

**58<sup>th</sup> CONFERENCE OF  
DIRECTORS GENERAL OF CIVIL AVIATION  
ASIA AND PACIFIC REGIONS**

*Dhaka, Bangladesh  
15 to 19 October 2023*

**AGENDA ITEM 4: AIR NAVIGATION**

**IMPLEMENTATION OF RNP AR APPROACH PROCEDURES  
IN MACAO, CHINA**

(Presented by Macao, China)

**INFORMATION PAPER**

**SUMMARY**

This Paper presents information of the implementation of RNP AR approach procedures at Macau International Airport (VMMC). The collaborative efforts of aircraft operator, air traffic service provider and regulator are highlighted. The successful implementation of RNP AR approach procedure has led in enhancing safety and efficiency, as well as improvement of operating minima.

## IMPLEMENTATION OF RNP AR APPROACH PROCEDURES IN MACAO, CHINA

### 1. INTRODUCTION

1.1 To enhance the safety and efficiency of aircraft operations at Macau International Airport, the Civil Aviation Authority – Macao, China (AACM) and the aviation industry collaborated closely in the development of RNP AR approach procedure.

1.2 The RNP AR approach procedure was officially published on 23 May 2019 in Macao AIP for public use. The operational approval of the Macao-based aircraft operator to use the procedure was granted in June the same year. Authorization process for other (including foreign) aircraft operators' use was also published after the launch of this approach procedure.

### 2. DISCUSSION

#### *Challenges on procedure development and operational approval*

2.1 Due to airspace restrictions in the vicinity of Macau International Airport, the primary approach to Macao runway 16 is a detoured non-precision approach with offset LOC/DME procedure. The turn on final approach segment requires demanding operating minimum to allow manual maneuver on final under visual condition. The unstable and missed approach rates of runway 16 are significantly higher than those of the opposite runway 34 approaches. Thus, runway 34 has been assigned as the preferential runway whenever the surface wind does not exceed the criteria. However, the south-east prevalent wind during summer favors the use of runway 16, which is less beneficial for operations.

2.2 Owing to the accurate positioning capability of the Global Navigation Satellite System (GNSS), combined with modern airborne avionics and onboard performance monitoring and alerting system, RNP AR approach allows the aircraft to follow the procedure flight track more precisely and proceed closer to the landing aerodrome, hence increasing the chance of a successful landing during meteorological condition with poor visibility or low cloud base.

2.3 AACM and aviation stakeholders have performed a feasibility study with the objective of enhancing safety, as well as reducing missed approach and diversion rates for runway 16 approach. AACM has taken the initiative to establish a task force comprising members from the air traffic service provider (ATSP) at Macau International Airport and the Macao-based aircraft operator Air Macau to develop the RNP AR approach procedure.

2.4 The ATSP has taken up the lead in engaging NavBlue, a subsidiary of Airbus, in the flight procedure development processes as prescribed in ICAO Doc 9905 and Doc 9906.

2.5 The RNP AR and conventional LOC/DME procedure are coexisting approach procedures for runway 16 as both may be requested by arrival traffic, subject to operator's RNP AR eligibility and prior authorization by AACM. To minimize the impact to ATC operations, the RNP AR procedure was designed to be an overlay with the conventional procedure (refer to Figure 1). As the airspace of Macao, China is designated as an Aerodrome Traffic Zone (ATZ) for operation of Macau International Airport. The ATZ is surrounded by the airspace sectors under Guangzhou and Hong Kong FIRs. Under the good rapport with these airspace authorities, the associated ATS units have given support to the implementation of the RNP AR approach procedure.



Figure 1 - Flight tracks of LOC/DME and RNP AR approach procedures

2.6 RNP AR, as its name suggests, requires authorization from the State where the approach procedure is situated. The PBN manual (ICAO Doc 9613) stipulates the process for aircraft operator to pursue an operational approval, encompassing evaluation of aircraft eligibility, continued airworthiness, equipment functionality, flight crew training and operating procedures, operational validation and Flight Operational Safety Assessment (FOSA) etc. For operator already certified with RNP AR capability by its State/Administration to further pursue an authorization for a specific RNP AR procedure, the process is at the discretion of the State/Administration which publishes the procedure.

2.7 To avoid redundant effort on the approval of aircraft, crew qualification and other common aspects already certified by the State of the operator, AACM adopts the authorization process by validating specific operational aspects of its RNP AR operational approval:

- A) Rationale of operator pursuing the authorization to conduct RNP AR approach in Macao.
- B) Specification of RNP AR approach operational approval granted by the State of the operator.
- C) Flight crew training programme related to RNP AR operations of the operator.
- D) Validation of Macao RNP AR procedures' flyability with the operator's aircraft and procedures.
- E) Monitoring programme and result collected from operator's RNP AR approaches to Macao.
- F) FOSA addressing risks specific to operator's aircraft operation with Macao RNP AR procedures.

*Benefits of the implementation of RNP AR approach procedures*

2.8 In the past, the primary approach procedure to Macau International Airport runway 16 was usually the conventional LOC/DME approach procedure. Due to the manual maneuver of a left turn to align the runway on final approach segment, operating minima of this approach are 3600 m visibility and 700 ft MDH for CAT C aircraft. With the RNP AR approach procedure, the minima can be lowered to 900 m visibility, and 250 ft MDH.

2.9 The air traffic of Macau International Airport has recently recovered from the stagnated public travelling during the COVID-19 pandemic. The demand to benefit from this RNP AR procedure has increased since Q2 of 2023. Currently, seven aircraft operators have been granted authorization from AACM to use RNP AR approach procedure to runway 16. The unstable approach and missed approach rates have been reduced significantly after the implementation of the RNP AR procedure.

2.10 The Macao-based operator Air Macau is the first airline to operate with this RNP AR approach procedure. Comparing the period from January to June, during which prevalent use of runway 16 at Macau International Airport is expected, before the implementation of RNP AR procedure in 2019, the missed approach rate using runway 16 for Air Macau was 2.208% while within the same period in 2023, the missed approach rate has decreased to 0.107%, which indicates a significant reduction of missed approaches. For operators not yet engaged in Macao RNP AR approaches, the missed approach rates were 1.869% in 2019 and 2.685% in 2023, respectively within the same period.

2.11 Figure 2 shows a comparison of the missed approach rates of runway 16 at Macau International Airport between Air Macau and operators not engaged with RNP AR approach procedures, as well as the improvement of Air Macau before and after implementing RNP AR approach operations, which demonstrates that the implementation of RNP AR procedure has greatly improved the operational reliability of runway 16 and enhanced the services of passenger and cargo transport by air to Macao.

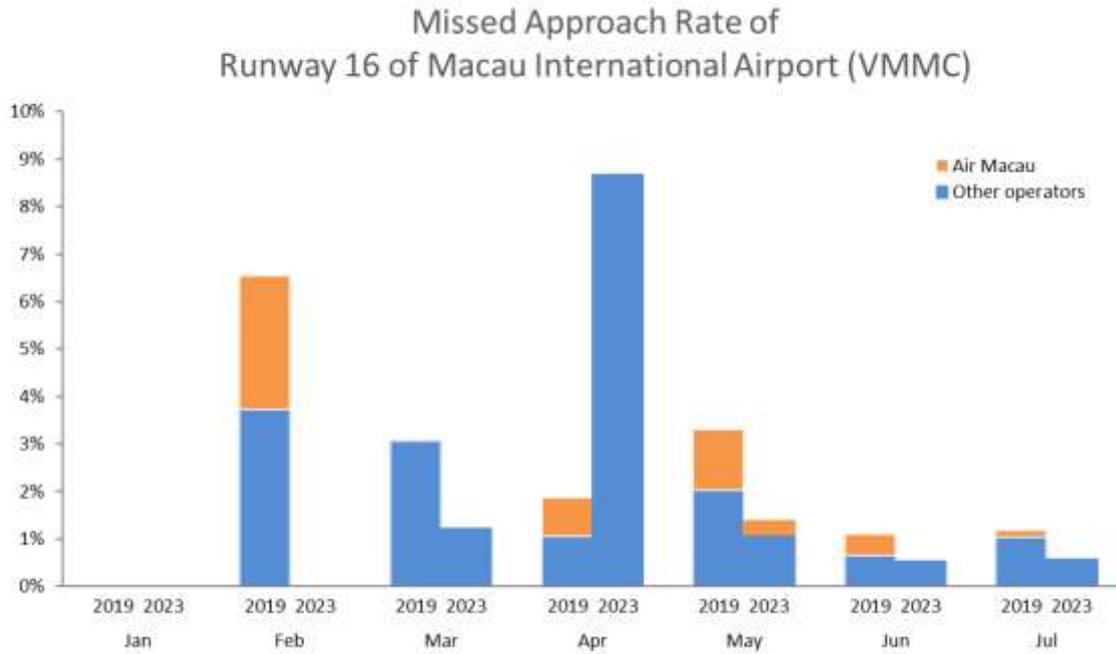


Figure 2 - Missed approach rate of Macau International Airport runway 16 with vs without RNP AR approach operation

2.12 With the reduced weather minima and lower missed approach rates, as well as the consequential shortened airborne time that help to reduce fuel consumption and carbon emission, AACM looks forward to an increasing number of RNP AR eligible operators and encourages aircraft operators to utilize RNP AR approach procedures at Macau International Airport.

### 3. ACTION BY THE CONFERENCE

3.1 The Conference is invited to note the information contained in this Paper.

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