the runway to 3,000 feet along the extended centerline and 3,000 feet wide, centered on the extended centerline.
- 15% occurred in an area between 3,000 and 15,000 feet along the extended runway centerline and 3,000 feet wide, centered on the extended centerline.

Air Force aircraft accident statistics found 75% of aircraft accidents resulted in definable impact areas. The size of the impact areas were:

- 5.06 acres overall average.
- 2.73 acres for fighters and trainers.
- 8.73 acres for heavy bombers and tankers.

Appendix C

NOISE AND NOISE LEVEL REDUCTION GUIDELINES

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NOISE AND NOISE LEVEL REDUCTION GUIDELINES

C.1 General

Noise, often defined as unwanted sound, is one of the most common environmental issues associated with aircraft operations. Of course, aircraft are not the only sources of noise in an urban or suburban surrounding, where noise from interstate and local roadway traffic, rail, industrial, and neighborhood sources also intrude on the everyday quality of life. Nevertheless, aircraft are readily identifiable to those affected by their noise and are typically singled out for special attention and criticism. Consequently, aircraft noise problems often dominate analyses of environmental impacts.

Sound is a physical phenomenon consisting of minute vibrations that travel through a medium such as air, and are sensed by the human ear. Whether that sound is interpreted as pleasant (*e.g.*, music) or unpleasant (*e.g.*, aircraft noise) depends largely on the listener's current activity, past experience, and attitude toward the source of that sound. It is often true that one person's music is another person's noise.

The measurement and human perception of sound involves two basic physical characteristics - intensity and frequency. Intensity is a measure of the acoustic energy of the sound vibrations and is expressed in terms of sound pressure. The higher the sound pressure, the more energy carried by the sound and the louder the perception of that sound. The second important physical characteristic is sound frequency, that is, the number of times per second the air vibrates or oscillates. Low-frequency sounds are characterized as rumbles or roars, while high-frequency sounds are typified by sirens or screeches.

The loudest sounds, which can be detected comfortably by the human ear, have intensities that are a trillion times larger than those of sounds that can be detected at the lower end of the spectrum. Because of this vast range, any attempt to represent the intensity of sound using a linear scale becomes very unwieldy. As a result, a logarithmic unit known as the decibel (dB) is used to represent the intensity of a sound. Such a representation is called a sound level.

A sound level of 0 dB is approximately the threshold of human hearing and is barely audible under extremely quiet listening conditions. Normal speech has a sound level of approximately 60 dB. Sound levels above 120 dB begin to be felt inside the human ear as discomfort and eventually pain at still higher levels.

Because of the logarithmic nature of the decibel unit, sound levels cannot be added or subtracted directly and are somewhat cumbersome to handle mathematically. However, some simple rules are useful in dealing with sound levels. First, if a sound's intensity is doubled, the sound level increases by 3 dB, regardless of the initial sound level. Thus, for example:

$$60 \text{ dB} + 60 \text{ dB} = 63 \text{ dB, and}$$

$$80 \text{ dB} + 80 \text{ dB} = 83 \text{ dB.}$$

The total sound level produced by two sounds of different levels is usually only slightly more than the higher of the two. For example:

60.0 dB + 70.0 dB = 70.4 dB.

Because the addition of sound levels behaves differently than that of ordinary numbers, such an addition is often referred to as "decibel addition" or "energy addition." The latter term arises from the fact that what is really happening when decibel values are added is each decibel value is first converted to its corresponding acoustic energy, then the energies are added using the normal rules of addition, and finally the total energy is converted to its decibel equivalent.

An important facet of decibel addition arises later when the concept of time-average sound levels is introduced to explain Day-Night Average A-Weighted Sound Level (DNL). Because of the logarithmic units, the louder levels that occur during the averaging period dominate the time-average sound levels. As a simple example, consider a sound level that is 100 dB and lasts for 30 seconds, followed by a sound level of 50 dB which also lasts for 30 seconds. The time-average sound level over the total 60-second period is 97 dB, not 75 dB.

Sound frequency is measured in terms of cycles per second (cps), or hertz (Hz), which is the preferred scientific unit for cps. The normal human ear can detect sounds that range in frequency from about 20 Hz to about 15,000 Hz. All sounds in this wide range of frequencies, however, are not heard equally well by the human ear, which is most sensitive to frequencies in the 1000 to 4000 Hz range. In measuring community noise, this frequency dependence is taken into account by adjusting the sound levels of the very high and low frequencies to approximate the human ear's lower sensitivity to those frequencies. This is called "A-weighting" and is commonly used in measurements of community environmental noise.

Sound levels measured using A-weighting are most properly called A-weighted sound levels while sound levels measured without any frequency weighting are most properly called sound levels. However, since most environmental impact analysis documents deal only with A-weighted sound levels, the adjective "A-weighted" is often omitted, and A-weighted sound levels are referred to simply as sound levels. In some instances it will be indicated that the sound levels have been A-weighted by using the abbreviation dBA or dB(A), rather than the abbreviation dB, for decibel. As long as the use of A-weighting is understood to be used, there is no difference implied by the terms "sound level" and "A-weighted sound level" or by the units dB, dBA, and dB(A).

In this document and most AICUZ documents, all sound levels are A-weighted sound levels and the adjective "A-weighted" has been omitted and dB is used for the decibel units.

Sound levels do not represent instantaneous measurements but rather averages over short periods of time. Two measurement time periods are most commonly used - one second and one-eighth of a second. Most environmental noise studies use slow response measurements,

and the adjective "slow response" is usually omitted. It is easy to understand why the proper descriptor "slow response A-weighted sound level" is usually shortened to "sound level" in environmental impact analysis documents.

C.2 Noise Metrics

A "metric" is defined as something "of, involving, or used in measurement." In environmental noise analyses, a metric refers to the unit or quantity that quantitatively measures the effect of noise on the environment. Noise studies have typically involved a confusing proliferation of noise metrics as individual researchers have attempted to understand and represent the effects of noise. As a result, past literature describing environmental noise abatement has included many different metrics.

Various federal agencies involved in environmental noise mitigation agree on common metrics for environmental impact analysis documents, and both the Department of Defense (DoD) and the FAA specified those which should be used for federal aviation noise assessments. These metrics are as follows.

C.2.1 Maximum Sound Level

The highest A-weighted sound level measured during a single event in which the sound level changes value as time goes on (*e.g.*, an aircraft overflight) is called the maximum A-weighted sound level or maximum sound level, for short. It is usually abbreviated by ALM, $L_{max,}$ or L_{Amax}.

C.2.2 Sound Exposure Level

Individual time-varying noise events have two main characteristics - a sound level which changes throughout the event and a period of time during which the event is heard. Although the maximum sound level, described above, provides some measure of the intrusiveness of the event, it alone does not completely describe the total event. The period of time during which the sound is heard is also significant. The Sound Exposure Level (abbreviated SEL or L_{AE}) combines both of these characteristics into a single metric.

Sound Exposure Level is a logarithmic measure of the total acoustic energy transmitted to the listener during the event. Mathematically, it represents the sound level of the constant sound that would, in one second, generate the same acoustic energy as did the actual time-varying noise event. Since aircraft overflights usually last longer than 1 second, the SEL of an overflight is usually greater than the ALM of the overflight.

Note that sound exposure level is a composite metric that represents both the intensity of a sound level of the constant sound and its duration. It does not directly represent the sound level heard at any given time, but rather provides a measure of the net impact of the entire acoustic event. It has been well established in the scientific community that SEL measures this impact much more reliably than just the ALM.

Because the SEL and the ALM are both A-weighted sound levels expressed in decibels, there is sometimes confusion between the two, so the specific metric used should be clearly stated.

C.2.3 Day-Night Average Sound Level

Time-average sound levels are measurements of sound levels that are averaged over a specified length of time. These levels provide a measure of the average sound energy during the measurement period.

For the evaluation of community noise effects, and particularly aircraft noise effects, the DNL (mathematically represented as L_{dn}) is used. DNL averages aircraft sound levels at a location over a complete 24-hour period, with a 10-dB adjustment added to those noise events that take place between 10:00 p.m. and 7:00 a.m. (local time). This 10-dB "penalty" represents the added intrusiveness of sounds that occur during normal sleeping hours, both because of the increased sensitivity to noise during those hours and because ambient sound levels during nighttime are typically about 10 dB lower than during daytime hours.

As noted earlier for SEL, DNL does not represent the sound level heard at any particular time. DNL provides a single measure of overall noise impact, but does not provide specific information on the number of noise events or the individual sound levels which occur during the day. For example, a DNL of 65 dB could result from a very few noisy events, or a large number of quieter events.

Scientific studies and social surveys which have been conducted to evaluate community annoyance to all types of environmental noise have found the DNL to be the best measure to predict annoyance. Its use is endorsed by the scientific community (See References C.1 through C-5 at the end of this section).

There is, in fact, a remarkable consistency in the results of attitudinal surveys about aircraft noise conducted in different countries to find the percentages of groups of people who express various degrees of annoyance when exposed to different levels of DNL.

Reference C.6 was published in 1978. A more recent study has reaffirmed this relationship (Reference C.7). In general, correlation coefficients of 0.85 to 0.95 are found between the percentages of groups of people highly annoyed and the level of average noise exposure. The correlation coefficients for the annoyance of individuals are relatively low, however, on the order of 0.5 or less. This is not surprising, considering the varying personal factors that influence the manner in which individuals react to noise. Nevertheless, findings substantiate that community annoyance to aircraft noise can be predicted quite reliably using DNL.

This relation between community annoyance and DNL has been confirmed, even for infrequent aircraft noise events. Reference C.8 reported the reactions of individuals in a community to daily helicopter overflights correlated quite well with the daily time-average sound levels over this range of numbers of daily noise events.

The use of DNL has been criticized as not accurately representing community annoyance and land-use compatibility with aircraft noise. Much of that criticism stems from a lack of understanding of the basis for the measurement or calculation of L_{dn}. One frequent criticism is based on the principle that people inherently react more to single noise events and not as much to "meaningless" time-average sound levels.

In fact, a time-average noise metric, such as DNL, takes into account both the noise levels of all individual events which occur during a 24-hour period and the number of times those events occur. As described briefly above, the logarithmic nature of the decibel unit causes the noise levels of the loudest events to control the 24-hour average.

As a simple example of this characteristic, consider a case in which only one aircraft overflight occurs in daytime during a 24-hour period, creating a sound level of 100 dB for 30 seconds. During the remaining 23 hours, 59 minutes, and 30 seconds of the day, the ambient sound level is 50 dB. The DNL for this 24-hour period is 65.5 dB. Assume, as a second example, that ten such 30-second overflights occur in daytime hours during the next 24-hour period, with the same ambient sound level of 50 dB during the remaining 23 hours and 55 minutes of the day. The DNL for this 24-hour period is 75.4 dB. Clearly, the averaging of noise over a 24-hour period does not ignore the louder single events and tends to emphasize both the sound levels and number of those events. This is the basic concept of a time-average sound metric, and specifically the DNL.

C.3 Noise Effects

C.3.1 Hearing Loss

Noise-induced hearing loss is probably the best-defined of the potential effects of human exposure to excessive noise. Federal workplace standards for protection from hearing loss allow a time-average level of 90 dB over an 8-hour work period, or 85 dB averaged over a 16-hour period. An outdoor DNL of 75 dBA is considered the threshold above which the risk of hearing loss should be evaluated. Following guidelines recommended by the Committee on Hearing, Bioacoustics, and Biomechanics of the National Research Council, the average change in the threshold of hearing for people exposed to DNL equal to or greater than 75 dBA was evaluated. Results indicated that an average of 1 dBA hearing loss could be expected for people exposed to DNL equal to or greater than 75 dBA. For the most sensitive 10 percent of the exposed population, the maximum anticipated hearing loss would be 4 dBA. These hearing loss projections must be considered conservative as the calculations are based on an average daily outdoor exposure of 16 hours (7:00 a.m. to 10:00 p.m.) over a 40-year period. Since it is unlikely that airport neighbors will remain outside their homes 16 hours per day for extended periods of time, there is little possibility of hearing loss below a DNL of 75 dB, and this level is extremely conservative.

C.3.2 Nonauditory Health Effects

Nonauditory health effects of long-term noise exposure, where noise may act as a risk factor, have never been found to occur at levels below those protective against noise-induced

hearing loss, described above. Most studies attempting to clarify such health effects have found that noise exposure levels established for hearing protection will also protect against any potential nonauditory health effects, at least in workplace conditions. The best scientific summary of these findings is contained in the lead paper at the National Institute of Health Conference on Noise and Hearing Loss, held on 22-24 January 1990 in Washington, D.C.

> "The nonauditory effects of chronic noise exposure, when noise is suspected to act as one of the risk factors in the development of hypertension, cardiovascular disease, and other nervous disorders, have never been proven to occur as chronic manifestations at levels below these criteria (an average of 75 dBA for complete protection against hearing loss for an eight-hour day). At the recent (1988) International Congress on Noise as a Public Health Problem, most studies attempting to clarify such health effects did not find them at levels below the criteria protective of noise-induced hearing loss, and even above these criteria, results regarding such health effects were ambiguous. Consequently, one comes to the conclusion that establishing and enforcing exposure levels protecting against noise-induced hearing loss would not only solve the noise-induced hearing loss problem but also any potential nonauditory health effects in the work place." (Reference C.9; parenthetical wording added for clarification.)

Although these findings were directed specifically at noise effects in the work place, they are equally applicable to aircraft noise effects in the community environment. Research studies regarding the nonauditory health effects of aircraft noise are ambiguous, at best, and often contradictory. Yet, even those studies which purport to find such health effects use time-average noise levels of 75 dB and higher for their research.

For example, in an often-quoted paper, two University of California at Los Angeles (UCLA) researchers apparently found a relationship between aircraft noise levels under the approach path to Los Angeles International Airport and increased mortality rates among the exposed residents by using an average noise exposure level greater than 75 dB for the "noise-exposed" population (Reference C.10). Nevertheless, three other UCLA professors analyzed those same data and found no relationship between noise exposure and mortality rates (Reference C.11).

In summary, there is no scientific basis for a claim that potential health effects exist for aircraft DNL below 75 dB.

C.3.3 Annoyance

The primary effect of aircraft noise on exposed communities is one of annoyance. Noise annoyance is defined by the U.S. Environmental Protection Agency as any negative subjective reaction on the part of an individual or group (Reference C.3). As noted in the discussion of DNL above, community annoyance is best predicted by that metric.

It is often suggested that a lower DNL, such as 60 or 55 dB, be adopted as the threshold of community noise annoyance for airport environmental analysis documents. While there is no technical reason why a lower level cannot be measured or calculated for comparison purposes, a DNL of 65 dB:

- provides a valid basis for comparing and assessing community noise effects;
- represents a noise exposure level which is normally dominated by aircraft noise and not other community or nearby highway noise sources; and
- reflects the FAA's threshold for grant-in-aid funding of airport noise mitigation projects.
- United States Department of Housing and Urban Development also establishes a DNL standard of 65 dB for eligibility for federally guaranteed home loans.

C.3.4 Speech Interference

Speech interference associated with aircraft noise is a primary cause of annoyance to individuals on the ground. The disruption of routine activities such as radio or television listening, telephone use, or family conversation gives rise to frustration and irritation. The quality of speech communication is also important in classrooms, offices, and industrial settings and can cause fatigue and vocal strain in those who attempt to communicate over the noise. Research has shown that "whenever intrusive noise exceeds approximately 60 dB indoors, there will be interference with speech communication" (Reference C.5). A steady A-weighted background sound level of 60 dB will produce 93 percent intelligibility; that of 70 dB will produce 66 percent intelligibility; and that of 75 dB will produce 2 percent intelligibility (Figure D-1 in Reference C.3).

C.3.5 Sleep Interference

Sleep interference may be measured in either of two ways. "Arousal" represents actual awakening from sleep, while a change in "sleep stage" represents a shift from one of four sleep stages to another stage of lighter sleep without actual awakening. In general, arousal requires a somewhat louder noise level than does a change in sleep stage.

A recent analysis sponsored by the Air Force summarized 21 published studies concerning the effects of noise on sleep (Reference C.14). The analysis concluded that a lack of reliable studies in homes, combined with large differences among the results from the various laboratory studies and the limited in-home studies, did not permit development of an acceptable accurate assessment procedure. The noise events used in the laboratory studies and in contrived in-home studies were presented at much higher rates of occurrence than would normally be experienced in the home. None of the laboratory studies was of sufficiently long duration to determine any effects of habituation, such as those which would occur under normal community conditions.

Nevertheless, some guidance is available in judging sleep interference. The U.S. Environmental Protection Agency (USEPA) identified an indoor DNL of 45 dB as necessary

to protect against sleep interference (Reference C.3). Assuming a very conservative structural noise insulation of 20 dB for typical dwelling units, this corresponds to an outdoor DNL of 65 dB as minimizing sleep interference.

The Federal Interagency Committee on Noise (Reference C.5) reviewed the sleep disturbance issue and presented an Air Force-developed sleep disturbance dose-response prediction curve, which is based on data from Reference C.14, as an interim tool for analysis of potential sleep disturbance. This interim curve shows that for an indoor SEL of 65 dB, approximately 15 percent or less of those exposed should be awakened.

C.3.6 Noise Effects on Domestic Animals and Wildlife

Animal species differ greatly in their responses to noise. Each species has adapted, physically and behaviorally, to fill its ecological role in nature, and its hearing ability usually reflects that role. Animals rely on their hearing to avoid predators, obtain food, and communicate with and attract other members of their species. Aircraft noise may mask or interfere with these functions. Secondary effects may include nonauditory effects similar to those exhibited by humans - stress, hypertension, and other nervous disorders. Tertiary effects may include interference with mating and resultant population declines.

Many scientific studies are available regarding the effects of noise on wildlife and some anecdotal reports of wildlife “flight due to noise.” Few of these studies or reports include any reliable measures of the actual noise levels involved.

In the absence of definitive data on the effect of noise on animals, the Committee on Hearing, Bioacoustics, and Biomechanics proposed that protective noise criteria for animals be taken to be the same as for humans (Reference C.16).

C.3.7 Effects of Noise-Induced Vibration on Structures and Humans

The sound from an aircraft overflight travels from the exterior to the interior of the house in one of two ways: through the solid structural elements and directly through the air. The sound transmission starts with noise impinging on the wall exterior. Some of this sound energy will be reflected away and some will make the wall vibrate. The vibrating wall radiates sound into the airspace, which in turn sets the interior finish surface vibrating, with some of the energy lost in the airspace. This surface then radiates sound into the dwelling interior. Vibrational energy also bypasses the air cavity by traveling through the studs and edge connections.

Normally, the most sensitive components of a structure to airborne noise are the windows and, infrequently, the plastered walls and ceilings. An evaluation of the peak sound pressure impinging on the structure is normally sufficient to determine the possibility of damage. In general, at sound levels above 130 dB, there is the possibility of structural damage. While certain frequencies (such as 30 Hz for window breakage) may be of more concern than other frequencies, conservatively, only sounds lasting more than 1 second above a sound level of 130 dB are potentially damaging to structural components (Reference C.17).

In terms of average acceleration of wall or ceiling vibration, the thresholds for structural damage (C.18) are:

- 0.5 meters/sec/sec—threshold of risk of damage to sensitive structures (e.g., ancient monuments); and
- meters/sec/sec—threshold of risk of damage to normal dwellings (e.g., houses with plaster ceilings and walls).

Noise-induced structural vibration may also cause annoyance to dwelling occupants because of induced secondary vibrations, or "rattle," of objects within the dwelling - hanging pictures, dishes, plaques, and bric-a-brac. Loose window panes may also vibrate noticeably when exposed to high levels of aircraft noise, causing homeowners to fear breakage. In general, such noise-induced vibrations occur at sound levels above those considered normally compatible with residential land use. Thus, assessments of noise exposure levels for compatible land use should also be protective of noise-induced secondary vibrations.

In the assessment of vibrations on humans, the following factors determine if a person will perceive and possibly react to building vibrations:

- Type of excitation: steady state, intermittent, or impulsive vibration;
- Frequency of the excitation. ISO 2631-2 (Reference C.18) recommends a frequency range of 1 to 80 Hz for the assessment of vibration on humans;
- Orientation of the body with respect to the vibration;
- The use of the occupied space; and
- Time of day.

C.3.8 Noise Effects on Terrain

It has been suggested that noise levels associated with low-flying aircraft may affect the terrain under the flight path by disturbing fragile soil or snow structures, especially in mountainous areas, causing landslides or avalanches. There are no known instances of such effects, and it is considered improbable that such effects will result from routine, subsonic aircraft operations.

C.3.9 Noise Effects on Historical and Archaeological Sites

Because of the potential for increased fragility of structural components of historical buildings and other historical sites, aircraft noise may affect such sites more severely than newer, modern structures. Again, there are few scientific studies of such effects to provide guidance for their assessment.

One study involved the measurements of sound levels and structural vibration levels in a superbly restored plantation house, originally built in 1795, and now situated approximately 1,500 feet from the centerline at the departure end of Runway 19L at Washington Dulles International Airport. These measurements were made in connection with the proposed

scheduled operation of the supersonic Concorde airplane at Dulles (Reference C.19). There was a special concern for the building's windows, since roughly half of the 324 panes were original. No instances of structural damage were found. Interestingly, despite the high levels of noise during Concorde takeoffs, the induced structural vibration levels were actually less than those induced by touring groups and vacuum cleaning.

As noted above for the noise effects of noise-induced vibrations of normal structures, assessments of noise exposure levels for normally compatible land uses should also be protective of historic and archaeological sites.

C.4 Noise Level Reduction Guidelines

A study that provides in-depth, state-of-the-art noise level reduction guidelines was prepared for the Naval Facilities Engineering Command (NAVFAC) in April 2005. The title of the document is *Guidelines for the Sound Insulation of Residences Exposed to Aircraft Operations* (C.20). A copy of this document can be obtained from NAVFAC Southern Division, Charleston, SC.

C.5 References

C.1. "Sound Level Descriptors for Determination of Compatible Land Use," American National Standards Institute Standard ANSI S3.23-1980.

C.2. "Quantities and Procedures for Description and Measurement of Environmental Sound, Part 1," American National Standards Institute Standard ANSI S12.9-1988.

C.3. "Information on Levels of Environmental Noise Requisite to Protect the Public Health and Welfare With an Adequate Margin of Safety," U.S. Environmental Protection Agency Report 550/9-74-004, March 1972.

C.4. "Guidelines for Considering Noise in Land-Use Planning and Control," Federal Interagency Committee on Urban Noise, June 1980.

C.5. "Federal Agency Review of Selected Airport Noise Analysis Issues," Federal Interagency Committee on Noise, August 1992.

C.6. Schultz, T.J. "Synthesis of Social Surveys on Noise Annoyance," J. Acoust. Soc. Am., 64, 377-405, August 1978.

C.7. Fidell, S., Barger, D.S., and Schultz, T.J., "Updating a Dosage-Effect Relationship for the Prevalence of Annoyance Due to General Transportation Noise," J. Acoust. Soc. Am., 89, 221-233, January 1991.

C.8. "Community Reactions to Helicopter Noise: Results from an Experimental Study," J. Acoust. Soc. Am., 82,479-492, August 1987.

C.9. Von Gierke, H.R., "The Noise-Induced Hearing Loss Problem," NIH Consensus Development Conference on Noise and Hearing Loss, Washington D.C., 22-24 January 1990.

C.10. Meacham, W.C., and Shaw, N., "Effects of Jet Noise on Mortality Rates," British J. Audiology, 77-80, August 1979.

C.11. Frericks, R.R., *et al*., "Los Angeles Airport Noise and Mortality: Faulty Analysis and Public Policy," Am J. Public Health, 357-362, April 1980.

C.12. Jones, F.N., and Tauschr, J., "Residence Under an Airport Landing Pattern as a Factor in Teratism," Archives of Environmental Health, 10-12 Jan/Feb 1978.

C.13. Edmonds, L.D., *et al*., "Airport Noise and Teratogenesis," Archives of Environmental Health, 243-247, July/August 1979.

C.14. Pearsons, K.S., Barber, D.S. and Tabachick, B.G., "Analyses of the Predictability of Noise-Induced Sleep Disturbance," USAF Report HSD-TR-89-029, October 1989.

C.15. Kryter, K.D., "Physiological, Psychological, and Social Effects of Noise," NASA Reference Publication 1115, 446, July 1984.

C.16. "Guidelines for Preparing Environmental Impact Statements on Noise," Committee on Hearing, Bioacoustics and Biomechanics, The National Research Council, National Academy of Sciences, 1977.

C.17. Von Gierke, H.E., and Ward, W.D., "Criteria for Noise and Vibration Exposure," Handbook of Acoustical Measurements and Noise Control, Third Edition, 1991.

C.18. "Evaluation of Human Exposure to Whole-Body Vibration - Part 2: Continuous and Shock-Induced Vibration in Buildings (1 to 80 Hz)", International Organization for Standardization, Standards 2631-2, February 1989.

C.19. Wesler, J.E., "Concorde Operations at Dulles International Airport," NOISEEXPO '77, Chicago, IL, March 1977.

C.20. *Guidelines for the Sound Insulation of Residences Exposed to Aircraft Operations*, Department of the Navy, Naval Facilities Engineering Command, Washington Navy Yard, 1322 Patterson Avenue, S.W., Suite 1000, Washington, DC 20374-5065.

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