GE Aviation

John Wayne Airport Departure Feasibility Assessment

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imagination at work

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The following table records all revisions to this document:

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1. Executive Summary

1.1. Background

GE Aviation's Air Traffic Optimization Services (Naverus, Inc.) has been contracted by the City of Newport Beach to evaluate the feasibility of developing an instrument departure procedure, based on recently published standards, in an effort to mitigate long-standing issues related to noise mitigation at John Wayne Airport (JWA)[1]. As part of a long-term plan to modernize airspace infrastructure in the United States, commonly known as NextGen, the FAA has published a new set of instrument flight procedure (IFP) design rules that take advantage of the latest generation of navigation technologies known as performance-based navigation (PBN), and in particular a specification of PBN known as required navigation performance (RNP). RNP allows for the creation of flight paths with complex geometry, including curved paths, and takes full advantage of latent capabilities onboard the majority of transport aircraft operating in the U.S.

In general, the creation of RNP flight paths designed in accordance with the new and emerging rule sets are a fundamental part of the NextGen plan. As this report describes, an opportunity exists to create an RNP procedure, using this new rule set, for aircraft departing JWA to the south. RNP technology would allow the design of departure flight paths that could potentially balance the differing, and sometimes competing environmental and noise interests of citizens from different neighborhoods in Newport Beach. RNP design offers a number of significant benefits including:

- The designed location of the flight path could incorporate input from citizens of Newport Beach to a greater extent than has been previously possible with legacy navigation methods. A curved flight path could be designed that would greatly reduce the potential for direct overflights of residential communities on both the east and west sides of the Back Bay.
- The new departure procedure would represent an important milestone for the FAA's NextGen plan: the first use of the RNP specification for a public-use departure.
- The RNP departure procedure could be flown by the majority of airline operators serving JWA.

Designing an RNP departure procedure for JWA that balances the needs of all stakeholders is a complex task that requires detailed knowledge and understanding of a broad range of technical, operational, and regulatory subjects. In addition, in order to achieve a successful outcome, special attention must be given to the integration of community interests within the technical design process. This report provides a comprehensive overview of these subjects as they relate to JWA in order to better inform the design of future departures from JWA and to provide guidance on design options available.

[1] JWA, a commonly used abbreviation for John Wayne Airport, will be used throughout this report. The ICAO identifier for John Wayne Airport is SNA.

1.2. Overview of Current Operations

1.2.1. Current Procedures

Currently, aircraft departing to the south from JWA fly a number of IFPs that use a variety of navigation technologies. These include legacy procedures that rely on ground-based navigation transmitters, as well as a form of PBN known as RNAV. As a result, communities on both sides of the Back Bay are exposed to overflights depending on a number of factors, including wind conditions, the departure that is being flown, and the type of aircraft flying it.

1.2.2. Current Concerns

The FAA has designed and implemented a number of different departures at JWA that have had varying degrees of success in avoiding overflights of communities surrounding the Newport Back Bay. The variety of technologies employed and the unique elements related to these technologies have resulted in a number of expressed community concerns:

- Departures based on older technologies (such as the MUSEL SIX) have a relatively wide dispersion pattern of paths across the ground. This has resulted in a commonly held perception by residents on both sides of the Back Bay that aircraft flying the MUSEL SIX departure create flight paths that are less concentrated over a single area but that scatter community overflights over a wide area.
- Departures based on PBN technologies (such as the DUUKE TWO RNAV Departure) have reduced the dispersion of paths across the ground. However, this has created a widespread community perception that aircraft flying the DUUKE TWO RNAV produce flight paths that are more concentrated and that directly and routinely overfly communities on the east side of the Back Bay.
- The most recently published RNAV departure (STREL ONE RNAV departure) was designed, in part, to address community concerns about concentrated overflights resulting from aircraft flying the DUUKE TWO RNAV departure. The design of the STREL procedure was intended to shift flight paths to the west over the center of the bay. However, this new path has created the perception that departures are now more highly concentrated over communities on the west side of the Back Bay.

1.2.3. Current Proposals

The FAA has proposed a new departure, the RAWLZ ONE RNAV, whose primary purpose is to address airspace issues related to integrating departures from JWA into the airspace infrastructure beyond the immediate vicinity of the airport. The initial proposed design for RAWLZ ONE utilizes the same initial path as the current STREL ONE RNAV departure and does not remedy the community perception of concentrated overflights on the west side of the Back Bay.

1.3. Recommended Solution

Based on the design objectives and implementation risks described in this report, GE Aviation recommends modifying the design of the proposed RAWLZ departure using new RNP criteria. This change would eliminate some straight-line flight segments currently in the RNAV design and replace them with a precisely engineered path that consists of a series of curves approximating the center of the Back Bay—from the departure end of the runway to open water. With community input, the path could be designed to avoid, to the maximum extent possible, populated areas on both the east and west sides of the bay. Furthermore, aircraft flying the RNP departure path would be able to more precisely track the centerline of the new curved path regardless of wind conditions.

1.4. Risks

The primary risks to this proposal are regulatory in nature and not technical. These regulatory risks are described in detail in this report and related to the fact that this procedure would represent the first public-use departure procedures using the RNP specification in the United States. These risks include:

- The specific geometry recommended for the modifications (curved paths) is not explicitly described in the 8260.58 rule set for use in departure procedure design. However, 8260.58 **does** include specifications for curved paths used in approach procedures. In order to use curved paths for the departure the FAA would need to make an exception for this procedure based on a "waiver" to the regulatory criteria. The timeline to develop and approve this waiver is unknown.
- Standards related to the charting of the proposed departure do not yet exist and would need to be developed.
- The mechanism by which airlines are approved to fly an RNP departure is not fully evolved.

1.5. Recommended Next Steps

The City of Newport Beach should respond to the FAA requesting modifications to the initial legs of the proposed RAWLZ departure using RNP technology, in accordance with the recommendations of this report. Suggested language for that response is included in Appendix A: Proposed Language.

2. John Wayne Airport Overview

2.1. Airport

John Wayne Airport (JWA) is located approximately 35 miles south of Los Angeles, between the cities of Santa Ana and Tustin to the north, Irvine to the north and east, Newport Beach to the south, and Costa Mesa to the west. In 2011 JWA served nearly 9 million passengers and is the only airport in Orange County providing commercial passenger service.[2]

The airport is served by two parallel north–south runways, 19R/01L and 19L/01R. Runway 19R/01L is used by turbojet commercial air carriers. Runway 19L/01R serves smaller general aviation aircraft. When the airport is in a "south flow" (landing and departing on Runways 19R and 19L), departing aircraft overfly a number of noise-sensitive areas within the city of Newport Beach, including an inland delta known as the Back Bay, and the communities surrounding the Back Bay.

JWA has one of the most restrictive aircraft access and noise monitoring programs in the world. Commercial air carrier operations are regulated by a plan known as the Phase 2 Commercial Airline Access Plan and Regulation ("Phase 2 Access Plan").[3] This plan places restrictions on operational capacity, hours of operations, and noise levels and is referenced throughout this report.

2.2. Airspace

JWA's proximity to Los Angeles International Airport (LAX) and some of the busiest airspace in the world increases the complexity associated with designing and implementing an IFP. All IFPs at JWA must be designed to integrate with existing airspace and air traffic requirements while ensuring safe and efficient flow of aircraft. One of the driving factors to any departure implemented at JWA is the desire to segregate JWA operations from operations at LAX and other area airports. This is accomplished through the design and implementation of an area of airspace around LAX that is primarily used for traffic operating into and out of LAX. This area is known as the LAX Class B airspace and is depicted in Figure 2.1. IFPs into and out of JWA are designed such that they avoid flight within the LAX Class B airspace to the maximum extent possible. The proposed RAWLS departure accomplishes this objective.

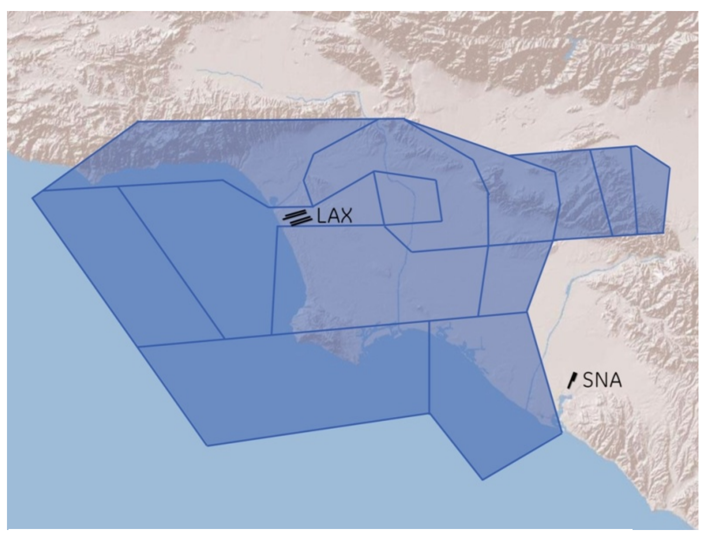

Figure 2.1: LAX Class B Airspace

[2] "Facts at a Glance," OCair.com, the Orange Country official website for John Wayne Airport. Santa Ana, California. http://www.ocair.com/newsroom/factsataglance.aspx
[3] "Access and Noise," OCair.com website. http://www.ocair.com/communityrelations/AccessandNoise.aspx

2.3. Noise Restrictions

Aircraft operating at JWA are required to comply with noise restrictions that are defined in the Phase 2 Access Plan. Compliance with these requirements is monitored through the use of a noise monitoring system that enables the tracking, measurement and recording of noise levels from each aircraft that operates into or out of the airport. The system consists of a number of different elements, including ten noise monitoring stations (NMS). Three NMS are located north of the airport to measure and record noise levels from aircraft that are landing to the south and departing to the north. Seven stations are located south of the airport to measure and record noise levels from aircraft that are departing to the south and landing to the north. The noise monitoring stations transmit noise events instantaneously to the Access and Noise Office, enabling the staff to have up-to-the-second data on aircraft operations. All IFPs at JWA should be designed in a manner that takes into account the restrictions defined in the Phase 2 Access Plan and enables compliance with these requirements to the maximum extent possible.[4] The primary focus of noise mitigation efforts has historically been for aircraft departing from Runways 19L/19R over the Newport Back Bay.

2.4. Departures

The following Instrument departures are in place and in common use at JWA for aircraft departing from Runways 19L/19R:

- Channel One Departure (CHNL1.SXC) – This is a traditional standard instrument departure (SID) used for northbound aircraft departing from Runways 19R/19L.
- Musel Six Departure (MUSEL6.MUSEL) - This is a traditional SID used for westbound and northwest-bound aircraft departing from Runways 19R/19L.
- Duke Two RNAV Departure (DUUKE TWO RNAV) - This is a PBN SID used for westbound aircraft departing from Runways 19R/19L.
- Strel One RNAV Departure (STREL ONE RNAV) - This is a PBN SID used for westbound aircraft departing from Runways 19R/19L.

[4] Ibid.

3. Noise Mitigation and Current Status of Operations at JWA

Designing IFPs into and out of JWA airport that can help to mitigate noise issues requires an understanding of the related regulatory requirements and community concerns. This section provides a brief historical overview of noise-related regulatory and legal issues that have evolved over the last 30 years at the national level and locally at JWA.

3.1. Background and Historical Overview

Since the 1960s, national and local regulatory authorities have sought to develop and implement strategies that reduce the impact of aircraft noise to affected communities. The Aircraft Noise Abatement Act of 1968, which authorized the FAA to define standards and issue regulations, was one of the first pieces of regulatory guidance issued related to mitigating aircraft noise. Since that time, specific regulatory guidance has been developed that defines aircraft and engine design standards related to reducing aircraft and engine noise, and operational requirements that attempt to mitigate the effect of aircraft noise. Some of the more important regulatory guidance at the national level includes the following:

- 14 CFR 36 Subpart B controls noise at its source through the definition and regulation of design standards related to noise emissions for Transport Category Airplanes.
- The Noise Control Act of 1972 amends the original act to involve the EPA in regulating airport noise under the National Environmental Policy Act (NEPA).
- The Aviation Safety and Noise Act of 1979 grants authority to the FAA to issue regulations on airport noise compatibility planning.
- The Airport Noise and Capacity Act of 1990 requires all jet aircraft operating at civilian airports to comply with FAR 36 Stage 3 noise limits by the year 2000.
- AC 91 -53 (1978) and AC 91-53A (1993) Noise Abatement Departure Profile describes operational procedures for conducting Noise Abatement Departure Profiles (NADP).

During this same period of time, requirements have evolved from individual states, airport operators, communities, and community groups that have resulted in the promulgation of operational limitations such as curfews, prohibitions on certain types of aircraft, and required noise abatement procedures.

At John Wayne Airport, the most significant guidance related to airport operations includes:

- A 1985 Stipulated Settlement Agreement ("Settlement Agreement") made in U.S. District Court between the County of Orange and the City of Newport Beach, Stop Polluting Our Newport (SPON, a community group), and the Airport Working Group (AWG, another community group).[5] The agreement settled a long-standing dispute between the parties regarding the regulation of aircraft operations at JWA. The agreement imposes a number of important

[5] The Settlement Agreement can be downloaded as a PDF from the City of Newport Beach official website: www.newportbeachca.gov. From the home page, navigate to Current Projects and Issues > John Wayne Airport > Settlement Agreement.

operational limitations to aircraft operating into and out of JWA. This agreement was amended in 2003.

- Phase 2 Commercial Airline Access Plan and Regulation[6]. This plan implements the following:
  - o Projects approved by the county related to the amended Settlement Agreement and including certification of Environmental Impact Report 582 (EIR 582).[7]
  - o Mitigation measures identified and adopted under the California Environmental Quality Act in connection with the approval of the John Wayne Airport Master Plan (1985) and related actions, including certification of Orange County EIR 508/EIS in 1985.[8]
  - o Mitigation measures for the 1985 master plan and related projects in connection with the review and approval by the FAA of EIR 508/EIS under NEPA.[9]

3.2. Current Status

As a result of the regulatory and legal agreements described, a wide range of noise mitigation strategies have been employed across the aviation industry with varying degrees of success. At JWA, these strategies have focused on a number of areas, including those described in the following sections.

3.2.1. Ground Infrastructure – Acoustical Insulation

Under federal and state law an Acoustical Insulation Program (AIP) was completed in 2009. Participation in this program was voluntary and was limited to residents who fell within the 65 dB community noise equivalent level (CNEL) contour.[10]

3.2.2. Operational Limitations

The Settlement Agreement and its Amendment impose four fundamental limitations on operations at John Wayne Airport:

1. **Limitations on noise levels.** Two different categories of aircraft are specified based on noise levels. The number of daily operations within each noise level is limited, based on a number of factors, with the quietest noncommercial operators having the least restrictive limitations.[11]
2. **Limitations on passenger levels**. Regularly scheduled commercial users may not serve more than a total of 10.8 million annual passengers in any calendar year through 2015.[12]

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[6] *Phase 2 Commercial Airline Access Plan and Regulation*, October 1, 1990-December 31, 2015. This document can be downloaded as a PDF from the Orange Country official website for John Wayne Airport: www.ocair.com. From the home page, navigate to Community Relations > Access and Noise > Access Plan.
[7] Ibid., Section 1.1.
[8] Ibid.
[9] Ibid.
[10] "Does JWA offer an acoustical insulation program?" in Frequently Asked Questions—Noise, OCair.com. http://www.ocair.com/communityrelations/FAQ-Noise.aspx
[11] Phase 2 Access Plan, Sections 2.1, 2.9, 2.10, and 3.1.
[12] Ibid., Section 2.26.

3. **Limitations on hours of operations**. Commercial air carrier departures may only be conducted between 0700 – 2200 Monday through Saturday and 0800 – 2200 on Sundays. Commercial Air Carrier arrivals may only be conducted between 0700 – 2300 Monday through Saturday and 0800 – 2300 on Sundays.[13]
4. **Limitations on the number of gates**. Through 31 December 2015 there may be no more than 20 loading bridges in use serving no more than one flight at a time.[14]

3.2.3. Noise Abatement Departure Profiles (NADP)

A common method employed for noise mitigation on departures is to control the aircraft's engine power setting and climb trajectory through operational procedures. A number of these procedures have been codified by user groups and regulatory agencies, including guidance described in FAA Advisory Circular (AC) 91-53A. At JWA this procedure, more commonly known as a "cutback procedure", is not mandated but can be used by operators in order to meet the noise limitations set forth in the Settlement Agreement. The guidance recommends a power reduction after takeoff at a minimum of 800 feet above the airport elevation. The reduced thrust setting is below the normal climb power setting and is based on maintaining a safe speed and power level until the aircraft climbs to 3000 feet above the airport elevation, at which point the aircraft begins to accelerate and full climb thrust is restored. Since the procedure is based upon altitudes, the geographic location of the power changes will be at different points along the departure path based on aircraft type, weight, and weather conditions. In some cases this problem is mitigated by specifying a fixed geographic location (such as a set distance from the departure runway) at which full climb thrust is restored.

3.2.4. Lateral Path Definition and Control

The starting point for evaluating any noise mitigation plan is the design and operation of the IFP that aircraft are to follow. IFPs are developed to provide aircraft with a means to reliably navigate along obstacle-free tracks, while integrating into the surrounding airspace infrastructure in the most efficient manner possible. In addition, IFPs can be designed to reduce or avoid overflight of sensitive areas. At JWA there are a number of different IFPs used by aircraft departing from Runway 19R/19L. Each of these departures has been designed using different parameters and is flown by a variety of aircraft, resulting in a distribution of actual flight paths over the ground. Designing flight paths that provide benefit in terms of noise mitigation involves a detailed understanding and careful integration of a number of different engineering parameters, including the geometric design of the lateral path itself, the characteristics of the navigation system used, and the ability of the aircraft to receive, replicate, and follow that path. Follow on sections of this report provide more detail on these elements as they relate to potential mitigation solutions at JWA.

[13] Ibid., Section 2.3.4.
[14] Amended Settlement Agreement, IV B.

3.3. Proposed RAWLZ Departure

Over the last 30 years, the FAA has designed and implemented a number of different departures that take advantage of evolving navigation technologies, integrate better with the surrounding airspace infrastructure, and provide for more efficient flight operations. The FAA plans to publish a new departure, the RAWLZ, and has requested input from the City of Newport Beach prior to putting it into service. This departure represents an evolutionary approach to IFP design and closely resembles previously implemented departures. A discussion of this departure and recommended design changes that could provide benefit are covered in detail in the following sections this report.

3.4. Community Concerns

GE Aviation met with a number of representatives from the surrounding communities to better understand concerns related to the current and proposed departures (see Appendix B: Community Engagement). The primary concern expressed was the perception of direct overflight of the communities on both sides of the Newport Back Bay. Any recommendations to the FAA regarding design changes to the proposed RAWLZ departure would be based, to the maximum extent possible, on addressing these concerns.

4. Utilization of PBN to Design Departure Paths at JWA

Recently published FAA guidance on the design of departure IFPs may offer an opportunity to further mitigate noise concerns at JWA by modifying the path of the proposed RAWLZ departure. In order to make an informed decision on designing or modifying existing departure flight paths, it is important to understand a wide range of technical, regulatory, and operational details. This section provides a high-level summary of some of the most important details.

4.1. Instrument Flight Procedure Design Overview

IFPs are developed in order to provide a means of navigating along an obstacle-free track without visual reference to the ground or surrounding obstacles. In order to design procedures that ensure an obstacle-free track, an obstacle evaluation area (OEA) is defined along the designed lateral track of each procedural segment. This OEA is an area whose dimensions and shape are defined within procedure design criteria rule sets, also known as procedure design criteria, and based, in part, on the navigation technology that is being used to define the path. For PBN procedures, it is also dependent on the way in which the design data is programmed into the aircraft's flight management system (FMS). All obstacles that fall within the OEA must be cleared vertically by a specified required obstacle clearance (ROC) value, which defines an obstacle clearance surface (OCS). Published segment altitudes are derived by evaluating the obstacles that lie within the OEA in each segment and adding the ROC value to the height of the obstacle. Figure 4.1 depicts a notional example of the OEA and OCS. The minimum altitude that an aircraft must climb to on an instrument departure is defined by the highest obstacle within the segment. Higher altitudes may be specified for a number of reasons, including airspace integration requirements or for noise mitigation purposes.

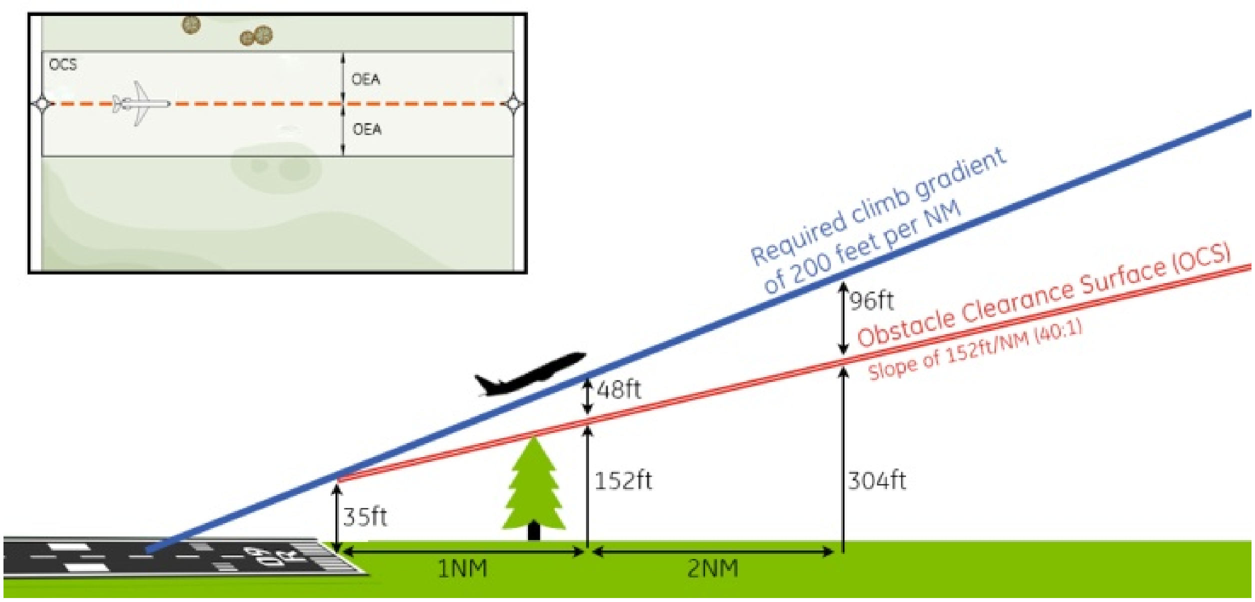

Figure 4.1: OEA and OCS

The successful design and operation of any IFP is achieved through the understanding and proper integration of a number of enabling functions, including:

- Designing the Path - Procedure Design Criteria

  IFPs are designed based on a wide range of navigation and flight guidance technologies. IFP design rule sets describe the characteristics of the geometric path and the engineering analysis that are conducted in order to ensure that the IFP provides an obstacle free path that integrates into the surrounding infrastructure. IFPs based on traditional technologies are constrained to relatively simple geometric paths that consist of a series of straight segments. Newer generation IFPs are able to employ geometries involving complex curved paths. The designed path is commonly referred to as the "Desired Path."

- Determining the Aircraft's Position – Position Definition

  The ability of the aircraft's onboard avionics to receive navigation signals and determine its position over the ground is commonly referred to as position definition. Position information can come from ground-based stations (VOR, DMS, ILS, LOC and others), space-based systems (GPS), equipment installed on the aircraft that requires no external signals such as inertial reference units (IRU), or a combination of these. The generation and transmission of the electronic signals are subject to a number of different errors and can result in a cross-track distribution of paths over the ground that the aircraft actually follows. Traditional ground-based navigation signals can have larger cross-track distributions than those provided by satellite-based systems such as GPS. This error source is commonly referred to as navigation system error (NSE).

- Replicating the Desired Path - Path Definition

  The avionics on board the aircraft must be able to replicate the desired path on a display in the flight deck, or through its automated systems, in a manner that allows the pilot or automated systems to follow the path. The replication of the desired path is commonly referred to as the "Defined Path." The defined path may be different than the desired path due to a number of factors, including the characteristics of the navigation signals being received and the accuracy of the flight deck displays and systems. This error source is commonly referred to as path definition error (PDE). Traditional flight deck displays replicated and presented the flight path directly from the ground electronic navigation signals onto relatively simple displays. The current generation of aircraft and the majority of commercial aircraft operating at JWA are equipped with an FMS that stores the geometric attributes of the designed path (desired path) in an electronic navigation database, presents it on a moving map display for the pilot, and transfers the data to the automated systems. The manner in which an IFP is coded into the database can have a profound effect on path definition and is described in more detail in Section 4.4 of this report.

- Following the Defined Path – Path Steering

  The precision to which the aircraft follows (steers to) the defined path is a function of an individual pilot's ability, or the aircraft's automated systems' ability, to follow the defined path. When a pilot is flying the aircraft, it is based on the display of the defined path, the display of the aircraft's current path, and information that allows the pilot to follow the path. When the automated systems are used, it is based on the design of the system itself. Differences in the specific types of displays and automated systems installed, and individual pilot technique, can result in a cross-track distribution of actual ground tracks that aircraft follow. This distribution is commonly referred to as flight technical error (FTE).

The combination of the design criteria used and the NSE, PDE, and FTE (referred to as total system error (TSE)) results in a distribution of actual flight paths for any IFP regardless of the navigation technology used and the installed equipment onboard the aircraft.

4.2. PBN Overview

The latest evolution of navigation technologies, broadly referred to as performance-based navigation (PBN) is a fundamental part of the FAA's airspace modernization plan known as NextGen, and offers opportunities to provide IFPs that can further mitigate noise issues at JWA. Today, operators worldwide are realizing the benefits of PBN operations through the application of approach and departure procedures. These benefits include the ability to design and fly complex flight paths that do not rely on a ground-based navigation infrastructure. These flight paths can be designed to enhance operational efficiencies, integrate better into the surrounding airspace, and mitigate environmental concerns by reducing or eliminating overflight of sensitive areas.

In the United States, two broad categories of PBN types have been specified, each with unique operational and procedure design requirements:

- RNAV
- RNP

Until recently, only the RNAV specification and rule sets were available in the United States for public use. The RNAV departures in current use at JWA and the proposed RAWLZ have been designed to the RNAV specification under RNAV rule sets. The RNP specification allows for more complex geometry to be used in the design of IFP paths and in some cases enables aircraft to fly these paths more precisely. A new procedure design rule set has been published by the FAA, Order 8260.58, which allows departures to be designed to the RNP specification. Designing and implementing PBN departures requires integrating a wide range of regulatory and technical components including, but not limited to:

- Departure procedure design criteria
- Electronic navigation data
- Aircraft capabilities
- Operational capabilities and approval
- Airspace integration
- Air traffic integration
- Weather considerations
- Environmental impact
- Regulatory processes

Compliance requirements within these components have evolved over the last 20 years and continue to evolve as the global airspace transitions to a PBN infrastructure. Meeting these requirements and carefully integrating the elements of these components with each other is critical in order to capture the benefit available through the application of PBN procedures. Procedure designers must carefully consider the options available within individual design elements. Maximum benefit is achieved through an iterative design process that examines each option in the context of the specific location in which the procedures will be implemented.

The following sections describe details of these components as they relate to the design and implementation of PBN procedures.

4.3. Departure Procedure Design Criteria

In the United States, the majority of instrument procedure design criteria are promulgated by the FAA under the provisions of the Code of Federal Regulations (CFR) Title 14 Part 97. The procedure design criteria sets describe the details of the geometric constructs, such as the OEA, OCS, and ROC, that must be complied with when designing an IFP. The procedure design criteria sets that must be complied with when designing RNAV procedures include but are not limited to the following:

- FAA Order 8260.19: *Flight Procedures and Airspace*
    - Overarching order that describes policies and procedures related to the integration, approval, deployment and ongoing operation of IFPs.
- FAA Order 8260.3: *United States Standard for Terminal Instrument Procedures (TERPS)*
    - Overarching guidance that provides technical details applicable to all IFPs.
- FAA Order 8260.46D: *Departure Procedure Program*
    - Procedure design document that describes the technical details used in the design and deployment of departure procedures.
- FAA Order 8260.44A: *Civil Utilization of Area Navigation (RNAV) Departure Procedures*
    - Subordinate to FAA Orders 8260.19, 8260.46D and 8260.3.
    - Procedure design document that describes the technical details used in the design of RNAV departures.
- FAA Order 1050.1: *Environmental Impacts: Policies and Procedures*
    - Provides guidance that ensures that proposed IFPs are compliant with NEPA.
- FAA Order 8260.58: *United States Standard for Performance Based Navigation*
    - A new order published in September 2012 that is subordinate to FAA Orders 8260.19 and 8260.3.
    - Procedure design document that provides a consolidated source for all PBN procedure design criteria, including PBN approaches and departures. This rule set combines the RNAV and RNP specification.

The single most important element in the creation of PBN departures that can mitigate issues related to overflight of sensitive areas in the vicinity of JWA is the ability to employ complex geometric sections into the design path, in particular a leg type known as radius to fix (RF), described in detail in Section 4.4. Previous PBN procedure design rule sets limited the geometric paths of departures to relatively simple, straight leg segments as part of the RNAV specification. The new 8260.58 rule set allows procedure designers to use more complex geometry, including the RF leg type, but limits its application to the design of approaches and missed approaches, not departures.

GE Aviation has designed many PBN departure procedures in operation throughout the world that use the RF leg type without the limitations imposed by the FAA Order 8260.58. In order to use this leg type at JWA in a fashion that is technically feasible and would achieve maximum benefit, procedure designers would need to request an exception to this limitation.

4.4. Electronic Navigation Data

PBN IFP paths consist of a series of waypoints that are connected to each other in accordance with the procedure design criteria. The location of these waypoints and the manner in which they are connected are the fundamental building blocks of all PBN procedures and are determined through an iterative process based on the design objectives and constraints. Once the design is complete it is converted into a series of attributes that are electronically coded into an electronic navigation database (NDB) and loaded into the aircraft's flight management computer (FMC) that is used by the flight management system (FMS) and other onboard avionics to define and fly the designed path. These attributes must conform to a global standard known as ARINC 424. This standard is applied in the design and production of all electronic navigation data and enabling avionics.

The ability to design and fly straight and turning segments is achieved through specifying an ARINC 424 coding construct that will allow an aircraft to achieve the desired path. The manner in which the procedure is coded can have a significant effect on the distribution of actual flight paths.

PBN departure IFP waypoints have a minimum of four attributes that a procedure designer must define: latitude, longitude, the type of geometry that is used to define the path into the waypoint (known as a "Path Terminator" and commonly referred to as "leg type"), and whether or not the way point is a "flyby" or "flyover" fix. In addition, a waypoint may also be coded with a specific altitude and airspeed that an aircraft must adhere to when crossing the waypoint.

A wide variety of leg types are used in PBN departure design. The following sections summarize the types that are relevant to the current and proposed RNAV IFPs at JWA.

4.4.1. TF Leg Type

The track to fix (TF) leg type is the most common leg type in the design of PBN procedures. The TF leg is constructed by connecting two waypoints to each other. A turning segment is constructed by connecting three waypoints with two TF legs (see Figure 4.2). A minimum of cross-track deviation occurs along each straight segment as it automatically corrects for the effect of wind in order to stay on the path. However, this leg type can result in a large distribution of actual aircraft paths along turning segments.

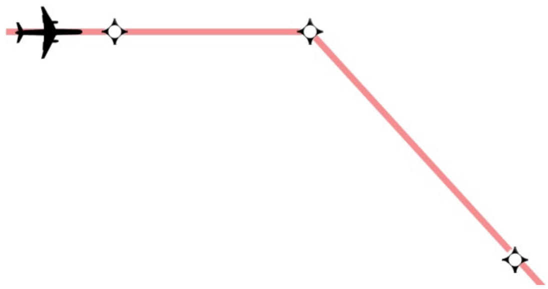

Figure 4.2: TF Leg Type

4.4.1.1. TF Using Flyby Waypoint

If the waypoint that connects the two legs is designated as a “flyby”, the aircraft rolls into the turn inbound to the waypoint at a location that allows it to roll out of the turn tangent to the outbound leg while maintaining a constant bank angle from roll in to roll out. When flying this type of procedure, most flight guidance systems command a standard-rate turn resulting in a fixed-bank angle of 25 to 30 degrees. The aircraft will never fly directly over the waypoint unless the inbound track is oriented in the exact same direction as the outbound track. The roll-in and roll-out points are located based on the aircraft’s groundspeed (a function of its airspeed and prevailing wind conditions) and the aircraft’s bank angle. At high groundspeeds or low bank angles, aircraft will start the turn earlier and roll out of the turn later than an aircraft at lower groundspeeds or higher bank angles. This results in a wide distribution of paths over the ground on the inside of the turn, as depicted in Figure 4.3

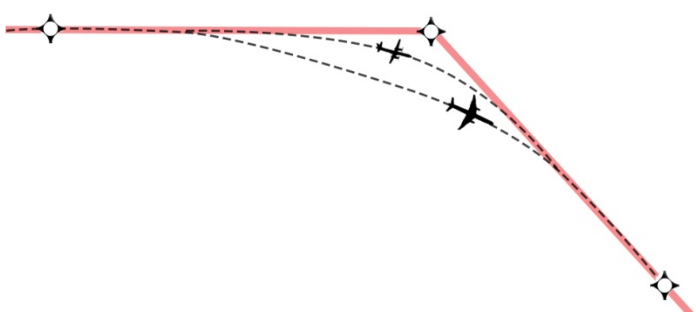

Figure 4.3: TF Leg Type and Distribution of Flight Paths Using Flyby Waypoint

4.4.1.2. TF Using Flyover Waypoint

If the waypoint is designated as a “flyover,” the aircraft will not begin the turn to intercept the outbound leg until passing over the waypoint. Once past the waypoint it starts a turn to intercept a point tangent to the outbound leg. The actual path of the aircraft is dependent on its speed, bank angle, and prevailing wind conditions. This results in a wide distribution of flight paths on the outside of the turn as shown in Figure 4.4.

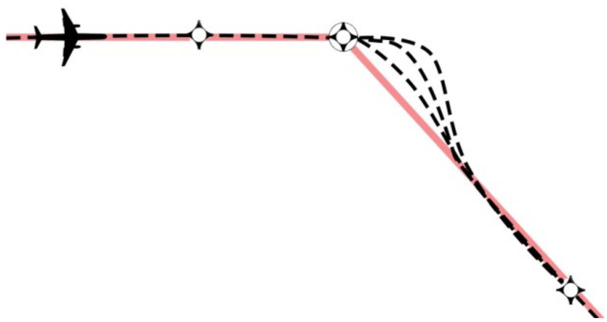

Figure 4.4: TF Leg Type and Distribution of Flight Paths Using Flyover Waypoint

4.4.2. CF Leg Type

The course to fix (CF) leg type is similar to the TF leg but constructed based on defining a magnetic course into the waypoint. An aircraft's avionics equipment uses geodetic reference systems based on true courses and headings and must apply local magnetic variation to correct the defined path. These variations and the manner in which they are accounted for can lead to differences in the defined paths between aircraft types and result in a wider distribution of actual flight paths. Turn construction using CF legs uses a similar methodology as those used for TF legs with the resultant distribution of actual flight paths as described in Section 4.4.1. The CF leg type is depicted in Figure 4.5.

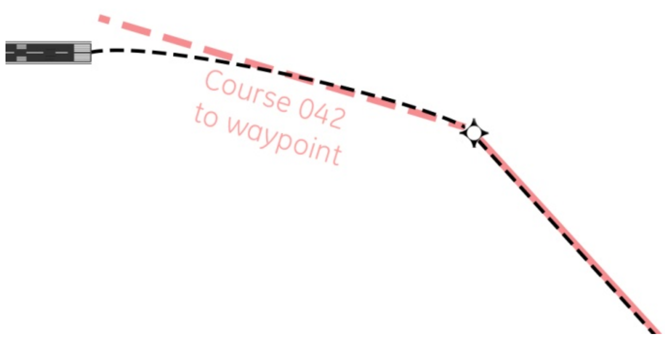

Figure 4.5: CF Leg Type

4.4.3. VR Leg Type

The heading to radial (VR) leg is shown in Figure 4.6 and requires the aircraft to fly on a magnetic heading until it reaches a specified crossing radial of another ground-based navigation facility, at which point it begins a turn to the subsequent leg at an unspecified position. This leg type results in a wide distribution of actual flight paths that are the result of the following factors:

- When an aircraft flies a magnetic heading, its actual path over the ground is dependent on the prevailing wind conditions.

- Deviations occur between aircraft navigation systems that result in actual magnetic headings being different than the aircraft's indicated (and desired) heading.
- Due to the inherent inaccuracies of electronic signals generated from these stations, the location over the ground of the specified radial can vary, resulting in a distribution of points at which an aircraft will initiate the turn to the subsequent leg.

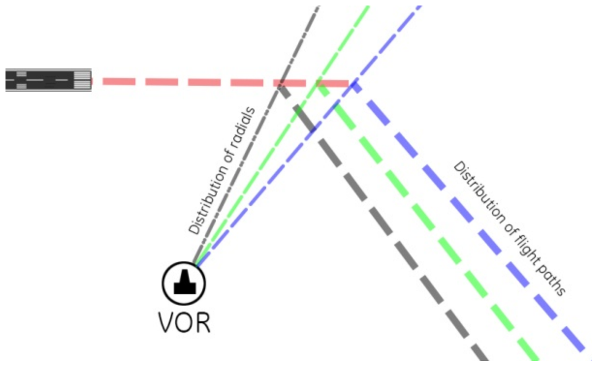

Figure 4.6: VR Leg Type and Distribution of Flight Paths

4.4.4. VI Leg Type

The heading to intercept (VI) leg type is shown in Figure 4.7 and requires the aircraft to fly a magnetic heading until reaching a point at which it initiates a turn to intercept a specified course into the next waypoint at an unspecified position. This leg type results in a wide distribution of actual flight paths that are the result of the following factors:

- When an aircraft flies a magnetic heading, its actual path over the ground is dependent on the prevailing wind conditions.
- Deviations occur between aircraft navigation systems that result in actual magnetic headings being different than the aircraft's indicated (and desired) heading.
- With the VI leg type, the initiation of the turn will always occur prior to crossing the path of the subsequent leg in a manner that allows it to intercept that leg at a tangent point, similar to the TF leg with a flyby waypoint. As such, the turn roll-in and roll-out points are dependent on the aircraft's speed, bank angle, and prevailing wind conditions.

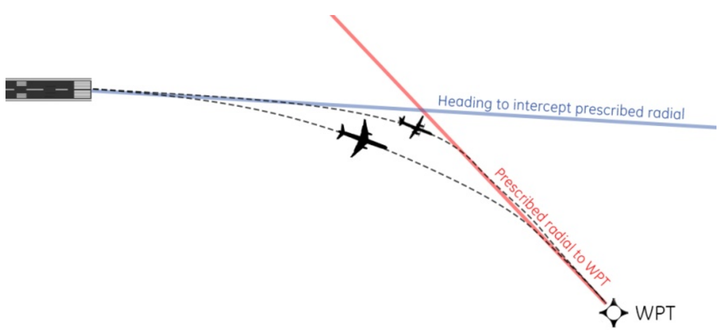

Figure 4.7: VI Leg Type and Distribution of Flight Paths

4.4.5. RF Leg Type

The radius to fix (RF) leg type is shown in Figure 4.8. It is a newer leg type that defines the roll-in and roll-out points as fixed locations based on a fixed radius that remains constant regardless of the aircraft's groundspeed, bank angle, or prevailing wind conditions. In this case, the aircraft's bank angle changes as groundspeed changes in order to remain on the fixed-radius track. As groundspeed increases, bank angle must increase up to the limit of the flight guidance system (approximately 25 to 30 degrees) in order for the aircraft to remain on the fixed-radius path. At a given groundspeed, a small radius turn requires a larger bank angle than a large radius turn. This is an important consideration when determining the optimum radius for particular leg.

In many cases, the RF leg transition results in the smallest distribution of potential flight paths than any other turn construction method. Operational data indicates that the total cross-track distribution of aircraft flying RF leg types is no more than 100 feet either side of the desired path. (see Appendix C: RF Leg Path Distribution Analysis).

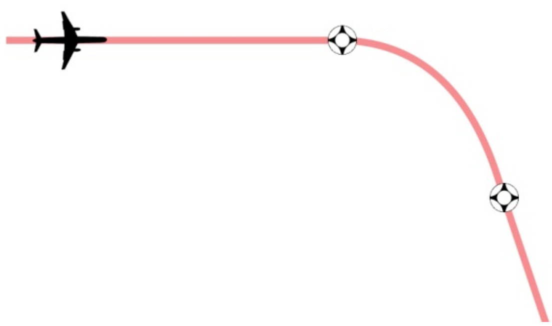

Figure 4.8: RF Leg Type and Distribution of Flight Paths

4.4.6. Limitations to Designing RF Leg Segments

The radius that procedure designers use to define the RF leg is based on the objectives of the design and the constraints of the design environment. In some cases, a small radius turn may be required in order to avoid terrain or reduce the total length of the flight path. In other cases a large radius turn may be desired in order to keep bank angles to a minimum. Certain elements of RF leg design are more restrictive than those of the TF leg, in particular, the manner in which the minimum radius is specified. The turn radius is derived through consideration of three key factors:

- Maximum allowable bank angle
- Maximum allowable indicated air speed (IAS)
- Maximum allowable tailwind

When determining the design turn radius used to construct the leg, FAA Order 8260.58 specifies two separate series of calculations: one for RF construction and one for TF construction. These calculations take into account variables such as IAS, aircraft altitude, and maximum tailwind component. They also impose limitations such as maximum actual bank angle. The resultant design radius and maximum actual bank angle for an aircraft at 10,000 feet mean sea level (MSL) and 250 knots IAS at maximum allowable tailwind component is shown in Table 4.1. As can be seen from the table, in this instance the RF leg type has a larger radius and smaller actual bank angle than the TF leg type.

Table 4.1: Order 8260.58 Bank Angle Limitations

Leg Type	Design Radius (Nautical Mile (NM))	Maximum Actual Bank Angle (Degrees)
TF	6.02 NM	25–30 degrees
RF	7.86 NM	18 degrees

If required, procedure designers can limit the size of the RF leg type radius through the application of an IAS limit on the turn that is published on the procedure chart. This provision has a number of potential operational drawbacks, including:

- The speed restriction required to create a small radius RF leg could be well below the aircraft's clean maneuver speed, resulting in the need to be in the takeoff configuration for an extended period of time. This could result in increased fuel burn and noise, reducing the overall efficiency of the procedure.
- The speed restriction is based on indicated airspeed and must account for a high tail wind. In conditions where there is no tailwind component or where there is a headwind, the groundspeed may be so low that the resultant bank angles would be less than the design 18 degrees, and in normal operations they would consistently be below 10 degrees. For RF turns that involve multiple small track-angle changes, these small bank angles can be beneficial. For RF turns that involve large track-angle changes, these long-duration shallow bank-angle turns are contrary to the normal procedure of using standard-rate turns.

Procedure designers must evaluate the benefits and penalties of each turn construct in order to arrive at the optimum solution for a particular set of design constraints.

4.5. Aircraft Capabilities and Qualification

In the United States, in order to fly a particular type of instrument operation, an aircraft must be certified and approved by the FAA as technically capable of conducting that operation. This approval is granted through a qualification process whereby manufacturers demonstrate compliance with requirements promulgated by the FAA. These requirements are described in a wide range of sources including, but not limited to, Advisory Circulars (AC) and Technical Service Orders (TSO).

Departures

In order to conduct RNAV or RNP departures designed in accordance with the requirements defined in FAA Order 8260.58, aircraft must demonstrate compliance with the following requirements:

- FAA AC 90-100A: *U.S. Terminal and En Route Area Navigation (RNAV) Operations*
    - o Describes systems requirements for aircraft to be approved to conduct RNAV departure procedures (including departure procedures (DP) and standard instrument departure procedures (SID).

- FAA AC 90-105; *Approval Guidance for RNP Operations*
    - Describes systems requirements for aircraft to be approved to conduct RNP departure procedures (including DPs and SIDs.

4.5.1. Avionics Features

There are a number of avionics features that are essential to flying a departure that uses the RF leg type, including:

- The ability of the FMS to recognize the RF leg type as part of a departure path.
- A "map" display capable of depicting curved path segments throughout the departure. This is an important feature and has been demonstrated to enhance pilot situational awareness and can be a key enabler to reducing FTE.
- A flight guidance system (flight director or autopilot) that has the ability to maintain lateral path steering along curved path segments from the beginning of the departure.
- Cockpit display of lateral and vertical deviation relative to the generated path in the pilot's primary field of view throughout the departure. It is essential that crews have the ability to monitor lateral deviation relative to the system's derived path.

The requirements described in AC 90-100A and AC 90-105 are based on enabling aircraft to fly departure procedures designed in accordance with FAA Order 8260.58, which does not include specific guidance on the use of the RF leg type in the design of departures. Regulatory provisions may need to be created describing how authorities could ensure that aircraft approved to conduct these types of operations have the proper capabilities.

4.6. Operational Capabilities and Qualification

Commercial air carriers that intend to conduct flight operations involving flying IFPs must be qualified and certified by the FAA to conduct those operations in accordance with 14 CFR Part 121. The certification is most commonly accomplished through the issuance of an Operations Specification (Ops Spec or OPSPEC) that grants approval to fly a specific type of IFP. Specific requirements of Operations Specifications are described in FAA Order 8900.1. In order to fly PBN departures (RNAV or RNP) that are designed using the FAA procedure design criteria previously described, operators must be approved via OPSPEC C063 - RNAV and RNP Terminal Operations.

A unique provision exists for IFPs that are developed using procedure design criteria other than those promulgated by the FAA. Operators can be approved to fly these types of IFPs under OPSPEC C381 – Special Non 14 CFR Part 97 Instrument Approach and Departure Procedures. The approval process for these procedures, commonly referred to as "specials," is different than the process used for IFPs designed in accordance with the FAA published criteria and has historically required more coordination and a longer approval time frame.

The Ops Spec describes specific requirements that an operator must comply with in order to be authorized to conduct the referenced operation. These requirements are further described in a number of sources that the Ops Spec refers to, including, but not limited to, Advisory Circulars. The operational requirements described in these documents cover a number of elements, including the following:

- Dispatch guidance and procedures
- Flight crew systems knowledge
- Flight crew guidance and procedures
- Training requirements and documentation
- Operations manuals and checklists
- Minimum equipment list (MEL)
- Management and control of electronic navigation data

In order to conduct RNAV or RNP departures designed in accordance to Order 8260.58 and approved under C063, operators must demonstrate compliance with the following documents:

- FAA AC 90-100A: *U.S. Terminal and En Route Area Navigation (RNAV) Operations*
    - Describes operational requirements for operators to be approved to conduct RNAV departure procedures
- FAA AC 90-105: *Approval Guidance for RNP Operations*
    - Describes operational requirements for operators to be approved to conduct RNP -1 departure procedures

The requirements described in these advisory circulars are based on enabling aircraft operators to fly departure procedures designed in accordance with FAA Order 8260.58, which does not include specific guidance on the use of the RF leg type in the design of departures. Regulatory provisions may need to be created describing how authorities could ensure that airlines approved to conduct these types of operations have the proper capabilities.

4.7. Airspace and Air Traffic Integration

One of the first steps to designing any new IFP is to fully analyze the airspace environment into which the new procedure will be deployed to ensure a high level of compatibility. This analysis should examine the airspace surrounding the airport, extending from the surface to the en-route structure. Specific elements that must be examined include:

- Radio navigation facilities
- VOR, DME, TACAN, ILS, LOC, LDA
- High-altitude and low-altitude airways
- Orientation of tracks
- Minimum altitudes
- SIDs and standard terminal arrival routes (STAR) for the candidate airport and surrounding airports
- Orientation of all published procedural tracks
- Minimum published segment altitudes
- Location and orientation of holding patterns

- All other published instrument approach and departure procedures at the candidate airport and surrounding airports
- Location of initial approach fix (IAF, the start point of an approach), final approach fix (FAF), missed approach fix (MAF, the termination point of a missed approach)
- Orientation of all published procedural tracks
- Minimum published segment altitudes
- Location and orientation of holding patterns
- Airspace classification
- Published minimum altitudes
- Sector altitudes, minimum safe altitudes (MSA), emergency safe altitudes (ESA)
- Airspace restrictions
- Military operating areas (MOA)
- Military instrument and visual low-level navigation routes (IR, VR)
- National parks
- Restricted airspace
- Prohibited airspace

All new IFPs must be approved by airspace and air traffic stakeholders before the procedure can be put into operational service. It is imperative that procedure designers understand how air traffic is managed in the airspace infrastructure and that any new IFPs take into full account the requirements set forth by air traffic control agencies. To the maximum extent possible, new procedures should be created that provide benefit not only to operators, but to airspace and air traffic managers as well. These requirements vary based on the characteristics of the airspace and may include the following elements:

- Radar versus non-radar controlled airspace
- En-route traffic flows and routing
- Terminal area traffic flows and routing
- Seasonal adjustments
- Planned airspace changes
- Radio communication requirements and capabilities

The airspace infrastructure surrounding John Wayne Airport is one of the most complex and heavily trafficked in the country. The integration into this airspace and air traffic environment of any new departure procedure at JWA will be one of the primary constraints to the location of its path. The potential benefit of any new departure must be evaluated against the risk of timely implementation of that departure based on airspace integration and air traffic issues.

A departure procedure that follows a substantially different path than the current procedures being flown could be highly disruptive to the existing procedures and traffic flows, and require a complete redesign of the entire airspace infrastructure. This represents a high level of risk to the timely implementation of such a procedure. Conversely, a new departure procedure that closely matches the paths of existing departure procedures would integrate into the infrastructure with minimal airspace redesign and represents a relatively low level of implementation risk.

Minimal integration risk can be achieved by designing new departures that have the following characteristics:

- Utilize existing waypoints, and fixes to the maximum extent possible.
- Overlay existing Departure Procedures to the maximum extent possible.

4.8. Weather Considerations

A thorough analysis of historical weather conditions can help procedure designers set efficient targets for procedure design outcomes. Weather elements to be analyzed should include the following:

- Prevailing ceiling
- Prevailing visibility
- Prevailing wind

4.9. Environmental Process

All IFPs must comply with the National Environmental Policy Act (NEPA) through the provisions set forth in FAA Order 1050.1. The provisions focus primarily on environmental impact and mitigation related to aircraft noise. Actions required to comply with these provisions fall into three broad categories:

- **The IFP qualifies for a Categorical Exclusion (CATEX)**. FAA Order 1050.1E Sec. 311 states: "Establishment of GPS, FMS, RNAV, or essentially similar systems that overlay existing procedures (including historical VFR radar tracks): In this process the proponent produces evidence that demonstrates the IFP produces little or no impact on the surrounding environment. In this case, the IFP is granted a categorical exclusion and is approved for operation without any mitigation."
- **The IFP does not qualify for a Categorical Exclusion (CATEX).** In this process the proponent conducts an environmental assessment (EA) to produce evidence that demonstrates the IFP produces little or no impact on the surrounding environment. In this case, the IFP is granted a Finding of No Significant Impact (FONSI) and is approved for operation without any mitigation.
- **The IFP does not qualify for a Finding Of No Significant Impact (FONSI)**. An Environmental Impact Statement (EIS) would have to be created. In this case, the levels of mitigations required to approve the procedure would depend on many factors that are outside the scope of this report.

In addition, any modified or new IFPs at JWA must comply with the requirements of the Phase 2 Access Plan and the Settlement Agreement.

4.10. Regulatory Approval

4.10.1. Procedure Design Approval

An overview of the potential regulatory approval process is shown in Appendix D: Approval Process. Although all IFPs go through a similar process, the time it takes from submission to approval can vary widely and is dependent on a number of factors including, but not limited to:

- **Procedure design criteria**. Procedures designed using criteria sets that are not in strict conformity to published rule sets and require waivers, may require a longer review process than those designed in strict conformance with published criteria.
- **Electronic navigation data**. Procedures that are coded in a manner that are not in strict conformance to published rule sets may require a longer review process than those designed in strict conformance with published criteria. In addition, suppliers of electronic navigation data may not have processes in place that can easily manage data that does not conform to the ARINC 424 standard.
- **Aircraft capabilities**. Procedures that require operators to invest in new aircraft equipment may not have a broad level of acceptance from these operators and could be difficult for procedure design authorities to prioritize.
- **Operational capabilities and approval**. Operators that need to develop and invest in new operational capabilities in order to fly the procedures may find it difficult to obtain approval in a timely manner.
- **Airspace integration**. Procedures that require any airspace redesign may require a much broader level of coordination with airspace managers. Procedures that are to be deployed into airspace that is in the process of redesign may be delayed unless they can be included as part of the redesign.
- **Air traffic integration**. Procedures that are not well integrated or coordinated with all affected airspace stakeholders during design may impose an impact on air traffic and could have a longer review process.
- **Environmental considerations**. Historically, procedures that require an EIS or EA require greater coordination and longer approval cycles than those that qualify for a CATEX.

5. Key Design Elements of Current Departures at JWA

The operational details of four of the more commonly used departures at JWA are described in this section. Each of these departures is broken down into individual legs and the following components of each leg are examined:

- **Design Path** – Also known as desired path, this is the intended centerline of the procedure. This section offers a brief description of this intended path.
- **Textual Path and System Errors** – This is the textual instruction that the flight crew reads from the navigation chart to determine the actions they must take in order to successfully fly the departure. This section describes the navigation facilities that the flight crew references in order to accomplish the departure, and the various potential system errors that can cause a distribution of actual flight paths over the ground.
- **Coded Path and System Errors** – This is an example of how the procedure could be coded into the FMS and a description of system errors that can cause a distribution of flight paths over the ground.

5.1. CHANNEL ONE RNAV DEPARTURE

The Channel 1 Departure (Figure 5.1) is a traditional Standard Instrument Departure (SID) that utilizes ground-based navigation facilities and is flown by aircraft with destinations to the north and northwest of JWA. Figure 5.2, provided by the City of Newport Beach, is a plot of ADS-B data from actual aircraft flying this departure. It is important to note that although this procedure utilizes ground-based navigation facilities, many suppliers of electronic navigation databases have this procedure coded into the electronic database such that FMS-equipped aircraft have the option of either flying the procedure with reference to the ground-based navigation facilities or using the FMS as the primary means of navigation. Most FMS-equipped operators prefer to utilize the FMS to fly this procedure as it often allows for more precise path definition and a reduction in the distribution of actual flight paths.

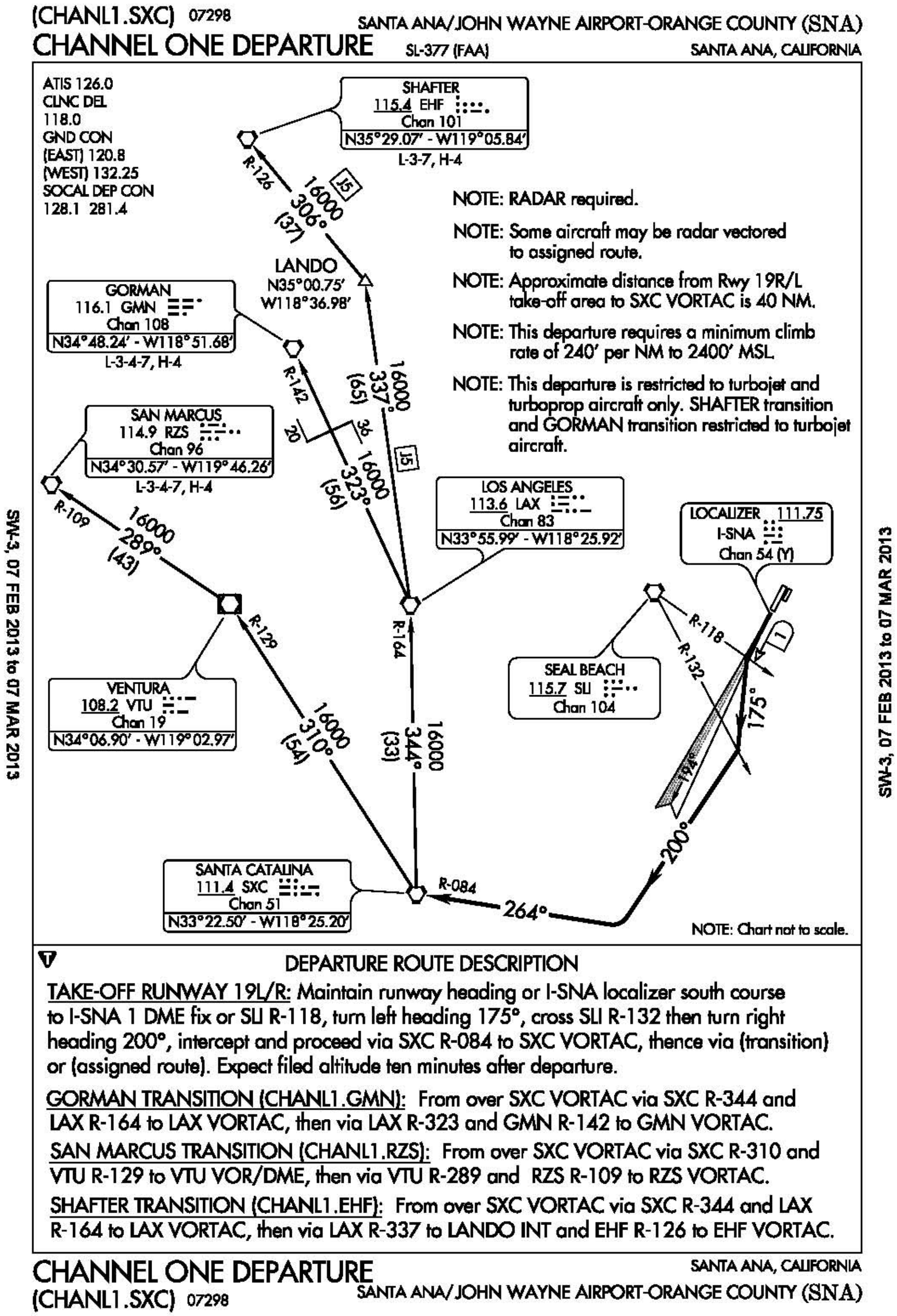

Figure 5.1: FAA Navigation Chart for CHANNEL ONE Departure[15]

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[15] Current FAA navigation charts may be obtained from the FAA website, AeroNav Products Terminal Procedure Publications: http://aeronav.faa.gov/index.asp?xml=aeronav/applications/d_tpp.

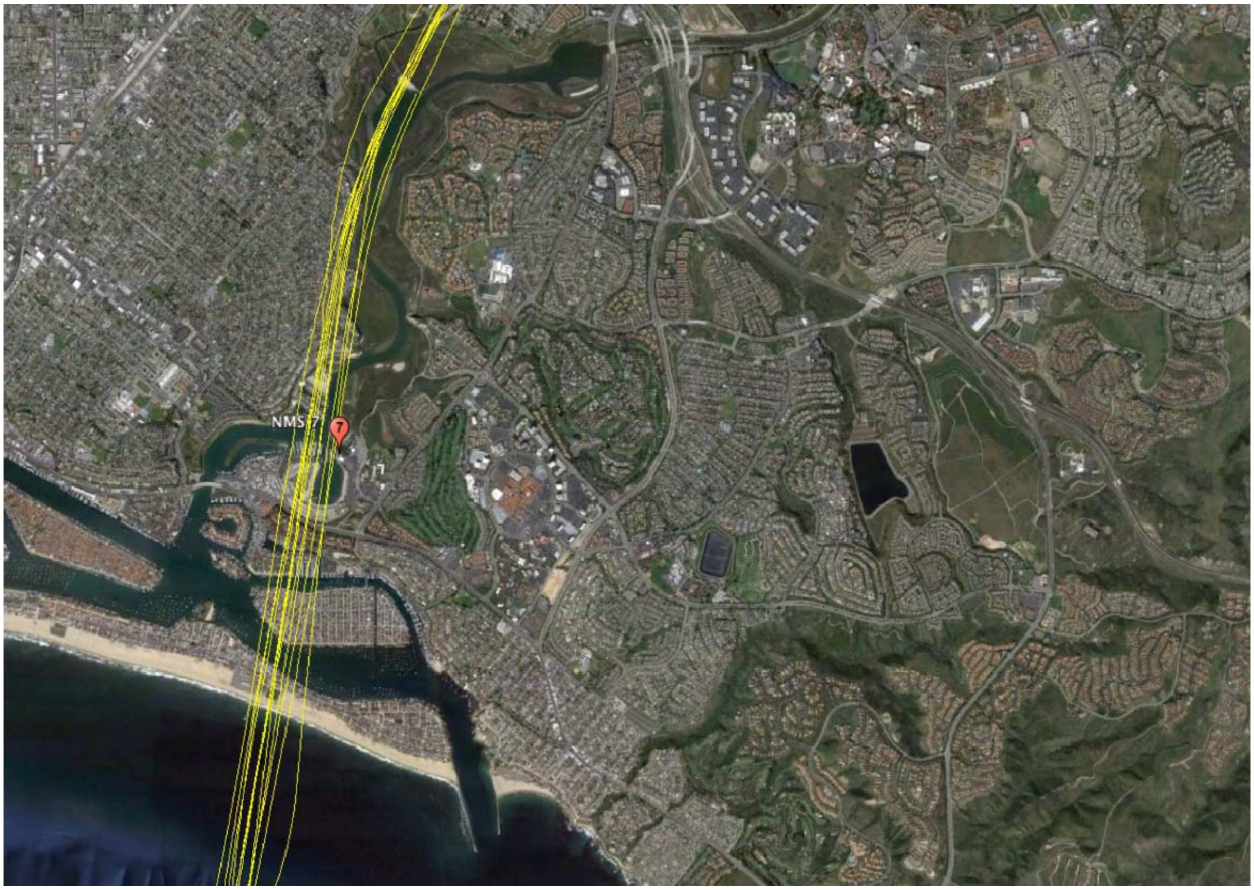


Figure 5.2: Distribution of CHANNEL ONE Flight Paths. Figure courtesy of City of Newport Beach.

The Channel 1 departure consists of a series of legs that take aircraft from the departure end of the runway to a navigation facility on Santa Catalina Island, and then on to airways towards the north and northwest. The first two legs of the departure fly over the Back Bay area and are described below:

Leg 1

- **Design Path**

  A straight segment that originates at the departure end of Runway 19R, is oriented on a true course that approximates a magnetic course of 194 degrees from the end of the runway, and terminates at a point where this course crosses the 118 degree radial of the Seal Beach (SLI R-118) VOR (an electronically generated signal that describes a course line originating at a ground-based navigation station located to the southwest of JWA and extends outward on a magnetic course of 118 degrees from the station), or, 1.0 nautical miles from the ISNA localizer (D1.0 ISNA) (another type of ground-based navigation facility located at the departure end of runway 19R).

- **Textual Path and System Errors / Non-FMS aircraft** – four separate options for flying the first leg are described:
  - Option 1 – *"Maintain runway heading (194 degrees magnetic) to D1.0 ISNA."*

    The heading that is indicated on an aircraft's compass is subjected to a number of variables that can result in different aircraft flying actual headings that are different than the indicated heading, resulting in different aircraft flying different paths. In addition, since the aircraft is flying a heading its actual path over the ground is dependent, in part, on prevailing wind conditions. With winds from the west the actual path will be east of the design centerline, and with winds out of the east the actual path will be west of the design centerline. Due to the inherent inaccuracies of electronic signals generated by ground-based navigation facilities such as the ISNA LOC, the location over the ground of D1.0 ISNA can vary, as well as the indications on the aircraft's navigation displays, meaning that the exact location of the termination of this leg is variable, resulting in aircraft commencing the turn onto the second leg at different points.
  - Option 2 – *"Maintain runway heading (194 degrees magnetic) to SLI R-118."*

    As is the case in option 1 the aircraft is flying a heading and its actual path over the ground is dependent, in part, on prevailing wind conditions resulting in variability to the east and west of the design centerline. Due to the inherent inaccuracies of electronic signals generated by ground-based navigation facilities such as the SLI VOR, the location over the ground of SLI R - 118 can vary, as well as the indications on the aircraft's navigation displays, meaning that the exact location of the termination of this leg is variable resulting in aircraft commencing the turn onto the second leg at different points. This position may also be different than the position described as D1.0 ISNA.
  - Option 3 – *"Maintain ISNA south course to D1.0 ISNA."*

    In this case, the aircraft will fly a fixed 194 degree magnetic course from the ISNA LOC navigation station to the location of D1.0 ISNA. Since the aircraft is flying a fixed course from the station, wind conditions will not have as much influence on the aircraft's path as in option 1 and 2. However, limitations on the aircraft's navigation displays, the inherent variability of the electronic course from the ISNA LOC, and pilot technique all introduce a degree of variability to the actual flight path. In addition, as described above, the location over the ground of D1.0 ISNA can vary, as well as the indications on the aircraft's navigation displays, meaning that the exact location of the termination of this leg is variable resulting in aircraft commencing the turn onto the second leg at different points.
  - Option 4 – *"Maintain ISNA south course to SLI R-118."*

    This is a combination of Option 1 and 3 with a combination of actual flight path variations described in those cases.

- **Coded Path and System Errors / FMS-equipped aircraft**

  If flight crews elect to fly this procedure using the FMS, many of the errors described above related to magnetic headings and location of turn points based on ground-based navigation facilities are eliminated. However, there are still a number of potential error sources. Because this procedure is defined by ground-based navigation facilities (Non-RNAV), the exact manner in which it is coded into the database may vary between suppliers of electronic navigation data. In general, suppliers attempt to create an electronic path that closely matches the intended design path and textual description. Although 4 different textual options are indicated, only one electronic path is coded into any individual supplier's navigation data base. One possible method is to construct a waypoint at a location that overlays the design location of D1.0 ISNA, and construct a 194 Course to Fix leg (CF) into that waypoint. The intent is to closely match the design centerline and have aircraft follow a path over the ground that is representative of Option 3 described above. Since the path is coded into the FMS it does not exhibit the same degree of variability as that generated by the ground-based navigation facilities. However, it should be noted that the CF leg type exhibits variability in the defined path as described in Section 4.4.2 of this report.

Leg 2

- **Design Path**

  A second straight segment that originates at the termination of the previous segment, is oriented along a true course that approximates a magnetic course of 175 degrees, and terminates at a point where this course crosses the 132 degree radial of the SLI VOR.

- **Textual Path and System Errors / Non-FMS aircraft** – "*Turn Left to a 175 degree heading, cross SLI-132 then turn right…*"

  At the termination of the previous leg, the aircraft turns to a 175 degree heading. As described on the previous leg, the point at which the aircraft begins the turn to a 175 degree heading varies. Once established on the 175 heading the actual path over the ground for each aircraft can vary due to wind conditions and variables in an aircraft's magnetic heading displays as previously described. Due to the inherent inaccuracies of electronic signals generated by ground-based navigation facilities such as the SLI VOR, the location over the ground of SLI R - 132 can vary, as well as the indications on the aircraft's navigation displays, meaning that the exact location of the termination of this leg is variable resulting in aircraft commencing the turn onto the third leg at different points.

- **Coded Path and System Errors / FMS-equipped aircraft**

  As on the previous leg, because this procedure is defined by ground-based navigation facilities (non-RNAV), the exact manner in which it is coded into the database may vary between suppliers of electronic navigation data. One possible method is to code this leg as a Heading to Radial leg (VR). In this case the aircraft will begin a turn to a 200 degree heading when it crosses the FMS's generated position of the SLI R-132. Although the FMS may generate a more consistent and accurate position of the SLI-R132 than the VOR itself, it is still subject to a degree of variability.

5.2. MUSEL SIX DEPARTURE

The Musel Six Departure (Figure 5.3) is a traditional Standard Instrument Departure (SID) that utilizes ground-based navigation facilities and is flown by aircraft with destinations to the east, northeast and southeast of JWA. Figure 5.4, provided by the City of Newport Beach, is a plot of ADS-B data from actual aircraft flying this departure. Like the Channel Departure, this procedure utilizes ground-based navigation facilities, however, many suppliers of electronic navigation databases have this procedure coded into the electronic database and most FMS-equipped operators prefer to utilize the FMS to fly this procedure. The departure consists of a series of legs that take the aircraft from the departure end of the runway to a navigation fix known as MUSEL (located over the water 13 nautical miles south of the John Wayne Airport) and then on to airways towards the east, northeast and southeast. The first 2 legs of the departure fly over the Back Bay area and are described below:

Leg 1

- All elements of this leg are the same as Leg 1 of the Channel departure described above and result in the same potential distribution of actual flight paths.

Leg 2

- **Design Path**

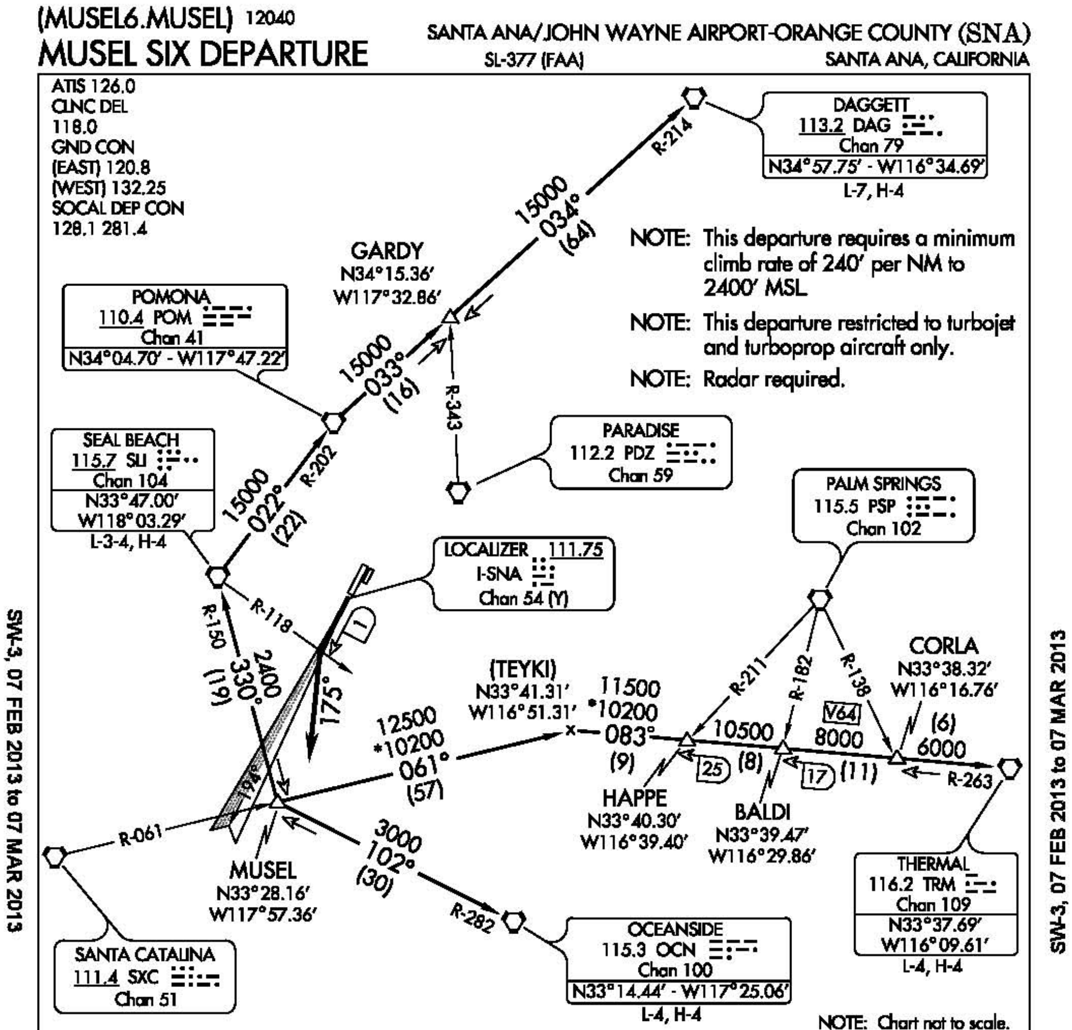
  A second straight segment that originates at the termination of the previous segment, is oriented along a true course that approximates a magnetic course of 175 degrees, and terminates at the MUSEL waypoint.

- **Textual Path and System Errors / Non-FMS aircraft** – *"Turn Left to a 175 degree heading, for RADAR vectors to MUSEL."*

  As described previously, the point at which the aircraft begins the turn to a 175 degree heading varies as well as the path over the ground while established on the 175 degree heading. The aircraft remains on this heading until air traffic control assigns the aircraft to proceed direct to MUSEL waypoint. Since the point at which controllers assign the aircraft to proceed to MUSEL is based on many variables, it is essentially indeterminate, resulting in a potentially large scatter of actual paths over the ground.

- **Coded Path and System Errors / FMS-equipped aircraft**

  As on the previous leg, because this procedure is defined by ground-based navigation facilities (Non-RNAV), the exact manner in which it is coded into the database may vary between suppliers of electronic navigation data. One possible method that most closely resembles the textual description and is essentially identical to the Non FMS methodology described above is to code this leg as a Heading to Manual termination leg (VM) In this instance the aircraft turns to a 175 degree heading and remains on this heading until air traffic control assigns the aircraft to proceed direct to MUSEL waypoint. Since the point at which controllers assign the aircraft to proceed to MUSEL is based on many variables, it is essentially indeterminate, resulting in a potentially large distribution of actual paths over the ground.



DEPARTURE ROUTE DESCRIPTION

TAKE-OFF RUNWAY 19L/R: Maintain runway heading or I-SNA localizer south course to I-SNA 1 DME fix or SLI R-118, turn left heading 175° for radar vectors to MUSEL INT, then via (transition) or (assigned route). Expect filed altitude ten minutes after departure.

DAGGETT TRANSITION (MUSEL6.DAG): From over MUSEL INT via SLI R-150 to SLI VORTAC, then via SLI R-022 and POM R-202 to POM VORTAC, then via POM R-033 and DAG R-214 to DAG VORTAC.

OCEANSIDE TRANSITION (MUSEL6.OCN): From over MUSEL INT via OCN R-282 to OCN VORTAC.

SEAL BEACH TRANSITION (MUSEL6.SLI): From over MUSEL INT via SLI R-150 to SLI VORTAC.

THERMAL TRANSITION (MUSEL6.TRM): From over MUSEL INT via SXC R-061 and TRM R-263 to TRM VORTAC.

MUSEL SIX DEPARTURE (MUSEL6.MUSEL) 12040
SANTA ANA, CALIFORNIA
SANTA ANA/JOHN WAYNE AIRPORT-ORANGE COUNTY (SNA)

Figure 5.3: FAA Navigation Chart for MUSEL SIX Departure

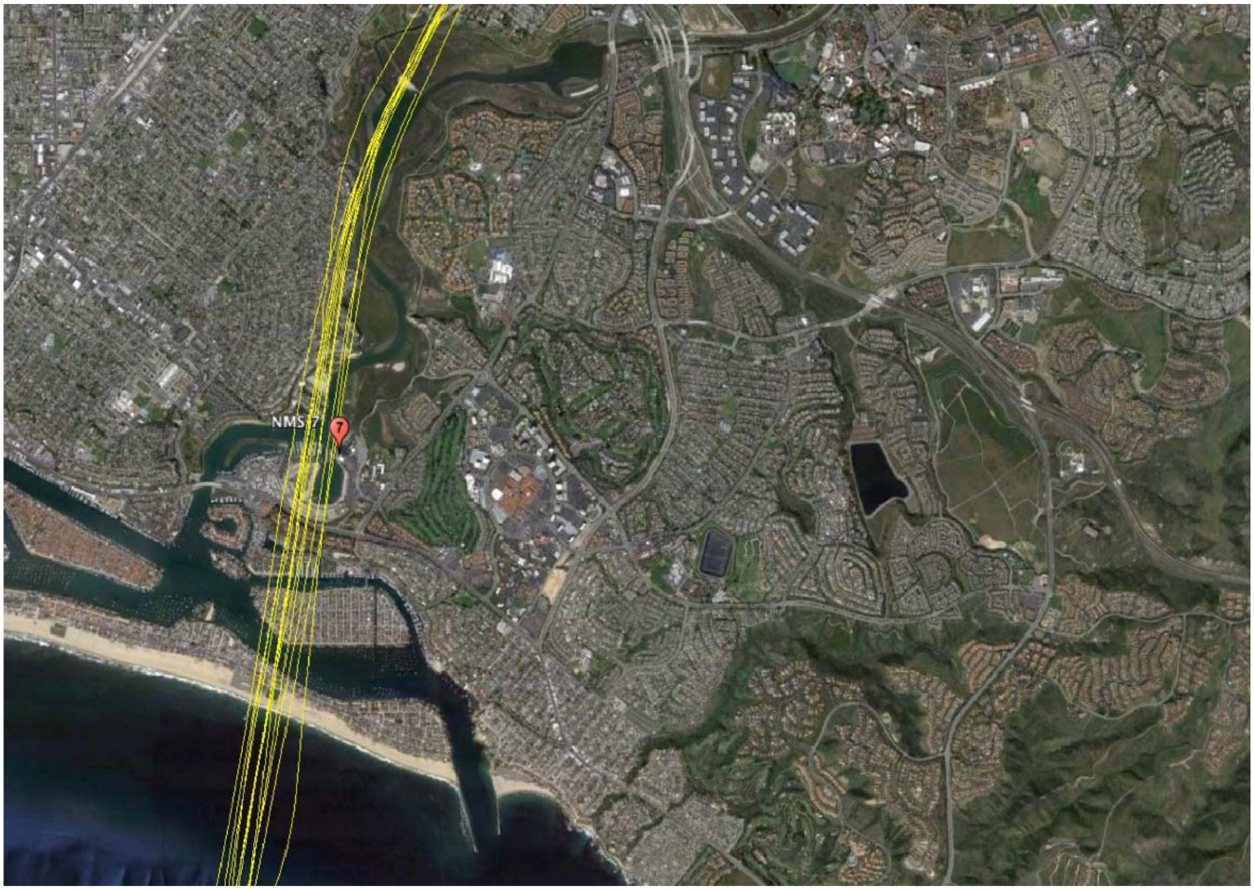


Figure 5.4: Distribution of MUSEL SIX Flight Paths. Figure courtesy of City of Newport Beach.

5.3. DUUKE TWO RNAV DEPARTURE

The (DUUKE 2 RNAV Departure (Figure 5.5) is a PBN (RNAV specification) Standard Instrument Departure (SID) that utilizes the FMS and other PBN enabling avionics onboard the aircraft, and is flown by aircraft with destinations to the east of JWA. There is a widespread community perception that aircraft flying this departure produce flight paths that are more concentrated and that directly overfly communities on the east side of the Back Bay than the traditional departures. The departure consists of a series of legs that the take aircraft from the departure end of the runway to a navigation fix known as PIGGEN (approximately 20 miles east of JWA) and then on to airways towards the east. The first two legs of the departure fly over the Back Bay area and are described below:

Leg 1

- **Design Path**

  A straight segment that originates at the departure end of Runway 19R, is oriented on a true course that approximates a magnetic course of 194 degrees from the end of the runway, and terminates at a point where this course intercepts a true course that approximates a magnetic course of 175 degrees into the DUUKE waypoint.

- **Textual Path, Coded Path and System Errors / FMS aircraft** - *"Climb heading 194 to intercept course 175 to DUUKE.*

  The first leg is coded as a Heading to Intercept (VI) requiring that the aircraft fly a magnetic heading of 194 degrees until intercepting the 175 course into the DUUKE waypoint. As described in Section 4.4.4, since the VI leg commands a magnetic heading, the aircraft's path over the ground, in part, is dependent on wind conditions and variations in the aircraft's magnetic compass system. In addition, the point at which the aircraft begins the turn towards DUUKE varies depending on the aircraft's speed over the ground. Faster airplanes will turn earlier than slower airplanes, resulting in a distribution of paths over the ground.

Leg 2

- **Design Path**

  A second straight segment that originates at the termination of the previous segment, is oriented along a true course that approximates a magnetic course of 175 degrees, into the DUUKE waypoint and terminates at the DUUKE waypoint.

- **Textual Path, Coded Path and System Errors / FMS aircraft** - *"...... intercept course 175 to DUUKE then on depicted route to PIGGN"*

  The second leg is coded as a Course to Fix (CF) into the DUUKE waypoint. The DUUKE waypoint is located over the water approximately 6 nautical miles south of JWA. The CF leg type exhibits variability and a scattering of paths over the ground as described in Section 4.4.2of this report.

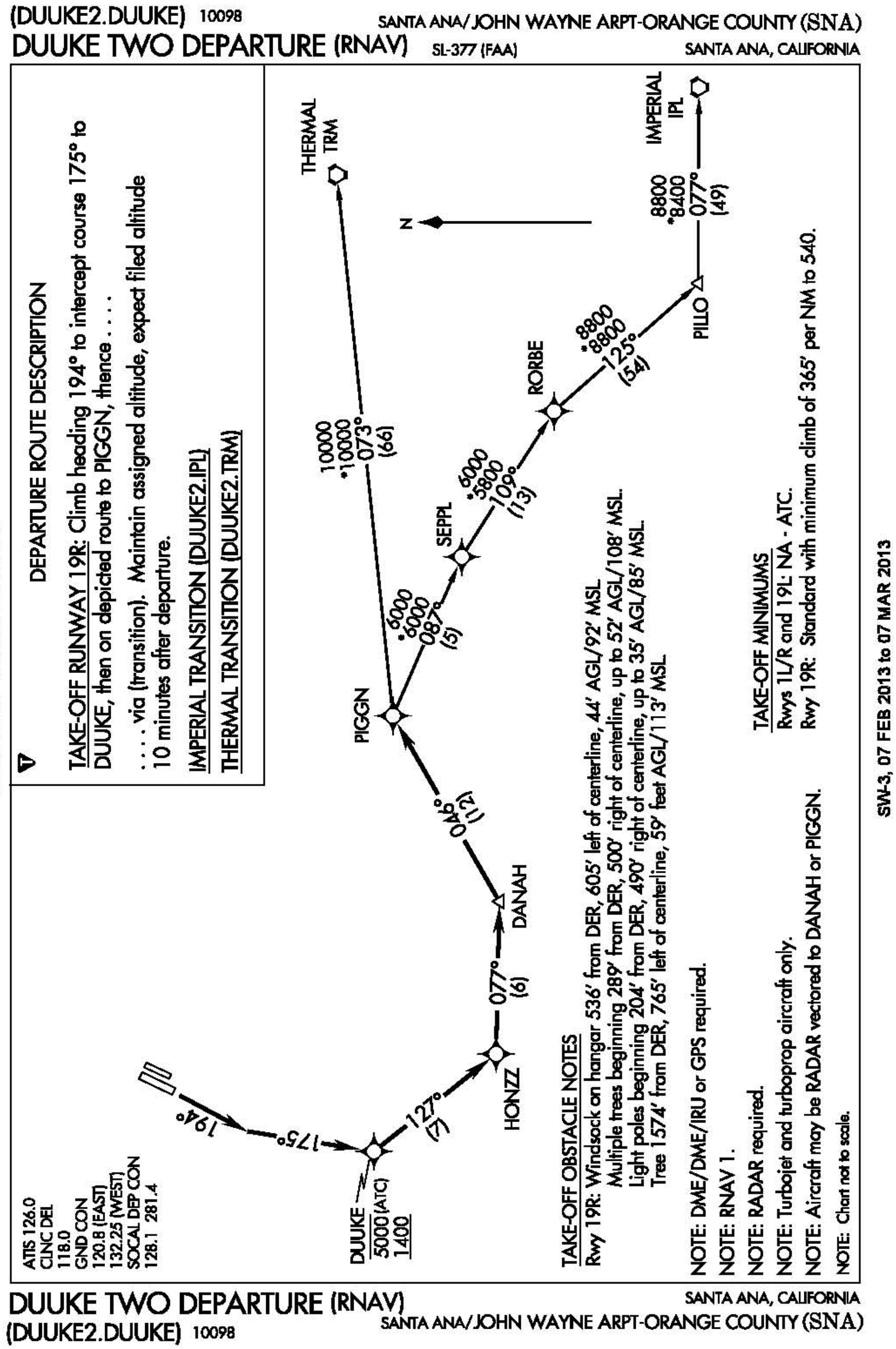


Figure 5.5: FAA Navigation Chart for DUUKE TWO RNAV Departure

5.4. STREL ONE DEPARTURE

The STREL 1 RNAV Departure (Figure 5.6) is a PBN (RNAV specification) Standard Instrument Departure (SID) that utilizes the FMS and other PBN enabling avionics onboard the aircraft, and is flown by aircraft with destinations to the east of JWA. Figure 5.7, provided by the City of Newport Beach, is a plot of ADS-B data from actual aircraft flying this departure. The departure was created, in part, to attempt to adjust the path of the DUUKE 2 RNAV departure to more closely align the design path with the center of the Back Bay when compared to the DUUKE 2 departure. There is a widespread community perception that aircraft flying this departure produce flight paths that are more concentrated and that directly overfly communities on the west side of the Back Bay when compared to the traditional departures and DUUKE departure. The departure consists of a series of legs that take aircraft from the departure end of the runway to a navigation fix known as PIGGEN (approximately 20 miles east of JWA) and then on to airways towards the east. The first three legs of the departure fly over the Back Bay area and are described below:

Leg 1

- **Design Path**

  A straight segment that originates at the departure end of Runway 19R, is oriented on a true course that approximates a magnetic course of 194 degrees from the end of the runway, and terminates at a point where this course intercepts a true course that approximates a magnetic course of 173 degrees into the TOING waypoint.

- **Textual Path, Coded Path and System Errors / FMS aircraft** - *"Climb heading 194 to intercept course 173 to TOING"*

  The first leg is coded as a Heading to Intercept (VI) requiring that the aircraft fly a magnetic heading of 194 degrees until intercepting the 173 course into the TOING waypoint. As described in Section 4.4.4, since the VI leg commands a magnetic heading, the aircraft's path over the ground, in part, is dependent on wind conditions and variations in the aircraft's magnetic compass system. In addition, the point at which the aircraft begins the turn towards TOING varies depending on the aircraft's speed over the ground. Faster airplanes will turn earlier than slower airplanes, resulting in a distribution of actual paths over the ground.

Leg 2

- **Design Path**

  A second straight segment that originates at the termination of the previous segment, is oriented along a true course that approximates a magnetic course of 173 degrees, into the TOING waypoint and terminates at the TOING waypoint. The TOING waypoint is coded as a flyover waypoint and located to be coincident with noise monitor 7. The intent of the design is to ensure that all aircraft directly overfly this noise monitor.

- **Textual Path, Coded Path and System Errors / FMS aircraft** – *"... then on track 173 degrees to cross..."*

  The second leg is coded as a Course to Fix (CF) into the TOING waypoint. The CF leg type exhibits variability and a distribution of actual paths over the ground as described in Section 4.4.2 of this report.

Leg 3

- **Design Path**

  A third straight segment that originates at the TOING waypoint and terminates at the STREL waypoint. The STREL waypoint is located approximately 0.1 nautical miles to the east of the DUUKE waypoint.

- **Textual Path, Coded Path and System Errors / FMS aircraft** - *"...then on track 173 degrees to cross..."*

  The third leg is coded as a Track to Fix (TF) into the STREL waypoint. Since the TOING waypoint is coded as a flyover, aircraft will not make any turn towards the STREL waypoint until past TOING. If the true tracks into TOING and into STREL are not exactly aligned with each other, aircraft will make minor path adjustments after crossing the TOING waypoint.

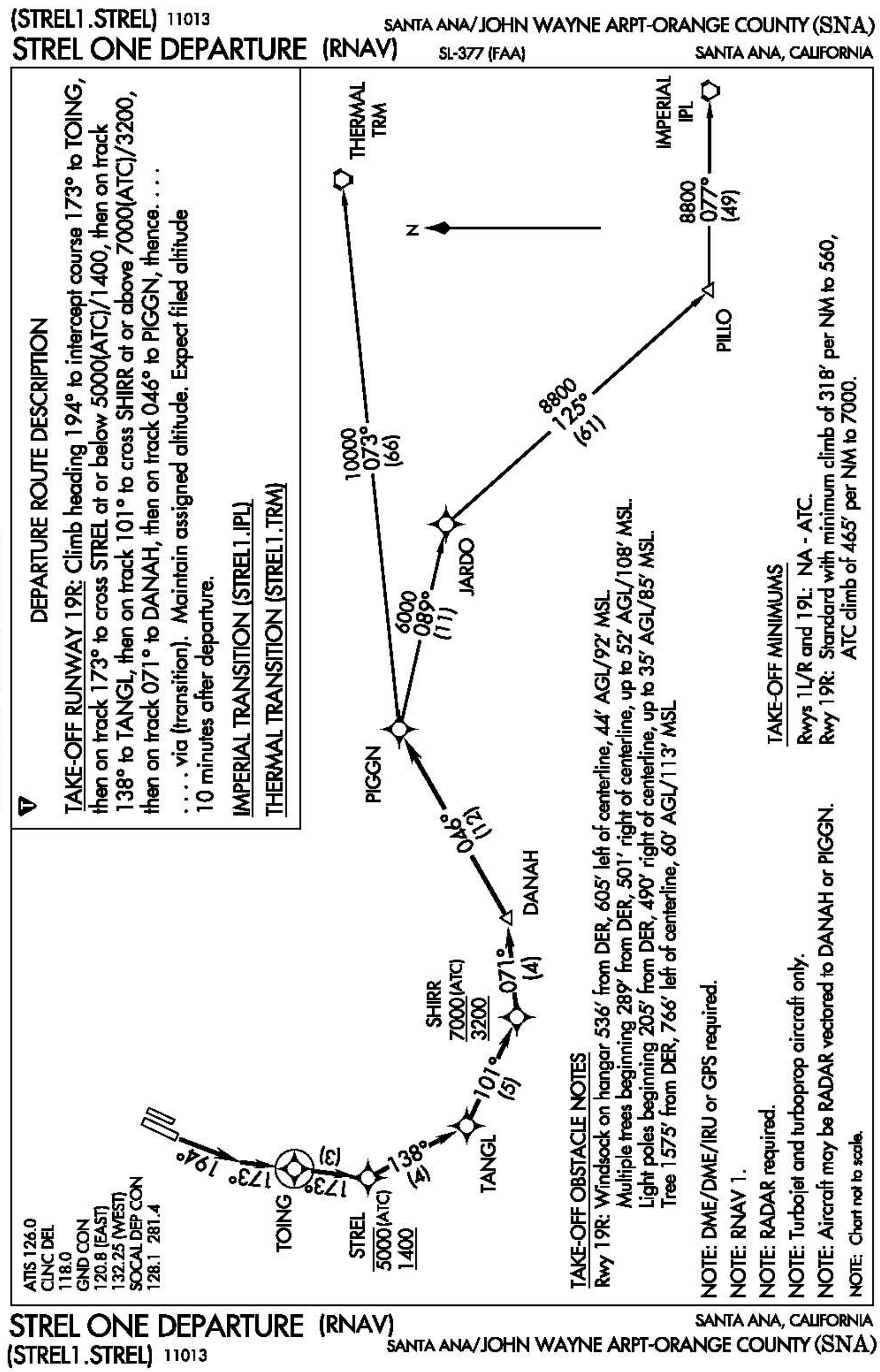


Figure 5.6: FAA Navigation Chart for STREL ONE RNAV Departure

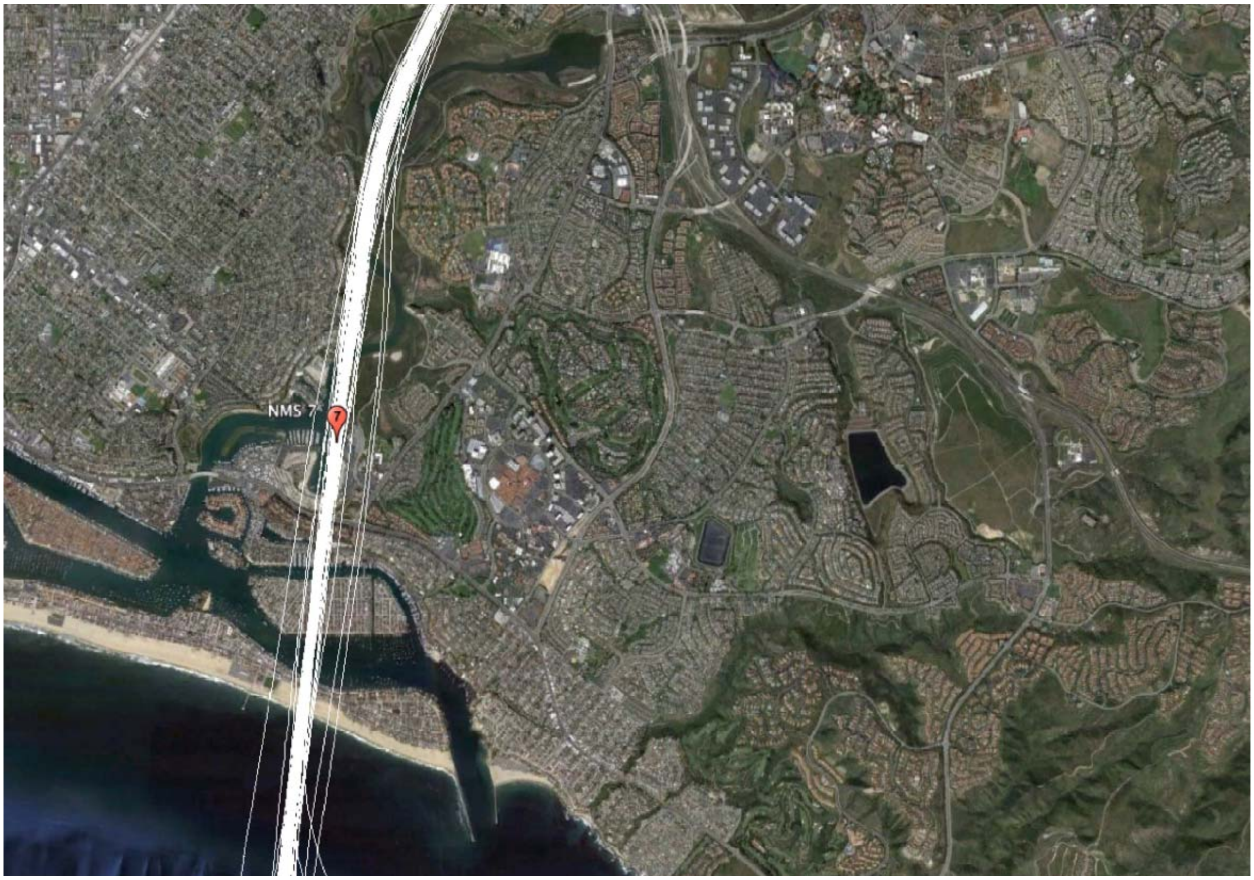


Figure 5.7: Distribution of STREL ONE RNAV Flight Paths. Figure courtesy of City of Newport Beach.

6. Flight Path Design Options at JWA

6.1. Design Objectives

In accordance with the statement of work, and in consideration of the issues detailed in this report, GE Aviation has determined that the optimum design objective is to make changes to the proposed RAWLZ departure that could be implemented in the next 12 to 24 months and meet the following requirements:

- **Path definition**. The departure procedure should reduce the potential over flight of the areas to the east and west of the Back Bay by following a path that is located based on input from the City of Newport Beach.
- **Procedure design criteria**. To the maximum extent possible the modifications should be compliant with FAA Order 8260.58 with a minimum number of waivers.
- **Electronic navigation data**. To the maximum extent possible the changes should conform to ARINC 424 requirements and adaptable to processes currently used by the suppliers of electronic navigation data.
- **Aircraft capabilities**. The departure procedure should be available to the majority of passenger carrying aircraft operating at JWA, without the need for operators to invest in new capabilities.
- **Operational approval**. Authorization to fly the departure procedure should be via Operations Specifications (OPSPEC) C063 (RNAV and RNP Terminal Operations).
- **Airspace integration**. The departure procedure should not require any changes to the existing airspace or known proposed future changes to the airspace.
- **Air traffic integration**. The departure procedure should require only minimal changes to the exiting air traffic control procedures used at JWA for departing aircraft.
- **Environmental considerations**. The departure procedure should be in full compliance with the Settlement Agreement and Phase 2 Access Plan. In addition, it should be designed so that it either qualifies for a CATEX or FONSI.
- **Procedure approval and publication**. The departure should be designed so that it can be approved and published through FAA IFP processes currently in place.

6.2. Design Options

After careful review and examination of the issues described in this report, two basic options emerged that could satisfy the stated objective. Both options are a compromise between the constraints and entail risk to the implementation time line. Each of these options and attendant risks are summarized in Table 6.1 and discussed in the following sections.

6.2.1. Diverse Departure Paths

As described in this report, aircraft flying traditional IFPs designed for use with ground-based navigation facilities operating older generation avionics have relatively large lateral deviations from the intended centerline of the flight path (TSE). This lack of precision in path control results in a dispersion or "fanning out" of actual aircraft paths along an "overflight corridor." Although this random dispersion of aircraft results in a larger percentage of the underlying population being exposed to direct overflight, each individual location along this corridor is exposed to only a fraction of the total aircraft flying the procedure. At JWA these departures have included the MUSEL and CHANNEL departures among others.

Aircraft flying PBN IFPs operating current generation avionics have a substantial reduction in the amount of lateral deviation from the design centerline and a much narrower "overflight corridor". This reduction in the dispersion of flight paths results in a concentration of overflights where a smaller percentage of the underling area is being exposed to direct overflight of every aircraft flying the procedure.

In some instances the "fanning effect" that traditional IFPs created may be a more desirable noise mitigation technique than the concentration that results from of a single PBN procedure. The fanning effect can be achieved by designing multiple flight paths using the Radius to Fix (RF) path terminator that begin at the departure end of the runway and terminate at a common waypoint as shown in Figure 6.1. This notional design shows three separate paths. Aircraft could fly any of the three paths based on a number of variables including time of day, day of week, or assigning a sequence of departing aircraft alternating tracks.

Figure 6.1: Notional Diverse Departure

This option represents a novel operational concept that has never been implemented in the United States and therefore has a number of potential risks, including:

- Define desired path – A consensus would need to be developed among stake holders, including residents of the surrounding communities, as to the number of paths that should be created and where they should be located.
- Procedure design criteria – The current FAA Order 8260.58 does not have provisions for using the RF leg type in the design of departures.
- Electronic navigation data – The path geometry may not conform to the current ARINC 424 standard or be allowed under the process used by some suppliers of electronic navigation data.
- Aircraft capabilities - The requirements described in AC 90-100A and AC 90-105 are based on enabling aircraft to fly departure procedures designed in accordance with FAA Order 8260.58 which does not include specific guidance on the use of the RF leg type, or the concept of multiple paths, in the design of departures. Regulatory provisions may need to be created describing how authorities could ensure that aircraft approved to conduct these types of operations have the proper capabilities.

- Operational capabilities and approval – Because of the unique nature of this operating concept, the approval may need to be granted under the provisions of OPSPEC C081 (Special Non CFR 14 Part 97 Procedures). This authorization could require the development of a number of operational provisions and procedures, and would require each air carrier to seek and gain approval through their respective Certificate Management Offices (CMO), potentially delaying wide use of the procedure.
- Airspace and air traffic integration – The mechanisms for assigning different departures to different aircraft would need to be developed and would require input and consensus from the surrounding communities, John Wayne Airport, airspace and air traffic managers, and participating airlines. This effort could take a substantial amount of time due to the unique nature of the operational concept.
- Environmental process – The procedure may require that an Environmental Assessment be conducted due to the unique nature of the operational concept and the ultimate design location of the flight paths.

6.2.2. Single Path Departure

This option would employ the use of the Radius to Fix (RF) leg type to engineer a single departure path that closely follows the center of the Newport Back Bay that avoids, to the maximum extent possible, direct over flight of noise sensitive areas to the east and west of the bay. This option has significantly less operational implementation risk than the diverse departures option:

- Define desired path – A consensus would need to be developed among stake holders, including residents of the surrounding communities, as to where the design path should be located.
- Procedure design criteria – The current FAA Order 8260.58 does not have provisions for using the RF leg type in the design of departures.
- Electronic navigation data – The path geometry may not conform to the current ARINC 424 standard or be allowed under the process used by some suppliers of electronic navigation data.
- Aircraft capabilities - The requirements described in AC 90-100A and AC 90-105 are based on enabling aircraft to fly departure procedures designed in accordance with FAA Order 8260.58 which does not include specific guidance on the use of the RF leg type in the design of departures. Regulatory provisions may need to be created describing how authorities could ensure that aircraft approved to conduct these types of operations have the proper capabilities.
- Operational approval – Approval could be granted under OPSPEC C063 (RNAV and RNP Terminal Operations) however, this OPSPEC has no provisions regarding flying departures that use the RF leg type.
- Airspace and air traffic integration – The integration risks of this procedure would be the same as for the currently proposed RAWLZ departure.
- Environmental process – The procedure should qualify for a CATEX.

- Operational implementation – The implementation process would be substantially similar to the process that would be used for the current proposed RAWLZ DP.

Table 6.1: Relative Risk Matrix

COMPLIANCE ELEMENT	RISK OF DIVERSE DEPARTURE	RISK OF SINGLE PATH DEPARTURE
Define Desired Path	MEDIUM	MEDIUM
Procedure Design Criteria	MEDIUM	MEDIUM
Electronic Navigation Data	MEDIUM	LOW/MEDIUM
Aircraft Capabilities	LOW/MEDIUM	LOW
Operational Approval	MEDIUM	LOW
Airspace Integration	MEDIUM	LOW
Air Traffic Integration	LOW/MEDIUM	LOW
Environmental Process	LOW/MEDIUM	LOW
Regulatory Process	MEDIUM/HIGH	LOW/MEDIUM

7. Recommended Solution - Modified RAWLZ Departure

Based on the design objectives and implementation risks described, GE Aviation recommends modifying the proposed RAWLZ departure using the RF leg type to design a single path RNP departure that follows the center of the Newport Back Bay from the departure end of the runway to open water. The path should be designed to avoid the populated areas on both the east and west side of the bay. The city of Newport Beach should provide appropriate detail to the procedure designers as to the desired location of the path.

7.1. Implementation Strategy

7.1.1. Location of Departure Path

The City of Newport Beach should provide appropriate detail to the FAA regarding the desired location of the departure path. This input should be based on engaging the communities surrounding the Back Bay and developing a consensus on the optimum location for the path. Details should be provided to the FAA in a mutually acceptable format.

7.1.2. Procedure Design Criteria and Approval

All elements of the modified departure should conform to the criteria used to design the current proposed RAWLZ departure with the following exceptions:

- Waiver the required departure leg types to allow for a series of RF legs beginning not later than 1.0 nm past the departure end of the runway and extending out towards the proximate location of the current STREL waypoint.
- Construct the RF legs and Obstacle Evaluation Area (OEA) in accordance with FAA Order 8260.58, Volume 6, Chapter 1.3.3 with waivers as necessary to allow for a combination of connected, opposite direction RF legs.

An equivalent level of safety case can be developed for these waivers based on the following:

- FAA Order 8260.58 allows for the use of RF legs in approach procedure design.
- The current RNAV (RNP) Rwy19 approach procedure at Ronald Reagan Washington National Airport (KDCA) employs waivers to the procedure design criteria to allow back to back RF turns on the final approach segment and has been operated successfully for a number of years.
- Previously demonstrated operational experience. The RF leg type has been used in PBN departure procedure design in regions around the world for nearly a decade using the ICAO Pans Ops design standards. These procedures are in operation in Australia, New Zealand, China and Peru and serve a diverse array of airlines flying a wide variety of transport aircraft including many of the types serving JWA.

7.1.3. Electronic Navigation Data

A number of the industry's largest suppliers of electronic navigation data currently provide airlines with departure procedures that use the RF leg type in other regions of the world. Although these suppliers should be capable of doing the same for airline customers in the United

States, procedure designers will need to coordinate with navigation data suppliers to ensure that those suppliers have the appropriate processes in place for coding RF legs on departures designed in accordance with waivered FAA criteria.

7.1.4. Aircraft Capabilities

The majority of the airline aircraft currently serving JWA should be capable of flying the modified procedure without any modifications or upgrades to existing equipment.

7.1.5. Operations Approval

Operators could be authorized to fly the modified procedure via OPSPEC C063. Airlines flying the current RNAV departures at JWA should already have this OPSPEC.

In order for regulators and operators to understand that the departure uses RF legs, and to apply the appropriate operational procedures necessary to fly RF legs, the navigation chart should be published with the note “RF Required”. FAA Order 8260.58 Volume 3 already requires PBN departure navigation charts to be published with similar equipment requirement notes.

7.1.6. Airspace and Air Traffic Integration

The modified procedure should not require any additional integration effort than would be required by the current proposed RAWLZ departure.

7.1.7. Environmental Process

The modified procedure should qualify for a Categorical Exclusion (CATEX). FAA Order 1050.1 SEC 311 lists categorical exclusions for FAA actions and includes the “establishment of GPS, FMS or essentially similar systems that overlay existing procedures.” The design path of the modified procedure should be within the lateral limits of the current departure procedures in operation of JWA. This could be substantiated during the design process through the use of historical radar data.

8. Requirements Summary

Path Definition

- Community engagement
- Mutually acceptable formats

Design Criteria

- FAA Order 8260.58 - PBN Instrument Procedure Design with WaiversFAA Order 8260.19 – Flight Procedures and Airspace
- FAA Order 8260.3 –United States Standard for Terminal Instrument Procedures (TERPS)
- FAA Order 8260.46D–Departure Procedure Program
- FAA Order 8260.44A – Civil Utilization of Area Navigation (RNAV) Departure Procedures
- FAA Order 1050.1 – Environmental Impacts: Policies and Procedures

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Electronic Navigation Data

- ARINC 424 with possible exceptions
- Coordination required with navigation data suppliers

Aircraft Capabilities

- AC 90-100A U.S. Area Navigation (RNAV)
- AC 90-105 RNP Operations

Operational Approval

- OPSPEC C063
- AC 90-100A U.S. Area Navigation (RNAV)
- AC 90-105 RNP Operations

Airspace and Air Traffic Integration

- Substanially similar to current proposed RAWLZ

Environmental Process

- FAA Order 1050.1 Environmental Impacts: Policies and Procedures
- Categorical Exclusion (CATEX)
- Finding of No Significant Impact (FONSI)

9. Next Steps

If the recommendations presented in this report are acceptable, The City of Newport Beach should engage the FAA through a response to their request for feedback on the proposed RAWLZ RNAV Departure. The response should have the following objectives:

1) Communicate the City's desire to have the proposed RAWLZ modified using the RF leg type that is designed, to the maximum extent possible, to follow a path defined by the City of Newport Beach through community engagement.
2) Propose to the FAA the implementation strategy described in this report.
3) Request a response from the FAA that communicates their acceptance of the proposal and any concerns they may have.
4) Provide for follow-up activities to develop a project framework and establish the mechanism that the City should use to define and communicate the location of the desired flight path.

Recommended language for the response is included in Appendix A: Proposed Language.

Appendix A: Proposed Language

Following is suggested text for portions of the written response from the City of Newport Beach to the FAA:

"In response to your request for the City of Newport Beach to review the proposed RAWLZ RNAV departure, the City has conducted an analysis of recently published criteria related to performance-based navigation (PBN) instrument procedure design, the technical issues related to design and implementation of PBN departure procedures, and the legal challenges surrounding operations at John Wayne Airport. The City believes that as a part of the FAA's NextGen plan, an opportunity exists to improve upon the long-standing issues related to noise mitigation at John Wayne Airport by modifying the proposed RAWLZ RNAV departure to take advantage of the recently published FAA Order 8260.58 PBN Instrument Procedure Design criteria. The City is requesting that the FAA consider the following:

- Modify the proposed RAWLZ RNAV departure using the RF leg type to design an RNP departure that follows the center of the Back Bay from the departure end of the runway to open water. The path should be designed to avoid the populated areas on both the east and west side of the bay. The city of Newport Beach, through community engagement, could provide appropriate detail to the procedure designers as to the desired location of the path.
- All elements of the modified departure should conform to the criteria used to design the current proposed RAWLZ departure with the following exceptions:
    - Waiver the required departure leg types to allow for a series of RF legs beginning not later than 1.0 NM past the departure end of the runway and extending out towards the proximate location of the current STREL waypoint.
    - Construct the RF legs and obstacle evaluation area (OEA) in accordance with FAA Order 8260.58, Volume 6, Chapter 1.3.3 with waivers as necessary to allow for a combination of connected, opposite direction RF legs.
- Ensure that the design path remains within the lateral bounds of the current departures being flown at JWA.
- Publish the procedure as an RNP-1 with the additional procedure note: "RF required."
- Operators could be authorized to fly the procedure via OPSPEC C063. Air carriers currently flying RNAV departures at JWA should already have this authorization.
- The procedure should qualify as a Categorical Exclusion under FAA Order 1050.1 SEC 311. This could be substantiated during the design and review process through the use of historical radar data.

The proposed modifications should not require a substantially higher level of coordination and review with airspace managers and stakeholders than the current proposed RAWLZ RNAV departure. The majority of air carriers flying RNAV departures at JWA are currently equipped with the enabling avionics to fly a departure procedure with RF legs.

We are looking forward to your consideration of this input. We suggest having a discussion on how we could develop a project framework and establish the mechanism that the City should use to define and communicate the location of the desired flight path.

Appendix B: Community Engagement

On February 7 2013 GE Aviation met with the following representatives from the City of Newport Beach and individuals from surrounding communities and organizations to better understand concerns related to the current and proposed departures.

NAME	AFFILIATION
Dave Kiff	**City Manager City of Newport Beach**
Tom Edwards	**City of Newport Beach**
Tom Anderson	**Area Resident**
Lee-Ann Bowman	**Area Resident**
Tony Khoury	**AWG**
Martin Kraty	**Area Resident**
Khan Nguyen	**City of Costa Mesa**
Bonnie ONeil	**Area Resident**
Bob Taylor	**Area Resident**
Karen Tringali	**Corona Del Mar**

Appendix C: RF Leg Path Distribution Analysis

The following graphics represent data collected by GE Aviation as part of an analysis to quantify the total lateral path distribution of aircraft RNP approaches on RF legs. Figure C.1 depicts aircraft position relative to the design centerline of the RF legs. The position information was derived from derived from radar data and ADS-B data. Figure C.2 is a close-up of the bottom portion of Figure C.1 that shows more detail. Figure C.3 is a histogram of the lateral path deviation from the design path.

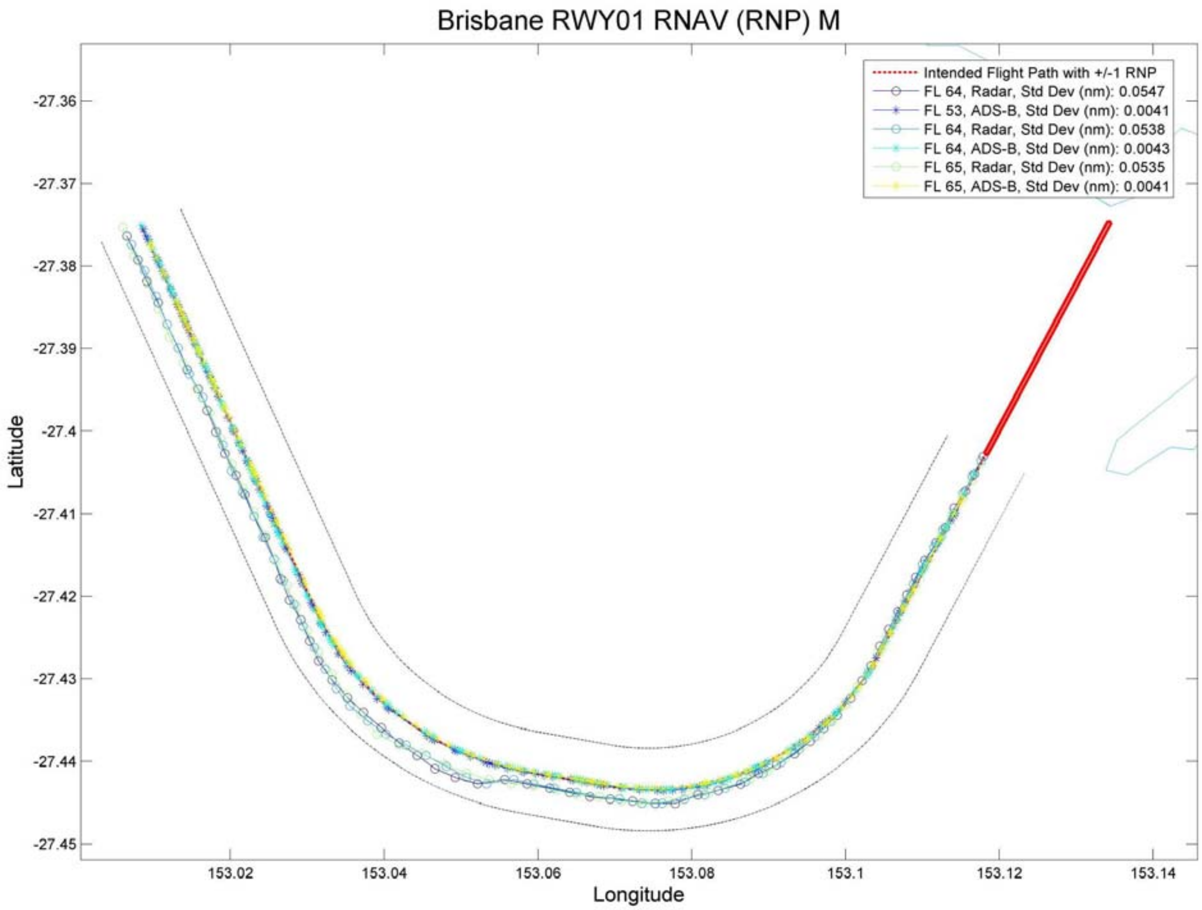

Figure C.1: Aircraft Position Relative to Design Path Centerline (radar and ADS-B data)

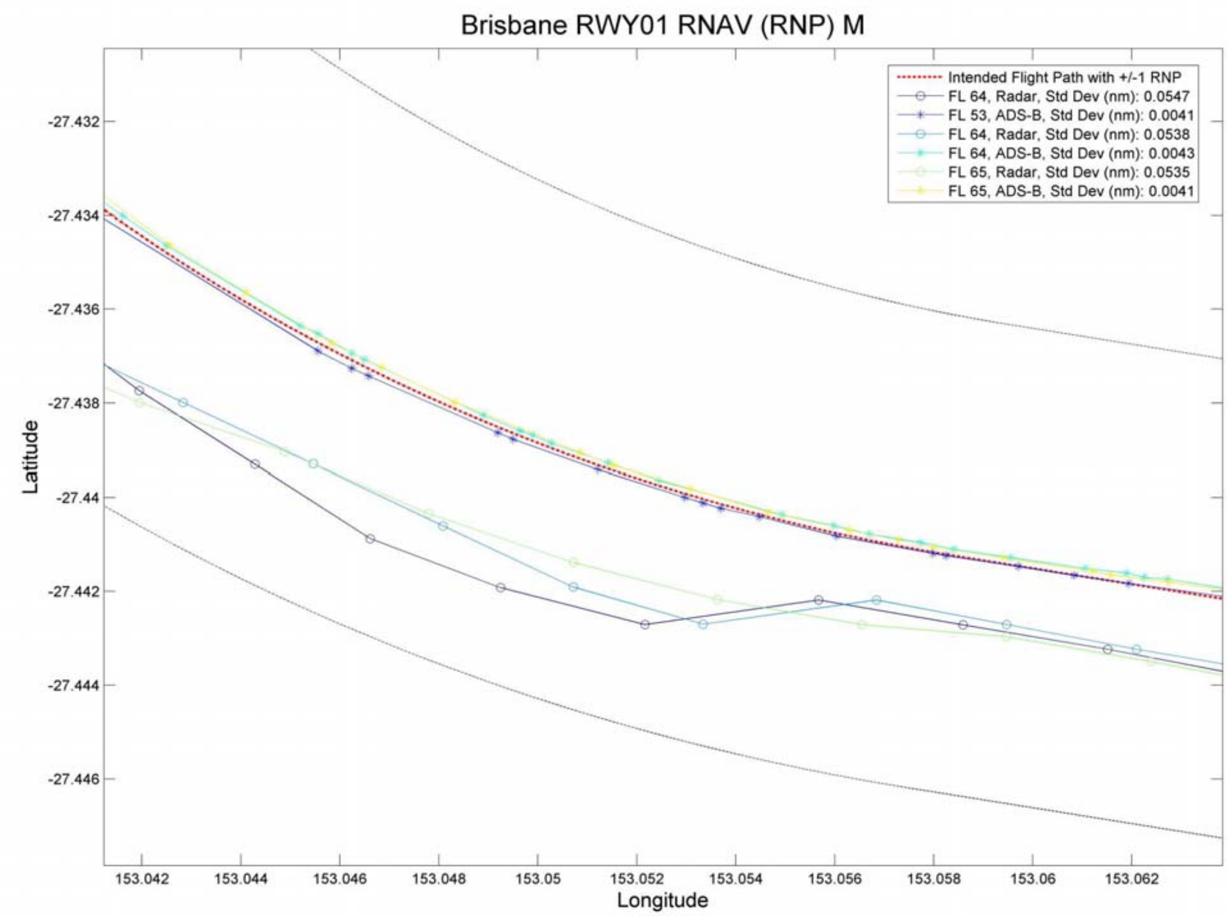

Figure C.2: Aircraft Position Relative to Design Path Centerline—Detail

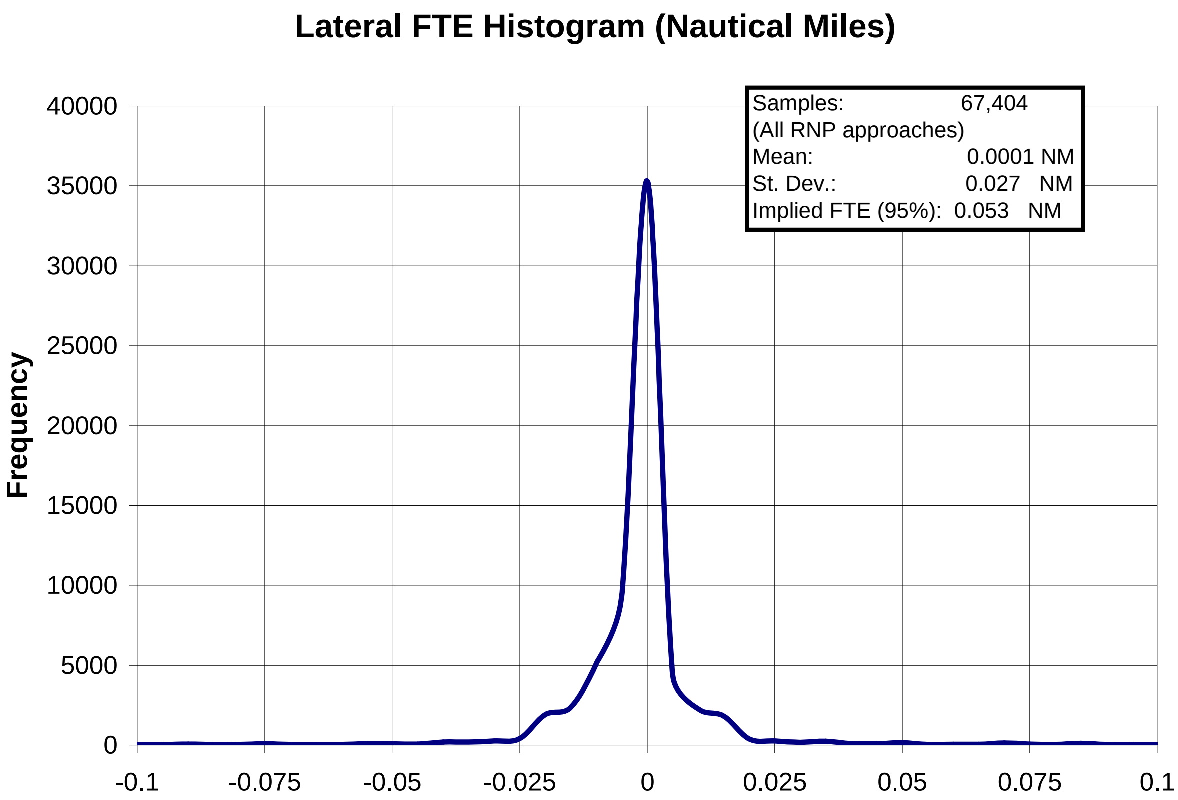

Figure C.3: Histogram

Appendix D: Approval Process

Primary Offices of Responsibility

- Flight Standards District Office (FSDO)/Certificate Management Office (CMO)
- RFSD-AWOPM
- National Flight Procedures Office (NFPO)
- Flight Technologies and Procedures Division (AFS-400)
- Air Transportation Division (AFS-200)
- General Aviation and Commercial Division (AFS-800)
- Flight Procedures Branch (AFS-410)
- Performance Based Flight Systems Branch (AFS-470)
- Flight Procedure Implementation Branch (AFS-460)

Current FAA policy for coordinating, processing and implementing instrument flight procedures

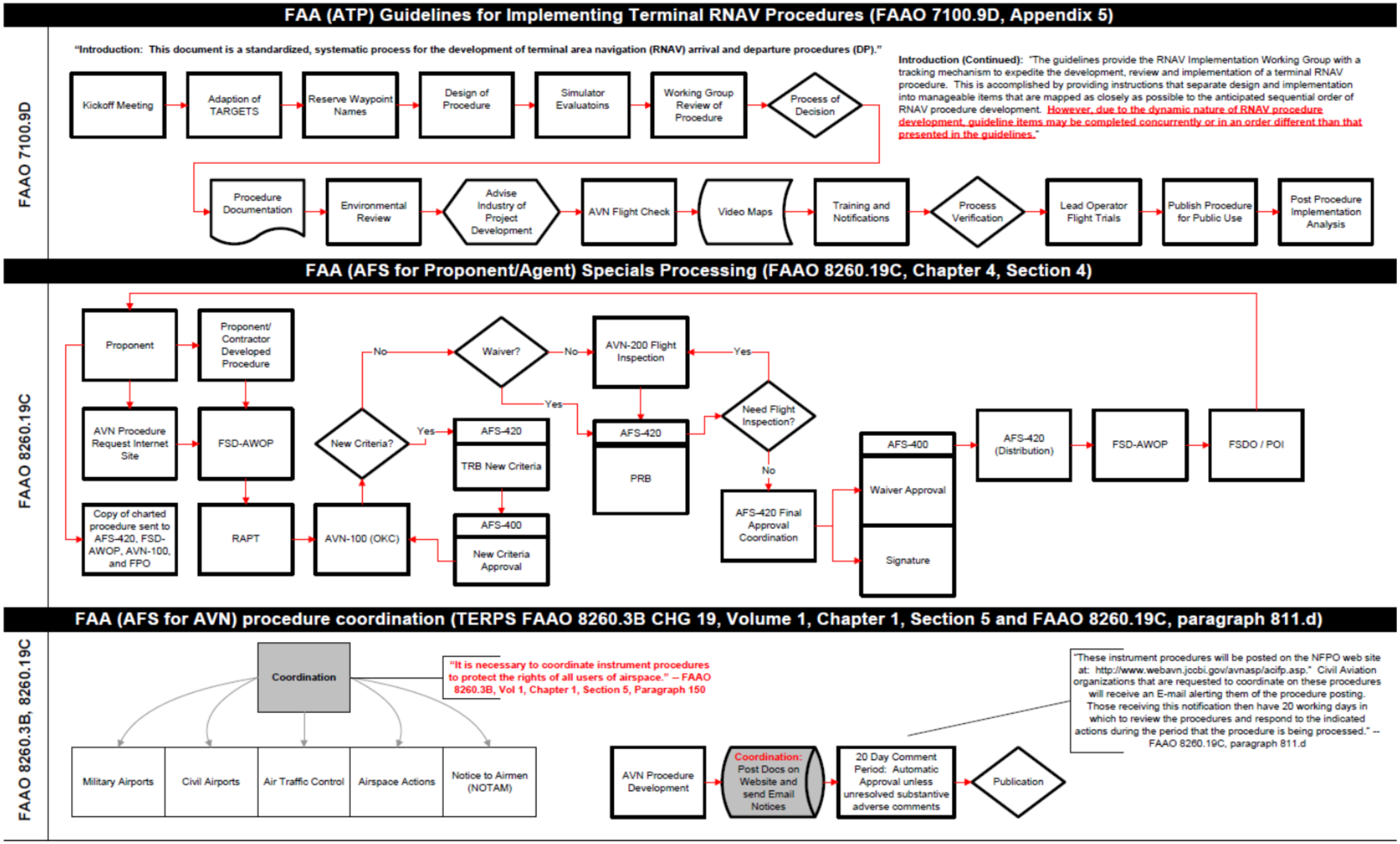

Figure D.1: Example of Potential FAA Process for Coordinating, Processing, and Implementing IFPs

Appendix E: Acronyms and Abbreviations

Term	Definition
AC	Advisory Circular
ADS-B	automatic dependent surveillance – broadcast (equipment on the aircraft automatically broadcasts data such as aircraft altitude, rate of altitude change, position, heading, and velocity)
AIP	acoustical insulation program
ARINC 424	international standard file format for aircraft navigation data published by Aeronautical Radio, Inc. (hence the ARINC)
AWG	airport working group
CATEX	categorical exclusion
CF	course to fix (an IFP leg type)
CFR	Code of Federal Regulations
CMO	Certificate Management Office
CNEL	community noise equivalent level
DME	distance measuring equipment (a ground-based navigation aid)
DP	departure procedure
EA	environmental assessment
EIR	environmental impact report
EIS	environmental impact statement
ESA	emergency safe altitude
FAF	final approach fix
FMC	flight management computer
FMS	flight management system
FONSI	finding of no significant impact
FSDO	Flight Standards District Office
FTE	flight technical error
GPS	Global Positioning System
IAF	initial approach fix
IAS	indicated airspeed
IFP	instrument flight procedure
ILS	instrument landing system (a ground-based navigation aid)
IR	instrument route
IRU	inertial reference unit
LDA	localizer-type directional aid
LOC	localizer (a ground-based navigation aid)
MAF	missed approach fix
MEL	minimum equipment list
MOA	military operating area

TERM	DEFINITION
MSA	minimum safe altitude
MSL	mean sea level
NADP	noise abatement departure profile
NDB	navigation database
NEPA	National Environmental Policy Act
NFPO	National Flight Procedures Office
NM	nautical mile
NMS	noise monitoring station
NSE	navigation system error
OCS	obstacle clearance surface
OEA	obstacle evaluation area
PBN	performance-based navigation
PDE	path definition error
RF	radius to fix (an IFP leg type)
RNAV	area navigation
RNP	required navigation performance
ROC	required obstacle clearance
SID	standard instrument departure
STAR	standard terminal arrival route
TACAN	tactical air navigation
TERPS	terminal instrument procedures
TF	track to fix (an IFP leg type)
TSE	total system error
TSO	Technical Service Order
VOR	VHF omnidirectional range beacon (a ground-based navigation aid)
VR	visual route