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WORKING PAPER

TWELFTH AIR NAVIGATION CONFERENCE

Montréal, 19 to 30 November 2012

Agenda Item 1: Strategic issues that address the challenge of integration, interoperability and harmonization of systems in support of the concept of "One Sky" for international civil aviation
1.1: Global Air Navigation Plan (GANP) – framework for global planning
c) Navigation roadmap

ADVANCED-RNP SPECIFICATION

(Presented by the Presidency of the European Union on behalf of the European Union and its Member States[1]; by the other Member States of the European Civil Aviation Conference[2]; and by the Member States of EUROCONTROL)

SUMMARY

The Advanced-RNP Specification has been under development in the European region since 2001. This Specification is included in the recently published advanced unedited copy of the new version of the PBN manual and is the basis of the operational requirements for the next Navigation step in ECAC.

Action: The Conference is invited to agree to the recommendation in paragraph 7.

1. INTRODUCTION

1.1 The European strategic direction for area navigation techniques envisages a progression from RNAV through RNP specifications to 4D. This is in keeping with the ICAO global CNS/ATM strategy and those of NextGen and the SESAR projects.

2. BACKGROUND

2.1 Following the implementation of RNAV 5 in 1998, European airspace planners identified the need for additional navigation capability in terminal and en route airspace.

[1] Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxemburg, Malta, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden and United Kingdom. All these 27 States are also Members of ECAC.

[2] Albania, Armenia, Azerbaijan, Bosnia and Herzegovina, Croatia, Georgia, Iceland, Moldova, Monaco, Montenegro, Norway, San Marino, Serbia, Switzerland, The former Yugoslav Republic of Macedonia, Turkey and Ukraine.

2.2 As a result, a specification for P-RNAV was published in 2000 and subsequently, to cater for high density traffic demand in the time period 2015 to 2020, extensive development of operational requirements were undertaken between 2001 and 2010 in various EUROCONTROL groups. Stakeholders included in these groups are ANSPs, NSAs, IATA, General Aviation, Military Operators, Functional Airspace Block Europe Central (FABEC[3]) and Eurocontrol experts.

2.3 In all of the above cases, virtually identical operational requirements were identified: the main ones related to reducing the route spacing in en route and terminal and controlling turn performance along these parallel routes and terminal routes. These principal requirements were subjected to extensive assessment and it was verified that reducing the route spacing from 10 NM to 6-7 NM in the European en route airspace and achieving 5 NM in the terminal airspace would bring significant capacity and flight efficiency benefits.

2.4 In all developments of the operational requirements, a uniform aircraft performance throughout the airspace was used as the basis for the operating environment. The scenario remains that a mandate achieves such uniformity and is the only way of ensuring that operators equip and ANSPs redesign their airspaces in order to achieve these capacity and efficiency benefits. This point is elaborated in section 3.4, *infra.*

Note.— RNAV 5 was achieved by an airspace mandate necessitated by the requirement for a uniform application across European airspace. The business case for this was proven through the increased airspace capacity enabled by implementation. P-RNAV (~RNAV 1) was not implemented as a mandate but rather provided as a means of implementing RNAV in terminal airspace to avoid extension of RNAV 5 into terminal areas. This approach was taken following an analysis that demonstrated that there was no business case for a uniform application of P-RNAV in all terminal airspace in Europe. This lack of a mandatory implementation created a deadlock: without a mandate, operators did not equip and ANSPs did not publish procedures. Because there were no procedures, operators saw no incentive to equip, and because operators did not equip, ANSPs did not publish procedures. This situation resulted in a lack of developments.

2.5 Real-time simulations undertaken over the last 15 years have confirmed consistently and repeatedly that ATC needs the aircraft navigation performance ‘qualification’ capability to be uniform within an airspace. This is because the navigation performance required of the aircraft (e.g. Advanced-RNP) forms the basis of how ATS routes (incl. SIDs/STARs) are designed and where they are placed. If the fleet navigation performance qualification is not standardized, different ATS routes (incl. SIDs/STARs), a set of routes for each navigation performance authorized in the airspace is required. The navigation performance mix is difficult for ATC to manage as a consequence of, inter alia:

a) ATC systems limitations for conveying different aircraft capability;

b) ATC Workload associated with the need to issue different (specific) clearances appropriate to the aircraft qualification;

c) need for duplicate routes to cater for the different navigation performances;

d) limited data storage space in the navigation database to handle the different route options;

[3] Under the Single European Sky (SES) there are nine FABs in Europe, the largest of which is the FAB Europe Central comprising Germany, France, BENELUX and Switzerland – the area of highest traffic density in Europe usually referred to as the ‘core area’.

e) Safety risks associated with the potential for ATC to wrongly identify the capability of the aircraft and therefore issue an incorrect clearance; and

f) Safety risks associated with the potential for the pilot to select the wrong route.

2.6 This reality has necessitated consideration of an Airspace mandate in respect of PBN and specifically of Advanced-RNP in the European en-route airspace above a FL still to be agreed.

2.7 In total, the operational requirements led to the identification of 7 potential navigation functions needed on board aircraft to enable the airspace requirements. These included the need for RNP (with on-board-performance-monitoring-and-alerting); fixed radius transition (FRT) and radius to fix (to enable the distance between parallel RNP routes to be maintained on turns); RNAV holding; tactical parallel offset; required time of arrival function (RTA) and vertical navigation (VNAV). These functionalities were presented to the ICAO PBN Study Group for inclusion in a new navigation specification known as Advanced-RNP.

3. INTERNATIONAL APPLICABILITY OF NAVIGATION FUNCTIONAL REQUIREMENTS

3.1 Since its evaluation in the RNPSORSG-PBNSG, the coherency of the Advanced-RNP specification has been ensured with European evolutions in SESAR developments. (Components of Advanced-RNP are included in work packages 15.3.1 (infrastructure) and 4.7.3 (route spacing)).

3.2 Although the above requirements were developed with the European applications in mind, all regions do not have similar requirements. As such, a global fit had to be sought when the Advanced-RNP specification was presented to the PBNSG.

3.3 To date, in order to ensure global interoperability of Advanced-RNP outside the European area, as well as enabling early application of capabilities already available in the European fleet, there has been harmonization of functional requirements. This has necessitated some modification to the European requirements and the potential to phase in some requirements and to create options for others. Currently this has resulted in identifying:

a) core functionalities of the specification requiring GNSS carriage, RNAV Holding, Parallel Offset, RF and Single FMS system. This core being realisable in Europe without delay; and

b) additional functional requirements for later application FRT, RTA and VNAV which will only become available on the majority of the fleet at a later date but nevertheless are expected to become required functions in some areas or regions.

3.4 An important aspect of the European airspace requirements is the need for a uniform airspace for en-route operations and for the navigation capability to enable closer route spacing on straight and turning segments. As such, the European implementation of Advanced-RNP envisages requiring FRT as well as core RNP in the European implementation. Furthermore, there is also an intention to mandate the use of Advanced-RNP in European en-route airspace above FL-X from a date still to be agreed but, taking account of the need for 7 years advance notice, cannot be before 2019. A SES interoperability implementing rule on PBN (considering the performance requirements and functionalities in Advanced-RNP and RNP APCH specifications) is being developed under the auspices

of the European Commission in full consultation with stakeholders (see Section 5 below). Air worthiness requirements and certification will also be needed.

3.5 It is envisaged that free route operations, already used in some areas of Europe will increase throughout the upper airspace. However, there will remain in the more dense areas of Europe a fixed route structure where waypoints will be defined to ensure routes avoid restricted airspace. Therefore even if free routing becomes extensively enabled, the need for closely spaced routes with FRT will remain.

4. ADVANCED-RNP BENEFITS

4.1 The Advanced-RNP specification, unlike any other PBN specification, addresses requirements and outlines application of operations for en route, terminal and approach phases of flight. This will reduce certification and operational approval costs for operators through having a single assessment of aircraft eligibility which is very different from today. In time, as further functional enhancements become available e.g., FRT and RTA as a function of time of arrival control (TOAC), the airworthiness approval can be amended.

4.2 The implementation of Advanced-RNP, whilst geared towards a future European PBN implementing rule (IR) has much more immediate applications, both in Europe and elsewhere. The core Advanced-RNP performances and functionalities extend what is currently available with navigation specifications such as RNAV 1 and RNP 1 to provide greater flexibility in terminal airspace from improved performance on SIDs, STARs and instrument approaches and enable increased predictability which can provide environmental benefits in terms of noise and flight efficiency. This, together with other functions commonly available on today's large air transport fleets permits the application of airspace design improvements available in the short term, whilst providing a platform for the inclusion of features such as FRT and RTA when they become more widely available.

4.3 The table below indicates the route spacing achievable with current specifications and Advanced-RNP based on a lateral navigation accuracy of 1 NM in a Radar Surveillance environment. A 2012 study shows that there are no gains in route spacing when the lateral navigation accuracy is 0.5 NM.

<table>
<tr><td>↓Parallel Routes / based on →</td><td colspan="2">Advanced-RNP*</td><td colspan="2">RNAV 1*</td><td>RNAV 5</td></tr>
<tr><td></td><td>En Route</td><td>Terminal</td><td>En Route</td><td>Terminal</td><td>En Route</td></tr>
<tr><td>Same Direction</td><td rowspan="3">7 NM</td><td rowspan="3">7 NM</td><td rowspan="3">9 NM</td><td rowspan="3">8 NM</td><td>16.5 NM</td></tr>
<tr><td>Opposite Direction</td><td>18 NM</td></tr>
<tr><td>Other</td><td>10-15 NM with increased ATC intervention rates</td></tr>
<tr><td>Spacing on turning segments</td><td colspan="2">As above</td><td colspan="2">Larger than above because no FRT</td><td>Much Larger than above because no FRT</td></tr>
<tr><td colspan="6">*Note: The Advanced-RNP and RNAV 1 route spacings are the result of collision risk modelling; the spacings achieved at local implementation could be different following a local implementation safety case.</td></tr>
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5. PBN IMPLEMENTING RULE

5.1 EUROCONTROL is tasked to develop a draft interoperability implementing rule on PBN that will define, in close coordination with the stakeholders, navigation requirements and identify the

functionalities required in en-route and terminal air-space, including arrival and departure, and also approach. The implementation of the PBN concept in Europe is a key enabler for increasing capacity, improving efficiency, reducing environmental impact, and improving access to airports, in order to meet the performance targets and operational needs in the European airspace as well as achieving global interoperability.

5.2 The overall goal of the implementing rule will be to ensure harmonized and coordinated implementation of ICAO Assembly Resolution A37-11 within the European ATM Network. In this context, the development process includes an analysis of the necessary actions to implement PBN routes and procedures, including RNAV approaches, in order to maximize the benefits from the airborne navigation capabilities.

5.3 The PBN implementing rule has been identified as an opportunity to increase interoperability of the military fleets. Although some military systems can meet the performance requirements of an ICAO Navigation specification, some differences remain. Recognition for some military systems capable of achieving PBN as an acceptable means of compliance through European regulatory processes may overcome equipment related issues encountered in the past.

5.4 The draft implementing rule should be completed by the end of May 2013.

6. ADVANCED-RNP AND THE PBN MANUAL

6.1 In order to gain global interoperability, the Advanced-RNP specification is being published in the PBN Manual for it to become the basis for States and Regulatory authorities for developing the necessary certification and operational approval material.

6.2 An unedited advanced version of the new edition of the PBN Manual has been uploaded on ICAO NET.

7. RECOMMENDATION

The Conference is invited to request ICAO to encourage the PIRGs to support the early deployment of PBN.

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