U.S. House of Representatives
Committee on Transportation and Infrastructure
Washington, DC 20515

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July 28, 2009

SUMMARY OF SUBJECT MATTER

TO: Members of the Subcommittee on Aviation

FROM: Subcommittee on Aviation Staff

SUBJECT: Hearing on "NextGen: Area Navigation (RNAV)/ Required Navigation Performance (RNP)"

PURPOSE OF HEARING

The Subcommittee on Aviation will meet on Wednesday, July 29, 2009, at 10:00 a.m., in room 2167 of the Rayburn House Office Building to receive testimony regarding NextGen: Area Navigation (RNAV) and Required Navigation Performance (RNP) procedures.

BACKGROUND

The current national airspace system (NAS) consists of a network of en route[1] airways, much like an interstate highway grid in the sky, interconnected by, and dependant on, ground-based navigation facilities. These ground-based facilities emit directional signals that aircraft use to navigate through geographic points in the airspace. Limits on the transmission distances of these signals prevent aircraft from flying direct routes on long-distance flights, and limit the utilization of airspace to predefined routes where aircraft can reliably transition from one navigational signal to the next.

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[1] The Federal Aviation Administration (FAA) uses three types of facilities to control traffic: *Airport towers* direct traffic to the ground before landing and after takeoff within 5 nautical miles of the airport and about 3,000 feet above the airport. *Terminal Radar Approach Control Facilities (TRACONs)* sequence and separate aircraft in terminal airspace – i.e., as they approach and leave airports, beginning about five nautical miles and ending about 50 nautical miles from the airport and generally up to 10,000 feet above the ground. *En route centers* control aircraft in high-altitude en route airspace – i.e., in transit and during approaches to some airports, generally controlling air space that extends above 18,000 feet for commercial aircraft.

In the terminal environment, near busy airports and metropolitan areas, aircraft follow arrival and departure routes by tracking ground-based navigational signals, much like navigation during the en route phase of flight, or by following the instructions of air traffic controllers, usually referred to as receiving radar vectors, that often require aircraft to fly, inefficient, zigzag-like patterns.

RNAV and RNP procedures rely on aircraft avionics for improved route precision. RNAV allows aircraft to fly any desired flight path without the limitations imposed by ground-based navigation systems. RNP is RNAV with the addition of an onboard monitoring and alerting capability for pilots that takes advantage of an aircraft's onboard navigation capability to fly more precise, efficient, and even curved paths into and out of airports.

RNAV and RNP procedures hold enormous potential to reduce aircraft fuel burn, noise and carbon emissions, boost controller productivity, and increase capacity. The Government Accountability Office (GAO) recently testified[2] that one stakeholder it interviewed reported that during a 12-month period, more than 8,000 RNP approaches at Brisbane, Australia, saved 34 Qantas 737-800 aircraft a total of 4,200 minutes of flying, 65,000 gallons of fuel, and 621 metric tons of carbon dioxide emissions. Average delays at the airport were reduced by 30 seconds for each arriving aircraft, which benefit from the fact that the RNP approaches take several miles off aircraft approach paths to the runway, compared with an existing visual approach. Since 2005, Alaska Airlines, an early RNP pioneer, has documented 5,300 flights that avoided diversions using RNP procedures. In 2008, avoiding these diversions saved the airline $8 million. The United Parcel Service, relying on Optimized Descent Profile[3] that uses RNP, uses these procedures at Louisville, Kentucky with reported savings of between 250 and 465 pounds of fuel (37-69 gallons) <u>per arrival</u>.

Both the FAA and industry stakeholders hold high expectations for RNAV and RNP procedures to provide near- to mid-term benefits. RNAV and RNP procedures are featured in the FAA's NextGen Implementation Plan (NGIP), and they are expected to be one major part of the RTCA NextGen Mid-Term Implementation Task Force final report that is due next month. These procedures have also been listed by the Department of Transportation Inspector General (DOT IG) as a key near-term capacity enhancing initiative.[4][5]

Yet, while RNAV/RNP procedures hold significant potential for near-term benefits, the FAA faces challenges implementing these procedures. For example, current RNAV/RNP routes are largely overlays of existing routes and have not required extensive environmental reviews. To maximize these benefits of RNAV/RNP, the FAA will need to review future airspace changes and

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[2] *GAO response to Chairman Costello question for the record (May 20, 2009): Hearing on the ATC Modernization and the Next Generation Air Transportation System: Near-Term Achievable Goals*, 111th Cong. (Mar. 18, 2009).

[3] Optimized Descent Profile is a general term for a broad class of aircraft descent routes and procedures that are designed to reduce fuel burn and emissions during descent by minimizing aircraft level offs and allowing an aircraft to maintain near-idle engines during descent.

[4] Department of Transportation Office of the Inspector General, *Observations on Short-Term Capacity Initiatives, Report Number: AV-2008-087* (Sept. 26, 2008).

[5] The recently introduced Senate FAA reauthorization bill (S. 1451, the "FAA Air Transportation and Safety Improvement Act"), includes provisions intended to accelerate the deployment of RNAV/RNP procedures. For example, section 314 of S. 1451 requires the FAA to develop a plan to deploy RNAV/RNP procedures at the top 35 airports by 2014, and throughout the entire NAS by 2018.

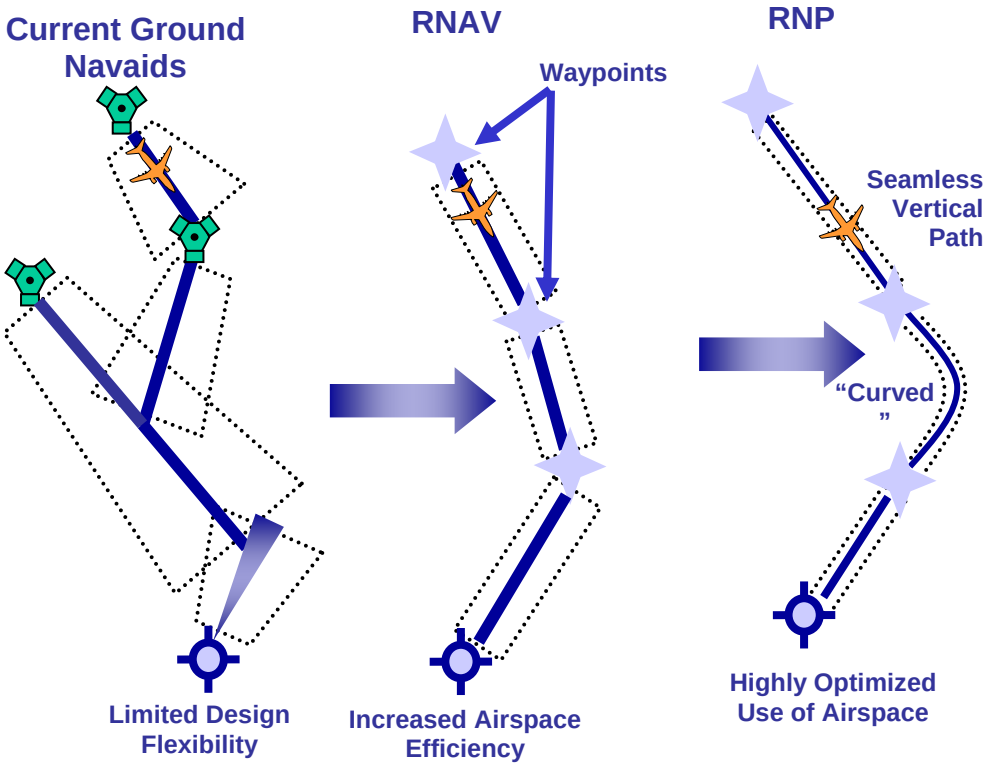
environmental impacts of moving routes and procedures outside of existing ground tracks to provide more direct, fuel efficient routes into and out of airports. However, these new routes may require more extensive environmental reviews, which in some instances could take up to eight years and cost $5 million per procedure.

Moreover, there are often significant technical challenges with integrating RNAV/RNP procedures into the existing airspace. Congested airspace, as found in nearly all major metropolitan areas, involves complex design requirements with stringent development criteria to include computer modeling, human factors studies, and actual flight and simulator trials.

I. <u>What is RNAV/RNP and How Does it Work?</u>

The process of designing RNAV/RNP procedures involves addressing many factors to ensure that the procedures provide a benefit to the FAA and system operators and are fully integrated into the existing airspace. Some steps that go into designing RNAV/RNP procedures include evaluating: different traffic flows and patterns within the existing airspace; the complexity of airport geometry including traffic flows within departure and arrival corridors; and aircraft equipage mix.

The procedure itself is essentially defined by: 1) a series of waypoints (i.e., specific points in three dimensional space that the aircraft will cross); 2) the horizontal and vertical path the aircraft will take will take over those waypoints; and 3) how an aircraft is expected to fly the path (i.e., altitude, speed, bank angles, etc.) as it progresses over waypoints. The FAA also conducts flight inspections using its own specially-equipped aircraft on the procedure to ensure that the procedure has been properly designed for the airspace, allows for adequate navigation signal reception, and provides adequate clearance from obstacles.



Source: FAA

Once a procedure concept and design are agreed upon by the relevant stakeholders, usually the carriers serving a particular airport, the FAA captures the RNAV/RNP procedure information on a form. The data captured on the form includes: the procedure name, procedure type (e.g., arrival, departure, or approach), names, latitudes, and longitudes for waypoints.

The FAA transmits the final FAA form for each procedure to FAA's National Flight Data Center (NFDC) where it is entered into the National Airspace System Resources (NASR) database. Once available through NFDC, the private navigation data suppliers, such as Jeppesen, Lido, and Navtech/EAG, translate this information into a standard format that is downloaded into navigation databases. The data is then supplied to avionics vendors, such as Honeywell or General Electric, in electronic form. Avionics vendors load that data into their processing software for further quality checks and to get it ready for loading into aircraft Flight Management Systems (FMS).[6] The vendor then sends the data, contained on a disk or in electronic format, to the airlines to be loaded into aircraft FMS.

RNAV and RNP procedures rely heavily on aircraft avionics, most notably aircraft FMS and the Global Positioning System (GPS). The GPS is satellite-based navigation capability that determines the position of the aircraft at all times. The FMS accesses the RNAV/RNP procedure data in its memory with the path that airplane supposed to be flying, and combines it with the position information it is getting from the GPS to compute where the aircraft is along the procedure path. If the FMS is coupled with aircraft's autopilot, which is the case for most of RNAV/RNP procedures, then the autopilot is flying the aircraft based on the instructions of the FMS such as when to turn, what altitude to keep, what speed to fly for each segment, and so forth.

Different RNAV and RNP levels measure the tolerance and precision that avionics are expected to guide the aircraft along the centerline of the path. Designations such as "RNAV-1," "RNP-2" or "RNP-0.3" refer to the distance (in nautical miles) from the centerline of the path to the border of the path that the avionics are expected to fly the aircraft. In the case of an RNP capable aircraft, the RNP system will alert the pilot if the aircraft gets too close to the border. RNP Special Aircraft and Aircrew Authorization Required (SAAAR) has stricter performance requirements, including additional training for the pilot and better equipped aircraft.

RNAV and RNP equipage have been steadily increasing over the past several years. MITRE-Center for Advanced Aviation System Development (CAASD)[7] analysis of the air transport fleet documents high levels of RNAV and growing levels of RNP equipage. Forecasts of new production aircraft indicate acceleration and continued growth in RNAV/RNP capability. For

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[6] The Air Transport Association (ATA) Online "Learning Center" defines a FMS as computerized avionics component found on most commercial and business aircraft to assist pilots in navigation, flight planning, and aircraft control functions. It is composed of four major components: Flight Management Computer (FMC), Auto Flight System (AFS), Navigation System including Inertial Reference System (IRS) and GPS, and Electronic Flight Instrument System (EFIS). **http://learningcenter.airlines.org/Pages/Default.aspx?Filter=f**

[7] MITRE is a non-profit organization and the CAASD was established in 1990 within MITRE. MITRE-CAASD is sponsored by the FAA as a Federally Funded Research and Development Center (FFRDC). An FFRDC meets certain special long-term research or development needs that cannot be met as effectively by existing in-house or contractor resources.

air transport aircraft operations in 2009, RNAV equipage exceeds 90 percent. RNP equipage (specifically RNP 0.3 capable aircraft) exceeds 60 percent. Advanced RNP (specifically RNP 0.3 with curved-path capable aircraft) equipage is nearly 40 percent.

II. RNAV/RNP and NextGen

a. The FAA's Plan, Industry Expectations and Challenges Ahead

According to the GAO, since 2004, the FAA has published more than 260 RNAV procedures (i.e., the departure and arrival portion of a flight just before and just after the aircraft enters or leaves en route airspace), more than 135 RNAV routes (i.e., the en route airspace portion of a flight), and 135 RNP approaches (i.e., the portion of a flight that is after the arrival and just before landing).[8] GAO states that FAA estimates that the following numbers of procedures remain to be developed:[9]

FAA's Estimate of the RNAV/RNP Procedures Needed in the NAS

Procedure type	Development targets
RNAV/RNP procedures (arrivals and departures)	2,000-4,000
RNAV/RNP routes	800-1,200
RNP approaches	1,000-2,000

Source: GAO (citing the FAA)

According to the GAO, FAA officials state that the agency plans to annually publish 50 RNAV/RNP procedures, 50 RNAV routes, and 50 RNP approaches to meet its goals for NextGen. Moreover, the FAA and industry are engaged in establishing new, more aggressive goals for RNAV/RNP procedure development. One longer-term goal is to develop procedures that deconflict and optimize arrival and departure interactions in terminal airspace and that connect city pairs for seamless, end-to-end RNAV/RNP operations.

Nevertheless, given the enormous potential benefits that RNAV/RNP procedures could provide, some industry stakeholders have spurred FAA to be even more aggressive and deploy more procedures more quickly. In addition, some stakeholders have noted that procedure development needs to move beyond basic overlays of existing routes to incorporate more fuel efficient flight paths. FAA officials note that processing time for individual procedures is often dependent on the complexity of the airspace, interactions with other procedures, environmental requirements, and the amount of coordination required between aviation customers, air traffic facilities, and other major stakeholders, such as the airport authority, FAA Flight Standards, and FAA Air Traffic Organization for each route or procedure.

In addition, MITRE has pointed out that overlay routes can, in fact, provide benefits to airlines by using RNP to facilitate Optimized Profile Descents (OPD). While there may be some benefit gained by using RNP approaches for OPD, it is unclear if these benefits would justify the avionics equipage and training costs incurred by system operators.

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[8] GAO *supra.*, note 2.
[9] *Id.*

Section 510 of S. 1451, requires the FAA to set a target of achieving a minimum of 200 RNP procedures each year through 2012.[10] FAA officials state that FAA could produce 200 RNP procedures a year, but that trying to meet such a goal could have unintended consequences and may actually slow the achievement of NextGen benefits.[11] Specifically, FAA claims that setting such a target for the production of routes may result in the promulgation of more overlay routes, which can be more quickly deployed due to the fact that they are more easily integrated into existing airspace and require less environmental due diligence.[12] In other words, the FAA could be forced to implement more overlay routes to meet an annual 200 RNP procedure target simply because overlays are faster and easier to implement.

The FAA believes it needs to take a strategic approach to RNP procedure development that would require integrating these procedures into corresponding and ongoing airspace redesign work.[13] The FAA hopes that this approach will maximize FAA and stakeholder benefits achieved by promoting more efficient routes and use of the available airspace.[14] Likewise, the DOT IG also notes that 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. Moreover, DOT IG states that the FAA will have to reassess its budget and plans for airspace redesign efforts to ensure adequate and stable funding.

Some stakeholders have stated that FAA has yet to clearly articulate its strategic vision for RNAV/RNP. Regardless, industry stakeholder acceptance of FAA's plan – including the quality and quantity of procedures the FAA produces – will be crucial, because stakeholders will be required to bear the cost of equipping their aircraft to take advantage of these procedures.[15]

In a recent report, the DOT IG also documents a number of other RNAV/RNP implementation challenges, including:[16]

- Controllers must manage a "*mixed equipage environment,*" in which they manage both RNAV/RNP and non-RNAV/RNP aircraft within the same airspace. This may limit the benefits from RNAV/RNP operations.

- The FAA will need to standardize "phraseology" – i.e., the voice communications language between pilots and air traffic controllers regarding RNAV/RNP procedures.

- The FAA will need to ensure that RNAV/RNP development is coordinated with broader modernization efforts (e.g., En Route Automation Modernization).

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[10] Section 511 of S. 1300, *The Aviation Investment and Modernization Act of 2007*, (the Senate's FAA reauthorization from the 110th Congress) also set 200 RNP procedure target.
[11] *FAA response to Chairman Costello question for the record (Apr. 30, 2009): Hearing on the ATC Modernization and the Next Generation Air Transportation System: Near-Term Achievable Goals*, 111th Cong. (Mar. 18, 2009).
[12] *Id.*
[13] *Id.*
[14] *Id.*
[15] ATA estimates the cost of equipage to range from $45,000 to $410,000 per airplane depending on the level of RNP performance, and existing equipment on the airplane, including displays, FMS and GPS. These numbers also include a substantial amount for pilot training.
[16] DOT IG*, supra* note 4.

- FAA will need to develop new criteria for complex RNP procedures, and operators will need to work with FAA for RNP approvals and authorizations.

- Air traffic controller training has, to date, been minimal because the controllers are already familiar with the existing routes. However, new and more sophisticated routes (e.g., networked routes) likely will require additional controller training. According to the FAA, the RNAV/RNP computer-based instruction is undergoing extensive revision to ensure controller training is up to date and certification requirements are met. However, according to the DOT IG, FAA lacks extensive and up-to-date training programs to help controllers understand and manage RNAV/RNP aircraft, and that the FAA's training on new procedures consists of briefings rather than formal courses on RNAV/RNP. DOT IG points out that the controller training issue is particularly important given the large number of developmental controllers in the system.

b. Third-Party Vendors: Southwest Airlines - A Case Study

In 2007, the FAA entered into agreements with two non-governmental third-parties (Naverus and Jeppesen) to design, implement, test, and validate "public"[17] RNP SAAAR procedures. According to the FAA, the intent of the third-party initiative was to provide aviation industry or the international community with FAA-qualified vendors that could develop procedures in and outside of the United States where existing infrastructure was lacking or did not create complex integration and implementation issues.[18] FAA officials state that the agency does not plan to rely on third parties to help speed the adoption of RNP procedures to meet the FAA NextGen goals, although it may rely on third-party expertise for specific projects.[19]

The president of the union representing technicians and specialists who certify and maintain FAA equipment and procedures, the Professional Aviation Safety Specialists, has repeatedly expressed doubts about the FAA's ability to adequately regulate, supervise or review the work of third-party design initiatives. H.R. 915, the "FAA Reauthorization Act of 2009", requires the DOT IG to assess the FAA's reliance on third-parties for development of new procedures and determine the FAA's ability to provide oversight. To date, the DOT IG has stated that the FAA has not established a coordinated oversight framework for third-parties, and that without this foundation, the potential for operational problems and safety risks increases.[20]

Regardless, some airlines believe that third-parties could potentially speed the implementation of RNAV/RNP, and provide more efficient and desirable routes. Likewise, private procedure designers maintain that they can provide airlines with routes that are more responsive to their airline customers' needs. Case in point: Southwest Airlines has been widely credited as an "early adopter" of NextGen. Southwest committed to invest $175 million ($144 million for

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[17] RNP procedures can be developed as "public" or "special" procedures. Public procedures are available to all users that have properly equipped aircraft, and have historically been paid for by the FAA. Special procedures are only available for a specific air carrier for which the procedure was designed, and generally paid for by that carrier. While FAA allows special procedures, historically these have been implemented only on a limited case-by-case basis.
[18] FAA *supra*., note 11.
[19] *Id.*
[20] Section 510 of S. 1451 would authorize the FAA to expand the role of third-parties to implement RNP procedures.

equipage, $22 million for pilot training; $9 other expenses) to implement RNP. In some cases, Southwest is utilizing the services of Naverus, a company formed by former Alaska Airlines technical pilots who pioneered RNP procedures, to design proprietary "special" RNP approach, departure, and en route instrument procedures.

Southwest Airlines' initial plan was to deploy special procedures to all 65 airports that Southwest served. Southwest envisioned that its customized RNP approaches will provide a much shorter track over the ground to the runway than radar vectors and already developed FAA RNAV public procedures. Southwest based its return on investment (ROI) on whether it could gain three miles or one minute of savings per flight. Southwest representatives indicate that the airline will not be successful in achieving its ROI if the FAA continues to create overlay type procedures. Southwest is starting to develop RNP procedures at Dallas Love Field and Houston Hobby Airport.

FAA officials have recently expressed concern with the proprietary nature of Southwest's approach, testifying before House Aviation Subcommittee, "The primary concern we have is the proposed operations for the Dallas/Houston project are exclusive to Southwest Airlines, developed with proprietary criteria that may not conform to common flight tracks or other instrument operations at the affected airports."[21] Moreover, according to the DOT IG, some FAA officials have expressed additional concerns that other air carriers may follow Southwest's approach and will increasingly request customized special procedures that could complicate the workload of air traffic controllers and increase the complexity of the NAS.

In any case, Southwest representatives indicate that last year the airline revised its plan to embrace the use of any procedures, including public procedures that could meet Southwest's operational needs. More recently, Southwest representatives have expressed frustration with aspects of the implementation process that seem independent of its decision to use a third-party developer to design special procedures - most notably the environmental review process. It appears that non-overlay special procedures designed by a private vendor face similar sorts of integration and environmental challenges as public procedures designed by the FAA.

c. Environmental Challenges

The National Environmental Policy Act (NEPA) institutes environmental policies that apply to the Federal Government, including environmental review procedures on Federal agency actions. NEPA requires agencies to evaluate the latent environmental impacts of their projects and document their review in a publicly available document. The scale of review and documentation are determined by the scale of anticipated environmental impacts: a categorical exclusion (CE), an environmental assessment (EA) and an environmental impact statement (EIS).

CEs[22] are used for categories of actions that have been determined not to have a significant effect on the human environment, individually or cumulatively, and therefore, do not require further analysis. Even though a CE represents a determination that an environmental review is not necessary, the determination still must be documented, and extraordinary circumstances could push a CE to an EA.

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[21] FAA *supra.,* note 11.
[22] 40 C.F.R. § 1508.4.

EAs[23] are conducted to determine whether an EIS is needed or a finding of no significant impact (FONSI) is appropriate. An EIS[24] is the most extensive review, and must discuss an adequate range of proposed alternatives, the direct, indirect, and cumulative effects or impacts of each, and may take years to produce. EISs are followed by the issuance of the Record of Decision (ROD) by the agency. Agencies must also take into consideration other future actions to evaluate the cumulative effect on the environment.

Agencies have been encouraged to develop more CEs in their policies because classifying actions under CEs is less of a burden on agency resources than EAs or EISs.[25] The FAA, for example, added 18 CEs to its list in 2004.

All new aviation procedures, including the establishment, modification, or application of airspace and air traffic procedures, are reviewed to assure compliance with environmental laws and regulations in accordance with FAA Order 1050.1. At one airport, it is possible that several different environmental reviews may have to take place for different procedures. The Air Traffic Noise Screening Tool (NST) is a computerized system that evaluates proposed changes in airspace and air traffic procedures to determine the level of environmental review required. NST evaluates proposed changes in arrival procedures up to 7,000 feet above ground level (AGL) and departure procedures up to 10,000 feet AGL. When a change increases noise of five decibels (dB) Day Night Level (DNL) (the average aircraft noise level over a 24-hour period averaged over the course of a year) or greater, the FAA judges if there are changes in accordance with Order 1050.1 that warrant an environmental assessment. Currently, any analysis of aircraft noise above 10,000 feet is an exception to FAA procedures, though the FAA does make an exception for analyzing aircraft noise between 10,000 and 18,000 feet over noise sensitive areas like national parks.

According to the FAA, if a change to an air traffic procedure is within the current footprint, as would likely be the case with an RNP overlay route, a CE will usually be granted. If the procedure is slightly outside the current footprint and a CE will not cover the changes, a focused EA may be done. The difference between an EA, which normally takes 12-18 months and a focused EA, which takes 6-12 months is the number of impact categories that must be evaluated.

If the procedure is completely outside of the current footprint, as could be the case for a more direct RNP procedures desired by airlines, a full environmental review will be required. This review could be an EA or, it may result in the need to complete an EIS, which may take up to two years (DOT IG states that is could be as many as eight years). The cost to conduct these environmental reviews ranges from $250,000 to $1 million for an EA, and several millions of dollars for a full EIS. In the case of a public procedure, FAA would bear this cost. In the case of a special procedure, the carrier would bear this cost.

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[23] 40 C.F.R. § 1508.9(a)(1). An EA that results in a FONSI is referred to as an EA-FONSI.
[24] 40 C.F.R. § 1501.4, and parts 1502 and 1503.
[25] *Establishing, Revising, and Using Categorical Exclusions under the National Environmental Policy Act*, 70 Fed. Reg. 54816, 54817 (Sept. 19, 2006).

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