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Performance Based Navigation (PBN) Implementation in Tehran FIR

1. Purpose

The purpose of this circular is to provide information concerning the planned changes to the implementation of PBN in En-route, Terminal and Approach phases of flight in Tehran FIR which will take place on 8th November 2018 (AIRAC cycle 1812).

2. Introduction

The Performance-based Navigation (PBN) concept seeks to move away from the traditional requirements for navigation capability by no longer specifying the carriage of specific equipment in order to meet navigation requirements but rather identifies the Navigation system performance requirements in terms of accuracy, integrity, continuity and functionality required for the proposed operations. This enables the development and introduction of new equipment, supported by the available ground and spaced based navigation infrastructure as well as self-contained navigation capability. PBN therefore enables operators to choose how these airspace requirements can best be met for the specific aircraft or group of similarly equipped aircraft.

The accuracy and functionality requirements are set out in the navigation specifications contained in the ICAO PBN Manual (Doc 9613). These specifications also identify potential options concerning the choice of navigation sensors and equipment. Recognising that continual developments in navigation capability are occurring, the identification given in ICAO Doc 9613 of the means by which the specification may be met does not preclude operators from presenting a safety case to the regulatory authorities by which they demonstrate that other means may be used to meet these requirements.
Compliance with WGS 84 and data quality prescribed in Annex 15 are integral into PBN.

3. Changes planned for Tehran FIR from AIRAC 1812

Performance Based Navigation has already started to be implemented in Tehran FIR. Initially it has been limited to a number of transit routes requiring RNAV 1 (route lateral track keeping accuracy of +/- 1 NM for 95% of the flight time) and a number of other routes requiring RNAV 5 (route lateral track keeping accuracy of +/- 5 NM for 95% of the flight time) either at all Flight Levels of above FL 285. These are listed under ENR 3.1 and 3.3 of AIP.

However, to this point, PBN implementation has been restricted to the most congested part of Tehran FIR to enable the implementation of additional routes. However, a large number of conventional routes remain to enable non-equipped aircraft to continue to operate. While this has enabled a significant increase in the capacity of routes supporting the major flows of traffic in Tehran IFR, with the continuing increase in traffic it is essential to further increase the capacity of the airspace both en-route and in the terminal airspace. Without the provision of such an increase, operators are likely to experience increasing delays and reduced efficiency of flight profiles.

An initial review undertaken in late 2016 and early 2017 identified that significant increases in airspace capacity could be achieved with the introduction of either RNAV 1 or RNP 1 routes. The introduction of either of these requirements could also enable significantly improved terminal airspace operations at the three main Tehran airports. In addition, the provision of strategically separated arrival and departure procedures whilst enabling increased capacity will also enable the provision fuel efficient departure and arrival routes offering continuous climb and descent profiles with environmental benefits.

A study of the navigation capability of aircraft operating in Tehran FIR carried toward the end of 2016 demonstrated that over 90% of aircraft already carried navigation equipment capable of being approved for RNAV 1 operation and a large proportion of these already had RNAV 1 approval in order to operate in states neighbouring the airspace of the I.R. of Iran. However, it was found that fewer aircraft could meet the requirements of RNP 1 (see note below) *. Since the airspace benefits that could be achieved from RNP 1 when compared to RNAV 1 did not warrant the additional cost to operators, it was decided that RNAV 1 would become the requirement for operating in Tehran FIR from 8th November 2018.

The implementation of RNAV 1 will require action from operators if they do not already have RNAV 1 approval, even for those airframes already equipped with RNAV 1 capable equipment. The main aspects that operators will need to address in the period well prior to 8th November 2018 are given below. They are set out more completely in ICAO 9613 Volume II-part B Chapter 3 “Implementing RNAV 1”:

a) aircraft equipment eligibility must be determined and documented in the Aircraft Flight Manual or equivalent,

b) operating procedures for the navigation systems employed must be documented,

c) a navigation database must be provided and the operator navigation database procedures (e.g. confirming validity of data base for the present AIRAC Cycle, cross checking the route and arrival/departure procedures against relevant charts) must be documented,

d) flight crew training based upon the operating procedures (B and C above) must be documented,

e) flight crew Training must be undertaken,

f) operational approval obtained in accordance with CAO IR – Air OPS.

The documentation associated with the above steps will need to be presented to the State of Registry for approval. For aircraft registered in the I.R. of Iran, this documentation must be submitted to Iran Civil Aviation Organization.

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* Note: While RNAV 1 and RNP 1 have the same lateral navigation accuracy and many common functional requirements, there is an important difference between RNAV and RNP functionality. RNP specifications have a requirement for On Board Performance Monitoring and Alerting. This capability results in it being possible to place increased reliance on the navigation equipment performance as the navigation system will provide

an alert if it cannot guarantee the navigation accuracy. This will enable operations in a number of situations where navigation performance accuracy is flight critical (e.g. flight below Minimum Radar Vectoring Altitude (MRVA)) or where ATC radar surveillance is not available. RNP systems need to have GNSS input to support the required monitoring and alerting. In the context of Tehran FIR, radar surveillance is available over nearly all of the airspace and the PBN implementation down to final approach will be above MRVA, consequently the introduction of a requirement for the carriage of RNP 1 equipment in the Tehran FIR will offer few benefits. In addition, many aircraft operating in the Tehran FIR are not equipped with GNSS. As a result, a requirement for the carriage of equipment meeting RNP1 would impose significant costs on many operators with little real benefit to the population as a whole. The approach procedures being provided at Imam Khomeini, Mehrabad and Payam airports as part of the PBN Implementation planned for 8th November 2018 will require GNSS equipage with On Board Performance Monitoring and Alerting (i.e. they will be RNP) but it will not become mandatory to be able to use these procedures.

3.1 Aircraft Equipage

RNAV 1 functionality requirements are set out in ICAO 9613 Volume II-part B Chapter 3 Implementing RNAV 1. For operations in the I.R. of Iran the following navigation infrastructure may be used for RNAV 1 operations:
a) GNSS;

GNSS Receivers must be approved in accordance with ETSO C129 (a), FAA TSO C129 (a) or later. (ETSO C129 or FAA TSO C129 is also applicable provided they include pseudo-range step detection and health word checking functions);

b) DME/DME;

Adequate DME coverage is provided in Tehran FIR to support DME based navigation operations both en-route (main part of Tehran FIR) and in Mehrabad Terminal Area down to approximately 3,000ft AGL. Below this altitude the procedures will be designed to ensure conventional navigation can be used. The RNAV system must be capable of auto-tuning multiple DME facilities, obtaining a position update within 30 seconds of tuning, maintaining continuous updating and performing reasonableness checks;

c) DME/DME/IRU;

The availability of IRU will enable IRU performance in accordance with US 14 CFR Part 121 Appendix G, automatic position updating from the DME/DME position. It must not allow VOR inputs to affect position accuracy;

Note: For more details, refer to ICAO PBN Manual (Doc 9613 - Part B Chapter 3) and PBN operational approval manual (Doc 9997 – Chapter 4 – 4.3)

3.2 Pilot training

While many or the aircraft operating on Tehran FIR are already capable of meeting the RNAV 1 accuracy requirement they are presently only approved to RNAV 5. One of the reasons for this has been the additional training needed to meet the RNAV 1 requirements. Information concerning pilot training requirements for RNAV 1 operations is provided in the ICAO PBN Manual Volume II Part B Chapter 3 “Implementing RNAV 1”. It will be necessary for operators to set out how they intend to meet the pilot training requirements in the period leading to RNAV 1 implementation. Operators will need to develop a training program and submit their training plan to their State of

Registry. For operators registered in the I.R. of Iran, the training program will need to be submitted to Iran Civil Aviation organization for approval.

Where appropriate the training plan may set out the degree to which existing training for RNAV 5 already meets the RNAV 1 requirement and the adaptations that will be made to that training to meet the additional needs of RNAV 1 operation.

Where operators already have RNAV 1 approval there will be no change in the training requirements for the Tehran RNAV 1 implementation.

3.3 Database

The navigation database should be obtained from an approved supplier who has complied with EUROCAE/RTCA document ED-76/DO-200A, Standards for Processing Aeronautical Data. The database is to include the totality of terminal procedures that will be used by the aircraft as it is not possible nor approved for the pilot to manually enter the procedure.

It is recognized that; it is not always possible for operators to obtain data from approved suppliers. Where this is the case, prior to the effective date of each navigation database, as a minimum, the operator must implement navigation database integrity checks using appropriate software tools or approved manual procedures to verify data relating to those waypoints which define the sections of arrival and departure procedures which lie below the applicable minimum obstacle clearance altitude. Such checks are in addition to any checks previously performed by the Flight Procedure Designers, unapproved navigation database suppliers, or navigation equipment manufacturers. The integrity checks need to identify any discrepancies between the navigation database and the published charts/procedures. Integrity checks may be performed by an approved third party and operators may join together to provide the service or to jointly procure this service. The checking should include the following:

a) detect any changes in monitored data items from the previous AIRAC Cycle data,
b) compare all identified changes with AIP changes applicable to the relevant AIRAC date,
c) identify any discrepancies that change the arrival or departure procedure from that given in the AIP,
d) institute actions which prevent the discrepant data being used for navigation (these will include but not necessarily limited to: informing pilots and prohibiting the pilots use of the discrepant data, implementing corrections to the data base where possible, follow up with the supplying company),
e) record the discrepancy and action taken,
f) Provide analyses of database quality and changes in quality levels by tracking the rates of discovered errors.

These checks could be undertaken by a software tool which enables an aircraft operator to conduct in dependent checks on specific data areas in a navigation database to ensure that integrity is maintained. The software tool does not have to be qualified in accordance withEUROCAEED-12B/RTCA DO-178B.

4. Approach Procedures

The Approach Phase refers to that portion of flight including Final Approach and Missed Approach Procedures.

4.1 Overview

As part of the PBN implementation it is proposed to provide Approach procedures based upon GNSS for those aircraft suitably equipped and approved at Imam Khomeini, Mehrabad and Payam airports. Conventional ILS facilities will be retained at Imam Khomeini and Mehrabad airports and the traditional non precision approaches will continue to be promulgated at all three airports. The use of the GNSS approach procedures will not be mandatory.

The approach procedures being adopted are Approaches with Barometric Vertical Guidance termed RNP APCH with Baro-VNAV (also called APV Baro/VNAV). These provide the pilot with guidance similar to that provided by ILS and flown to LNAV/VNAV minima. The vertical accuracy is lower than that provided by ILS, being subject to temperature effects as well as errors due to inaccuracies in the barometric system. As a result the RNP APCH minima will normally be higher than the ILS minima to the same runway.

Studies have shown that providing vertical guidance for pilots reduces the risk of Controlled Flights into Terrain (CFITs) when compared with conventional non precision approach and, while the lower precision of vertical guidance with RNP APCH with Baro-VNAV necessitates a higher decision height than for ILS approaches, the availability of these procedures will provide increased safety when the ILS is not available. This action is in accordance with the decision of the 36th Session of the ICAO Assembly which adopted Resolution A36-23 urging all States to implement APV procedures to all runway ends serving aircraft with a maximum take-off mass of 5700 kg or more. Whilst it is only intended to implement APV approaches to Mehrabad, Imam Khomeini and Payam airports at the AIRAC cycle 1812, it is intended to extend this capability to other airports at a future date.

The APV Baro-VNAV procedures have been designed in accordance with criteria for Area Navigation (RNAV) approach procedures using barometric vertical navigation as stipulated in the ICAO PANS-OPS (Doc 8168) Volume II.

APV Baro-VNAV procedures are not permitted when the aerodrome temperature is below the promulgated minimum aerodrome temperature for the procedure unless the RNAV system is equipped with approved cold temperature compensation for final approach.

The GNSS system does not provide real time alerts for Satellite errors without a regional or local monitoring system. For this reason, the GNSS receiver has to undertake a validation check. This is called Receiver Autonomous Integrity Monitoring (RAIM) and for such a monitoring system to operate, the receiver needs to have in view at least one more satellite than is needed to undertake the position calculation. For a number of years there have been sufficient satellites available that the occurrence of situations where RAIM cannot be provided is rare. However, this can change due to satellite failure or withdrawal from service and, before commencing a flight where it is intended to undertake an APV approach, the pilot is to ensure that GNSS guidance will be sufficient to ensure the availability of RAIM for the expected time of arrival and for 15 minutes each side of this time.

In the event of a RAIM alert being given during the execution of an APV procedure the pilot is to execute a missed approach.

4.2 Missed approach

The accuracy requirements for the missed approach procedure are 1 NM for 95% of time compared with 0.3 NM for 95% of time for final approach. However, if there is degradation in accuracy causing a RAIM alert for approach, a continued reduction in accuracy is possible and this could result in a similar warning on the missed approach. While a GNSS based missed approach might be achieved, the pilot should be aware that a potential event leading to a simultaneous loss

of GNSS guidance during final approach and missed approach is likely and the pilot should therefore be prepared to revert to a conventional missed approach procedure. It is intended for the missed approaches for GNSS procedures to overlay the conventional procedures.

4.3 Equipment Requirements for RNP Approach to LNAV/VNAV minima

The requirements for aircraft equipage are set out in ICAO PBN Manual (Doc 9613) VOL II chapter 5A. Section A.5.3.3 set out the full requirements, the following highlights some of the requirements:

a) the equipment must provide On Board Performance Monitoring and Alerting

b) During operations on the final approach segment of an RNP APCH down to LNAV/VNAV minima, the lateral total system error must be within ±0.3 NM for at least 95 per cent of the total flight time. The along-track error must also be within ±0.3 NM for at least 95 per cent of the total flight time.

c) Integrity: Malfunction of the aircraft navigation equipment is classified as a major failure condition under airworthiness regulations (i.e. 10^{-5} per hour).

d) On Board Performance Monitoring and Alerting: During operations on the initial and intermediate segments and for the RNAV missed approach of an RNP APCH, the RNP system, or the RNP system and pilot in combination, shall provide an alert if the accuracy requirement is not met, or if the probability that the lateral Total System Error (TSE)* exceeds 2 NM is greater than 10^{-5}. During operations on the final approach segment of an RNP APCH down to LNAV or LNAV/VNAV minima, the RNP system, or the RNP system and pilot in combination, shall provide an alert if the accuracy requirement is not met, or if the probability that the lateral TSE exceeds 0.6 NM is greater than 10^{-5}.
   * TSE –The Total System Error is the combination of Navigation system error and the pilot or autopilot track keeping error

e) signal-in-space: During operations on the initial and intermediate segments and for the RNAV missed approach of an RNP APCH, the aircraft navigation equipment shall provide an alert if the probability of signal-in-space errors causing a lateral position error greater than 2 NM exceeds 10^{-7} per hour. During operations on the final approach segment of an RNP APCH down to LNAV or LNAV/VNAV minima, the aircraft navigation equipment shall provide an alert if the probability of signal-in-space errors causing a lateral position error greater than 0.6 NM exceeds 10^{-7} per hour.

The following systems meet the accuracy, integrity and continuity requirements of these criteria:

a) GNSS stand-alone systems, equipment approved in accordance with TSO-C129a/ ETSO-C129aClass A, E/TSO-C146 () Class Gamma and operational class 1, 2 or 3, or TSO C-196();

b) GNSS sensors used in multi-sensor system (e.g. FMS) equipment approved in accordance with TSO C129 ( )/ ETSO-C129 ( ) Class B1, C1, B3, C3 or E/TSO C145 () class 1, 2 or 3, or TSO C-196() and

c) Multi-sensor systems using GNSS approved in accordance with AC20-130A or TSO-C115b, as well as having been demonstrated for RNP APCH capability.

The PBN Manual identifies that for RNP procedures, the RNP system may only use DME updating when authorized by the State. In the context of the RNP approach procedures in the Tehran FIR, DME updating may not be used after the Final Approach Fix

5. Contingency procedures

The pilot must notify ATC of the loss of the navigation capability required for the ATS route or procedure being executed. The pilot should expect to receive instruction from ATC. This might be to continue using conventional navigation or to be radar vectored to the exit point from Tehran FIR or to the final approach of the destination airport.

6. GNSS Coverage

Operators are responsible for ensuring expected coverage and availability of GNSS for flights they schedule. For an RNP APRCH, it is necessary to ensure at the time of flight preparation, that the RAIM function is expected to be possible for the estimated time for arrival (ETA) +/-15 minutes. This may be achieved using, either RAIM NOTAMs (included in Pre-flight Information Bulletin), a forecast tool which is part of the on-board equipment or a ground based software tool. In the latter case, information on possible unavailability of satellites will need to be entered in forecasting program. Where a ground based tool is employed, the operator shall ensure that the satellite masking angle assumed by this tool is consistent with that of on-board equipment.

7. Phraseology and Flight Planning

Phraseology and requirements for flight planning will be published in the amendment to the AIP formally adopting the PBN implementation

8. Additional Information

Further information on planning and implementation issues for PBN can be obtained from Iran Civil Aviation Organization.

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