March 21, 2018

Mr. Ali Bahrami
Associate Administrator for Aviation Safety
Federal Aviation Administration
800 Independence Avenue, SW
Washington, D.C. 20591

Dear Ali,

The Performance Based Operations Aviation Rulemaking Committee (PARC) is pleased to submit the following recommendation for revising design criteria relative to obstacle evaluation assessments (OEA) for Advanced RNP (A-RNP) procedures.

The PARC Navigation Working Group completed a review and analysis of the current OEA requirements for A-RNP procedures, and further assess if design criteria could be aligned with RNP AR design criteria. After a comprehensive review, it was determined that the requirements for A-RNP and RNP AR OEA could be aligned. Harmonizing A-RNP and RNP AR design criteria will increase the participation rates of aircraft flying procedures, and reduce costs to the FAA because there may not be a requirement to design multiple procedures flying over the same path.

The Working Group consisted of Subject Matter Experts (SMEs) that resulted in a thorough analysis leading to their recommendations, which were subsequently supported by the PARC Steering Group. This activity further validates the effectiveness of a forward leaning technical team comprised of operators, manufacturers, and the FAA. Specific details of the recommendation are delineated in the following report.

It is the request of the PARC, as always, that we be provided a formal response.

The PARC appreciates your continued support of our activities and invites you to join us in a discussion of these recommendations at any time at your convenience. Please call me if you have any questions or would like to set up a discussion.

Sincerely,

Mark Bradley
Chairman, PARC
404-915-2144

Cc: Mark Steinbicker
Chris Hope
Mike Cramer
Merrill Armstrong
Donna Creasap
TJ Nichols

RECOMMENDATION TO REDUCE OEA WIDTH FOR A-RNP

Introduction

In early 2017, MITRE and FAA met to discuss implementation of A-RNP and what issues might arise. MITRE analysis noted several drawbacks to implementation benefits due to procedure design constraints which were documented at that meeting. The PARC Nav WG was asked to review and perhaps make recommendations regarding these issues.

The two of the issues were the fact that the Obstacle Evaluation Area around an A-RNP path has been set at 3xRNP (2xRNP primary and a 1xRNP secondary), a very limiting requirement. This also leads to issues with turns where turn radius is limited to 3xRNP to avoid overlap of OEAs in course reversals and similar constructions. The Nav WG has worked on these two issues together since if the A-RNP OEA can be reduced, it will also eliminate the RF turn radius minimum as a problem. There is a great deal to be gained if the OEA for A-RNP can reasonably be made the same as RNP AR for RNP values greater than 0.3, where AR procedures are being promulgated simply to allow use of RF legs in the IAP design.

The WG discussions noted other areas of harmonization that may be needed in addition to the lateral OEA requirements before there can be a simple one-to-one exchange of A-RNP for an AR procedure. The vertical obstacle clearance surfaces are also different, with RNP AR using the vertical error budget rather than the LNAV/VNAV surfaces. In some instances, this will cause the AR minimums to be higher than A-RNP, just as is the case now with the LNAV/VNAV minimums compared to AR. The WG has this on the 2018 work program and will work through it in conjunction with attempting to resolve the issue where RNP AR can often not attain the desired 250' HAT because of how the VEB is designed and applied. The two issues are related and will be worked together. In the meantime, the OEA issue will move us much further forward in using A-RNP in lieu of AR for RNP > 0.3 with RF.

The following sections will state the recommendation alone followed by two more sections, the first of which shows what the motivation is for such a reduction and the second of which gives the technical airworthiness reasoning behind the recommendation.

Recommendation

The Navigation WG recommends that FAA harmonize A-RNP and RNP AR procedure design criteria as follows:

1. Change the A-RNP obstacle evaluation areas to 2xRNP either side of the lateral path,
2. Apply RNP AR path and OEA construction methods (down to RNP 0.3) to A-RNP procedure design.

Motivation for Change

One of the main concepts behind the introduction of A-RNP for approaches to landing was to allow aircraft that were highly equipped to fly paths that closely mirrored existing RNP AR approaches at a 0.3 RNP level. Of course, since this concept also opened the door to pilots that may not have the same level

of training as RNP AR, some stipulations were made to ensure the same high level of safety is retained. This includes rules such as no turns in the Final Approach Segment (FAS). These stipulations however should be limited to tangible ways to keep high levels of safety while retaining accessible approaches to airports.

Keeping OEA harmonized with RNP AR instead of RNAV GPS is one area that current guidance has limited which is not adding increased safety but could limit common approach path and increased cost for the FAA to retain accessibility to airports. Below are the points to support this statement:

1) To qualify for A-RNP, aircraft meet similar airworthiness eligibility as for RNP AR (See last section of this recommendation *"FAA Airworthiness Case for Advanced RNP (A-RNP) Lateral OCS Reduction"*). This level of equipage ensures path compliance and has the same pilot action resulting in a go-around if actual navigation performance (ANP) exceeds required navigation performance (RNP). Since the level of equipage ensures the path compliance, the added secondary surfaces are redundant.
2) When it comes to cost, industry understands we cannot ask the FAA to support multiple approaches to the same runway without a justification. If A-RNP retains the 3xRNP OEA, this would go against this request from the FAA. Since industry intent is to try and leverage existing RNP AR procedures that could be flown without the need for AR authorization, having a differing OEA assessment would mean existing procedures would not be valid without new source and flight validation. KDEN is often used as an example of this, see Figure 1:

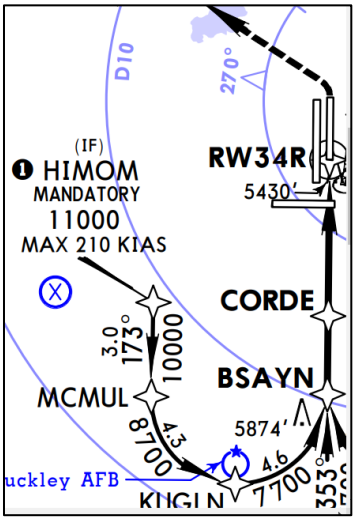

Figure 1

In this example, the procedure meets all the guidelines set forth for A-RNP but was designed and implemented with a 2xRNP OEA. The FAA could re-assess this procedure for 3xRNP but the secondary surfaces could pull in new obstacles causing a need to have an altered lateral/vertical path and therefore a new procedure with a different suffix **OR** a loss in the efficiency on the already established design. A-RNP OEA harmonization ensures existing procedures meeting the A-RNP guidelines will be quickly available for use while keeping costs down for the FAA.

3) The current 3xRNP OEA also has the potential to limit access to airports where safe operations could exist with 2xRNP OEA as they do today. The following list is an example of some airports that have RNAV procedures with 2xRNP OEA that would likely not be available for A-RNP:

a. SNA RNAV (RNP) Z RWY 20R
b. DAL RNAV (RNP) W RWY 13R
c. OMA RNAV (RNP) Z RWY 14R
d. OMA RNAV (RNP) Z RWY 18
e. OMA RNAV (RNP) Z RWY 32L
f. CRP RNAV (RNP) Z RWY 13
g. HRL RNAV (RNP) Z RWY 17R
h. BNA RNAV (RNP) Z RWY 31
i. GEG RNAV (RNP) Z RWY 3
j. GEG RNAV (RNP) Z RWY 25
k. RNO RNAV (RNP) Z RWY 16R
l. RNO RNAV (RNP) Y RWY 16R
m. BOI RNAV (RNP) Z RWY 10R
n. BOI RNAV (RNP) Z RWY 28R
o. PDX RNAV (RNP) Y RWY 28L
p. ABQ RNAV (RNP) Z RWY 21
q. ABQ RNAV (RNP) Z RWY 8

While it is admirable to keep training to a level that affords A-RNP operations where RNP AR operations may be limited, there invariable a need for some training. Understanding of RF is already defined in guidance and there may also be a need for pilots to understand missed approach requirements if a go-around from an EoR type operation is commenced. It is our opinion that these training requirements while simple, can be enough to allow for 2xRNP OEA and not have a need to design new procedures for the NAS.

Technical Justification Supporting the Recommendation

FAA Airworthiness Case for Advanced RNP (A-RNP) Lateral OCS Reduction

A white paper prepared by Barry Miller, FAA AIR-6B1

This white paper proposes new procedure design criteria for aircraft eligible for A-RNP operations. The paper purports that the airworthiness eligibility criteria for A-RNP from AC 20-138D, Change 2, is effectively identical to the airworthiness eligibility basis for RNP AR approach operations limited to no lower than RNP 0.30. Since the airworthiness eligibility requirements are identical, the realized aircraft performance can be identical. Thus, given identical aircraft eligibility and performance, and a common means to operate the aircraft during these procedures, the procedure design lateral protection for A-RNP procedure design criteria can exclude the traditional secondary lateral obstruction clearance area (OCA) just as RNP AR approach procedures limited RNP 0.30 does today. This white paper offers extracts of the airworthiness eligibility criteria in support of this proposal for consideration by members of the PARC Nav WG.

Before offering the airworthiness extracts, the WG should consider the key procedural A-RNP functions the FAA plans to employ in the U.S. As clarified in FAA AC 90-105A, these functions are limited to: RF legs, RNP scalability (e.g. the ability to procedurally apply any RNP value between RNP 1.0 and RNP 0.30

leg segment by leg segment) and parallel offset lateral paths. However, the FAA airworthiness eligibility also relies on a continuity requirement stated in Appendix 3 to AC 20-138D, Change 2, stating:

> **Appendix 3. Advanced RNP Functions.**
>
> **A3-1. Introduction.**
>
> **a.** ICAO document 9613 Performance Based Navigation (PBN) Manual, fourth edition, 2013 lists six advanced RNP functions. The six functions are:
>
> - RF legs
> - Parallel offsets
> - Scalable RNP
> - RNAV holding
> - Fixed radius transitions (FRT)
> - Time of arrival control (TOAC)
>
> **Note:** The PBN Manual includes Higher Continuity as an advanced RNP function. Higher continuity is not really a function, but a result of the hazard level associated with advanced RNP functions affecting aircraft equipage (see paragraph A3-1.e).
>
> **A3-1.e.:** The continuity requirement for advanced RNP implementation is classified as a major failure condition that can be satisfied with dual independent equipage.

The reference in paragraph A3-1.e. above is important. Stated another way, the continuity requirement results in the design assurance for the installed equipment supporting A-RNP requires protection against major failure conditions. In simpler terms, the probability that the equipment supporting A-RNP is lost or misleading during the A-RNP procedure must be remote (i.e. a probability of less than 1 in 100,000 [i.e. 1×10^{-5}] that a failure occurs or misleading guidance results). Generally, all aircraft OEMs meet this continuity requirement by providing dual, independent equipage.

Given the continuity airworthiness requirement for A-RNP aircraft eligibility, the same continuity requirement exists for RNP AR approach eligibility when the approach procedure requires no less than RNP 0.30 during the approach and no less than RNP 1.0 during the missed approach. In this case, the airworthiness requirement is found in AC 20-138D, Change 2, Appendix 2, paragraph A2-1, RNP AR General Requirements, subparagraph f., which states:

> **f.** Hazard Affects.
>
> - The system must be consistent with at least a major failure condition for the display of misleading lateral or vertical guidance on an RNP AR approach.
> - The system must be consistent with at least a major failure condition for the loss of lateral guidance and a minor failure condition for loss of vertical guidance on an RNP AR approach.

While these requirements may appear different, AC 20-138D, Change 2, addresses this difference in paragraphs 12-2., Failure Classification, and in A3-1.b., which state:

> **12-2. Failure Classification.**
>
> **a.** From en route through Category I precision approach, the loss of navigation function is typically considered to be a major failure condition for the aircraft (see AC 25.1309-1, AC 23.1309-1, AC 27-1, or AC 29-2 as applicable). Other aircraft navigation systems should be considered when determining GNSS loss of navigation, which could be major (no other navigation systems) or minor (other applicable navigation systems). Navigation data is considered to be misleading when un-annunciated position errors exist. For en route, terminal, LNAV, and LNAV/VNAV approaches, presenting misleading information to the flight crew is considered to be a major failure condition for the aircraft.
>
> **A3-1.b.** The equipment must include RF legs, Parallel offsets, Scalable RNP, RNAV holding, and FRTs for "advanced RNP" recognition. The rationale for including all of these functions is for international harmonization. To include "advanced RNP" recognition, the equipment, at a minimum, must meet the performance and functional criteria for RNP 2.0, RNP 1.0 and RNP APCH to LNAV minima.

The bottom line is, the design assurance requirements are identical for eligibility for both A-RNP procedures (terminal and approach procedures) and for RNP AR approach procedures limited to RNP 0.30 during the approach and RNP 1.0 during the missed approach.

Given common design assurance requirements, then the question of similarity then involves the functional requirements the two navigation specifications require. Since both operations are RNP operations, they both have an inherent requirement to achieve RNP eligibility through GNSS equipage. This is a practical requirement; and, while FAA AIR is willing to recognize other means of RNP capability, such as DME/DME radio-updating (D/D-updating) of the RNP system, no OEM has an RNP airworthiness approval recognizing the ability to predict the availability of another means of achieving RNP capability, such as their D/D-based RNP capability. Thus, to date, no OEM claims any practical RNP eligibility through a means other than GNSS.

With GNSS availability and use a foundational requirement for both navigation specifications, the issues then become the similarity of the functional requirements for A-RNP procedure applications and those for RNP AR approach. Given the two specifications, the key functions to consider are RNP scalability and eligibility for procedures with RF legs. When pursuing an eligibility basis for both A-RNP procedures and RNP AR procedures, the aircraft and RNP system may meet the scalability functional requirement through automatic setting of RNP values extracted from the onboard navigation database leg segment by leg segment or, IAW both AC 20-138D and AC 90-105A, flight crew procedures for manually setting the lowest RNP value an RNP procedure requires may mitigate the absence of automatic RNP scalability. So, the RNP scalability functional requirement does not constrain the application of the lateral OCA an RNP0 procedure provides.

In contrast to RNP scalability, RF leg airworthiness eligibility relies on AC 20-138D, Change 2, Appendix 7, for guidance for demonstrating RF leg eligibility. However, U.S. operational requirements also bolster the eligibility criteria for *all* RNP procedures applying RF legs by requiring the aircraft to include either an

autopilot (AP) or a flight director (FD) capable of coupling with the roll steering commands from the aircraft's RNP system. This operational requirement is found in the following paragraph in AC 20-138D, Change 2, Appendix 3, as a U.S. A-RNP eligibility requirement:

> **A3-2.b.(1).** Functional Criteria.
>
> (1) Autopilot and Flight Director.
>
> Flight Standards requires using an autopilot or FD with at least "roll-steering" capability that is driven by the RNP system during RNP procedures with RF legs (see guidance in AC 90-105A). The autopilot/FD must operate with suitable accuracy to track the lateral and, as appropriate, vertical paths required by a specific RNP procedure.

In contrast, in Appendix 2 of the same AC, the airworthiness requirements for RNP AR eligibility do not mandate RF leg eligibility (see RNP AR General Requirements, paragraph c.(1), Path Definition and Flight Planning). While this was originally intended to support aircraft without an airworthiness approval recognizing RF leg eligibility, no operator has ever formally asked for an RNP AR ops approval for ops conducted in an aircraft without RF leg eligibility.

Meanwhile, at RTCA, the new RNP MASPS and MOPS, DO-236C and DO-283B respectively, both now require RF leg functionality. Likewise, the ICAO PBN Study Group is also updating ICAO Document 9613 to make RF leg eligibility a "hard" requirement for RNP AR operations. In concert with these public standards, FAA AIR-6B1 made RF leg eligibility a hard requirement through TSO-C115D for RNP systems and through the update to AC 20-138D in Change 2, paragraph A3-1.b. (above). In concert, the aircraft-level requirement for RF leg eligibility exists in RTCA DO-236C when an OEM applies for a type certificate or supplemental type certificate (TC/STC) recognizing the aircraft's RNP capability. Thus, all current airworthiness guidance and requirements require RF leg airworthiness for an aircraft to be eligible to conduct both A-RNP procedures and RNP AR approach procedures

Given a common airworthiness approval basis and functional foundation for eligibility for both A-RNP procedures and for RNP AR approach procedure limited to no lower than RNP 0.30, the resulting aircraft performance when conducting either an A-RNP procedure or an RNP AR procedure will be identical when the flight crew operates the aircraft's flight guidance in the same manner for each operation. That is, given RF legs operationally require the flight crew to couple and use either AP or FD guidance, identical lateral track-keeping performance can occur during either A-RNP procedures and RNP AR approach procedures (limited to no lower than RNP 0.30) as long as the flight crew uses the AP or FD to control lateral flight technical error (FTE).

While the use of the AP or the FD guidance coupled to the roll steering commands from the aircraft's RNP system may yield the same lateral FTE during an A-RNP terminal procedure or an RNP AR approach, there is currently no FAA operational requirement for the flight crew to use the AP or the FD guidance during an A-RNP procedure that does include an RF leg segment. That is, the flight crew may elect to manually fly the RNP procedure. With this in mind, should A-RNP procedures no longer require the secondary lateral obstruction clearance area and use just a 2×RNP lateral semi-width for the OCA, the FAA operational implementation of A-RNP procedures needs to require the flight crew to use either AP or FD-coupled guidance during all A-RNP procedures. For example, the A-RNP procedures' PBN Box could state, "AP or FD required". This annotation would offer prudent way to ensure the realized lateral

tracking performance for both A-RNP procedures and RNP AR procedures using no less than RNP 0.30 is virtually identical. This can also be bolstered by an editorial update to the Airman's Information Manual (AIM) and by a change to AC 90-105A clarifying the new requirement.

Summary

Overall, when comparing airworthiness requirements for A-RNP procedures and for RNP AR procedures using no lower than RNP 0.30, the foundational design assurance requirements for each RNP operation are identical. Airworthiness approval ensures the aircraft implementation of RNP protects against major failure conditions and misleading guidance. The same airworthiness requirements also ensure the aircraft's RNP implementation requires GNSS. Likewise, when the procedures employ RF legs, the same airworthiness and operations approval requirements exits between A-RNP and RNP AR approaches. Also, the U.S. implementation of RNP scalability allows an operator to meet the requirement through the aircraft's RNP system's automated means or through an operational mitigation, and, again, this key function is handled identically during both unique RNP operations. Thus, with identical airworthiness and operational characteristics in mind, there is no rationale for retaining a secondary lateral obstruction clearance area (OCA) for A-RNP procedures when RNP AR procedures using the very same airworthiness and operational approval basis do not require the secondary OCA.

Recommendation

To maximize the benefits of A-RNP aircraft and operator eligibility in the U.S., the PARC Nav WG should recommend FAA provide A-RNP terminal procedure design criteria using a 2×RNP lateral OCA. Likewise, consistent with the aircraft's airworthiness requirements, the recommendation should ask the FAA AFS to require the operator to conduct A-RNP operations only when GNSS is available and when they operate an eligible aircraft using the aircraft's AP or FD guidance coupled to the roll steering commands from the aircraft's RNP system. The recommendation should also ask the FAA to publish each A-RNP procedure charts and identify the GNSS requirement and a requirement to use AP or FD guidance through use of the PBN Box on the A-RNP procedure charts.