THE CHALLENGES AND BENEFITS OF IMPLEMENTING PERFORMANCE BASED NAVIGATION (PBN) INSTRUMENT FLIGHT PROCEDURES

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ABSTRACT:

Performance Based Navigation (PBN) Instrument Flight Procedures (IFP) includes all the variations of Area Navigation (RNAV) IFPs to include Lateral Navigation (LNAV), Lateral Navigation/Vertical Navigation (LNAV/VNAV), Localizer Performance with Vertical (LPV), Localizer Performance (LP) and Required Navigation Performance (RNP).

Some of the challenges associated with PBN IFP implementation is the criteria used for the obstruction assessment. The criterion is unlike any other type IFP to date. Procedure developers can no longer draw protected areas on topographic maps, assess obstructions from the map, and then document their findings on procedures forms to effect the charting of the flight procedure. Developers will be required to use spreadsheets and computer programs to determine the assessment area and compute the lateral and vertical areas associated with appropriate clearance surfaces. Training of developers will be critical. Procedure developers will have to be knowledgeable and capable of using Aeronautical Radio, Inc. (ARINC) "Navigation Systems Data Base", Specification 424 to document the procedure to ensure proper application of the procedure by onboard avionics. Air Traffic Control may be required to change existing traffic flow patterns to accommodate IFP design.

Some of the Benefits associated with PBN IFP implementation are the possible reduction of ground based navigation aids, or at least the realignment or repositioning for better access to more locations with existing systems. The ability to utilize Radius-To-Fix path terminators, enabling access to airports that previously could not get an IFP due to the inability of ground based navigation aids support. Constant Descent Angle (CDA) application enables reduction of aircraft emissions, noise and fuel consumption on the IFP.

INTRODUCTION:

Even though PBN covers a broad spectrum of Area Navigation (RNAV) applications, this paper and briefing is focused on the application of Required Navigation Performance (RNP) Approval Required (AR). Discussion will be centered on the benefits of the RNP criteria and the challenges for developers and flight inspection operations.

BENEFITS:

There are some major benefits for aviation operators when using RNP AR approaches.

Reduced obstruction evaluation areas. The lateral area of an RNP AR approach is 2 times the RNP level of a given segment on each side of the flight path. The obstruction evaluation area is the same width (i.e., linear) from the beginning to the end of each segment. The final approach segment standard RNP level is RNP 0.30, for a total width of 1.2 NM. This can be reduced to as small as RNP 0.10 or a total width of 0.40 NM. These reduced widths and linear evaluation area can eliminate many obstructions that would impact obstruction evaluation areas on most other traditional instrument flight procedures.

No secondary obstruction evaluation areas. Traditional instrument flight procedures employ secondary areas for obstruction clearance relief along the edge of the obstruction evaluation area. RNP AR procedures do not require secondary areas and may gain relief from obstructions near the segment primary areas.

Missed approach obstruction evaluation areas. The standard RNP missed approach obstruction evaluation area begins at the width of the final approach segment and expands at 15 degrees until reaching a total width of 4 NM. This area is much smaller than a conventional missed approach area that reaches a total width of 12 NM. The standard RNP missed approach requires a minimum straight ahead segment of 5 NM before turns can be designed. In addition to the standard RNP missed approach, an alternative missed approach design that is linear, allows turning areas closer to the missed approach point, commonly referred to as the "telescoping" missed approach evaluation area, where the missed approach RNP level increases incrementally and does not splay. This telescoping area is normally used to eliminate obstructions and/or when turns are required prior to the 5 NM point in the standard RNP missed approach.

Radius-to-Fix (RF) path terminators. Radius-to-Fix (RF) path terminators or leg types may be used in the design of RNP AR approach procedures. These leg types may provide access to airports where traditional ground-based navigational facilities could not. These RF legs are very similar to a DME arc segment from a VOR/DME or TACAN. RF legs may be used in any segment of the RNP instrument flight procedure and are limited only by the bank angle. The Palm Springs, CA RNAV (RNP) Rwy 13R approach is an example of how RF legs are used to gain access to a runway end where a TF straight in final approach segment is not possible.

<u>CHALLENGES.</u>

Operator Authorization and Training. One of the greatest challenges is getting operators equipped, certified and trained. Within the United States, Advisory Circular 90-101, RNP Operational Approval, outlines these requirements.

Air Traffic Control Procedures and Training. Air Traffic procedures and training need to be established with regard to RF leg types.

RADAR vectors and clearances direct to the beginning of an RF leg are not permitted. A straight segment must precede RF legs and the aircraft must be established on the straight segment prior to entering any RF leg.

Air Traffic Controller training programs must emphasis the importance of allowing the aircraft to fly the charted RNP instrument procedure uninhibited, including charted speed restrictions. Speed restrictions are based on the design of the procedure track and associated obstruction evaluation areas.

RNP Criteria Application. The criteria used to develop RNP instrument flight procedures are unlike any conventional instrument procedure. One of the biggest changes for developers is the use of the Vertical Error Budget (VEB). The VEB establishes the obstruction evaluation surface for RNP final approach segments. The VEB considers factors such as final approach fix altitude, final approach glidepath angle, airport/threshold elevation, RNP level, and average cold temperature of the airport. The VEB represents the minimum amount of obstruction clearance required for the final approach segment. This computation will need to be done for every level of RNP minimums provided on the approach procedure. These calculations may have to be done several times to establish the most beneficial minimums before finalizing the procedure.

The challenges of establishing an RF leg are to ensure the entry and exit RF waypoint placement is tangent to either a TF Leg or consecutive RF Legs. Procedure development automation will eventually overcome this challenge.

Obtaining airport temperature records to determine the average cold temperature, which is the primary basis of the VEB. The average cold temperature represents the coldest day of the year averaged over the previous 5 years. This information is available from government sources or can be obtained via the Internet.

Benefits of the Procedure. One of the biggest challenges is to provide the best benefit of a given procedure at a specific location. Input will be required from the proponent (operator), Air Traffic Control, equipment capabilities of the operators, and certification levels of the operators. All of these should be considered when determining to use RF leg type, climb gradients, missed approach design and RNP level of the final approach segment.

Flight Inspection Technique. An RNP AR approach procedure is unlike an ILS approach and should not be flight inspected in the same manner. Below path checks should be limited to obstruction checks only. The obstruction evaluation surface (VEB) originates further from the threshold than the ILS surface and will intersect the ILS obstruction surface in the final approach segment. The RNP AR obstruction surface is approximately .6 degrees below a 3 degree glidepath angle and varies as the glidepath angle changes.