



WORKING PAPER

ASSEMBLY — 40TH SESSION

TECHNICAL COMMISSION

Agenda Item 30: Other issues to be considered by the Technical Commission

EFFICIENCY IN AIR TRAFFIC MANAGEMENT THROUGH REQUIRED NAVIGATION PERFORMANCE AUTHORISATION REQUIRED (RNP AR)

(Presented by CANSO, ACI and ICCAIA)

EXECUTIVE SUMMARY

Required Navigation Performance Authorisation Required (RNP AR) has historically been used to improve accessibility to terrain challenged airports but the efficiencies of RNP AR procedures can also provide a multitude of safety, capacity and environmental benefits.

This paper highlights those benefits that RNP AR procedures and operations provide to all stakeholders in the aviation industry. The paper also identifies some key milestones in RNP AR procedure development and examples of operational applications that have seen RNP AR becoming a key enabler of the performance-based navigation (PBN) airspace concept and supporting efficiencies in global air traffic management (ATM). It concludes that a system-wide strategy of promoting and implementing RNP AR procedures at a multitude of high, medium and low-density airports should be pursued.

Action: The Assembly is invited to:

- a) take note of the information and benefits regarding the implementation of RNP AR;
- b) take note of the efficiency that can be obtained by implementing RNP AR for ATM efficiency, and reduced flight distances, fuel burn and CO₂ emissions;
- c) take note of recent benefits of the application of new ICAO separation Standards incorporated into *Procedures for Air Navigation Services (PANS) — Air Traffic Management (PANS-ATM, Doc 4444)* specifically related to *Established on RNP AR*;
- d) recognise the work of CANSO and its Members in introducing RNP AR;
- e) instruct ICAO to create implementation guidance material for States on implementing *Established on RNP AR* in Doc 9643 , *Manual on Simultaneous Operations on Parallel or Near-Parallel Instrument Runways* based on the information referenced in this working paper; and
- f) urge all States to consider introducing RNP AR where applicable based on the expertise of CANSO and its Members.

<i>Strategic Objectives:</i>	This working paper relates to the Safety, Air Navigation Capacity and Efficiency and Environmental Protection Strategic Objectives.
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¹ Arabic, Chinese, English, French, Russian and Spanish versions provided by CANSO, ACI and ICCAIA.

1. INTRODUCTION

1.1 The continued development and implementation of required navigation performance procedures (RNP) has been a key enabler in supporting States to move to a modern, performance-based navigation (PBN) airspace model. The precise and predictable track containment of RNP authorisation required (RNP AR) procedures has seen its application evolve from providing improved accessibility to terrain and obstacle challenged airports, to a variety of airspace and operational contexts and considerations, with safety, environmental and efficiency benefits across the entire ATM system.

2. HISTORY OF RNP AR PROCEDURE DEVELOPMENT

2.1 RNP procedures were first introduced into the ICAO *Procedures for Air Navigation Services – Aircraft Operations* (PANS-OPS) in 1998, where the concept of defining a performance requirement applicable for a procedure or route was established. Using global navigation satellite system (GNSS) technology, combined with modern aircraft avionics that provide on-board monitoring of actual navigation performance and alerting when the performance does not meet the specified requirement, precise three-dimensional curved flight procedures and tracks could be designed and implemented.

2.2 The initial benefits of RNP AR procedures provided improved accessibility to airports with terrain or obstacle issues that limited instrument flight rules (IFR) accessibility, particularly in poor weather. The on-board monitoring and alerting aspect of RNP in terms of actual navigation performance (ANP) greatly enhanced the safety of operations in these environments. In 1996, Alaska Airlines flew the first RNP procedure in the terrain challenged environment surrounding Juneau, Alaska. Through the establishment of specific requirements for the execution of radius to fix (RF) legs for this navigation specification, RNP AR procedures utilised curved procedure segments, which followed the Gastineau Channel, providing a safer and predictable path to the airport.

2.3 The three-dimensional nature and precise track containment of RNP AR procedures was soon recognised as having applications beyond terrain challenged environments. RNP AR procedures can be used in congested, high traffic airspace to provide efficient track structure and track containment to separate aircraft from other aircraft or controlled airspace constraints. Additionally, as the vertical component of the procedure could be geared towards continuous descent operations (CDOs) by specifying required vertical descent angles and/or altitude constraints, additional flight efficiency benefits associated with CDO could be realised. The lateral and vertical track guidance provided by RNP AR procedures support highly efficient flight profiles, which can significantly reduce track mileage when compared to conventional, ground-based procedures. The reduction in track mileage leads to a saving of flight time and fuel burn, with the resultant reduction in greenhouse gas emissions. Due to the efficient flight profiles of RNP AR procedures, a reliance on visual approaches to support airport capacity can also be removed and significantly reduce unstable approaches.

2.4 New air traffic control (ATC) separation Standards have also been developed that take advantage of the precision, monitoring and alerting aspect of RNP AR procedures. The PANS-ATM and the manual on simultaneous operations on parallel or near-parallel instrument runways (SOIR) both now contain guidance on how RNP AR procedures can be used for simultaneous dependent and independent parallel runway operations.

2.5 Additionally, a new separation Standard, *Established on RNP AR* has recently been incorporated into PANS-ATM following research initially undertaken by a member of the ICAO Separation and Airspace Safety Panel (SASP), which was brought forward as an operational proposal and received broad support from members of SASP. The *Established on RNP AR* separation Standard utilises

the precise containment of RNP AR to deem an aircraft as “established” on the final approach course at the commencement of the approach procedure.

2.6 *Established on RNP AR* enables an aircraft to be considered as established on final approach course further back in the approach. Simultaneous approaches can therefore be conducted with an aircraft flying an efficient CDO RNP AR procedure on one or more of the parallel runways. Aircraft arriving to the other parallel runway can be sequenced to final without the need to ensure vertical separation. The use of the Standard reduces ATC workload by removing the requirement for vectoring, as well as providing predictable flight paths. Workload and safety benefits are also realised by aircrew, by enabling the flight management computer to manage the aircraft’s lateral and vertical profile in what is normally a very busy environment.

2.7 Prior to the PANS-ATM inclusion, the Federal Aviation Administration (FAA) had been using the concept at Denver International Airport during visual meteorological conditions in certain runway configurations. Denver has now evolved to include instrument meteorological conditions (IMC) operations as well. When the Standard was officially incorporated into PANS-ATM in November 2018, NAV CANADA began full *Established on RNP AR* operations at Calgary International Airport (see Section 4 case study). Several other major international airports, including London Heathrow, Brisbane International and Houston International Airports are actively assessing the potential implementation of this new PANS-ATM Standard.

3. ENVIRONMENTAL BENEFITS OF RNP AR OPERATIONS

3.1 RNP AR has been used to significantly reduce track mileage flown in terminal areas for approach operations, when compared to traditional sequencing to conventional, straight in approach procedures. For example, Airways New Zealand have indicated the introduction of RNP AR approaches for Runway 23 at Auckland International (NZAA) reduced track mileage flown by arrivals by approximately 14 miles when compared to traditional, straight in approaches. Boeing and the FAA have indicated RNP AR procedures to Runway 16R at Seattle-Tacoma International Airport (KSEA) reduce track miles flown for a straight in vectored “traditional” procedure to by 23.5 miles. Several SESAR projects have demonstrated success with RNP AR, such as RISE (RNP Implementation Synchronized in Europe) which involved PBN deployment at eight regional airports in southern Europe. The resultant saving of track miles, combined with the CDO nature of RNP AR procedures in these examples contributes to less time in system, reduced fuel burn and greenhouse gas emissions for arriving aircraft.

3.2 Traditional aircraft sequencing techniques have required aircraft to navigate by overflying ground-based navigation aids and be subsequently vectored to the final approach course. Due to the unpredictability of track-mileage, pilots were inclined to descend sooner and level off prior to final approach. These level flight segments resulted in increased aircraft noise through the addition of thrust while level and the resultant aircraft configurations that increased airframe noise.

3.3 The lateral and vertical profile management of RNP AR can be utilised to support CDOs. CDOs see aircraft commencing descent from high level cruise altitudes, and use minimum thrust during the descent phase of the flight to a point on final approach lined up with the runway. The continuous descent of the CDOs profile enables aircraft to remain at higher altitudes for as long as possible and once descent has started, avoids low altitude level segments, which requires increased engine thrust. Aircraft levelling off at lower altitudes also require the deployment of lift generating devices such as flaps and slats which result in increased aircraft airframe noise. RNP AR procedures can be designed to facilitate continuous descent from the en-route into the terminal environment to the point where the aircraft is lined up with the runway. Studies conducted by the United Kingdom Civil Aviation Authority (CAP 1544

“Review of Arrival Noise Controls”) and FAA (Paper #594 “Determining the Environmental Benefits of Implementing Continuous Descent Arrival Procedures”) have identified the quieter profile of CDOs have been proven to reduce aircraft noise up to 5 decibels.

3.4 Due to the precise track nature of RNP AR based procedures, more aircraft may fly over the same place on the ground more often, with the resultant concentration of engine and airframe noise. While this can be a drawback, the concentration aspect of RNP AR procedures can be a valuable noise mitigation if used appropriately. Ideally, procedure design should concentrate aircraft over non-residential areas where possible. RNP AR procedures can also be developed so that flight paths avoid dense populations or noise sensitive areas, or overfly topographical features such as rivers, highways or agricultural areas. In removing the need for low level segments of flight during simultaneous parallel operations the resultant engine and aircraft airframe noise, as well as associated fuel burn to sustain level flight, can be significantly reduced.

3.5 Operations associated with *Established on RNP AR* further contribute to track mileage, flight time and fuel burn savings, as well as noise benefits by enabling higher utilisation of the RNP AR procedures during busy simultaneous parallel operations. Through their NextGen performance snapshots, the FAA have indicated through the use of *Established on RNP AR* at Denver International Airport (KDEN), during instrument meteorological conditions, aircraft could avoid flying an extra 15 to 20 miles before turning final. At normal terminal area manoeuvring speeds, this could equate to a savings of up to 5 minutes of flying time.

3.6 In high-density parallel runway operations, *Established on RNP AR* allows ATC to conduct simultaneous independent operations more efficiently. Traditional simultaneous parallel approach operations, where sufficient lateral distance is not possible due to the proximity of the parallel runways, require ATC to sequence arriving aircraft to the final approach course using vectors while maintaining 1000 feet vertical separation until the aircraft are established on the final approach course. This “High – Low” parallel operation sees aircraft on the “Low” side pushed down to lower altitudes and level off for a significant portion of the late downwind and/or base leg.

3.7 Operational efficiencies attainable with RNP AR and *Established on RNP AR* should be assessed against additional costs and factors such as local equipage rates. However, it should be recognised that a number of airports with RNP AR within an airline operational network are needed to drive the business case for equipage, therefore action on commissioning RNP AR should not necessarily wait for sufficient airline equipage, or airport specific positive business cases. A system-wide strategy of implementing RNP AR procedures at a multitude of high, medium and low-density airports may provide a multitude of benefits including significant economic benefits to industry stakeholders. For example, in Canada the National RNP AR development project, is introducing RNP AR procedures at 40 airports of varying traffic levels. NAV CANADA has determined that use of the procedures will enable savings of approximately CAD \$132 million in avoided fuel costs by 2020.

4. **ESTABLISHED ON RNP AR IMPLEMENTATION AT CALGARY INTERNATIONAL AIRPORT (CYYC)**

4.1 On November 8, 2018 coincident with the inclusion of the new *Established on RNP AR* separation standard into PANS-ATM, Calgary International Airport (CYYC) in Canada began full use of the new Standard as outlined by ICAO.

4.2 The difference in track mileage in using the *Established on RNP AR* separation Standard when compared to the traditional “High-Low” operation at CYYC reduces track miles by approximately

11 track miles, depending on runway configuration and direction of flight. “Tangent” approach segments were added to the traditional “curved” approach paths of RNP AR procedures to better enable connectivity with arriving traffic flows. These tangent RNP AR approach segments allow ATC to consider arriving aircraft cleared for the RNP AR approach to be “established on final” for separation purposes up to 20 track miles from the airport.

4.3 The track mileage savings from the use of *Established on RNP AR* at CYYC can reduce approximately 3 to 4 minutes of flight time for every flight. Over the course of a day, CYYC averages 100 RNP AR approaches, which translates to a reduction of up to 1100 track miles per day. From a time perspective this equates to approximately 4 to 5 flight hours saved per day, or 1 400 to 1 800 hours per year. These flight time savings reduce the period during which arriving aircraft are flying at low altitudes over communities surrounding the airport. In terms of fuel savings, airline operators have indicated each RNP AR approach at CYYC can save a narrow-body aircraft up to 100 kilograms of fuel, with approximately 200 to 300 kilograms saved for a wide-body aircraft. Over the course of a year, 36 000 RNP AR approaches at Calgary International will result in a reduction of 4.1 million kilograms of CO₂ emissions from the reduced fuel burn.

5. THE ROLE OF CANSO IN SUPPORTING THE DEVELOPMENT OF PBN

5.1 PBN is an important priority for CANSO Members and a key enabler in efforts to transform ATM performance globally. CANSO has been a strong advocate for PBN deployment since its inception and released *Accelerating Air Traffic Management Efficiency: A Call to Industry* in 2012. The association has promoted the benefits of PBN within the industry and its stakeholders, given the importance not only of ensuring that air navigation services providers (ANSPs) are PBN capable but also that airlines take the necessary steps to ensure they have the appropriate avionics and their crews are trained.

5.2 *Performance Based Navigation Best Practice Guide for ANSPs* was published by CANSO in 2015 in order to provide practical guidance on performance-based navigation (PBN) as it applies primarily to terminal airspace environments. In addition, in February 2017 CANSO produced *Performance-Based Navigation for ANSPs: Concept 2030*, which identifies current and future PBN-related technologies and services, and potential impediments to successfully implementing PBN, highlighting capabilities and resources that ANSPs might consider. These types of publications support ANSPs with their strategic planning as they prepare for, or continue with, PBN implementation in their own regions.

6. CONCLUSION

6.1 CANSO continues to work with ICAO Regional offices and CANSO members to examine ways of further supporting RNP AR deployment and in highlighting the benefits that can be achieved in many instances for ATM and aircraft operations as well as for the environment.

6.2 The Assembly is invited to agree to the actions in the Executive Summary.