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Virtual Phase (Asynchronous, 19 January to 17 February 2026)
In-person Phase (Mexico City, Mexico, 2 to 6 March 2026)

Agenda Item 8: CAR/SAM Air Navigation Implementation

ADOPTION OF RF LEGS AS THE DEFAULT DESIGN OPTION IN PBN/RNP APPROACHES WITHOUT AR: APPLICATION AT MEXICO CITY INTERNATIONAL AIRPORT (MMMX)

(Presented by Mexico)

EXECUTIVE SUMMARY

This paper analyses the implementation of RNP 1 approach procedures (without Required Authorization, AR) incorporating fixed-radius (RF) legs at Mexico City International Airport (MMMX), specifically the ILS/RNP "Y" approaches to Runways 05. Based on the design criteria established in ICAO Doc 8168, simulator validations, airline operational feedback, actual utilization data (showing a 91.6% adoption rate of the "Y" procedures with RF out of 982 operations analysed), and the amendments derived from that feedback, the paper identifies significant benefits in terms of operational efficiency, reduced fuel burn, CO_2 emissions mitigation, and noise reduction. This evidence supports the proposal to adopt RF legs as the default design option for PBN/RNP approaches without AR, in order to promote a standardized approach that optimizes performance without compromising safety.

Action:	Discuss and analyse the information related to the identified benefits of adopting RF legs as the default design option in PBN/RNP approaches without AR, intended to foster their implementation at airports in the CAR/SAM Region, leveraging the experience gained from the implementation at Mexico City International Airport (MMMX).
Strategic Objectives 2026-2050:	• Every flight is safe and secure • Aviation is environmentally sustainable • Aviation delivers seamless, accessible, and reliable mobility for all • No country left behind • The International Civil Aviation Convention and Other Treaties, Laws and Regulations Address All Challenges • The Economic Development of Air Transport Assures the Delivery of Economic Prosperity and Societal Well-Being for All
References:	• Doc 8168, Volume II, Procedures for Air Navigation Services — Aircraft Operations (PANS-OPS), Construction of Visual and Instrument Flight Procedures • Doc 9931, Manual on Continuous Descent Operations (CDO).

1. Introduction

1.1 As part of airspace modernization at Mexico City International Airport (MMMX), RNP 1 approach procedures without Required Authorization (AR) were implemented, incorporating fixed-radius (RF) legs prior to the final approach track. These procedures, designated ILS/RNP "Y" for Runways 05L and 05R, aim to optimize operations in high-density traffic configurations by enabling more efficient and stable trajectories. A preliminary analysis conducted in September 2023 compared conventional approaches (ILS Z and standard RNP, with nominal lengths of 19.5 NM from the IAF to the threshold) with shortened versions integrating RF legs, reducing the distance to 17.7 NM for ILS and RNP without AR.

1.2 The incorporation of RF legs in PBN/RNP approaches without AR represents an evolution in procedure design aligned with the design criteria in ICAO Doc 8168. The use of RF legs prior to the FAF in approaches at MMMX has demonstrated measurable benefits, supported by operational utilization data that show a marked preference for RF procedures. This motivates the present paper, which aims to argue for their adoption as the default option in similar designs.

2 Applicable design criteria according to DOC 8168

2.1 Volume II of ICAO Doc 8168 establishes the criteria for the construction of instrument flight procedures, including RF legs under RNP specifications without AR. An RF leg is defined as a constant-radius circular path, determined by a turn centre and an end reference point, with a path tangential to the preceding and following legs at the start and end points of the circular path.

2.2 For RNP APCH, RF legs are permitted in the initial and intermediate segments, requiring only RF capability in addition to RNP APCH capability by the aircraft. The document emphasizes that RF turns facilitate precise alignment with the final approach track, minimizing fly-by or fly-over turns. At MMMX, the "Y" procedures were established with a 120° course change and 2.2 NM turn radii, with altitude constraints that ensure continuous descents while allowing the aircraft to intercept below the ILS glide path (see Appendix B).

3 Validation through simulator trials

3.1 The flyability of the RF procedures was validated through simulations on an A320neo model, starting at 12,000 ft at the beginning of the approaches and descending to 8,900 ft at 1.4 NM prior to the FAF, remaining level until intercepting the localizer or the FAF, respectively for ILS and RNP. The results confirmed a stable interception of the final segment without the need for additional mitigations. Additional trials conducted in Aeromexico simulators (B737-800 and B787-9), Volaris (A320) and Viva Aerobus (A320) corroborated operational feasibility, highlighting the accuracy of RF legs in high-elevation environments such as MMMX (7,341 ft AMSL).

3.2 These analytical trials demonstrated that RF legs improve trajectory predictability by reducing lateral deviations and facilitating Continuous Descent Operations (CDO). The procedures entered into operation in September 2024 under a scheme where aircraft could request either the new approach or the existing one, enabling a transition aligned with operators' capabilities.

4. Operator feedback and utilization data

4.1 As part of post-implementation work, feedback was collected from various users. For example, Aeromexico feedback based on 1,000 real operations (including E190, B737 NG/MAX and B787

fleets) evidenced highly positive performance: only 5 approaches (0.5% of the total) showed issues. Tracks remained direct, and final configuration (flaps and landing gear deployment) was concentrated near the FAF, resulting in improved safety and fuel efficiency.

4.2 Operators also highlighted drawbacks associated with strict constraints (e.g., level-off at 8,900 ft at MX962/MX970 prior to the FAF), which prevented continuous descents and led to increased noise generation on approach. Accordingly, they suggested altitude windows that would enable CDO, consistent with ICAO principles for minimizing environmental impacts.

4.3 In response to this feedback, it was proposed to modify the intermediate segment of the "Y" approaches by establishing an 8,900 to 9,300 ft window at MX962/MX970. An analysis of 500 real flights (February 2025) showed that 100% complied with an altitude of +10,000 ft at MX960/MX980, but only a fraction achieved the strict 8,900 ft at MX962, with an average actual altitude of 10,385 ft. The proposed window allows descent gradients ranging from 0 to 286 ft/NM, while always keeping aircraft below the glide path (located at 9,357 ft at MX960 for Runway 05R), thereby promoting CDO and enabling reductions in noise and fuel emissions. (See **Appendix A)**

4.4 This modification, derived from statistical data and references such as Doc 9931, increases operational flexibility without compromising glide path interception, aligning with sustainability and operational safety objectives.

5 Operational utilization data

5.1 Operational utilization data, derived from an analysis of 982 real approaches at MMMX during December 2025, reveal predominant adoption of the RNP "Y" procedures with 900 operations (91.6% of the total), compared with 82 operations on RNP "Z" (8.4%). This distribution indicates a clear preference for RF trajectories, likely attributable to their greater efficiency and predictability.

5.2 Key operators include Aeromexico, Aeromexico Connect, Volaris and Viva Aerobus. International airlines such as American and United Airlines also show an inclination toward the "Y" approach. Only one operator (ANX/FAM) used exclusively the non-RF variant. These quantitative data, summarized in the table below, underscore the feasibility and practical acceptance of RF legs in real operational environments:

ICAO	Airline	RNP Y	RNP Z	% Individual Y	% Individual Z
AMX	Aeroméxico	409	0	100,0 %	0,0 %
SLI	Aeroméxico Connect	115	0	100,0 %	0,0 %
VOI	Volaris	106	39	73,1 %	26,9 %
VIV	Viva Aerobús	103	33	75,7 %	24,3 %
UAL	United Airlines	30	2	93,8 %	6,2 %
AAL	American Airlines	27	2	93,1 %	6,9 %
Total		900	82	91,6 %	8,4 %

5.3 This high utilization rate empirically reinforces the advantages of RF legs by demonstrating their successful integration across diverse fleets and daily operations.

6 Benefits of adopting rf legs as the default option

6.1 Operational Efficiency and Capacity: RF legs enable shorter distances, resulting in more direct and stable trajectories, with precise turns that avoid overshoots. At MMMX, this translates into daily savings of 2,420 NM (assuming 515 arrivals/day), improving flow at congested airports. Utilization data confirm this efficiency, as 91.6% of operations opted for the RF "Y" approach, suggesting effective reductions in flight time and airspace congestion.

6.2 Reduced Fuel Burn and Emissions: Calculations using the Small Emitters Tool (EUROCONTROL) show average savings per aircraft of 14 kg/flight for RNP, scaling to 29,820 kg per month. CO_2 emissions are reduced by 3,131 kg/flight (A320), totaling 93,933 kg/month, contributing to environmental targets. The operational preference for RF approaches amplifies these benefits at real scale. In post-implementation meetings, some major operators have reported significant savings reaching several million dollars annually due to the new procedures.

6.3 Noise Mitigation: These approaches, by enabling continuous descent and more predictable trajectories, reduce noise in adjacent urban areas, as observed at MMMX. Simulations confirm that aircraft maintain a clean configuration until the FAF, and utilization data indicate that this advantage materializes in the majority of operations.

6.4 Operational Safety: RF precision reduces the number of deviations. As a default design option, RF legs reduce trajectory and time variability, enabling improved air traffic management and increasing operational safety.

6.5 In summary, these benefits—quantified through empirical data and aligned with PANS-OPS criteria—support transitioning RF legs from optional to default in RNP without AR, particularly in complex environments where real utilization percentages validate their operational superiority.

7. Conclusions and recommendations

7.1 The implementation of these approaches at MMMX demonstrates that RF legs in PBN/RNP approaches without AR improve efficiency, sustainability and safety, supported by analytical simulator evidence, real operations (including a 91.6% adoption rate for RF procedures), and adaptive amendments.

7.2 Participants are encouraged to consider adopting RF legs as the default design option when updating regional guidance and promoting validation in other States, prioritizing airports with specific topographical or environmental constraints.

8 Suggested action

8.1 The Meeting is invited to:

To discuss and analyze the information related to the advantages identified in the adoption of RF sections as a default design option in non-AR PBN/RNP approaches, in order to promote its implementation in the airports of the CAR/SAM region under the experience of the implementation at Mexico City International Airport (MMMX).