FAA Grant: Flight Safety Foundation, Inc. - 2010G023

A Recommended Process:

Safely Reducing Redundant or Underutilized Instrument Approach Procedures

March 2011

Appendices

Executive Summary

The number of instrument approach procedures (IAPs) continues to increase due to the Federal Aviation Administration's (FAA's) ongoing air traffic control modernization initiative called the Next Generation Air Transportation System (NextGen). The FAA National Aeronautical Navigation Services maintains an ongoing desire to reduce the number of IAPs that are underutilized or redundant in nature. In September 2010, the FAA awarded a grant to Flight Safety Foundation to research and develop a process that can be used to identify and ultimately eliminate such procedures.

The Foundation held meetings with FAA personnel and key airspace user organizations. The meetings were beneficial, with a significant amount of information collected. It became clear that instrument landing system (ILS) and area navigation/required navigation performance (RNAV/RNP) are the mainstays for most instrument approach operations, and nondirectional beacon (NDB) approaches are no longer desired except when no other option is available. The interviewees also revealed a concern about the extent to which certain unused or redundant very high frequency omnidirectional range (VOR) approaches should be proposed for cancellation.

Based on feedback obtained during the interviews and in-person surveys, it appears that the FAA can expect to reduce the current number of IAPs by at least 800, provided that the airspace users respond as favorably to the FAA proposal as they did to the research conducted by the Foundation. An 800-approach reduction would represent a 12 percent reduction in ground-based approaches and a 4 percent reduction in the FAA's total IAP inventory of public approach procedures.

The Foundation also sought insight from airspace users on what they perceive as the barriers that prevent them from relying solely on global positioning system (GPS)-based navigation signals. Several were identified, including: 1) the need for RNAV operations everywhere, in every phase of flight, 2) the need for safety enhancements in the form of approaches with vertical guidance where turbojet aircraft may operate, and 3) the need to equip aircraft with appropriate GPS-based avionics that can be used without a requirement for other navigation systems aboard the aircraft.

Introduction

The Federal Aviation Administration (FAA) National Aeronautical Navigation Services (AeroNav Services) maintains more than 17,000 instrument approach procedures (IAPs) throughout the National Airspace System (NAS). Instrument approaches are the foundation for instrument operations. Without them, aircraft cannot land at airports when visibility and cloud ceilings are below minimums allowed for flight in visual meteorological conditions, meaning that safety, capacity and operational efficiency are impacted.

The number of IAPs continues to increase due to the FAA's ongoing air traffic control (ATC) modernization initiative called the Next Generation Air Transportation System (NextGen). When NextGen is fully deployed, the FAA will have transitioned from a ground-based navigation system to a space-based (satellite) navigation system. However, during the NextGen deployment, and in the period of time during which aircraft are upgrading to NextGen navigation capabilities, the FAA will need to maintain the legacy navigation aids and associated IAPs.

With so many IAPs published, the FAA has expressed a desire to reduce a number of IAPs that are believed to be underutilized or redundant in nature. The FAA wants to invest its limited resources on the most beneficial IAPs, based on area navigation (RNAV) and required navigation performance (RNP). By reducing the number of redundant or underutilized approaches, the FAA can apply the cost savings toward the further expansion of RNAV and RNP throughout the NAS.

Project Narrative

In September 2010, the FAA awarded a grant to Flight Safety Foundation to research and develop a process to identify and ultimately cancel underutilized or redundant instrument approach procedures. Often, these approaches rely on ground-based systems that lack vertical guidance. Use of these procedures may offer less of a safety margin than existing satellite-based approaches.

This task analysis and evaluation is in support of the evolution to NextGen services in the NAS. It consists of three steps:

1. Research and develop a process that can be used to identify and ultimately cancel underutilized or redundant instrument approaches.

2. Provide a list of criteria and recommended actions to be used in executing the process.

3. In conjunction with this activity, identify the following:

    - Barriers to reducing further operator reliance on existing ground-based navigation systems that airspace users prefer not to utilize.
    - Opportunities to leverage the use of RNAV in future air traffic procedures as a means of reducing reliance on ground-based navigation aids.

- Opportunities to improve safety by increasing the use of approach procedures with vertical guidance.

Methodology
The primary method of collecting data was a series of interviews with the airspace user community. The FAA indicated that the process developed by the Foundation must incorporate feedback from the key aviation users. With the assistance of a questionnaire, the Foundation interviewed the following national organizations (in alphabetical order):

- Aircraft Owners and Pilots Association (AOPA)
- Air Transport Association (ATA)
- National Business Aviation Association (NBAA)
- Regional Airline Association (RAA)
- U.S. Air Force

A sample of the questionnaire can be found in Appendix A, and the organizational responses can be found in Appendices B-G.

Kickoff meeting
AeroNav Services met with the Foundation for a kickoff meeting to discuss the overall strategy and the specific tactics to achieve it.

In general, the FAA's strategy is to reduce the number of ground-based (legacy) IAPs so that the resources can be used to continue deployment of RNAV and RNP procedures. The FAA desires to reduce the ground-based approaches only where they are deemed redundant or unnecessary. The FAA does not intend to reduce access to airports or airspace by canceling IAPs that serve a purpose.

The FAA and the Foundation discussed several types of legacy IAPs that may be considered "low hanging fruit," including non-directional beacon (NDB), very high frequency omnidirectional range/distance measuring equipment (VOR/DME) RNAV, and certain VOR IAPs. The FAA and the Foundation also discussed the possibility of reducing the number of approaches with circling minimums at locations where operational impact is minimal.

Based on the discussion at the kickoff meeting, the Foundation executed the proposed strategy to interview key aviation organizations to better measure the level of airspace user support for the FAA strategy.

Number of Published IAPs Today
As of September 23, 2010, the IAP inventory included more than 17,011 approaches. The breakdown of approaches is listed in Tables 1 and 2:

Procedure Type	*# of IAPs*
GPS Stand-alone	425
RNAV (LNAV minimums)	4,909
RNAV (VNAV minimums)	2,280
RNAV (LPV minimums)	2,329
RNAV (RNP minimums)	237
RNAV (RNP specials)	7
Total:	10,187

Table 1. FAA Satellite-Based IAPs

Procedure Type	*# of IAPs*
ILS	1,339
ILS (CAT II)	170
ILS (CAT III)	121
ILS PRM	44
GLS	5
MLS	0
LOC	1,427
LOC (Back Course)	81
NDB	953
TACAN	32
VOR	1,366
VOR/DME	969
VOR/DME RNAV	33
LDA	33
LDA PRM	4
PAR	8
ASR	242
SDF	11
Total	6,838

Table 2. FAA Ground-Based IAPs

The Transition to RNAV/RNP

Since 1993, the FAA has approved the global positioning system (GPS) for supplemental use in the domestic, oceanic, terminal and nonprecision approach phases of flight in controlled airspace. The initial operating capability was declared for GPS by the Department of Defense (DOD) and the Department of Transportation (DOT) on December 8, 1993, and the FAA authorized aircraft to utilize GPS for instrument flight, provided that the GPS receiver meets the FAA's Technical Standard Order (TSO) C-129 criteria for

receiver autonomous integrity monitoring (RAIM). The first GPS IAP was published in 1995, and the FAA began developing hundreds of nonprecision GPS IAPs yearly. The instrument flight rules (IFR) GPS systems were operationally limited, and the FAA required traditional navigation sources such as VORs and tactical air navigation (TACANs) to be operational, with associated receiver equipment to be operational aboard the aircraft to serve as a backup.

The use of GPS as the primary means of navigation for the domestic en route through nonprecision approach phases of flight required better availability and continuity of service (reliability) than is available from the stand-alone GPS system. The FAA's wide area augmentation system (WAAS) made this possible. The FAA developed WAAS to improve the accuracy, integrity and availability of GPS signals. Operational since 2003, WAAS allows GPS to be used as the aviation navigation system from takeoff through landing with LPV (localizer performance with vertical guidance) IAPs providing minimums similar to or the same as Category I precision IAP minimums. The FAA has published more LPV approaches than instrument landing system (ILS) approaches, paving the way for increases in safety and access at thousands of airports. In fact, WAAS is a foundational element of NextGen that meets the FAA's strategic objective for a seamless satellite navigation system for civil aviation improving capacity and safety.

Unlike TSO-C129 GPS avionics, which were certified as a supplement to other means of navigation, WAAS avionics are evaluated and operationally approved to be used without reliance on other navigation systems. As such, installation of WAAS avionics does not require the aircraft to have other equipment appropriate to the route to be flown.

The FAA is continuously evolving the transition strategy to assess the current state of the NAS and to determine the best combination of navigation aids and approaches necessary to serve aviation’s needs, and the path or paths the transition can take. The transition will continue to be a slow process, gaining insight into constantly evolving requirements and needs.

The first step of this evolution is to fully implement satellite-based navigation, both in terms of infrastructure upgrades and aircraft avionics installations. As satellite navigation becomes more of the standard, conventional ground-based navigation aids and the associated IAPs can be phased out. Most would agree that some type of network of ground-based navigation aids will remain in place in case of radio interference that blocks receivers from accessing satellite-based navigation signals. This will not replicate the capability of the operating NAS, but rather it will be in place to ensure the safe operation of aircraft until satellite navigation can be re-established.

During the transition to satellite navigation, the FAA has maintained virtually all of the ground-based IAPs while adding more than twice as many RNAV/RNP IAPs, meaning that the total number of IAPs has grown tremendously. Over time, as ground-based navigation aids are reduced, the FAA expects a reduction in the overall number of IAPs as well, as shown in Figure 1.

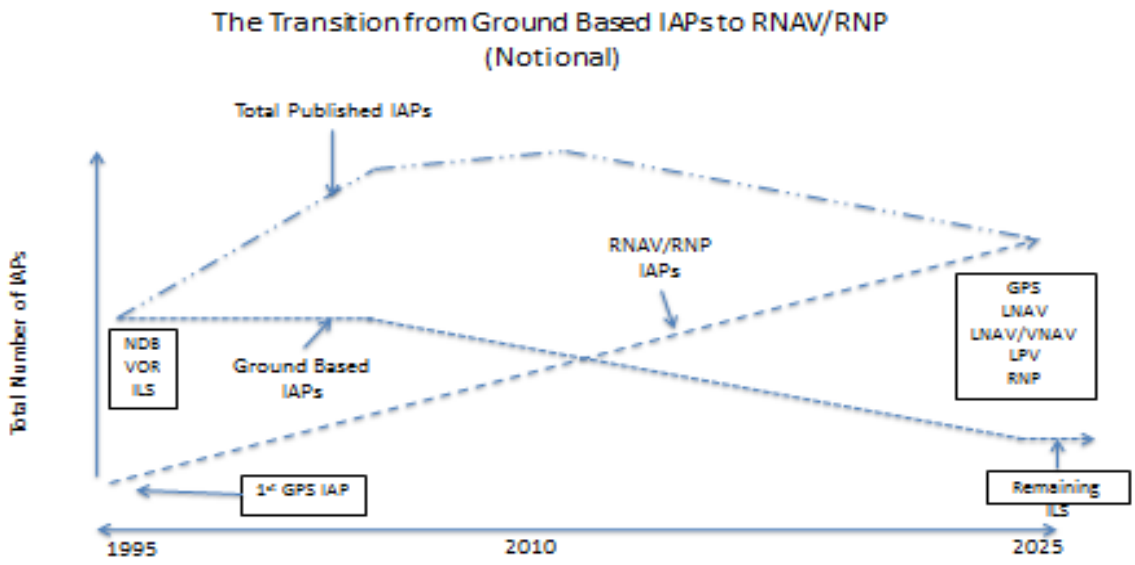

Figure 1: Notional Transition of IAP Volume

In the near- and mid-term NextGen, the FAA will retain portions of the legacy ground-based navigation infrastructure to support navigation if GPS becomes unavailable due to interference. The FAA plans to sustain a network of DMEs that would provide a redundant RNAV capability for en route airspace above Flight Level (FL) 180. A reduced set of VORs is expected to be retained to support a backup capability for low-altitude en route airspace, as well as instrument approach procedures. At least one ILS will be retained at airports where this service is provided today, unless the ILS is not necessary as part of the backup service, and traffic use does not justify a requirement for continued and uninterrupted service. These actions effectively reduce the threat to air transportation from disruption of GPS services in today's operational environment. The continued development and deployment of spectrum diversity (L1 and L5 frequencies on the GPS satellites), as well as improved anti-jamming capability, adequately address the issue of GPS interference.

In order to support the concepts and operations envisioned in the far-term of NextGen, the FAA is investigating the need for additional alternative positioning, navigation and timing (PNT) services. Because NextGen is highly reliant on GPS for foundational elements including RNAV RNP, trajectory-based operations (TBO), four-dimensional trajectory (4DT), and automatic dependent surveillance–broadcast (ADS–B), the FAA must ensure that adequate PNT services exist. Existing goals for the alternative PNT (APNT) effort call for any backup to support existing ILS and certain levels of RNP so that there is no need to establish new IAPs or retain legacy VOR, NDB and other types of ground-based non-RNAV IAPs.

RNAV (GPS) Equipage

One of the best indicators of the progress being made in the transition from ground-based navigation to satellite-based navigation is the level of aircraft equipage with the necessary avionics to fly the RNAV or RNP IAPs. The FAA publishes information that allowed the Foundation to estimate the equipage for both the airlines and the general aviation fleet.

Airline Equipage (Part 121)

According to the FAA, there were 18,519 air carrier aircraft in 2009. The table below depicts the breakdown of the aircraft into categories. *Airline (Part 121) Equipage*

The MITRE Corporation's Center for Advanced Aviation Systems tracks airline fleet equipage, and they report that the current airline equipage with LNAV (lateral navigation), LNAV/VNAV (lateral navigation/vertical navigation) or LPV totals more than 7,500 of the nation's 9,977 jet aircraft operated under Federal Aviation Regulations (FARs) Part 121. Equipage statistics for turboprop, piston and rotary wing aircraft operated under Part 121 were not available. Table 3 below depicts the number of aircraft known to be equipped with an approach-capable IFR GPS navigation system.

Aircraft Type	*# of Aircraft*	*Approach-Capable IFR GPS Equipage*
Jet	9,977	7,500
Turboprop	2,576	
Piston	3,143	
Rotary Wing	2,823	
Total:	18,519	

Table 3: GPS Approach-Capable Jet Airliners

General Aviation Equipage (non-Part 121)

According to the FAA, there were 223,876 general aviation aircraft in 2009. The FAA uses surveys to track equipage of the general aviation and air taxi fleet. The most recent survey of avionics equipage published by the FAA is from 2008. At that time, the FAA surveys revealed that nearly 89,000 piston engine aircraft had some sort of GPS approved for IFR operations (en route or approach). In Table 4 below, the general aviation fleet is divided into aircraft categories, and the number of aircraft with approach-capable GPS is provided.

Aircraft Type	*# of Aircraft*	*Approach-Capable IFR GPS Equipage*
Jet	10,951	7,583
Turboprop	8,673	3,683
Piston w/Electric System	151,981	58,408
Rotary Wing	9,504	2,002
Glider	868	13
Lighter–Than–Air	85	31
Experimental	20,039	4,010
Total:	202,101	75,730

Table 4: GPS Approach-Capable General Aviation Aircraft

The equipage estimates indicate that the majority of aircraft operators are utilizing ILS for precision approach and some type of RNAV procedure for nonprecision approaches (RNAV and/or RNP). During the interview process, several of the organizations affirmed the data.

Interview Results and Relevant Data

The Foundation held meetings with all airspace user organizations. In general, the meetings were beneficial and a significant amount of information was collected. It became immediately clear that RNAV/RNP is a mainstay for many operations and that NDB approaches are no longer desired except when no other option is available. The interviewees also revealed that there is a concern about the extent to which certain unused or redundant VOR approaches should be proposed for cancellation.

The concern strengthened significantly when discussing the possibility of a widespread reduction in VOR approaches, especially in cases in which data show that the VOR approaches are used regularly. The information in Figure 2 shows the perceived acceptance for eliminating ground-based instrument approaches along a scale.

In addition to gauging the level of concern about specific approaches that would be canceled, the interviews also provided insights into what criteria should be used to develop a candidate list of IAPs for coordination. The full text of notes and information received during the interviews is included in Appendices B–G.

None of the organizations interviewed was opposed to an FAA proposal to eliminate all but a small number of NDB approaches.

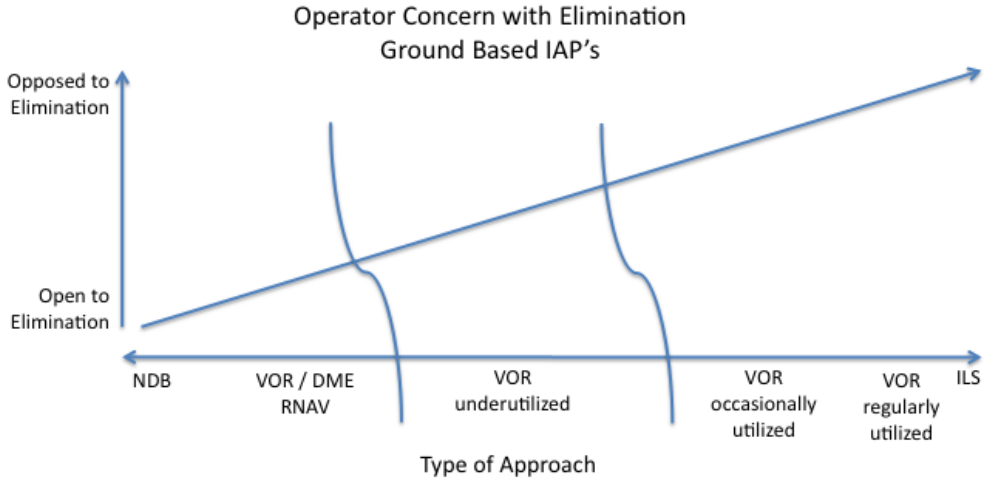

Figure 2: Operator Concern Scale, From NDB to ILS Approaches

Recommended Process for Identifying and Canceling Approaches

The Foundation has developed a recommended process for identifying and canceling the IAPs. It largely reflects the process used by the FAA in past efforts to reduce IAPs but ensures that the FAA has coordinated with ATC facilities and other government agencies before asking the public for comments. It is recommended that the FAA include the following steps:

- ✓ **Identification of the eligible instrument approaches.** The development of a candidate list of IAPs is expected to take between 60 and 90 days, depending on the availability of information and the level of available automation to develop a candidate "pool" of airports from which to derive the IAP list.
- ✓ **Request for comments from the DOD and associated ATC facilities.** Prior to publicly coordinating the approaches, the FAA should coordinate with the associated ATC facility and the DOD contacts for U.S. Air Force, U.S. Army, and U.S. Navy. The FAA should consider using a Web site, with a standardized form, to enter comments. A 30-day comment period is recommended.
- ✓ **Publish candidate list for public review.** The FAA should contact the organizations interviewed for this report, seeking their comments and feedback on the candidate IAPs. As a demonstration of the FAA's efforts to maintain organizational transparency, the FAA may also chose to publish the list in the *Federal Register*. The FAA should consider using a Web site, with a standardized form, to enter comments. A 60-day comment period is recommended.
- ✓ **Review of the comments.** The FAA should review the comments and determine how best to respond. Criteria will need to be developed after reviewing the comments to ensure a fair and balanced response.
- ✓ **Follow-on discussion with the airspace users (may not be necessary).** In some rare cases, the FAA may need to contact those who submitted comments and seek clarification of what has been submitted.
- ✓ **Finalizing the list of the instrument approaches to be canceled.** Once the FAA has decided on a strategy to respond to comments, a final list of IAPs can be generated.
- ✓ **Provide written response to each commenter, explaining the FAA's ultimate decision.** Draft a response to each commenter. Consider using e-mail as the method of communication.
- ✓ **Coordinating the cancellation date with appropriate internal FAA offices.** The FAA should develop an aggressive cancellation strategy that eliminates the approaches within two 56-day update cycles.

A Process to Identify Candidate IAPs: A Two-Phase Strategy

Based on the feedback and insights garnered from the interviews with the aviation stakeholders, the Foundation proposes a two-phase cancellation strategy, in which NDB and VOR/DME RNAV approaches are proposed for cancellation and user coordination is completed. Then, the second phase would deal with a set of underutilized or redundant VOR procedures. Both phases can be completed in 12–18 months.

Phase 1: NDB and VOR/DME RNAV
The first phase of the cancellation process includes all of the NDB and VOR/DME RNAV approach procedures. In advance of the publication of the proposal, the FAA should conduct an analysis to more fully evaluate the potential impact. The Foundation recommends reviewing the airports to ensure that other RNAV and ground-based IAPs with lower minimums are available to the same runway ends, and recommends that the FAA coordinate with DOD officials in advance of the coordination with civil aviation users.

The FAA should ensure that the NDB approaches are not utilized by flight schools or academies that may be training pilots for operations outside the United States. The Foundation has obtained a list of flight schools that are approved to train foreigners (see Appendix B), and is generally aware of flight schools that may be training Americans for operations in foreign countries where NDBs may still be a primary source of instrument navigation. The Foundation recommends an initial discussion with these training organizations before removing an IAP.

The FAA should ensure that any airport that currently is served by VOR/DME RNAV procedures also has another ground-based IAP as well as another RNAV-based IAP. The VOR/DME RNAV IAP should be retained only if it is the only approach to the airport.

Phase 2: Underutilized VOR
The second phase of the cancellation initiative includes a process in which a subset of airports with candidate VOR and circling minimum IAPs can be identified, and then a rigorous review of each airport can be conducted. The FAA's ability to identify eligible airports is unknown, and so the scope of this step is difficult to quantify at this time. The first-tier review takes the entire list of IAPs at airports and removes those airports with a published IAP that has the following conditions:

- The airport only has RNAV/RNP IAPs
- The airport has only one ground-based IAP (VOR or ILS)
- The airport has an RNAV IAP and only one other ground-based IAP including VOR and ILS
- The airport is identified by the FAA (AeroNav Services) as an airport that needs VOR approaches available for backup navigation in the event of GPS interference.

The second-tier review is to extract specific airports from the subgroup remaining and add airports into the cancellation category if they meet the following criteria:

- All airports that are currently served with approaches from a VOR that is slated for cancellation (disestablishment) in the next three fiscal years.
- One of the 100 busiest airline airports (by takeoff and landing traffic counts)
- All airports with an NDB IAP
- All airports with a VOR–DME RNAV IAP
- All airports with two or more VOR IAPs, as well as RNAV IAPs
- All airports with an ILS and a VOR IAP, plus more than one RNAV IAP

The Foundation anticipates that, after the second-tier review is complete, there will be a set of airports, with multiple ground-based instrument approaches, that can be evaluated on an individual basis. At this point, the process will become much more detailed, and an

airport-by-airport review will be required to apply the criteria and considerations provided by the airspace users during the Foundation's interviews.

The following evaluation criteria were provided by operators who were interviewed:

- It is critical to align any efforts associated with VOR disestablishment with efforts to identify and eliminate redundant or underutilized VOR approaches.
- Evaluate traffic count data from ATC sources. Using weather information, cross-reference the utilization of the procedures against times when visual meteorological conditions did not prevail.
- It would be appropriate to look for underutilized VOR approaches at the top 100 airline airports but to evaluate the nonprecision approaches as a whole. Consider the broader impact on the airport and not just the approach utilization statistics.
- For the remainder of the airports, if there are multiple approaches that are eligible for elimination at an airport, don't eliminate too many approaches per reduction cycle.
- If there are RNAV procedures to both ends of the runway, and if there is an ILS and a VOR approach to the same runway, and a VOR only on the opposite direction runway, propose eliminating the VOR that is serving the same runway end as the ILS.
- Circling minimums may be eligible for removal provided there are RNAV procedures to all runway ends, and provided that there are several ground-based instrument approaches available for use.
- If there are multiple VOR approaches that are eligible for removal from an airline airport, consider retaining VOR/DME IAPs at the airline airports because they often deliver the lowest minimums.
- If there are multiple VOR approaches that are eligible for removal from a non-airline airport, consider eliminating the VOR/DME IAP and retaining the VOR IAP, because the majority of non-airline aircraft do not carry a stand-alone DME. Most general aviation aircraft rely on GPS as their source of DME.

Eliminating Circling Minimums

During the interviews, the Foundation queried stakeholders about the possibility of reducing the IAPs with straight-in and circling minimums. Nearly all agreed that they are willing to consider a reduction in IAPs with circling minimums, especially if all runways are served with a straight-in IAP. Other considerations become difficult to discuss at a policy level, and it is likely that during the review of redundant/underutilized procedures, the reviewer could identify opportunities to eliminate circling in specific scenarios.

Eliminating Barriers to Further IAP Elimination — Develop an RNAV Strategy

The Foundation's research and the interviews conducted with the airspace user representatives identified several areas in which the FAA could reduce reliance on ground-based IAPs.

Those interviewed remain supportive of RNAV, and they generally support the FAA's efforts to utilize RNAV more and nonprecision ground-based navigation approaches less. There are, of course, exceptions to this support, primarily when specific operators can highlight IAPs or other operations in which the FAA has yet to provide RNAV-based procedures that offer streamlined operations or increased safety.

The Foundation's research revealed that the quality and volume of RNAV IAPs provides incentives for operator utilization of RNAV and reduces operator reliance on ground-based IAPs.

As a result of the feedback obtained during the interviews, the Foundation submits the following observations and recommendations on how the FAA can continue the transition from ground-based navigation for IAPs to satellite-based navigation for IAPs.

- Focus on RNAV everywhere. The Foundation recommends that the FAA establish and publish a policy that informs operators that ATC operations in the United States are now RNAV-based. That is, RNAV operations are the normal method of operating, and operations utilizing ground-based navigation aids (while still supported), are not the normal method of operating in the NAS.
- Publish RNAV IAPs at every airport with a ground-based procedure. The FAA could ensure that no airport has a ground-based approach as the only option.
- Eliminate GPS overlay procedures. The FAA should identify and remove all GPS overlay approaches. All RNAV or GPS procedures should become stand-alone. If special conditions exist that would result in higher minimums for a stand-alone GPS, the FAA should develop strategies to ensure that a new RNAV approach has minimums that are equal to, or better than, the ground-based navigation approach.
- Eliminate the use of V and J airways. Because the majority of active IFR aircraft are equipped with RNAV, the FAA could normalize non-airway-based routing capability. The change would make airway flying "non-normal." The use of airways by exception represents a significant changeover from ground-based navigation to satellite navigation.
- Establish a mandate for WAAS navigation, consistent with the ADS–B mandate. Given the stringent level of positional accuracy required for compliance with the ADS–B mandate, the use of WAAS receivers for compliance with the mandate is expected to dramatically increase. However, the FAA did not require that an aircraft's navigation system also utilize WAAS receivers if they are installed on the aircraft. The FAA should consider mandating that if an aircraft is equipped with a WAAS receiver (or equivalent level of performance from another PNT system) for any other aviation application, that the receiver also be used for navigation.
- Increase the use of approach procedures with VNAV. The Foundation's data have shown a dramatic increase in risk of accidents by turbine-powered aircraft when the use of vertical guidance is not available on IAPs.
- Ensure that all city-pair RNAV routings are shorter than V and J airway-based city-pair routings.

Target Improvements in Safety — Focus on Vertically Guided Approaches

The Foundation conducted an extensive review of fatal airline accidents that occurred during the approach and landing phase of flights between 1984 and 2007. Instrument approach procedure design was one of the considerations evaluated. Among the accidents investigated where the data was available, three-fourths of the accidents happened where a precision approach aid (with vertical guidance) was not available or was not used.

The Foundation recommends a focused agenda by the FAA to ensure that all approaches flown by turbine aircraft have electronic vertical guidance. Ensuring that all approaches have vertical guidance serves as an incentive to flight crews and operators to embrace RNAV and RNP, and abandon use of traditional ground-based IAPs.

VOR Disestablishment

During the research phase, the Foundation learned that the FAA is planning to disestablish VORs beginning in fiscal year 2012, consistent with the Federal Radionavigation Plan (FRP) and other strategy documents.

The aero charting team will need to carefully coordinate the elimination of redundant and unnecessary approaches with the FAA navigation offices in charge of the disestablishment strategy. From the airspace user perspective, the FAA will need to ensure that the procedures chosen, when combined with the VORs canceled, do not have a cumulative impact on operations that could result in stronger opposition to the reductions in approaches.

Regulatory Review

The Foundation conducted a regulatory review of FARs Parts 91, 121 and 135. In summary, the regulations pertaining to instrument approach minimums do not favor ground-based or satellite-based approaches. The Foundation confirmed that regulations and guidance limit the use of unaugmented GPS without reliance on any other form of navigation. A sample of the documentation in nearly all aircraft equipped with an IFR GPS is provided on the next page (Figure 3).

Essentially, aircraft operators not equipped with WAAS are unable to operate under RNAV without also carrying a VOR for a navigation backup. This means that the aircraft operators are required to carry equipment they no longer desire to use, which in turn requires the FAA to maintain IAPs that support the systems mandated to be carried for a backup purpose.

Without changes to the regulatory structure in which unaugmented GPS is currently approved, the FAA will likely be required to retain many VOR-based procedures. However, there is opportunity to define the minimum level of backup services that a GPS-equipped aircraft would need, and the definition could become the basis for further reductions below the full complement of IAPs but above the minimum required.

Oakton International Corp.
2714 Clarkes Landing Drive
Oakton, Va. 22124

Flight Manual Supplement for
Cessna 150G N 2937S

Section II - Limitations

A. The KLN 89B GPS Pilot's Guide Bendix/King P/N 006-08786-0000, dated May, 1995 (or later applicable revision) must be immediately available to the flight crew whenever navigation is predicated on the use of the system. The Operational Revision Status (ORS) of the Pilot's Guide must match the ORS level annunciated on the self test page.

B. IFR Navigation is restricted as follows:

1. The system must utilize ORS level 01 or later FAA approved revision.
2. The data on the self test page must be verified prior to use
3. IFR en route and terminal navigation is prohibited unless the pilot verifies the ac currency of the data base or verifies each selected waypoint for accuracy by reference to current approved data.
4. Instrument approaches must be accomplished in accordance with approved instrument approach procedures that are retrieved from the KLN 89B data base. The KLN 89B data base must incorporate the current update cycle.

(a) The KLN 89B Quick Reference, Bendix/King P/N 006-087870000, dated 5/95 (or later applicable revision) must be immediately available to the flight crew during instrument approach operations.

(b) Instrument approaches must be conducted in the approach mode and RAIM must be available at the Final Approach Fix.

(c) APR ACTV mode must annunciated at the Final Approach Fix.

(d) Accomplishment of ILS, LOC. LOC-BC, LDA, SDF, and MLS approaches are not authorized.

(e) When an alternate airport is required by the applicable operating rules, it must be served by an approach based on other than GPS or Loran-C navigation.

(f) The KLN 89B can only be used for approach guidance if the reference coordinate datum system for the instrument approach is WGS-84 or NAD-83. (All approaches in the KLN 89B data base use the WGS-84 or the NAD-83 geodetic datums.)

5. The aircraft must have other approved navigational equipment appropriate to the route of flight installed and operational.

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Figure 3: Sample of a Flight Manual Supplement Imposing Limitations on a TSO C-129 GPS

Potential IAP Reduction Forecast

Based on feedback obtained during the interviews and in-person surveys, it appears that the FAA can expect to reduce the number of IAPs by at least 800, provided that the airspace users respond as favorably to the FAA proposal as they did to the initial survey. This would represent a 12 percent reduction in ground-based IAPs and a 4 percent reduction in the FAA's total IAP inventory of public procedures (Figure 4).

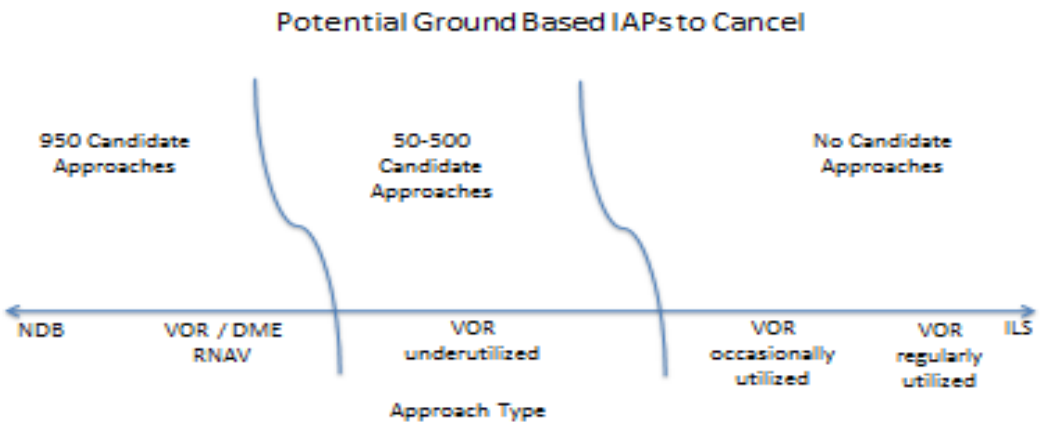

Figure 4: Potential Volume of IAPs That Could Be Canceled

Appendix A

Redundant/Underutilized Procedures Questionnaire

Part 1: The Transition to Satellite Navigation (broad discussion)

1. Does your organization support the FAA's goal to transition from ground-based navigation to satellite-based navigation for instrument approaches?

2. Are there any regulatory, policy or procedural barriers that prevent pilots and aircraft operators from utilizing satellite-based approaches exclusively? If yes, please provide details.

3. Are there any barriers that the FAA should consider removing so that pilots can maximize their investment in GPS-based navigation equipment? If yes, please provide details.

4. To what extent is the fleet of aircraft equipped with satellite-based navigation equipment? (Percentage of the fleet)

5. What year will at least ninety percent (90%) of the aircraft fleet in your segment of the aviation industry, who operate under Instrument Flight Rules (IFR), be equipped with satellite-based navigation systems capable of flying a nonprecision GPS approach?

6. Where should aero navigation services increase their focus, to provide satellite-based procedures: approach, arrival/departure or en route? How will an increased focus in this domain benefit your community?

Part 2: The Transition Away From Ground-Based Instrument Approaches

1. If pilots have the choice between GPS and ground-based nonprecision instrument approaches, which do they prefer to use most of the time? Why?

2. Are there specific times, locations, or situations where pilots would prefer to use GPS for a nonprecision instrument approach, but they cannot? If yes, please provide details. How can the FAA resolve the issue?

3. The FAA has now published more than 2,100 LPV approaches, which can provide airport access below nonprecision approach minimums. Do pilots prefer these LPV approaches over any type of nonprecision approaches?

4. On a scale of one to ten (1-10), are pilots and aircraft operators confident that GPS signals are reliable and adequately available? 1=No confidence & 10=Complete trust.

5. Has pilot and operator confidence in the GPS signal declined or improved over the past 10 years? Why?

6. How frequently (percent of the total approaches flown) do pilots utilize ground-based nonprecision approach procedures?

7. How frequently (percent of the total approaches flown) do pilots utilize nonprecision GPS approach procedures? Nonprecision GPS procedures include GPS and LNAV.

8. How would pilots or aircraft operators define an approach as redundant or underutilized?

9. Do you (your organization) believe there are underutilized or redundant ground-based instrument approaches that can be eliminated without impacting safety or access? If so, please provide insights on where or how to develop a list of these procedures. If not, please explain.

Appendix B

Redundant/Underutilized Procedures Questionnaire
Aircraft Owners and Pilots Association
October 19, 2010

Part 1: The Transition to Satellite Navigation (broad discussion)

1. Does your organization support the FAA's goal to transition from ground-based navigation to satellite-based navigation for instrument approaches?

   Yes

2. Are there any regulatory, policy or procedural barriers that prevent pilots and aircraft operators from utilizing satellite-based approaches exclusively? If yes, please provide details.

   There is policy that limits GPS to be a supplemental system. Another system like VOR, is also required to be operational onboard the aircraft.

3. Are there any barriers that the FAA should consider removing so that pilots can maximize their investment in GPS-based navigation equipment? If yes, please provide details.

   PTS is probably more of a barrier than equipage.

4. To what extent is the fleet of aircraft equipped with satellite-based navigation equipment? (Percentage of the fleet)

   More than 70 percent of the members report using GPS on a regular basis.

5. Where should aero navigation services increase their focus, to provide satellite-based procedures: approach, arrival/departure or en route? How will an increased focus in this domain benefit your community?

   Airways? Is there any cost to maintain them? If so, what is the cost? The FAA CTOP initiative will require pilots to file defined routes, how can we get rid of airways? It appears FAA may need to keep airways for CDM purposes. The T-routes haven't been all that successful; it is hard to get cleared to fly them.

Part 2: The Transition Away From Ground-Based Instrument Approaches

1. Do you (your organization) believe there are underutilized or redundant ground-based instrument approaches that can be eliminated without impacting safety or access? If so, please provide insights on where or how to develop a list of these procedures. If not, please explain.

   AOPA would be willing to go out with a list to solicit feedback on all NDBs. The fact that FAA was responsive before, there is trust to try some more.

   Considerations for eliminating approaches
   - As long as that isn't the only approach, an NDB is low hanging fruit
   - Another ground-based approach with lower minimums
   - Just based on where we are today, we would support that step – propose eliminating.
   - At airline airports w/lots ILS. If there is ILS for CAT A/B then not a VOR to every runway end, for the Operational Evolution Partnership (OEP) or the top 100 airports or something
   - There are a few schools that are authorized to train foreign students under an M-1 (used to be called J-1) visa. They may still need NDBs. Here is the list:
     1. Scandinavian Flight Academy — Gillespie Field, El Cajon, California
     2. Delta Connection Academy — Orlando Sanford International Airport, Orlando
     3. Helicopter Adventures — Space Coast Regional Airport, Titusville, Florida; Acadiana Regional Airport, New Iberia, Louisiana; Buchanan Field Airport, Concord, California
     4. Air-Ben Aviation Academy — St. Lucie County International Airport, Fort Pierce, Florida
     5. Pelican Airways — North Perry Airport, Hollywood, Florida
     6. Hillsboro Aviation — Hillsboro Airport, Hillsboro, Oregon
     7. Phoenix East Aviation — Daytona Beach International Airport, Daytona Beach, Florida

   - When considering whether a VOR approach needs to be retained or not, the question should be asked, is the VOR that supports the approach going to be retained as part of the minimum operational network or basic backup network? If so, perhaps it should not be canceled.
   - DME requirements. If the approach retained requires a DME (and assuming GPS is out), then it would not be very helpful because many general aviation aircraft use GPS in lieu of DME.
   - Redundant options maybe remove one. If it adds requirement for GPS and or DME then seems like need to keep approaches.
   - Until fundamental changes to avionics required for IFR flight, VOR approaches.
   - Two approaches, get rid of one.
   - Traffic count is one of the filters, not the only filter.

- What about places that are VFR most of the time? Do they need six procedures (i.e., Phoenix metro area)? Look at the metro area where it is good weather a lot of time.
- Which approaches are the ones that ATC will allow for practice approaches?

VOR at a general aviation airport? How to determine criteria? Let's review a few airports:

- VOR at Frederick (Maryland) Municipal Airport — there is only one so probably need to keep it.
- Manassas (Virginia) Regional Airport — ILS/LOC and 2 RNAV's, probably none there to eliminate
- Carroll County (Maryland) Regional Airport — VOR and RNAV both, perhaps some opportunity to eliminate.
- Phoenix Deer Valley Airport — all GPS approaches
- Scottsdale (Arizona) Municipal Airport — has two circling VOR approaches. If the "or GPS" was converted to stand-alone RNAV, then would AOPA believe that there still needs to have a VOR approach? The –A at Scottsdale has higher mins than the –Charlie.
- Greater Cumberland (Maryland) Regional Airport — Loc DME and LOC-A. Need LOC A? Not sure.

Appendix C

Redundant/Underutilized Procedures Questionnaire
Air Line Pilots Association, International
November 15, 2010

Considerations when developing a process:

- Don't increase amount of circling.
- Use utilization data by approach. Low utilization may be needed to be kept but zero utilization is key.
- The redundancy is desired but how much redundancy is desired? Still a role for ground based navigation aids.
- Nearby alternates
- Circling minimums?
- Reduce VOR at large airports?
- Ground based procedures still in ops specs?
- Mainline airlines fly charter flights too so they need to have access to the necessary approaches.
- Not taking away lowest minimums.
- Figure out how to identify those that are redundant.
- How much of the time VNAV? Less than we would think.
- Concur that valid utilization data will be key, and could be an issue as facilities don't generally count procedures that are used in VMC for training. Although not a big issue for our members per se, that fact means the source and validity of the data.
- NDB approaches as a group should get a hard look. You had asked us to comment on how many carriers even have NDB in their ops specs, and the consensus is that they still exist in a few OpsSpecs even if they are not, as a matter of common practice, flown. Getting to the bottom of that one would probably need carefully crafted survey questions. Carriers like Alaska servicing remote areas, and a lot of the cargo or small feeder carriers flying older equipment (727, B1900, J31) may make greater use of NDB. Our Canadian carriers still fly NDB approaches, especially at remote airfields.
- Procedures that are never used should be prime candidates for elimination. However, procedures that are seldom used should not automatically be considered as marginally useful. It may be that the XXX to Runway 99 is almost never used, but when it is, it's the only way to get in. Thus, each would have to be evaluated individually.
- Don't eliminate the approach with the lowest mins.
- Don't eliminate any approach that will result in an increase in the need to circle.
- ALPA has a stated goal of vertical and lateral guidance to every runway end served by air carriers.
- We discussed the prevalence of the use of FMS-generated vertical path information on NP approaches. Many of the RJs, especially the CRJ-200 and the ERJ135/145 do *not* have the capability to generate vertical paths.

Appendix D

Redundant/Underutilized Procedures Questionnaire
Air Transport Association
November 1, 2010

Part 1: The Transition to Satellite Navigation (broad discussion)

No specific input received in this section.

Part 2: The Transition Away From Ground-Based Instrument Approaches

2. Do you (your organization) believe there are underutilized or redundant ground-based instrument approaches that can be eliminated without impacting safety or access? If so, please provide insights on where or how to develop a list of these procedures. If not, please explain.

   - It is possible, what is key is dispatch reliability and access.
   - Should take into consideration the traffic counts at the airports.
   - Military is in process eliminating TACAN and going to GPS approaches.
   - Backup needed for alternate airports. Outages require us to still use VOR sometimes. For example, Fort Myers, Florida, when the VOR was used. And, down in the Caribbean, the ATA members are still reliant on NDB approaches alternate selection.
   - Even here in the Lower 48, NDB routes may be needed for minimum equipment list (MEL) or RAIM issue.
   - Dispatch is key. Dispatch w/FMC inop could use NDB route along DIXON in the Outer Banks and North Carolina.
   - The airline SOCs organized by regional basis so be sure to coordinate extensively any list you may develop.

Appendix E

Redundant/Underutilized Procedures Questionnaire
National Business Aviation Association
October 29, 2010

Part 1: The Transition to Satellite Navigation (broad discussion)

6. Does your organization support the FAA's goal to transition from ground-based navigation to satellite-based navigation for instrument approaches?

   Yes we do

7. Are there any regulatory, policy or procedural barriers that prevent pilots and aircraft operators from utilizing satellite-based approaches exclusively? If yes, please provide details.

   The NBAA members are still required to carry ground-based navigation equipment, even though they don't want to. It would be nice if there were changes to policy and regulations that allow our members to remove their VOR equipment and fly exclusively with RNAV, RNP or ILS

8. To what extent is the fleet of aircraft equipped with satellite-based navigation equipment? (Percentage of the fleet)

   Although NBAA does not track fleet equipage, the FAA statistics appear to be within reason.

9. What year will at least ninety percent (90%) of the aircraft fleet in your segment of the aviation industry, who operate under Instrument Flight Rules (IFR), be equipped with satellite-based navigation systems capable of flying a nonprecision GPS approach?

   By 2020 or before.

Part 2: The Transition Away from Ground-Based Instrument Approaches

3. Are there specific times, locations, or situations where pilots would prefer to use GPS for a nonprecision instrument approach, but they cannot? If yes, please provide details. How can the FAA resolve the issue?

   If there is an airport without an RNAV procedures, then our members have no choice but to utilize a ground-based nonprecision approach, preferably a VOR approach.

4. The FAA has now published more than 2,100 LPV approaches, which can provide airport access below nonprecision approach minimums. Do pilots prefer these LPV approaches over any type of nonprecision approaches?

   Our membership equipage with WAAS LPV is not yet at a critical mass. However, the members that have equipped their aircraft with WAAS find the LPV approaches valuable.

5. How frequently (percent of the total approaches flown) do pilots utilize ground-based nonprecision approach procedures?

   Our members generally use ground based nonprecision approach procedures when their destination airport does not have an RNAV or GPS approach.

6. Do you (your organization) believe there are underutilized or redundant ground-based instrument approaches that can be eliminated without impacting safety or access? If so, please provide insights on where or how to develop a list of these procedures. If not, please explain.

We believe there are procedures that can be eliminated. Certainly NDBs should be considered. Some VORs at the larger airports where there are plenty of ILS and RNAV or GPS procedures could also likely be reduced.

Direct quotes:
For our membership you still have a number of folks that use VOR procedures for sure. Out in the Midwest and western areas. Further from metropolitan areas, use of VOR is still needed. Not everyone still equipped.

Look at the airport — is it the only way in or out. Not sure there is a process that would tell you the answer except by looking at airport by airport.

Process to look at procedures and then survey local groups for specific airports

From low hanging fruit perspective. No need for NDB procedures anywhere. There might be a place, where NDB is sole way to get into the airport. Minimums would not be that good anyway.

Appendix F

Redundant/Underutilized Procedures Questionnaire

Regional Airline Association
October 19, 2010

Part 1: The Transition to Satellite Navigation (broad discussion)

10. Does your organization support the FAA's goal to transition from ground-based navigation to satellite-based navigation for instrument approaches?

11. Are there any regulatory, policy or procedural barriers that prevent pilots and aircraft operators from utilizing satellite-based approaches exclusively? If yes, please provide details.

    Yes, the issue is that GPS is not a primary system. If aircraft operators have the GPS equipment onboard the aircraft, they sometimes cannot use it to its fullest extent, due to limitations imposed by the regulator. If operators cannot see the benefits before making a decision to equip, and if the benefits cannot be achieved easily, then business case gets watered down quickly.

    Also, the regional airlines are still taking delivery of aircraft today that aren't NextGen.

    Some of the RAA members have removed VOR and NDB approaches from the ops specs. That allows them to stop training to these approaches. However, a number of airlines that don't conduct VOR or NDB approach do side step, or circle to land so there needs to be careful consideration before removing circling minimums.

    RAIM prediction should be less conservative and more consistent than the avionics capability. Frustration about the use of GPS so limiting inconsistent with experience. If you have dual source why not use it for primary means? So we need to keep the VORs around due to the AFS limitations on GPS confidence. DOD assurance creates a gap between RNAV w/o WAAS.

12. Are there any barriers that the FAA should consider removing so that pilots can maximize their investment in GPS-based navigation equipment? If yes, please provide details.

    RNAV in the western part of the United States is more helpful than on the East Coast. On the East Coast routings and services are still airways based. The RAA members find it difficult to take advantage of RNAV on East Coast except for SID/STAR. En route, the aircraft stay on the airway. Westbound from NYC huge SID benefit. Out West some RNAV routes are helping too.

There are many airports out West where one runway has an ILS and RNAV approaches speed up arrivals from the other direction. Some aircraft have advisory VNAV (needle and coupled up). Only few aircraft w/VNAV. Q400, CRJ 900/100 and large Embraer have VNAV. Everyone else is still nonprecision.

13. Based on your knowledge of the portion of the aviation industry in which your organization is focused, to what extent is the fleet of aircraft equipped with satellite-based navigation equipment? (Percentage of the fleet)

    No answer provided

14. What year will at least ninety percent (90%) of the aircraft fleet in your segment of the aviation industry, who operate under Instrument Flight Rules (IFR), be equipped with satellite-based navigation systems capable of flying a nonprecision GPS approach?

    No answer provided

15. Where should aero navigation services increase their focus, to provide satellite-based procedures: approach, arrival/departure or en route? How will an increased focus in this domain benefit your community?

    In the en route phase of flight, the FAA could "disconnect routes to NAVAIDs," just design routes that are more direct. If the lines came off the charts, it would really accelerate benefits to regional airlines. Keep the VOR for waypoints but remove the lines.

Part 2: The Transition Away From Ground-Based Instrument Approaches

7. If pilots have the choice between GPS and ground-based nonprecision instrument approaches, which do they prefer to use most of the time? Why?

   Primarily ILS or RNAV for nonprecision. Their RNAV systems are not sole means and need the ground based navigation aids. Dispatch to airport w/ILS and RNAV approach then it is ok. If it is RNAV as primary access and there is wind shift they need a VOR. Doubt if anyone using NDB. VOR may be an issue but not that often.

8. Has pilot and operator confidence in the GPS signal declined or improved over the past 10 years? Why?

   On GPS confidence. Higher than what they are permitted to utilize. RAIM is an issue where a RAIM check is needed before takeoff. Need to flight plan around the forecast outage. There have been very few outages so the view for existing outage forecast is too conservative.

Notes on a process and criteria for eliminating approaches:

- Identify airports for primaries and alternates. See what approaches are there to choose from. Criteria like do you need procedure and why. Routinely for landings, occasionally, used as alternate. Make sure all operators have chance to look at it. No surprises. Coordination key
- FAA doesn't have a good list of operators to reach out for. AFS can provide operators and approved airports. Direct reach out to operators, officials at airline designated with ops specs. Tech group at RAA. Perry Solomonson at Horizon Air. ATO said they wanted associations to reach out to operators.

Appendix G

Redundant/Underutilized Procedures Questionnaire
United States Air Force
November 15, 2010

NDBs today are used primarily for training purposes, estimate about 90 percent of the time for training purposes.

There are underutilized or redundant approaches that could be removed. We will need to look at them site by site. NDB and certain VOR could be on the list for consideration, but we won't know whether they are needed until we circulate the list broadly. DOD will provide USAF POC and Navy POC. The ARMY POCs are available from the FAA.

Appendix H

Acronyms

4DT four-dimensional trajectory

ADS–B automatic dependent surveillance–broadcast

AFS Federal Aviation Administration Flight Standards Service

ALPA Air Line Pilots Association, International

AOPA Aircraft Owners and Pilots Association

APNT alternative positioning, navigation and timing

ASR airport surveillance radar

ATA Air Transport Association

ATO air traffic organization

CAT category

CDM collaborative decision making

CTOP Collaborative Trajectory Options Program

DME distance measuring equipment

DOD Department of Defense

DOT Department of Transportation

FAA Federal Aviation Administration

FARs Federal Aviation Regulations

FMC flight management computer

FMS flight management system

FRP Federal Radionavigation Plan

GLS global navigation satellite system (GNSS) landing system

GPS global positioning system

IAP instrument approach procedure

IFR instrument flight rules

ILS instrument landing system

LNAV lateral navigation

LDA localizer type directional aid

LOC localizer

LOC–BC localizer–back course

LPV localizer performance with vertical guidance

MEL minimum equipment list

MLS microwave landing system

NAS National Airspace System

NAVAID navigational aid

NBAA National Business Aviation Association

NDB non-directional beacon

NP nonprecision

OEP operational evolution partnership

PAR precision approach radar

P/N part number

PNT positioning, navigation and timing

POC point of contact

PRM precision runway monitor

PTS practical test standards

RAA Regional Airline Association

RAIM receiver autonomous integrity monitoring

RNAV area navigation

RNP required navigation performance

SDF simplified directional facility

SID standard instrument departure

SOC systems operation center

STAR standard terminal arrival

TACAN tactical air navigation

TBO trajectory based operations

VNAV vertical navigation

TSO technical standard order

VMC visual meteorological conditions

VOR very high frequency omni-directional range

WAAS wide area augmentation system