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Subcommittee on Aviation
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Challenges in Implementing Performance-Based Navigation in the U.S. Air Transportation System

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Mr. Chairman and Members of the Subcommittee:

We appreciate the opportunity to testify today on the Federal Aviation Administration's (FAA) efforts to modernize airspace through Area Navigation (RNAV) and Required Navigation Performance (RNP). These initiatives are cornerstones of the Next Generation Air Transportation System (NextGen), which will move today's ground-based air traffic control system to a more efficient one that relies on satellite navigation and on-board aircraft avionics. The potential benefits of RNAV and RNP are significant and include shorter, more direct flight paths; improved airport arrival rates; enhanced controller productivity; fuel savings; and reduced aircraft noise.

FAA and industry plan to invest billions of dollars over the next decade to bring about NextGen initiatives. To better ensure taxpayer dollars and private sector investments are used efficiently, FAA will need to carefully coordinate these efforts with industry stakeholders and within its own lines of business.

RNAV and RNP are key to NextGen's success, but fundamental issues need to be addressed. While RNAV and RNP have considerable industry support, some stakeholders are dissatisfied with the Agency's overall method for implementing these initiatives. Of particular concern is FAA's practice of laying most "new" routes over existing routes and the fact that air carriers are not using them. Stakeholders and FAA also disagree on the potential role, responsibilities, and oversight of non-Government third parties in speeding the adoption of RNP. Regardless of who develops the new procedures, FAA must provide one level of safety oversight.

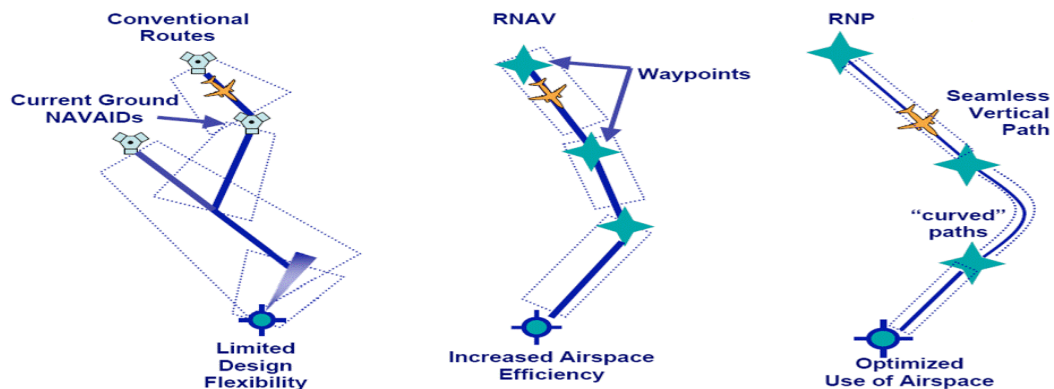
Today, I will cover two areas: (1) barriers and challenges affecting the successful implementation of RNAV and RNP and (2) the role and oversight challenges associated with use of third parties in developing new procedures. I will conclude with actions needed to ensure the safe and effective implementation of RNAV and RNP.

OVERVIEW AND BACKGROUND ON RNAV AND RNP

An important part of NextGen is the establishment of new routes and procedures that rely on satellite-based navigation. FAA first implemented RNAV in 2001 and RNP in 2005 as a way to increase national airspace capacity and efficiency. Since 2001, FAA has published 270 RNAV approach and departure procedures, 159 RNAV routes, and 148 RNP approach procedures.¹ FAA's goals are to annually publish 50 RNAV approach and departure procedures, 12 RNAV routes, and 50 RNP approach procedures through 2013.

There are important differences between conventional route procedures and RNAV/RNP. Traditionally, aircraft have flown conventional routes adhering to the ground-based navigational infrastructure, which requires aircraft to fly in a zigzag pattern so that they can be tracked by air traffic control radar systems. RNAV and RNP increase airspace efficiency by providing more direct paths (see figure).

Figure. Conventional, RNAV, and RNP Navigational Methods



Source: FAA

For RNAV, aircraft use an on-board Global Positioning System (GPS) to fly any desired flight path without the limitations imposed by ground-based navigation systems. RNP is a form of RNAV that adds monitoring and alerting capabilities to the cockpit to guide aircraft more precisely to and from airports. Currently, RNP routes are only available to specially equipped aircraft and trained aircrews, and air carriers must meet certain qualifications to fly these RNP approaches.²

Alaska Airlines pioneered RNP in 1996 to address unique terrain and weather challenges it faced in Juneau, Alaska. RNP-equipped aircraft allowed pilots to safely navigate between mountains on either side of the Gastineau Channel even during

¹ While FAA has implemented RNP procedures for arrivals, it has not yet developed procedures for departures or routes that link city pairs.

² This is referred to as RNP Authorization Required, or "RNP AR."

times of low visibility—this reduced the number of canceled and diverted flights into Juneau during bad weather. Alaska Airlines has implemented about 20 special RNP procedures, with annual average savings of about \$14 million. It was not until several years later that FAA implemented the first public RNP procedure.

RNP procedures can be developed as public or special procedures. Public procedures are available to all users that have properly equipped aircraft; special procedures are only available to a specific air carrier for whom the procedure was designed. While FAA allows special procedures, these have historically been implemented only on a limited basis for commercial airlines. Of the more than 500 RNAV and RNP routes and procedures, 148 are public RNP procedures and 30 are special RNP procedures. Table 1 provides details on the differences between public and special procedures.

Table 1. Public and Special RNP Procedures

Requirements	Public RNP Procedures	Special RNP Procedures
Who Can Use the Procedure?	Available to all users that have properly equipped aircraft	Only available for a specific air carrier for which the procedure was designed
Publication/Federal Aviation Regulation	Federal Register in accordance with 14 C.F.R. Part 97 ^{/a}	Not Published/Non-Part 97
Number of Procedures	148 RNP AR	30 RNP AR
Who Develops and Implements?	<i>Currently:</i> FAA’s Office of Aviation System Standards <i>Proposed:</i> Third parties	FAA’s Office of Aviation System Standards and private industry procedure developers (airlines and third parties)
Who pays?	FAA	Airspace user and FAA ^{/b}

/a Standard Instrument Procedures, 14 C.F.R. § 97 (1963). This FAA regulation governs the development of standard instrument approach procedures to airports in the United States.

/b Airspace users usually pay for special procedures, but FAA may provide this service to industry in some cases.

Other countries such as Canada, Australia, China, and New Zealand have implemented RNP procedures in recent years. For example, 18 RNP departures and approach procedures deployed at the airport in Brisbane, Australia, have been flown more than 15,000 times and have provided measurable benefits, such as fuel savings and reduced flight time, to the airlines that flew them.

Significant numbers of U.S. commercial transport aircraft are already equipped for some level of performance-based navigation.³ Almost all U.S. air carriers are equipped to perform RNAV at the Nation’s top 35 airports; however, the percentage

³ FAA defines performance-based navigation (PBN) as a framework for defining navigation requirements that can be applied to air traffic route, instrument procedure, or defined airspace. PBN comprises both RNAV and RNP and provides a basis for the design and implementation of flight paths that can enhance capacity.

of equipment for the more demanding RNP capability is much lower, and the number of aircraft and flight crews equipped and authorized to fly those procedures has lagged behind. For example, 10 major air carriers⁴ have 97 percent of their aircraft equipped with RNAV capability, but only 47 percent are equipped with RNP capability, and just 23 percent are authorized to fly RNP procedures.

FAA and industry representatives believe RNP can provide several high-value operational improvements, particularly at or around congested airports. For example, RNP can improve capacity and arrival efficiency through the use of parallel approaches to closely spaced runways and approaches to converging runways. RNP can also de-conflict operations at adjacent airports (e.g., Chicago O’Hare and Chicago Midway) through curved, final approaches to runways. Moreover, aircraft currently use a staggered, “stair-step” pattern on approach for landing, but RNP can allow a more level approach while enabling aircraft to avoid obstacles, such as buildings, near the airport.

FAA FACES SIGNIFICANT CHALLENGES WITH RNAV/RNP IMPLEMENTATION

FAA has faced significant challenges implementing RNAV and RNP, and consequently, has not fully achieved the measurable benefits of these procedures. First, FAA’s method for implementing new RNP procedures relies heavily on existing routes; as a result, air carriers are not using them. Second, continuing operational issues and concerns over workload and training for controllers and pilots have limited the use of RNAV procedures at some airports. Finally, FAA has not yet made adjustments to key programs such as airspace redesign efforts and modernization projects that will be needed to deliver the expected benefits of RNAV and RNP procedures.

Relying on Existing Routes Has Yielded Little Measurable Gain

While FAA has met or exceeded its annual RNP production goals, most of the RNP procedures it has rolled out have been overlays of existing routes because the Agency’s goals primarily focus on the number of procedures produced. While overlaid routes can be deployed more quickly because they do not have to go through an extensive environmental review, they do not maximize the benefits that can be achieved through RNP procedures. As a result, industry is dissatisfied with the overall quality of RNP procedures, and they are not widely used.

Further, FAA has not established an effective process for analyzing and measuring the benefits of new procedures from a “before–and–after” perspective. FAA program

⁴ Air Tran Airways, Alaska Airlines, American Airlines, Continental Airlines, Delta Air Lines, Jet Blue Airways, Northwest Airlines, Southwest Airlines, United Airlines, and US Airways.

officials also do not track data that would show how often airlines use RNP procedures or reasons why they are not being used. While FAA has implemented RNP at sites recommended by a joint FAA and industry group, the sites were based on prioritization work accomplished several years ago. FAA simply followed the list without performing updated analyses to ensure the procedures would be beneficial. For example, FAA designed and implemented a procedure in Palm Springs; yet, no air carrier has used the procedure since it was implemented because its design did not provide airlines with any measurable benefits, such as a shorter flight path or the ability to fly at lower altitudes.

One RNP procedure deployed at Reagan Washington National Airport has demonstrated some benefits. The procedure allows pilots to follow a more precise path—not available through conventional or RNAV procedures—along the Potomac River while avoiding restricted airspace and obstacles. While some air carriers are approved to use this procedure, only a few are actually using it because the procedure is designed specifically for a limited number of aircraft types.

FAA has also not updated its air traffic policies for controllers and pilots on how to use these procedures at airports with parallel runways. Due to current air traffic provisions,⁵ controllers are not yet allowed to accept an RNP procedure into the National Airspace System (NAS) at some airports with parallel runways. For example, at the Atlanta Hartsfield International Airport, FAA implemented 10 RNP procedures in May 2007 hoping that updated air traffic policies would be in place. Absent updated policies, controllers have never cleared an aircraft for landing using an RNP procedure in Atlanta. FAA is still evaluating whether the policies can safely be updated through a project at George Bush Intercontinental Airport in Houston, but this is a lengthy process that has already taken more than 4 years. FAA expects to complete this evaluation by the end of calendar year 2009.

Even if FAA updates its policies and determines that RNP can be allowed at airports with parallel runways, airline representatives told us they would not use the RNP procedures at Atlanta because they are overlays of existing conventional procedures, thus providing little or no added benefits other than a backup in the event the ground-based navigation aid shuts down.

Operational Issues Limit the Use of RNAV/RNP Procedures

There have been significant benefits from RNAV procedures at certain airports such as Atlanta, Dallas Fort Worth, and Phoenix. For example, RNAV departure procedures implemented at Atlanta in 2006 have increased throughput and reduced delays with a measured capacity gain of 9 to 12 departures an hour. Fewer delays have resulted in cumulative fuel savings of about \$105 million for the operators who

⁵ FAA Order JO 7110.65, Air Traffic Control Handbook, paragraphs 5-9-6 and 5-9-7 prescribe aircraft separation standards required for parallel dependent and simultaneous independent operations.

flew these procedures through 2008. However, current controller and pilot training continues to limit the full use and effectiveness of these procedures. For example, at Dallas Fort Worth and Atlanta, there have been some recent operational problems related to pilots programming incorrect RNAV departure waypoints into the Flight Management System (FMS) and thus not flying the correct path.

To mitigate this problem, FAA has developed a process for pilots to read back the runway assignment and first waypoint before taking off. This process was implemented at Dallas Fort Worth on June 1, 2009, and will be implemented NAS-wide once a further safety study is completed. FAA estimates that it will be collecting data for another 30 to 60 days before deciding whether to change the process nationwide.

A longstanding operational concern is the potential impacts of “mixed equipage” where controllers will be expected to manage aircraft with different capabilities seeking to exploit different procedures. Mixed equipage presents a major challenge for the transition to NextGen. Experts believe that between 80 and 100 percent of aircraft at any given location will need to be equipped with new NextGen systems to realize benefits and limit the potential for introducing new hazards. Assessing and addressing the impacts of mixed equipage are also important for several efforts that rely on aircraft equipage, including RNAV/RNP, data link communications for controllers and pilots, and Automatic Dependent Surveillance-Broadcast (ADS-B).⁶

A prolonged mixed-equipage environment is not desirable and will likely increase—not decrease—controller workload. This is one reason why some believe incentives will be needed to spur airlines to purchase and install new avionics. In the interim, FAA needs to develop plans to mitigate differences with aircraft equipage. This includes developing effective training for controllers and pilots and adjusting existing air traffic control systems. FAA may also have to segregate specific airspace for properly equipped aircraft.

New Procedures, Airspace Redesign Efforts, and Modernization Projects Are Not Operationally Integrated

As we noted in March of this year, FAA will need to manage capacity-enhancing initiatives as portfolios to deliver benefits because new systems, new procedures, and airspace changes are interdependent.⁷ To date, FAA has not developed a plan to effectively manage and budget for the elements necessary to deliver RNP benefits at already congested airports. This is particularly important as FAA shifts away from overlays of existing routes to more complex and demanding ones that can enhance the

⁶ ADS-B is a surveillance system that uses information from satellite-based systems to identify and track aircraft positions.

⁷ OIG Testimony Number CC-2009-044, “Federal Aviation Administration: Actions Needed To Achieve Mid-Term NextGen Goals,” March 18, 2009. OIG reports and testimonies are available on our website: www.oig.dot.gov.

flow of air traffic. Greater reliance on RNAV/RNP will force FAA to reevaluate budgets and plans for several key efforts.

- Airspace Redesign: Airspace redesign projects are critical to realize the full benefits of runways and can enhance capacity even without new infrastructure. Currently, FAA is pursuing six airspace projects nationwide,⁸ including a major but controversial effort to revamp airspace in the New York/ New Jersey/Philadelphia area. This project is undergoing litigation and has drawn public concerns about its environmental impact on the area. FAA plans to spend \$11.2 million⁹ in airspace redesign efforts in fiscal year 2009. A level of coordination between airspace redesign projects and RNAV/RNP procedures—that currently does not exist—will be essential as procedures move beyond overlays and local operations to networking routes between city pairs such as Chicago, Illinois, and Washington, D.C. Also, FAA will have to reassess its budget and plans for airspace redesign efforts to ensure adequate and stable funding.
- Air Traffic Control Modernization Projects: FAA will have to modify the automation systems, such as controller displays and related computer equipment, that controllers rely on to manage traffic in the vicinity of airports. According to FAA and others, a software enhancement that will allow controllers to merge and space aircraft is needed to obtain the benefits of new RNP procedures for enhancing airport capacity. This will also help controllers to safely manage traffic in a mixed-equipage environment. However, FAA has only begun planning and developing requirements for this capability; therefore, the cost and schedule parameters needed to adjust existing systems have not been baselined.
- Controller Training Programs: FAA lacks extensive and up-to-date training programs to help controllers understand and manage RNAV/RNP aircraft. This is particularly important given the large number of developmental controllers in the system. FAA's training on new procedures consists of briefings rather than formal courses on RNAV/RNP. As FAA moves toward implementing more advanced RNP routes, extensive training will be required for controllers to gain confidence in their ability to use RNAV/RNP. As one industry expert pointed out, simulators will be needed to support the training of the controller workforce. Without adequate controller training, RNAV/RNP cannot be successfully introduced.

⁸ These projects are (1) New York/New Jersey/Philadelphia Redesign (2) Chicago Airspace Project, (3) Houston Area Traffic System, (4) Western Corridor, (5) Oceanic, and (6) High Altitude Airspace Management.

⁹ Of the \$11.2 million funding, \$8.2 million was received from the Agency's operations account and \$3.0 million was received from its capital account.

FAA HAS NOT CLEARLY DEFINED THE ROLE OF THIRD PARTIES AND FACES CHALLENGES IN ENSURING EFFECTIVE SAFETY OVERSIGHT

The role of third parties in developing RNAV/RNP procedures is unclear, and industry representatives are skeptical of FAA's ability to deliver the more complex procedures in a timely manner. Any use of third parties will inevitably carry a new layer of safety concerns, and FAA has yet to establish a coordinated oversight framework to mitigate potential operational risks.

The Role of Third Parties is Unclear, and Stakeholders' Views of Benefits Differ

FAA entered into agreements in 2007 with two non-Governmental third parties to design, integrate, test, and validate public RNP procedures. According to FAA, the intent of the third-party initiative was to provide industry or the international community with FAA-qualified vendors who could develop procedures within and outside the United States where existing infrastructure was lacking or where the new procedures would not create complex integration and implementation issues.

Yet, FAA has never clearly communicated the potential third-party roles and responsibilities to airspace users. FAA does not plan to rely on third parties to help speed the adoption of RNP procedures for NextGen. FAA program officials told us that they do not need assistance from third parties in domestic airspace because the Agency has met or exceeded its goals for the number of procedures produced and has provided airlines with all the requested procedures. However, airlines disagree with this conclusion and continue to believe third parties could help speed up the adoption of quality RNP procedures.

In addition, the business case for third parties to develop public procedures for specific airlines does not appear to be workable. Third parties have not developed these in the past, and the extent to which air carriers will hire them to do so is still unknown. It will depend on whether air carriers believe it is cost beneficial to pay third parties to develop public RNP procedures. Industry representatives we interviewed questioned whether air carriers will be able to justify the cost for third parties to develop these types of procedures because they would benefit other carriers and can be obtained from FAA at no cost. In addition, representatives at one of the third-party vendors told us the agreement with FAA is not cost beneficial for them because it specifies that third parties will be responsible for maintaining the procedures, which increases their liabilities and risks.

The third-party process for developing special procedures is somewhat different. FAA has had a process in place for years in which third parties have developed special procedures as requested by specific operators. However, FAA approved these

only on a limited, case-by-case basis. RNAV/RNP program officials are now concerned that air carriers will increasingly request third parties to produce special procedures, which are tailored to the requesting airline's needs, rather than rely on public procedures produced by FAA. FAA states that an increasing number of special procedures will further complicate the workload of air traffic controllers and increase the complexity of the NAS.

As noted by industry, FAA can mitigate this problem by seeking ways to transition specials into public procedures that could be used by any airline that chooses to equip their aircraft and train flight crews. Recognizing that there may be a legitimate need for special procedures at some locations, FAA needs to ensure that its Flight Standards and Air Traffic offices coordinate at a national level to safely integrate any new special procedures into the NAS, especially if special procedures are more widely adopted going forward.

The role of third parties in moving forward with NextGen is a policy call for Congress. The nature and extent of this role hinges on the in-house skill mix and expertise of FAA and whether the Agency can deliver the more demanding procedures called for by industry. FAA could rely on third parties for specific projects based on a contractual relationship. As FAA points out, third parties could provide valuable expertise, capabilities, and resources that could complement FAA's efforts in the short and long term. However, third parties should not be relied on to conduct safety assessments of the procedures they develop.

FAA Has Not Established a Coordinated Oversight Framework for Third Parties

Absent clear roles and responsibilities, it is difficult at best for FAA to establish a plan to oversee third parties. To its credit, FAA has drafted guidance for industry on the authorization process used to design and develop RNP procedures and has begun developing an oversight plan. However, FAA will need to implement a formal oversight program to ensure that third parties properly follow FAA design criteria and procedures for key areas. These include flight validation, obstacle assessments, integration of the procedure into the NAS, and procedure maintenance. Without this foundation, the potential for operational problems and safety risks increases.

Past problems with implementation of new procedures show that safety issues can occur. We identified key areas in which FAA will need to establish strong oversight controls once it completes efforts to qualify these vendors. Based on an internal audit performed in 2007, FAA determined that the Agency had not performed required procedure maintenance reviews for 100 percent of the procedures sampled. These reviews are important because they check for routine maintenance of the procedures, including checking for new ground obstacles and other changes along flight paths.

Regardless of who develops the procedures, FAA must provide one level of safety oversight and address organizational barriers and fragmented efforts that exist between Agency lines of business. For example, although FAA’s Flight Standards office oversees the process for developing procedures by FAA and third parties, it does not have the authority to enforce penalties for non-compliances that it finds with the procedures developed internally by FAA employees. That authority lies within the Air Traffic Safety Oversight Division. As shown in table 2, several offices within FAA’s Aviation Safety and Air Traffic organizations play a role in ensuring the safe development and integration of new flight procedures into the NAS.

Table 2. Roles and Responsibilities in the Development and Oversight of Flight Procedures

FAA Office	Responsibilities
<i>Air Traffic Organization</i>	
RNAV/RNP Group	<ul style="list-style-type: none"> • Implements and integrates RNAV and RNP routes and procedures into the NAS
Aviation System Standards	<ul style="list-style-type: none"> • Designs and develops public and special instrument flight procedures (IFP) • Operates a fleet of flight inspection aircraft for airborne evaluation of IFPs and maintains public procedures
Air Traffic Facilities	<ul style="list-style-type: none"> • Evaluate and use the procedures operationally • Train controllers on new procedures
<i>Aviation Safety</i>	
Flight Standards Service	<ul style="list-style-type: none"> • Develops and evaluates design criteria for IFPs • Oversees flight inspection policy and all IFP development, both FAA and third-parties • Approves special procedures • Enforces non-compliance penalties for procedures developed by third parties
Air Traffic Safety Oversight Services	<ul style="list-style-type: none"> • Independently oversees the Air Traffic Organization • Audits Air Traffic facilities, including the Aviation System Standards (office that develops instrument flight procedures) • Enforces non-compliance penalties for procedures developed internally

FAA cannot effectively determine its oversight staffing needs because the extent that airlines will use third parties is unknown. FAA officials told us that staffing of 14 personnel in its oversight office is currently sufficient; however, it has yet to authorize the two third parties for developing RNP procedures or determine the demand for their services. If FAA increases the number of procedures produced each year, it will have to reassess staffing needs.

CONCLUSIONS AND ACTIONS NEEDED TO ENSURE SAFE AND EFFECTIVE IMPLEMENTATION OF RNAV/RNP

NextGen is an important initiative to enhance capacity, reduce delays, and fundamentally change the way air traffic is managed, and RNAV and RNP are critical to its success. Nearly 40 percent of the 123 operational improvements under review by a joint Government/industry taskforce on NextGen involve RNAV/RNP. Yet, FAA has not fully laid the groundwork in areas such as developing RNP procedures that provide measurable benefits, ensuring air traffic policies keep pace with new aircraft technology, and making the necessary adjustments to air traffic control systems to accommodate these new procedures. In addition, because FAA has not clearly defined the roles and responsibilities of third parties, it will be difficult to establish an effective oversight framework.

We look forward to the task force's recommendations by the end of this summer and will work with FAA and Congress to continually monitor the following areas to ensure successful implementation of RNAV/RNP.

- Aligning FAA's flight plan goals with producing *quality* RNP procedures that have significant benefits rather than focusing on the number of procedures.
- Establishing priorities for new routes and funding requirements for related airspace redesign projects and systems that controllers rely on to manage traffic.
- Performing cost-benefit analyses in close coordination with all stakeholders before and after implementing RNP procedures.
- Ensuring air traffic controllers and pilots are aware of and trained on procedures before they are implemented.
- Developing and establishing a policy on how and to what extent third parties will be used to help support FAA's NextGen efforts and ensure an effective oversight approach.

Mr. Chairman, this concludes my prepared statement. I would be happy to address any questions that you or other Members of the Subcommittee may have.