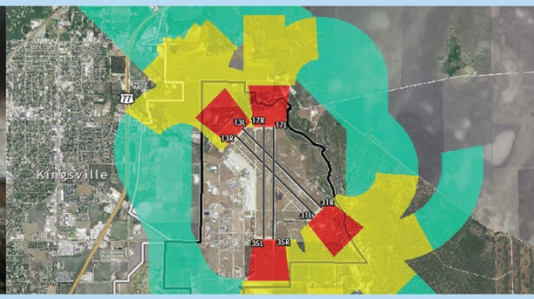

History and Development of Accident Potential Zones

NAVFAC
Naval Facilities Engineering Command

Table of Contents

1 INTRODUCTION

This report focuses on the Accident Potential Zone (APZ) component of the Department of Defense (DOD) Air Installations Compatible Use Zones (AICUZ) Program, specifically the Navy's, and provides background on the history, development, and implementation of APZs (Clear Zone, APZ I, and APZ II). It also discusses the different types of APZs, differences in APZ across the military services, and the impact on APZs of historical changes and updates to Navy guidance and instructions. Lastly, the report includes a summary of case studies of recent major aircraft mishaps.

2 APZs AND THE AICUZ PROGRAM

In the early 1970s, the DOD established the AICUZ Program in response to growing incompatible urban development around military airfields. The goal of this program is to protect the health and safety of the public while also protecting military operational capabilities. Increased development near an airfield will likely result in more people being exposed to noise and accident potential. The AICUZ Program provides a means for the DOD to define impact areas on the communities by mapping aircraft noise and accident potential areas, ultimately allowing identification and analysis of land use compatibility.

The AICUZ Program provides a means for the DOD to define impact areas on the communities by mapping aircraft noise and accident potential areas, ultimately allowing identification and analysis of land use compatibility.

The Navy-specific guidance provided for APZs is outlined in OPNAVINST 11010.36 (see Section 3 for additional details). Navy APZs extend from the end of the runway and apply to the predominant arrival, departure and pattern flight tracks. APZs are generally determined based on the number of operations conducted at the air station—more specifically, the number of operations conducted for specific flight tracks. Section 4.4 describes the three types of APZs in detail.

Through years of accident data analysis and related studies, the APZ concept has evolved. Today, the AICUZ footprints (that contain the APZs) are incorporated into community land use plans around the country and are a vital tool used by the Navy to coordinate and communicate with neighboring communities, government entities, stakeholders and individuals regarding compatible land use and development concerns in APZs.

2.1 Compatible Land Uses

DOD policy is to work toward promoting compatible land use development near air stations and to encourage local governments to incorporate the AICUZ study recommendations into their local land use planning and control process. AICUZ studies use the Standard Land Use Coding Manual (SLUCM), which is a standard descriptor of land uses and the federally-accepted resource for AICUZ study evaluations. The SLUCM standards group similar types of land uses based on function. They provide DOD and local planners with information describing specific land use categories, which can be examined in conjunction with the DOD guidelines to provide the basis for land use compatibility within APZs. In the Clear Zone, most uses are incompatible with Navy aircraft operations. For this reason, the Navy's policy, where possible, is to acquire real property interests in land within the Clear Zone to ensure incompatible development does not occur. Within APZ I and APZ II, a variety of land uses are compatible; however, people intensive uses (e.g., schools, apartments, and churches) should be restricted because of the greater safety risk in these areas. The SLUCM standards are valuable in categorizing land uses surrounding air installations; however, that they do not take population densities for land uses into account, which is often more relevant to determining compatibility related to APZs.

3 MILITARY GUIDANCE AND INSTRUCTIONS RELATED TO APZs

DOD Instruction (DODI) 4165.57, originally released in 1975, updated in November 1977, and most recently in 2011, directs the AICUZ Program. These instructions set forth the DOD's policy on achieving compatibility between private lands and military airfields; securing safety of flight and public welfare through height and land use restrictions near installations and in areas susceptible to aircraft accidents; defining AICUZ procedures; and acquiring interest in real property to protect the operational capability of active military airfields. DODI 4165.57 provides the overarching policies that establish and require all military departments to develop, implement, and maintain an AICUZ program for air installations. These instructions also provide the guidelines for configuring fixed-wing and rotary-wing (helicopter) APZs.

The Office of the Assistant Secretary of Defense guidelines included only two types of fixed-wing runways for defining APZs with provisions for retaining existing Clear Zones where necessary. Class A runways are restricted to smaller, lighter aircraft and less than 8,000 feet. The DOD categorized all other runways as Class B runways. Both Class A and B runways have the standard 3,000-foot-long Clear Zone. Class A runways have a rectangular shaped 1,000-foot-wide Clear Zone and 1,000-foot-wide by 2,500-foot-long APZ I and APZ II. Class B runways have a 3,000-foot-wide Clear Zone and 3,000-foot-wide APZ I and APZ II, where APZ I is 5,000-feet long and APZ II is 7,000-feet long. Revisions to language in the AICUZ policy emphasized that guidelines cannot provide complete protection against aircraft accidents and use of guidelines do not guarantee safety.

In May 1979, the DON implemented OPNAVINST 11010.36 establishing the Navy/Marine Corps AICUZ Program. The Instructions have been updated in 1988 (36A), 2002 (36B), and 2008(36C).

The Air Force and the Navy subsequently published their own instructions to implement the DODI policies. APZ dimensions for the Navy and Air Force instructions are based on an analysis of combined Air Force, Navy, and Army aircraft accident data provided to the Deputy Assistant Secretary, Office of the Assistant Secretary of Defense, which is known as the "Tri-Service Study" recommendations. This study and its findings are discussed in detail below.

In May 1979, the Department of the Navy (DON) released the Office of Chief of Naval Operations Instructions (OPNAVINST 11010.36) establishing the Navy/Marine Corps AICUZ Program. The Navy updated the Instructions in 1988 (36A), 2002 (36B), and 2008 (36C). Navy instructions also established operational parameters for APZs requiring a minimum of 10,000 operations per runway and 5,000 operations per flight track as the basis for APZs. The Navy's 2002 AICUZ program update (36B) required the Navy to use projected operations (versus current operation data) in the AICUZ Study to support local communities with long-range planning efforts and future growth projections for developing their comprehensive plans and zoning ordinances.

Navy AICUZ Program policies have progressively evolved to reflect new land uses and consider density and floor-area ratio measures in APZs land use compatibility guidelines. Air Force AICUZ Program instructions have evolved to provide guidance for property acquisition in the Clear Zone and inclusion of the Joint Land Use Study in the AICUZ Study analysis.

4 KEY HISTORICAL STUDIES AFFECTING THE HISTORY AND DEVELOPMENT OF APZs

4.1 The Airport and its Neighbors, The Report of the President's Airport Commission (better known as the "Doolittle Report"), May 1952

In the early 1950s, the rapid growth of the aviation industry led to concerns regarding the increase in both military and commercial aircraft accidents. As airport facilities grew, communities near airports grew. A series of tragic mishaps in the New York/Northeastern New Jersey area promoted the desire to conduct further federal investigation into flight safety.

To address these growing concerns, President Truman established the President's Airport Commission in 1952 to evaluate issues with airport location as well as safety characteristics of aircraft operations. President Truman appointed General James Doolittle (USAF ret.), aviation pioneer and Medal of Honor recipient, as the Chairman of the Commission. The Commission surveyed and assessed information from various civil and military aeronautical and airport management organizations, municipal governments, and civic associations throughout the United States.

The "Doolittle Report" established aircraft accident buffer areas around airports.

The report provides a comprehensive analysis of airport land use and planning considerations, airfield safety, including effective zoning regulations to control land use near airports. The federal government used the Doolittle report as an initial step towards reevaluating national aviation policies to reflect airport growth requirements and formed the foundation for establishing Clear Zones and APZs off runways and implementing guidelines to control land use near airports.

The Doolittle Report recommended designating a "clear zone" at the end of runways, one-half mile long and 1,000 feet wide, which would be clear of obstacles to flights.

4.1.1 Findings and Recommendations

The Doolittle Report evaluated flight and aircraft characteristics. The major findings from the report laid the foundation for the APZ concept and the origins of the Air Force AICUZ Program. Some of these findings include:

- **Incorporate cleared runway extension areas into airports:** Clear obstructions on the dominant runways at new airports at each runway end at least one half mile in length and 1,000 feet wide.
- **Establish effective zoning laws:** Establish a fan-shaped zone beyond the half-mile Clear Zone, at least 2 miles long and 6,000 feet wide at its outer limits at new airports by zoning law, air easement, or land purchase at each end of the dominant runway.
- **Land use compatibility:** Control the height of buildings and the use of land to eliminate the construction of public buildings (e.g., churches, hospitals, and schools) and restrict residences to more distant locations.

4.2 DOD Analysis of Aircraft Accidents

This section summarizes both individual and combined Air Force, Navy, and Army analyses of key aircraft accident data.

4.2.1 Tri-Service Study (April 1974)

One cornerstone study, prepared in 1974, is a compilation of individual service mishap data from Air Force, Army, and Navy/Marine Corps. The format of the study is a memorandum provided to the Deputy Assistant Secretary, Office of the Assistant Secretary of Defense and is known as the "Tri-Service Study."

The Tri-Service Study resulted in the definition of separate APZs - Clear Zone, APZ I, and APZ II-for each class of runway and general guidelines for applying zones to specific situations.

The Tri-Service Study is comprised of two key attachments "Aircraft Crash Analysis for Air Installation Compatible Use Zones" and "Proposed Aircraft Accident Potential Guidelines." The Study documents lessons learned from Navy and Air Force studies and also proposes integrated policy to incorporate across the services' AICUZ programs. The study evaluated 581 major aircraft accidents.

The Tri-Service Study analysis concluded that the majority of aircraft accidents occurred along the extended runway centerline and on/or near the runway area. The Study resulted in the definition of separate APZs (Clear Zone, APZ I, and APZ II) for each class of runway and general guidelines for applying zones to specific situations. The configuration of the Clear Zone varied between services whereas the APZ I and APZ II were the same. The Tri-Service Study also established guidelines for compatible land uses and density of use for each zone to prevent people-intensive uses within APZs. The text box titled "Conclusions of the Tri-Service Study" summarizes other major conclusions from the Tri-Service Study.

Additionally, the Tri-Service Study states that although DOD instructions indicate that the DOD should acquire or purchase land within the "clear zones," ownership of all property within the Clear Zones is not possible. Therefore, the DOD proposed land use guidelines for Clear Zones. The DOD advises that the only acceptable land uses within Clear Zones are agricultural uses and open space and people intensive uses or buildings should not be located within Clear Zones. The DOD deemed APZ I incompatible for land uses that concentrated people in small areas and APZ II incompatible with high-density functions, such as churches, assembly places, theaters, and multi-family residential facilities.

Conclusions of the Tri-Service Study

- 65 percent of accidents occurred within 5 miles of extended runway centerline (Navy);
- 75 percent of accidents occurred within 10 miles of runway centerline (Air Force);
- 97 percent of accidents occurred within one mile (Army);
- Fighter and training aircraft account for over 59 percent of total aircraft accidents;
- 25 percent of all accidents occur on or near a runway;
- Over 94 percent of accidents occurring between thresholds and off-runway surface were within 1,000 feet of the runway centerline and 1.9 percent were between 1,000 and 4,500 feet;
- More accidents occurred during approaches versus departures. The Air Force and Navy both experienced twice as many accidents during landing;
- The number of accidents was insignificant beyond 15,000 feet from the runway centerline;
- The type of aircraft determines the impact area over which debris scatters. Heavier aircraft had a larger area than lighter smaller aircraft. The average impact area was 5.06 acres; and
- Accident plots varied for different classes of aircraft; therefore, the size and configuration of APZs should be different for each class of aircraft.

4.2.2 Other Key Accident Studies

4.2.2.1 Air Force Accident Studies

Since its initial studies in the early 1960s through the time of the Tri-Service Study in 1974 and up through the 1990s, the Air Force has evaluated critical aircraft accident data to test and validate APZ dimensions through a series of studies and analyses. The following is a summary of key studies:

1960-1964, Summary of USAF Aircraft Accidents in Vicinity of Airfields – 5-Mile Zone

This accident study examined the number of major Air Force aircraft accidents occurring during the five-year period from 1960 through 1964. The assessment charted the distance and direction from the airfield where the accident occurred. The study concluded that aircraft accidents in the vicinity of the airfields will occur predominately in approach and take-off zones along the extended centerlines of runways. The study states that the area up to 2.5 miles from the airfield is the most critical area for aircraft accidents to occur.

1972, USAF Study Evaluating Zones for Specific Training Aircraft Types

The Air Force began to address accident potential in late 1972 by defining zones for specific training aircraft (T-37s and T-38s) in correspondence with overflight altitudes. Delineation of three zones includes; Zone 1 - the area less than 200 feet above ground level (AGL); Zone 2 - the area between 200 and 500 AGL; and Zone 3 – the area between 500 and 1,000 feet AGL. The Air Force plotted the locations of training aircraft

accidents occurring between 1968 and 1972 within 10 nautical miles of the airfields. The study found that 90 percent of the total number of accidents occurred adjacent to the airfield and within the three delineated zones.

1973, USAF Service-wide Accident Hazard Study

In 1973, the Air Force conducted a service-wide accident hazard study based on historic accident data for four aircraft classes (i.e., fighters, trainers, tanker/transport, and bombers) to identify specific areas near an airfield with significant aircraft accident potential. The study evaluated 369 major in-flight aircraft accidents occurring between 1968 and 1972 within 10 nautical miles of airfields.

1973 Air Force Accident Study Findings

- Accident potential increased significantly near the extended runway centerline (Clear Zone);
- 75 percent of accidents plotted occurred near the extended runway centerline;
- 22.8 percent occurred on or near the runway, within a 2,000-foot-wide area from threshold to threshold;
- 61 percent of the total accidents occurred during landing and 29 percent occurred during takeoff;
- Fighter and training aircraft accounted for more than 80 percent of all major accidents;
- Approximately 70 percent of accidents occurred during daylight hours; and
- 75 percent of the total accidents had a definable debris impact area, which varied in size for different types of aircraft and different phases of flight.

The study identified patterns of accident occurrence and revealed that the majority of accidents occurred on or near the runway within a 3,000-foot-wide corridor extending from the runway threshold along the centerline for 15,000 feet. Based on the analysis of historic data, three APZs were defined extending 3,000 feet (Clear Zone), 8,000 feet (APZ I), and 15,000 feet (APZ II) outward from the runway threshold. Approximately 62 percent of the accidents occurred on or adjacent to the airfield or within the Clear Zone, 8 percent occurred in APZ I, and 5 percent in APZ II. Because the Clear Zone was an extreme high accident potential area, the Air Force study proposed policies to acquire property rights for land within the Clear Zones. Based on the lower percent of accidents within the APZ I and APZ II, the DOD deemed that purchase of property was not essential; however, land use and planning guidelines would help limit people intensive uses within these areas. The Air Force based their land use recommendations on the *risk* of injury and damage and not on the *probability* of an accident occurring.

The Air Force 1999 analysis still concluded that the highest probability of accidents occur within the areas immediately off the runway and near the airfield. Thus, the study's findings reflected the same patterns of accident occurrences and supported the use of the existing Clear Zones and APZs.

1999 to 2000, Clear Zone Criteria Study

In 1999, Air Force Air Mobility Command Headquarters (HQ AMC) requested that the Air Force consider reducing the overall dimensions of their Clear Zones for Class B runways to equal the size of the Federal Aviation Administration's (FAA's) largest Runway Protection Zone (RPZ) designated for large aircraft. This action would reduce the area of the Air Force Clear Zones by 62percent (see Figure 4-1 for comparison of Air Force Clear Zones and FAA RPZ). The HQ AMC's proposed change responded to Air Force policies that restricted the use of existing facilities located in Clear Zones and the

cost of acquiring Clear Zone property as mandated under the 1994 Air Force's AICUZ instruction AFI 32-7063. Additionally, Air Force land use criteria were more restrictive than the FAA's criteria. HQ AMC also noted that Air Force safety increased since the 1973 accident hazard study, and felt adoption of the FAA's RPZ would not compromise safety.

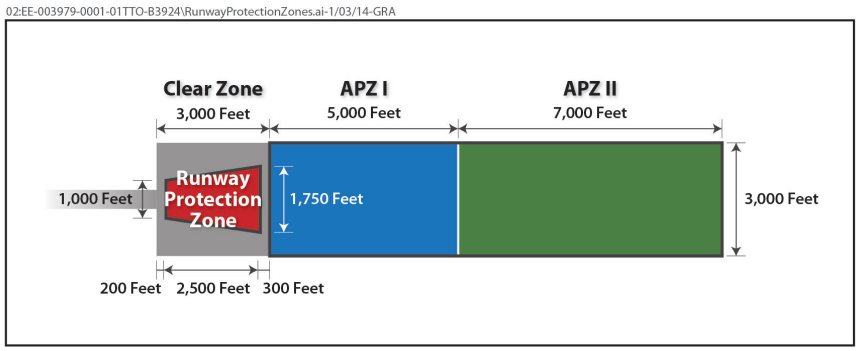

Figure 4-1: FAA Runway Protection Zone and the Air Force Clear Zones
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As a component of this study, the Air Force analyzed accident data from 1984 to 1998. The methodology of the analysis is parallel to the methodology used in the 1973 Air Force accident study. Conclusions from the new study found that 20 percent of the accidents occurred within the Clear Zones, 8 percent within APZ II, and 3 percent within APZ I. Additionally, the cumulative percentages of accidents showed significant changes occurring at breakpoints of 3,000 feet, 5,000 feet, and 8,000 feet from the runway threshold. The Air Force determined minimal difference in total accident percentage for varying widths (2,000-foot, 3,000-foot, and 4,000-foot widths) along the runway centerline. Although the number of accidents has decreased since the 1973 accident hazard study, the Air Force's 1999 analysis still concluded that the highest probability of accidents occur within the areas immediately off of the runway and near the airfield. Thus, the study's findings reflected the same patterns of accident occurrences and supported the use of the existing Clear Zones and APZs.

As part of the 1999 study, the Air Force evaluated the implications of changing Clear Zone dimensions as applied to airfield criteria, mission requirements, changes in the APZs, and impacts to the DOD AICUZ Program objectives. Changing Clear Zone dimensions would also have significant implications on land use guidelines established under the AICUZ Program. Adopting the FAA RPZs would require the Air Force to move the APZs boundaries 500 feet to align with the new RPZ. Consequently, the 500-foot area would no longer be subject compatible land use guidelines. In addition, while reducing the size of the Clear Zone would allow land uses activities closer to the runways without violating airfield criteria, these areas may still be subject to land use restrictions based on noise exposure levels. Based on the 1999 Study, the Air Force decided that reducing the Clear Zone did not support the overall AICUZ program goals.

As part of a 1999 aircraft accident study, the Air Force evaluated the implications of changing Clear Zone dimensions as applicable to airfield criteria, mission requirements, changes in the APZs, and impacts to the AICUZ Program objectives.

The Study concluded that the Air Force and the FAA should have different airfield criteria since Air Force operations and mission requirements significantly differ from civil airport operations.

Differences in Air Force and civil aircraft operations are attributed to the following:

- Civil airports primarily conduct single operations, while military conduct flight training and emergency landing practices;
- The Air Force trains student pilots with high performance fighter aircraft and larger aircraft;
- Air Force carry munitions and jettisonable fuel tanks;
- Air Force perform formation takeoffs; and,
- Military aircraft have greater debris impact area than civil aircraft.

4.2.2.2 Navy Accident Studies

From 1973 to 1974, the Navy conducted a similar aircraft accident study as the USAF study conducted in 1973 for utility, tactical, and training aircraft and helicopters. The Navy's study evaluated 318 major in-flight aircraft accidents occurring between 1968 and 1972 within a 5-nautical mile radius of runways. The Navy's analysis determined that the highest accident potential occurred within the area 750 feet laterally from the runway centerline and 3,000 feet from the runway end within the standard approach fan. The analysis also revealed that there are several different operational and training characteristics between the Navy and Air Force. This is in part due to the Navy pilot training for carriers and their Field Carrier Landing Practice (FCLP) pattern around airfields.

4.3 APZ Development Timeline

The concept of the APZ has not been a static one but rather dynamic and evolving over the last 40 to 50 years. Since the release of the Doolittle Report in the early 1950s, both the Air Force and Navy have analyzed a substantial amount of aircraft accident data to better understand and test APZ configuration as it relates to historic aircraft accidents. The following represents some of the key milestones in the historical evolution of the major issues related to the history and development of APZs. The APZ development timelines illustrated in Figure 4-2 includes several of the following highlights:

- **1952** – The Doolittle Commission: "The Airport and Its Neighbors" introduces the concept of Clear Zones at the end of the runways, and provides recommendations for zoning regulations to control land use near airport facilities. The report defined cleared runway extensions (Clear Zones) as one-half mile long and 1,000 feet wide, which are to be considered as part of the airport. Beyond the cleared extension area, a fan-shaped buffer area following the approach-departure zones 2.5 miles from the runway threshold should be the basis for establishing zoning regulations.

- **1965 and 1968** – Air Force completes Summary of Aircraft Accidents reports. These reports are an analysis of major aircraft accidents within 5 nautical miles of airfields to determine the distance from runways where accidents primarily occur.

- **1971** – The Air Force examines the Greenbelt Concept to address encroachment around airfield by establish buffer zones around installations through the purchase of property. Due to budgetary considerations, the Air Force deems the Greenbelt Concept economically infeasible.

- **1973** – The DOD initiates the AICUZ Program. AICUZ Program creates the concepts of APZs to promote compatible land use for the protection of people under aircraft flight paths.

- **1974** – A comprehensive analysis of aircraft accident data for the Air Force, Army, and Navy (the Tri-Service Study) is compiled. APZs are defined as areas where an aircraft accident is most likely to occur if an accident were to take place. Based on the findings, the DOD identifies dimensions for Clear Zones, APZ I, and APZ II for three runway classes (Accident Potential Class A, B, or C).

- **1975** – DOD revises AICUZ guidelines to include only two types of runways (Class A and B) for the configuration of APZs.

- **1975** – The General Services Administration issues a Federal Management Circular No. FMC 72-2 requiring federal airfield operating agencies, including the DOD, to develop land use plans to analyze land use compatibility concerns and propose solutions to support property acquisition and disposal. In turn, the DOD requires military services to prepare a report for each installation describing accident potential and noise areas and the value of property located within the installation's APZs and noise zones, as well as, their recommendations for relocating operations, acquiring land, or the possibilities of relying on local zoning.

- **1977** – DOD publishes Instruction DODI 4165.57 as the official policy to guide the AICUZ program for all military services. The DODI provided guidelines for configuring and modifying APZs and required that all active military runways have a Clear Zone. The DODI also defined the acquisition policy for property within the Clear Zones.

- **1979** – DOD Chief of Naval Operations publishes AICUZ Instruction 11010.36, which established the Navy's guidelines for APZs following DODI policy. The Navy's specific CZ/APZ policy set forth that due to the characteristics of flight operations at Navy and Marine Corps installations, the trapezoidal or "fan-shaped" Clear Zone shall be used. The policy also established a 5,000 annual operations threshold for development of APZ I and allowed for modifications of standard APZ geometry to follow the curve of the flight path.

- **1981** – NAVFAC P-80.3 planning criteria for shore installations airfield safety clearances established.

- **1988** – Chief of Naval Operations publishes AICUZ Instruction Update – 11010.36A.

- **2002** – Chief of Naval Operations publishes AICUZ Instruction Update – 11010.36B.

- **2008** – Chief of Naval Operations publishes AICUZ Instruction Update – 11010.36C.

- **Present day** – Using the AICUZ Program as a primary tool, the military continues to evaluate aircraft operations data, accident data and studies, and overall aircraft safety issues in support of mission sustainment and the protection of health, safety, and welfare of the public.

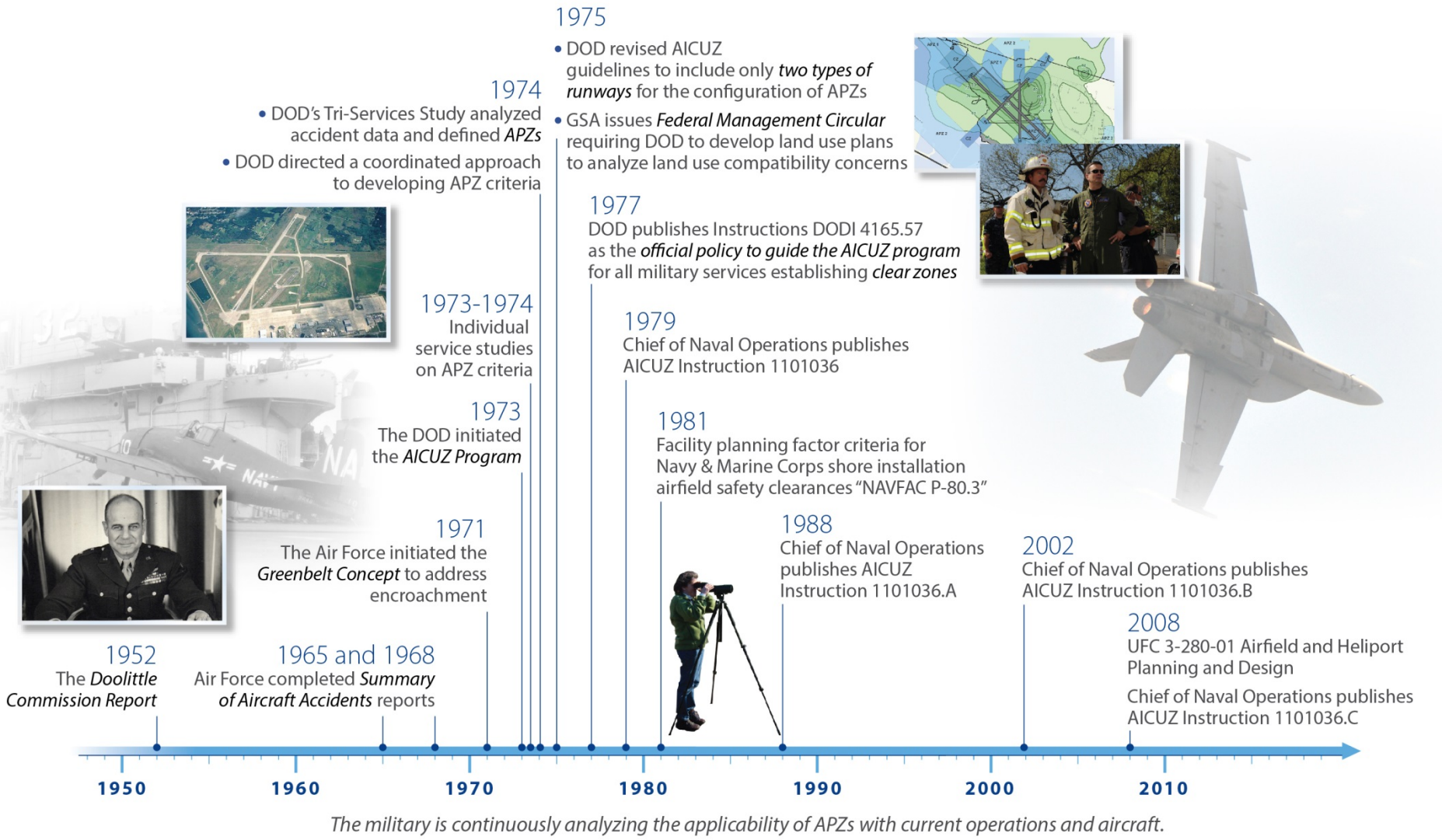

Figure 4-2: APZ History and Development Timeline

4.4 Methodology for APZ Development

Historic accident data is the basis for the location and geometry of APZs in relation to runways. By identifying patterns of accident occurrences, the DOD determined the geometric characteristic to develop effective APZs. Key accident data used in the assessment of APZs included: location of accidents, the class of aircraft, and the phase of flight during which the accident occurred. Accident information was plotted using an x,y coordinate system to determine the cumulative frequency of accidents as a function of the distance from the runway threshold along the runway centerline for all aircraft classes. The DOD noted significant changes in the slope of the cumulative distribution curve at distances of 3,000 feet, 8,000 feet, and 15,000 feet from the runway threshold (see Figure 4-3). These break points correspond with APZ dimensions proposed in the 1974 Tri-Service Study and are the basis for the establishment of the optimal length of APZs for Class B runways.

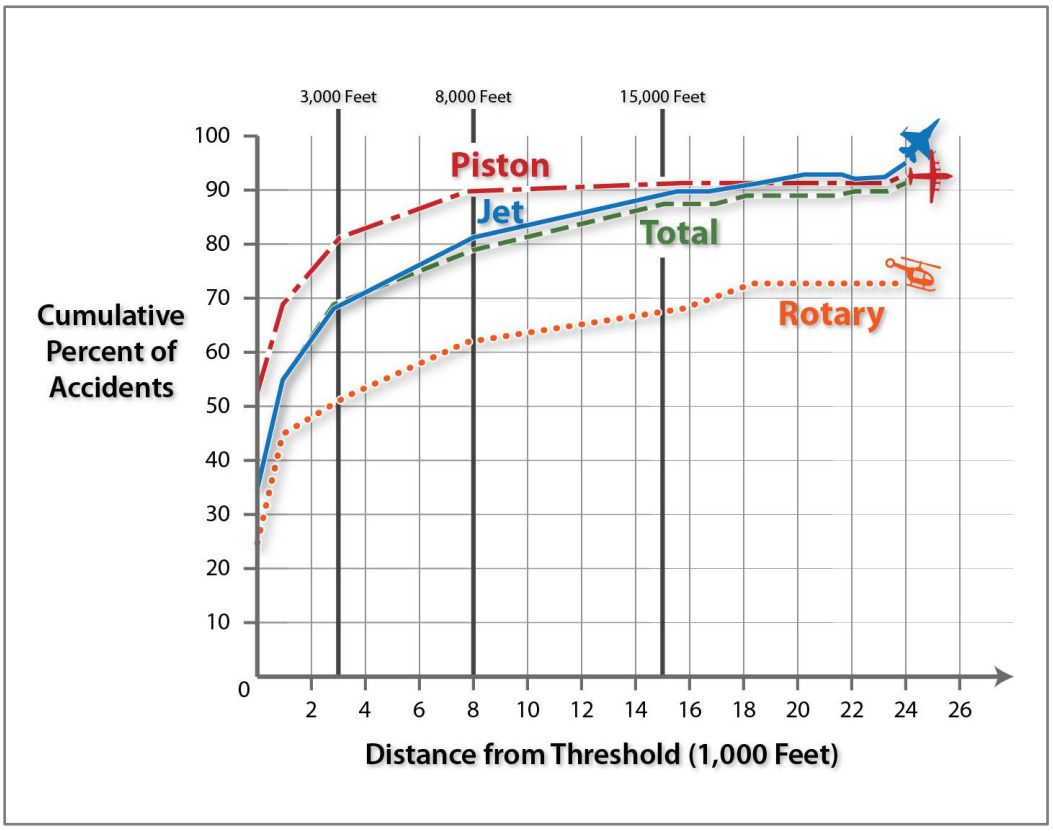

Figure 4-3: Cumulative Distribution Curve

DOD also examined the historic accident data for patterns of accident occurrence related to area. Accident information was analyzed to identify the smallest area with the maximum percent of accidents (i.e., highest concentration of incidents) for establishment of optimal widths for APZs; 1,000 foot wide APZs for Class A and 3,000 foot wide APZs for Class B runways.

4.5 Different Types of APZs (fixed-wing/rotary-wing)

4.5.1 Fixed-Wing Aircraft APZs

Today, the DOD uses two classes of fixed-wing runways (Class A and Class B) to define APZs. Class A runways are used primarily by light aircraft and do not have the potential for intensive use by heavy or high-performance aircraft. Class B runways are all other fixed-wing runways. There are three different types of APZs: the Clear Zone, APZ I, and APZ II. APZ configurations differ among services. General descriptions of the Clear Zone, APZ I, and APZ II for fixed-wing aircraft are provided below. Figures 4-4 and 4-5 illustrate Class A and B APZs for fixed-wing aircraft.

- **Clear Zone.** The Clear Zone extends outward along the extended runway centerline for a distance of 3,000 feet. The width dimensions of a Class A runway Clear Zone are uniform and measure 1,000 feet from the end of the runway and to its outer edges. Class B runway Clear Zone widths dimensions vary between services. Clear Zones should remain undeveloped. A Clear Zone may be acquired by the government in fee, or by restrictive use easements, to keep it clear of obstructions to flight and underlying incompatible land uses. All active runways require a Clear Zone, which should remain undeveloped.

- **APZ I.** APZ I is the area beyond the Clear Zone. For Class A Runways, APZ I is typically 1,000 feet in width and 2,500 feet in length and may be rectangular or curved to conform to the shape of the predominant flight track. For Class B Runways, APZ I is typically 3,000 feet in width and 5,000 feet in length and may also be rectangular or curved to conform to the shape of the predominant flight track.

- **APZ II.** APZ II is the area beyond APZ I. For Class A Runways, APZ II is typically 1,000 feet in width and 2,500 feet in length and may be rectangular or curved to conform to the shape of the predominant flight track. For Class B Runways, APZ II is typically 3,000 feet in width and 7,000 feet in length and may be rectangular or curved to conform to the shape of the predominant flight track.

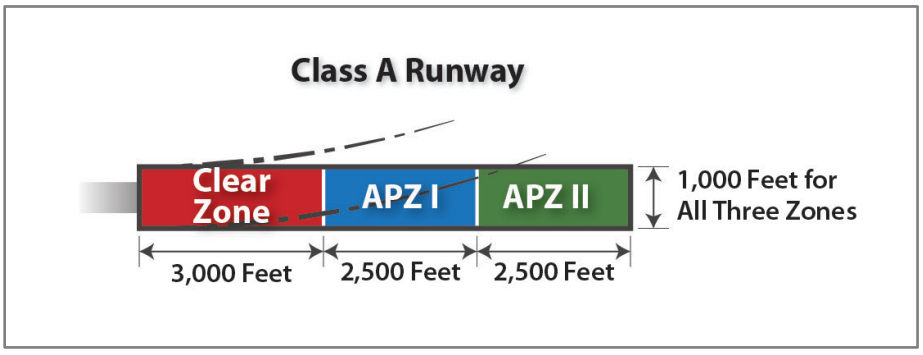

Figure 4-4: Standard Class A Runway Accident Potential Zones for Fixed-Wing Aircraft (Navy and Air Force)
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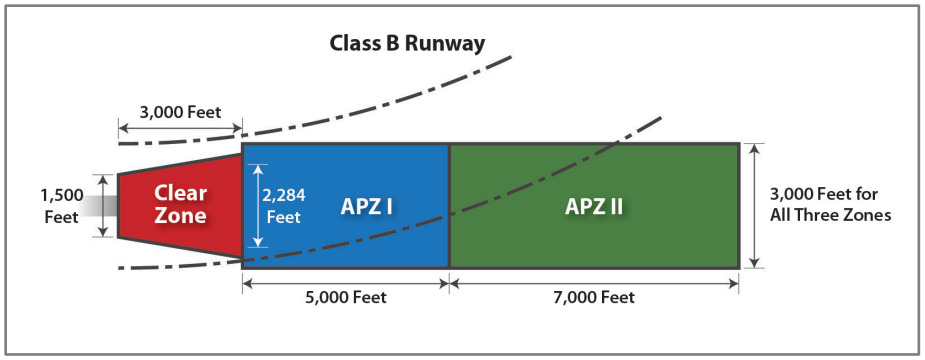

Figure 4-5: Standard Class B Runway Accident Potential Zones for Fixed-Wing Aircraft (Navy only)
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4.5.2 Rotary-Wing Aircraft APZs

Rotary-wing aircraft APZs are smaller than fixed-wing aircraft APZs, and are located under the rotary-wing approach-departure surface. Clear Zones and APZs are applied to rotary-wing runways, helipads, landing lanes, and hover points. Clear Zones are applied to all Visual Flight Rules (VFR) landing pads/runways for rotary wing aircraft. Air installations that support daily rotary-wing training and operational missions have an APZ I. Per Navy policy, helipads that support administrative functions and hospitals typically generate a low volume of operations and do not require APZ I or APZ II. Figure 4-6 illustrates APZs for rotary-wing aircraft.

- **Clear Zone.** VFR rotary wing landing pads/runways use the Clear Zone as the takeoff safety zone. The takeoff safety zone is that area under the VFR approach/ departure surface until that surface is 50 feet above the established landing area elevation.

- **APZ I.** APZ I is the area beyond the Clear Zone for the remainder of the approach/departure zone, defined as the area under the VFR approach/departure surface until that surface is 150 feet above the established landing area elevation.

- **APZ II.** Helicopter flight paths do not apply an APZ II unless the local accident history indicates the need for additional protection.

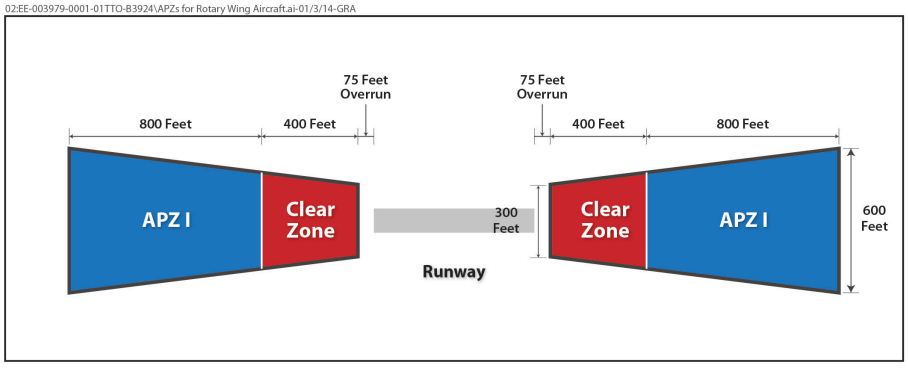

Figure 4-6: Standard Accident Potential Zones for Rotary-Wing Aircraft
Figure is not to scale

4.6 Differences in APZs by Service

Navy airfield Class B runway Clear Zones are a trapezoidal area that measures 1,500 feet in width at the runway threshold and 2,284 feet in width at the outer edge and follow the established approach and departure surface and width of the primary surface for existing runways and new runway construction.

APZs between military services differ primarily based on size, configuration, and operational parameters. The Navy, Army, and Air Force Clear Zones differ in size and/or shape for Class B runways.

Both Army and Air Force Class B runway Clear Zones are rectangular. Army airfield Clear Zones are 1,000 feet wide, and Air Force airfield runway Clear Zones are 3,000 feet wide. Navy airfield Class B runways Clear Zones are a trapezoidal area that measures 1,500 feet in width at the runway threshold and 2,284 feet in width at the outer edge. Navy and Air Force airfield Class B runway APZ I and APZ II widths are 3,000 feet. The width of Army airfield Class B runway APZ I and APZ II is 1,000 feet. APZs for all three services share the same length: APZ I is 5,000 feet and APZ II is 7,000 feet.

Flight tracks may depart the runway centerline before the end of the Clear Zone. In addition to the graphic depiction of curved APZs in Figures 4-4 and 4-5, APZs for Class A or Class B runways can also split or merge to follow major flight paths (see Figures 4-7 and 4-8). Navy APZs curve to follow flight tracks and apply to the predominant arrival and departure flight tracks used by the aircraft (flight tracks experiencing 5,000 or more annual fixed wing operations receive an APZ). Therefore, if an airfield has more than one predominant flight track to or from the runway, APZs can extend in the direction of each flight track. Air Force APZs only curve when the majority of runway operations (80 percent of operations) follow a single track. The geometry of Air Force APZs is not subject to site-specific modification.

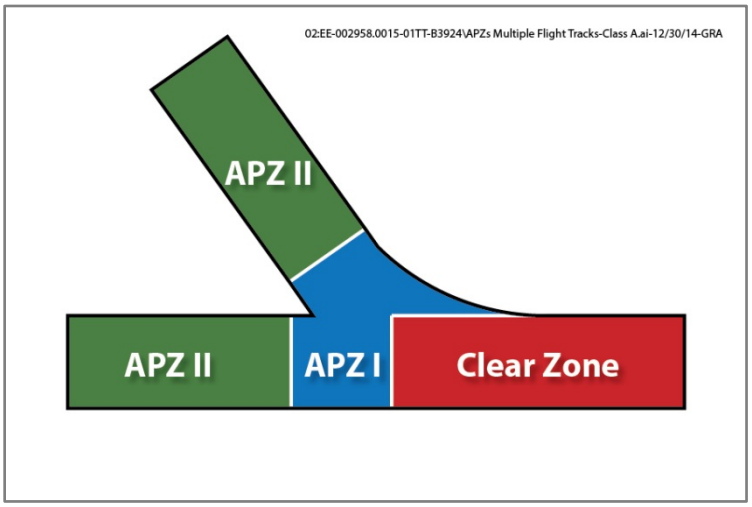

Figure 4-7: Class A Runway: Example of Split or Merged APZs and Curved APZs (Navy)
Figure is not to scale

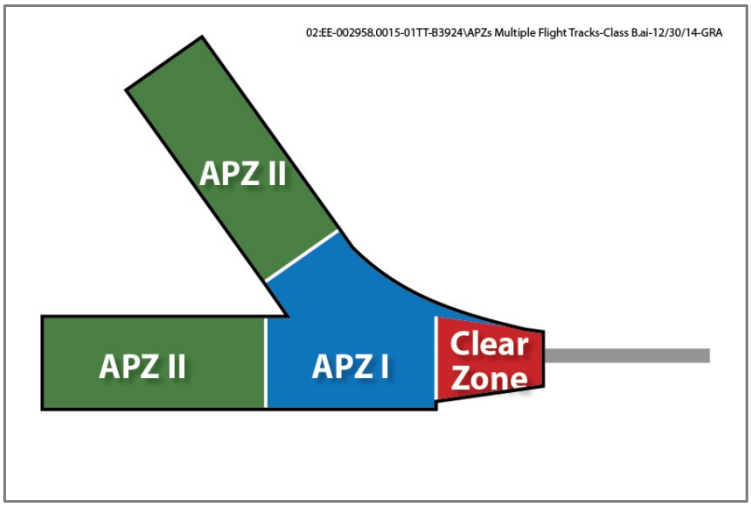

Figure 4-8: Class B Runway: Example of Split or Merged APZs and Curved APZs (Navy)
Figure is not to scale

All Air Force airfield active runways have APZs regardless of operations conducted on the runway. Navy airfield APZs are, in part, based on the number of operations conducted at the airfield, more specifically, the type or number of operations conducted on specific flight tracks (a flight track that experience 5,000 or more annual operations [departures or approaches] receives an APZ). When FCLP is an active aspect of aircraft operations at an installation, APZ II extends the entire FCLP track beyond APZ I (see Figure 4-9).

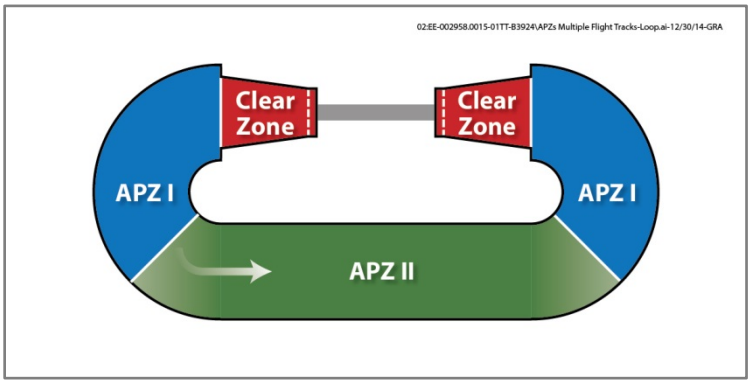

Figure 4-9: Example of APZ II extended for FCLP flight track

5 CASE STUDIES OF RECENT MAJOR AIRCRAFT MISHAPS

5.1 Navy/Marine Corps Mishaps

Virginia Beach, Virginia, April 6, 2012 – FA -18 Crashes into Mayfair Mews, Mishap occurs in APZ II for NAS Oceana

On April 6, 2012, a Navy FA-18D Hornet crashed into the Mayfair Mews apartment complex in Virginia Beach, Virginia, shortly after takeoff from Naval Air Station (NAS) Oceana during a scheduled training exercise. This area is within established APZs for NAS Oceana.

NAS Oceana is the sole East Coast Master Jet Base and home to the east coast strike-fighter squadrons of FA aircraft. The strike-fighter squadrons of the FA-18 C/D Hornets and FA-18 E/F Super Hornets are homebased at NAS Oceana. On April 6, 2012, a Navy FA-18D Hornet crashed into the Mayfair Mews apartment complex in Virginia Beach, Virginia, shortly after takeoff from NAS Oceana during a scheduled training exercise. The accident mishap occurred in APZ II for NAS Oceana. The Manual of the Judge Advocate General (JAGMAN) investigation found that the accident resulted from two significant, unrelated engine malfunctions. The right engine failed due to ingestion of fuel into the right intake and the left engine afterburner failed to light when the pilot selected it after the right engine malfunction.

FA-18 Mishap at NAS Oceana

Post-mishap analysis indicated that failure of an electrical component likely caused the crash. Fortunately, no loss of life resulted.

The Naval Safety Center reported a steady decline in the overall mishap rate for all naval aircraft. The FA-18 Hornet mishap rate has also declined over the years. The safety center's data indicates that the reliability of the engine in use during the accident has been exceptionally good over the life of the FA-18 program.

Although this mishap did not result in loss of life, existing development within APZ II for NAS Ocean, and in the immediate vicinity of this site, includes incompatible development for APZ II associated with apartment buildings and densely developed residential units.

MCAS Miramar, San Diego, California - December 8, 2008, MCAS Miramar, FA-18 Crashes into Residential Neighborhood, Crash occurs outside of Established APZs for MCAS Miramar

On December 8, 2008, a United States Marine Corp FA-18D crashed into a residential neighborhood in University City, a community of San Diego, California. Along with several other aircraft, the pilot conducted day and night carrier qualifications aboard the USS *Abraham Lincoln*, approximately 60 miles offshore of San Diego. Only one pilot boarded the aircraft. After departing the carrier, the pilot reported an oil caution light for the right engine. The pilot then shut down the engine, and after efforts to clear the problem failed, declared an emergency. Air traffic controllers originally directed the pilot to land at the closest divert field, NAS North Island. However, squadron officials soon overruled and directed the pilot to proceed to Marine Corps Air Station (MCAS) Miramar, the plane's home base.

On final approach, the jet lost all electric power and crashed into a residential area located 2 miles from the MCAS Miramar airfield – outside of the APZs for the air station. The pilot ejected safely, however, the plane crashed in a residential area destroying two homes and killing four people, including two children. The investigative report concluded that the accident was preventable and faulted the commander of the squadron, the operations officer, the pilot, and the operations duty officer for the crash.

This mishap occurred at some distance from MCAS Miramar (1.99 miles) and outside of an established APZ, indicating that not all mishaps occur within established APZs. For aircraft safety reasons, it is therefore important to understand development trends and land use patterns and activities that are present and emerging in areas just outside of established APZs and the AICUZ and the safety implications for the surrounding community.

FA-18 Mishap at MCAS Miramar

5.2 Air Force Mishap

Dover AFB, Dover, Delaware – April 3, 2006 – C-5, Mishap occurred short of runway in APZ I

C-5B Mishap at Dover AFB

On April 3, 2006, a C-5B Galaxy crashed at Dover AFB, Delaware, after the cockpit indicated an unlocked thrust reverser. The C-5B assigned to the 436th Airlift Wing and flown by a reserve crew from the 709th Airlift Squadron, 512th Airlift Wing crashed about 2,000 feet (610 meters) short of the runway while attempting a heavyweight emergency landing at Dover Air Force Base, Delaware.

The aircraft took off from Dover 21 minutes earlier and reported an in-flight emergency 10 minutes into the flight. All 17 people aboard survived, but two received serious injuries. The Air Force's accident investigation report concluded the cause to be human error; most notably the crew manipulated the throttle of the number two engine as if it was still running while keeping the number three engine at idle. Upon impact, the aircraft broke apart into three major pieces on a grassy area surrounding the base's fenced perimeter.

The mishap occurred in APZ I with no fatalities. Purchase of this land occurred one year prior to the mishap by the USAF to provide extra space to protect civilians from an incident like this, reinforcing the importance of compatible land use planning within APZs.

6 CONCLUSIONS

The APZ concept is a critical component of the AICUZ Program in protecting the safety and welfare of communities surrounding air installations.

While the overall number of aircraft accidents has decreased since the 1970s, historical studies assessed for the various services indicate that the spatial distribution of accident areas are consistent with the results of more current studies. This indicates that APZs, as they presently exist, are founded on a strong and justifiable methodology and that the findings from the statistical analysis used in the early studies are still relevant today.

With the introduction of new and more advanced weapon systems and the evolving nature of the Navy's testing and training missions, the potential for new safety impacts from aircraft accidents is possible. The Navy should evaluate aircraft accident data on an ongoing basis to assess the configuration and justification of present-day APZs so that they remain a reliable and informative source of data for DOD and local planning agencies to promote safety.

In addition, the land use categories, as defined in the SLUCM, are also an integral component of compatible land use planning. The SLUCM standards provide detailed information describing specific land use categories, which the DOD and local planners can use in conjunction with DOD guidelines to assign compatibility within APZs. The basis for the DOD guidelines is to minimize risk to persons in each APZ. To ensure appropriate land use compatibility standards within APZs, evaluation of DOD guidelines for land uses in relation to the SLUCM codes should occur on a routine basis.

7 BIBLIOGRAPHY

The bibliography below provides a listing of the relevant studies reviewed and used in this analysis. Included is a summary of each study and its relevance to the history and development of APZs.

CH2M Hill. May 1982. *Navy Aircraft Accident Statistics 1968-1981*. Prepared for NAVFACENGCOM.

> This report is an analysis of 13 years of aircraft accidents at naval air stations, including the cumulative percentages of accidents by zone (Clear Zone, APZ-I and APZ-II). The intended purpose of this study was to confirm that accident potential zones (APZ) sizes and shapes were truly inclusive of most accident locations. Results of this Navy analysis reinforced the Tri-service Study criteria used for developing size and shape of zones.

Comptroller General of the United States. May 21, 1976. *Policies and Scope of AICUZ Program.* Report to Committee on Appropriations House of Representatives.

> This is a comprehensive assessment of the AICUZ Program. The report provides background on the AICUZ program and information on the policies for establishing compatible use zones around military air bases and on services' estimates on the cost to acquire land or easement, as necessary, to control lands.

Doolittle, James. May 1952. *The Airport and Its Neighbors, The Report of the President's Airport Commission*.

> This report, commonly referred to as the Doolittle Report, is in response to President Truman's request to evaluate problems with airport locations and safety characteristics of aircraft operations. The Doolittle Report provides a comprehensive analysis of airport land use and planning considerations at the local community level and the national level, acknowledging both their assets and problems. Ultimately, the Doolittle Report laid the foundation for establishing clear zones and accident potential zones off runways and implementing guidelines to control land use near airports.

Navy Safety Center. No date. *Summary of Aircraft Accidents within 5 Miles of USN/USMC Airfields-1964-1968*. Prepared by the Aircraft Analysis Division of the Naval Safety Center at Naval Air Station Norfolk, Virginia.

> This report is a compilation of data from records of aircraft accidents that occurred within a 5-mile radius of a U.S. Navy or Marine Corps airfield. The report's analysis includes the distance and direction from the airfield that accidents occurred, the type of aircraft involved, injuries to civilians, and damage to private property. This report is patterned after the U.S. Air Force aircraft accident studies and holds similar conclusions to the U.S. Air Force Study findings.

Needles, Howard and Tammen & Bergendoff. July 1992. *AICUZ Program Evaluation and Assessment*. Submitted to Naval Facilities Engineering Command by Howard Needles Tammen & Bergendoff in association with Freelich, Leitner, Carlisle & Shorlidge.

> This study is a comprehensive review and assessment of the success of the AICUZ program in achieving land use compatibility near Navy air installations. This study discusses the historical issues that have been raised concerning the justification of APZ boundaries and land use compatibility guidelines, and further evaluates program elements, such as the methodology and application of APZs and their contribution to the overall program effectiveness. The recommendations specific to APZs and compatibility focus on density and land use intensity within APZs. The study also provides additional references to other studies that should be obtained regarding assessments of APZs and accident assessments around airports.
>
> Section V of this study (Legal Review) provides an assessment of various federal legislation related to noise and safety and case studies related to the overall effectiveness of the AICUZ program. The study's conclusions emphasize that participation in the local land use planning process is an effective means to contribute to the AICUZ program's objectives.

United States Air Force. No Date. *Summary of USAF Aircraft Accidents in Vicinity of Airfields, 5 Mile Zone- 1960-1964.* Study NR 21-65. Directorate of Aerospace Safety Deputy the Inspector General.

> This report addresses information obtained from review of U.S. Air Force aircraft accident reports that occurred within a 5-mile radius of an airfield during the period of 1960 through 1964. This report, however, is limited to only those aircraft taking off or attempting to land at an airfield.

United States Air Force. 1973. *Summary of USAF Aircraft Accidents in Vicinity of Airfields - 1968-1972.* Prepared by Headquarters Strategic Air Command in conjunction with Directorate of Aerospace Safety.

> This report is a follow-up to the earlier U.S. Air Force report (*Summary of USAF Aircraft Accidents in Vicinity of Airfields, 5 Mile Zone- 1960-1964)* and provides information obtained from review of all U.S. Air Force aircraft accident reports that occurred within a 10-nautical mile radius of an airfield during 1968-1972.

United States Air Force. March 1974. *Aircraft Crash Analysis for AICUZ.* Prepared in cooperation with the U.S. Army and Navy/Marine Corps.

> This report, commonly referred to as the Tri-Service Study, summarizes the U.S. Air Force, Army, and Navy and Marine Corps' accident potential analyses and provides the historic context and accident data that shaped the development of APZs for each service branch. The analyses considered aircraft type, flight procedures, and accident histories. The analyses were used to support guidelines to establish APZs and to change existing safety criteria for siting facilities on United States Department of Defense (DOD) installations. Ultimately, APZs were applied to three

classes of runways. Runway classes were based on the primary type of aircraft using the runway.

United States Department of Defense. April 10, 1975. Air Installations Compatible Use Zones (AICUZ) and Aircraft Crash Hazards Memorandum. Office of the Assistant Secretary of Defense.

This is a memo from the Office of the Assistant Secretary of Defense, Installation and Housing to Assistant Secretaries of Army, Navy and Air Force regarding AICUZ and Aircraft Crash Hazards. The memo provides basic information on the aircraft APZ guidelines to be used in conjunction with DOD AICUZ Program.

United States Department of Defense. November 8, 1977. *Air Installations Compatible Use Zones, Department of Defense Instructions (DODI) 4165.57.*

These instructions establish the DOD policy on achieving compatible use of public and private lands in the vicinity of military airfields; and require military departments to develop, implement, and maintain an AICUZ program for installations with flying operations. DODIs define restrictions on uses and heights of obstructions near air installations to ensure safety of flight and public safety.

United States Air Force. May 1999. *Clear Zone Criteria Study (1999 – 2000)*.

In 1999, Air Mobility Command Headquarters (HQ AMC) requested that the Air Force consider reducing their clear zone dimensions, to equal the size of the FAA's largest Runway Protection Zone (RPZ) designated for large aircraft, in an effort to minimize the number of airfield waivers and costs for acquiring property in clear zones. This study summarizes the U.S. Air Force's analysis of new accident data from 1984 to 1998, including accident location plots and mathematically analysis of data. The study also compares the Air Forces clear zones and the Federal Aviation Administration (FAA) RPZ dimensions and land use compatibility guidelines to determine whether the FAA RPZs are more appropriately sized.

United States Department of the Navy. 2008. *Air Installations Compatible Use Zones (AICUZ) Program, Office of the Chief of Naval Operations Instructions (OPNAVINST) 11010.36C.* October 9, 2008.

This instruction replaced OPNAVINST 11010.36B, and provides the Navy's current guidance for policies, procedures, and guidelines related to implementing the AICUZ Program. The instructions provide recommendations for land use compatibility with high noise level, accident potential areas, and obstruction clearance criteria associated with military airfield operations. Theses instructions also detail the development of APZs for rotary and fixed-wing aircraft. The major changes in this instruction included additional notes related to the land use compatibility guidelines for APZs, the addition of day-night average sound level (DNL)/community noise equivalent level "A"-weighted (CNEL) 60 noise contours, as well as real property guidance to reflect the new encroachment partnering (EP)

program and updates to the roles, responsibilities, and regions as it relates to the AICUZ Program.

Preceding OPNAV Instruction versions include:

United States Department of the Navy. 1979. *Air Installations Compatible Use Zones (AICUZ) Program, OPNAVINST 11010.36 (May 25, 1979).*

The original instruction that provided the Navy's guidance for policies, procedures, and guidelines related to implementing the AICUZ Program. It was based on providing land use recommendations for noise zones and APZs related to military aircraft operations. It also provided information on the implementation of the AICUZ Program at local commands.

United States Department of the Navy. 1988. *Air Installations Compatible Use Zones (AICUZ) Program, OPNAVINST 11010.36A (April 11, 1988).*

Replacing OPNAVINST 11010.36, the major changes in this instruction included AICUZ updates looking at a five-year forward projection of operations, which is referred to as the "prospective" AICUZ. In addition, with respect to APZs, additional guidance was provided regarding the application of APZ to Field Carrier Landing Practices (FCLP) flight tracks.

United States Department of the Navy. 2002. *Air Installations Compatible Use Zones (AICUZ) Program, OPNAVINST 11010.36B (December 19, 2002).*

Replacing OPNAVINST 11010.36A, the major changes in this instruction included the introduction of the new Rotorcraft Noise Model (RNM) for use in modeling rotary-wing aircraft and the use of single-event noise analyses to augment the DNL/CNEL, as well as the use of Average Annual Day (AAD) for noise contours. Floor Area Ratio (FAR) density considerations were also added to the land use compatibility guidelines. Additional updates related to modifying the AICUZ Footprint and the establishment of two centers of excellence related to AICUZ issues were established within this instruction update.

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