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AGENDA ITEM 4: AIR NAVIGATION

MODERNIZATION OF CNS/ATM SYSTEMS IN MACAO, CHINA

(Presented by Macao, China)

INFORMATION PAPER

SUMMARY

This paper provides information on the project for modernization of the CNS/ATM systems in Macao, China.

MODERNIZATION OF CNS/ATM SYSTEMS IN MACAO, CHINA

1. INTRODUCTION

1.1 The Macau International Airport (MIA) began construction in 1990 on reclaimed land and officially opened for operations at the end of 1995. Its single runway is 3,360 meters long and 45 meters wide, capable of accommodating large passenger aircraft such as the Boeing 747-400 and equipped with conventional navigation aids. Runway 34 is equipped with an ILS (CAT II) and Runway 16 is equipped with an offset localizer with DME. A DVOR/DME is installed at the end of Runway 34.

1.2 The first major replacement of the CNS/ATM systems in MIA was achieved between 2008 and 2010. Since then, the systems have been put into operation for almost 15 years. The planning by airport concessionary for upcoming replacement/modernization is ongoing for the purpose of enhancing safety and efficiency as well as coping up with continuous developments in Air Navigation Service (ANS) aspects by ICAO in these years.

1.3 System aging and lack of support for the latest technology, such as the ICAO Meteorological Information Exchange Model (IWXXM), are major shortcomings of MIA's existing CNS/ATM systems. Modernizing the CNS/ATM systems is essential for providing seamless, safe, and efficient air navigation services in line with the Asia-Pacific region's Seamless ATM/ANS goals.

1.4 The CNS/ATM systems planned to be replaced or introduced consist of the following: A-CDM System, AMHS with CRV, A/G VHF, Multilateration (MLAT) and ADS-B, Offset localizer with DME for Runway 16, ILS (CAT II) for Runway 34, DVOR/DME, VCCS, Automatic Weather Observing System, D-ATIS and DCL, ATM Automation System, Telemetry System for AGL, Panoramic Monitoring System.

2. DISCUSSION

A-CDM System Implementation

2.1 The implementation of the Airport Collaborative Decision Making (A-CDM) System significantly improves efficiency, predictability, and coordination among the main stakeholders involved in airport operations. It enables real-time information sharing and collaborative practices among airlines, airports, air traffic control, ground handling services, and various partners in the aviation industry.

2.2 The A-CDM System at MIA became operational in 2021. Involved airport operators are regularly entering data into the A-CDM system as part of their daily operations. Recently, Macao ATC has begun using the generated Target Off-Block Time (TOBT) solely for reference. Other entities involved at MIA utilize A-CDM data to enhance their planning and organization of daily operations.

2.3 In 2024, the A-CDM System at MIA underwent enhancements, including the installation of cameras at commercial parking stands for automatic data collection related to operations like passenger boarding bridge, push-back and fueling. Additionally, GPS/BeiDou transceivers were installed in 40 vehicles operating within MIA.

2.4 MIA is currently working on subsequent projects for the A-CDM to improve system accuracy. At the same time, efforts are being made to coordinate data exchange with the traffic flow management system of neighboring ATC units. Integrating the traffic flow management system is crucial for boosting efficiency and predictability.

AMHS Replacement and CRV Implementation

2.5 The first Air Traffic Services Message Handling System (AMHS) of MIA was commissioned in 2009 to replace the legacy AFTN system. As the AMHS has reached the end of its system life cycle, MIA launched the AMHS replacement project in end 2023 and the new AMHS became operational in April 2025.

2.6 MIA joined the ICAO APAC Common aeRonautical Virtual Private Network (CRV) in 2024, signing a contract with PCCW for Package C+ with 2 MB of capacity and an allocation of 64 kbps for each AMHS circuit.

2.7 The original AMHS (OSI stack) of MIA was connected to Guangzhou (AFTN) and Hong Kong, China (AMHS) via the International Private Leased Circuits (IPLCs). After the transition, MIA's new AMHS (IPS stack) is connected to Beijing (AMHS) and Hong Kong, China (AMHS) via CRV.

2.8 The system installation of the AMHS replacement project in MIA was finished in August 2024. Subsequently, joint ATN/AMHS tests and trials were conducted to evaluate the basic connectivity, interoperability, functionality, and integrity of the IPS Routers, AMHS systems, and AMHS/AFTN Gateway Systems between MIA and its peer sites in Beijing and Hong Kong, China. The ATN/AMHS tests and trials which have been conducted are summarized in the following table.

Test Item	Test Date	Test Procedure Reference
IP Infrastructure Tests	August 2024	IP Infrastructure Test Guidelines for EUR AMHS, version 2.0
Inter-Operability Tests	December 2024 – January 2025	Appendix D-UA (AMHS UA Conformance Tests) & Appendix E (AMHS Interoperability Tests) of EUR AMHS Manual, version 17.0
Pre-Operational Tests (with testing traffic)	January 2025 – March 2025	Test messages are sent from Hong Kong and Guangzhou to MIA's new AMHS
Pre-Operational Trials (with operational traffic)	21 March – 4 April 2025	Appendix F (AMHS Pre-operational Tests) of EUR AMHS Manual, version 17.0

2.9 The IP Infrastructure Tests and Inter-Operability Tests were conducted with Beijing and Hong Kong, China respectively over the CRV. These tests aim to validate the connectivity, compatibility and interoperability of MIA's new AMHS and its peer sites before migrating from ATN/OSI over IPLC to ATN/IPS over CRV.

2.10 Prior to the formal Pre-Operational Trials, Pre-Operational Tests were conducted on MIA's new AMHS with test messages received from Hong Kong and Guangzhou. The Pre-Operational Tests lasted for around two months to confirm the functionality and integrity of MIA's new AMHS.

2.11 A two-week Pre-Operational Trials of the AMHS/CRV circuits began on 21 March 2025 and concluded successfully on 4 April 2025. During the trial period, the Macao – Beijing and Macao – Hong Kong AMHS/CRV circuits were tested simultaneously with operational traffic. Throughout the Pre-Operational Trials, there were no circuit interruptions, no equipment failures, or message losses. Following the positive outcomes of the Pre-Operational Trials and the successful Inter-Operability Tests, operational traffic exchange on the AMHS/CRV circuits continued and MIA's new AMHS has been operational since then.

Conventional Navigation Aids and ATM Automation System Replacement

2.12 MIA has implemented RNP SIDs, STARs and approach procedures for both runway ends since 2013. Moreover, an RNP AR approach procedure has also been implemented in 2019 to improve the weather minima for Runway 16.

2.13 In order to maintain the operational efficacy of the predominant runway (i.e. Runway 34), the ILS and DVOR/DME replacements are offset in separated timeframe such that both the GNSS based RNP approach and conventional DVOR/DME instrument non precision approach are still available. i.e. ILS is planned to be replaced in 2026 and DVOR/DME is planned to be replaced in 2027.

2.14 The design of the new Aerodrome Control tower automation system, which is planned to be replaced in 2027, has incorporated the applicable essence in the ASIA/PAC ATM Automation System implementation and operations guidance document. The system enables centralized acquisition, processing, and display of information such as ground surveillance, flight plans, flight traffic, weather, and other aeronautical information. Through information integration and decision support technologies, the system provides tower controllers with an electronic, centralized, intelligent working platform.

Cooperation between Authority and Airport Operator

2.15 Cooperation between the Civil Aviation Authority and the Airport Operator is essential for a successful CNS/ATM system replacement project. It requires strong, structured cooperation by aligning on goals, sharing responsibilities, and maintaining open communication, both entities can ensure the deployment of a safe, compliant, and integrated air traffic management system.

2.16 The following table summarizes the main responsibilities and areas of cooperation between the Civil Aviation Authority of Macao, China (AACM) and the Airport Operator of Macao, China (MIA) in the CNS/ATM system replacement project.

<table>
<tr><th>Stakeholder</th><th>Main Responsibilities</th><th>Cooperation</th></tr>
<tr><td>AACM</td><td>• Regulatory and safety oversight
• Compliance with ICAO SARPs
• Coordination with adjacent ATC units
• Regular audits to ensure system effectiveness</td><td rowspan="2">• Technical planning and joint assessment of existing CNS/ATM infrastructure
• Defining technical requirements and system specifications
• Ensuring interoperability with existing systems and international partners
• Joint participation in Site Acceptance Testing (SAT) and Factory Acceptance Testing (FAT)
• Monitoring and evaluation</td></tr>
<tr><td>MIA</td><td>• Funding and procurement (including tendering process)
• System installation, testing and training
• Coordination with airlines and ground services
• Operational integration</td></tr>
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Support of Asia Pacific Seamless ANS Plan

2.17 The Seamless ANS Plan aims to facilitate harmonized, efficient, and safe air traffic operations across Flight Information Regions (FIRs) and States, eliminating unnecessary delays and fragmentation. This plan is primarily guided by the ICAO Global Air Navigation Plan (GANP) and the Aviation System Block Upgrades (ASBU) methodology.

2.18 The implementation of A-CDM at MIA is a crucial factor in achieving seamless ANS, enhancing operational efficiency and predictability in accordance with the ICAO ASBU Framework. It lays the groundwork for collaborative, efficient, and data-driven air navigation services that align with the broader vision of Seamless ATM.

2.19 MIA's new AMHS is ready for IWXXM and can relay these messages via CRV. IWXXM is key element of the Seamless ANS Plan and designed to be scalable to handle additional data, thereby improving the flow of meteorological information and meeting the future demands for more precise data and advanced meteorological services.

2.20 Even with the global transition towards Performance-Based Navigation (PBN), selected conventional navigation aids such as VOR, DME, and ILS, which have been identified as Minimal Operating Networks (MON), remain essential for ensuring continuity, redundancy, and safety in airspace. The CNS/ATM system replacement plan at MIA outlines a strategic approach for the rationalization, maintenance, and future role of these conventional navigation aids within a Seamless ANS framework.

3. ACTION BY THE CONFERENCE

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

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