

## AERONAUTICAL CIRCULAR CIVIL AVIATION AUTHORITY – MACAO, CHINA

**SUBJECT:** *Instrument Flight Procedures Approval Requirements*

**EFFECTIVE DATE:**

1 June 2016

**CANCELLATION:**

Nil.

**GENERAL:**

The President of Civil Aviation Authority – Macao, China (AACM), in exercise of his power under Paragraph 89 of the Air Navigation Regulation of Macao (ANRM) and Article 35 of the Statutes of Civil Aviation Authority, approved by the Decree-Law 10/91/M, established this Aeronautical Circular (AC).

**1. Introduction**

1.1 This AC provides standards and requirements for the design and maintenance of instrument flight procedure (IFP). This is to ensure that all instrument flight procedures intended for use by aircraft operating under instrument flight rules (IFR) within Macao ATZ meet International Civil Aviation Organization (ICAO) requirements for instrument flight procedures.

1.2 The criteria for instrument flight procedure design in Macao ATZ are mainly based on the following documents:

- (a) ICAO Doc 8168 - Procedures for Air Navigation Services – Aircraft Operations (PANS-OPS); and
- (b) ICAO Doc 9905 – Required Navigation Performance Authorization Required (RNP AR) Procedure Design Manual (for RNP AR procedures).

Where there is a difference between a requirement in this AC and these two ICAO documents, the requirements in this AC shall prevail.

1.3 This AC shall be read in conjunction with the following ICAO documents as appropriate. The related provisions in these documents shall be complied with for the design and maintenance of instrument flight procedure.

- (a) ICAO Doc 9368 – Instrument Flight Procedures Construction Manual
- (b) ICAO Doc 9371 – Template Manual for Holding, Reversal and Racetrack Procedures
- (c) ICAO Doc 9274 – Manual on the Use of the Collision Risk Model (CRM) for ILS Operations
- (d) ICAO Doc 9365 – Manual of All-Weather Operations
- (e) ICAO Doc 9613 – Performance-based Navigation (PBN) Manual
- (f) ICAO Doc 9906 – Quality Assurance Manual for Flight Procedure Design
- (g) ICAO Doc 9997 – Performance-based Navigation (PBN) Operational Approval Manual
- (h) ICAO Doc 9674 – World Geodetic System — 1984 (WGS-84) Manual
- (i) ICAO Doc 8697 – Aeronautical Chart Manual
- (j) ICAO Annex 4 – Aeronautical Charts
- (k) ICAO Annex 5 – Units of Measurement to be Used in Air and Ground Operations
- (l) ICAO Annex 6 – Operation of Aircraft
- (m) ICAO Annex 14 Vol I – Aerodrome Design and Operations
- (n) ICAO Annex 14 Vol II – Heliports
- (o) ICAO Annex 15 – Aeronautical Information Services

## 2. Definitions

- ***Flight procedure designer*** means a person responsible for flight procedure design who meets the competency requirements.
- ***Instrument flight procedure (IFP)*** means a description of a series of predetermined flight manoeuvres by reference to flight instruments, published by electronic and/or printed means.
- ***Procedure design service provider (PDSP)*** means a body that provides procedure design services. It may also be a training provider providing procedure designer training.
- ***Sponsor*** means Airport Operator or Air Traffic Services Provider, who proposes a new design, changes to, or withdrawal of an IFP.

## 3. Applicability

- 3.1 The standards and requirements laid down in this AC are applicable to the sponsor of an IFP.

#### **4. General**

- 4.1 The sponsor of an IFP is either the airport operator or an air traffic services provider; the sponsor is responsible for:
- (a) maintenance of the IFP;
  - (b) initiating any new design or change to the IFP;
  - (c) ensuring that any new design or change to the IFP is undertaken by a procedure design service provider (PDSP) accepted by the AACM; and
  - (d) ensuring compliance with the standards and requirements laid down in this AC.

#### **5. Procedure design service provider (PDSP)**

##### **5.1 Organization**

- 5.1.1 The PDSP shall maintain an appropriate instrument design office to enable the flight procedure designer to carry on design work in instrument flight procedures in accordance with the requirements set out in this AC.
- 5.1.2 The PDSP shall ensure that the designs of instrument flight procedure are in accordance with:
- a) applicable criteria set out or referred to in the ICAO documents listed in paragraph 1.2; and
  - b) applicable requirements as set out in this AC.
- 5.1.3 The PDSP shall make provisions for a person(s) trained in instrument flight procedure design to check and verify independently the plans of each instrument flight procedure designed.
- 5.1.4 PDSP shall be qualified according to requirements established by the State/Administration, AACM shall ensure the design process provided by the PDSP meets the requirements laid down in this AC.

##### **5.2 Instrument Flight Procedure Design Manual**

- 5.2.1 The PDSP shall develop and maintain an operations manual. The operations manual shall demonstrate how to comply with the requirements set out in this AC.
- 5.2.2 The contents of the operations manual shall include but not limited to the following:
- a) the information required of the PDSP as mentioned in this AC; and
  - b) a description of the instrument flight procedure design office that shows the role, responsibilities and job functions of the instrument flight

procedure design office personnel who are responsible for ensuring the compliance of the organisation with the requirements in sub-paragraph a).

5.2.3 The PDSP shall:

- a) keep the operations manual in a readily accessible form;
- b) ensure that the flight procedure designer has ready access to the operations manual; and
- c) amend the operations manual whenever necessary to keep its content up to date.

5.2.4 The PDSP shall make a copy of the most current operations manual available to the AACM upon request.

5.3 Resource Requirements

5.3.1 The PDSP shall provide and maintain facilities for the design work on instrument flight procedures. This would include:

- a) having available equipment appropriate for the design, design verification, flight validation, and maintenance of the types of instrument flight procedures;
- b) access to relevant and current data including, but not limited to, aeronautical data, land contour data, and obstacle data for the design, design verification, flight verification, and maintenance of the instrument flight procedures; and
- c) ready access to copies of relevant documentation comprising technical standards, practices, and instructions, and any other documentation that may be necessary for the design, design verification, flight validation, and maintenance of the types of instrument flight procedure.

5.3.2 If an aeronautical database and aeronautical data is required for designing an instrument flight procedure, the PDSP shall ensure the integrity of the database and the data. The data used shall be current, traceable, and meets the required level of verifiable accuracy for the design.

5.4 Documents and Records Control System

5.4.1 The PDSP shall establish and put into effect, a system for controlling documents and records relating to the instrument flight procedures on which the designer carries on design work, including the policies and procedures for making, amending, preserving and disposing of those documents and records.

5.4.2 The PDSP shall, at the AACM's request, make the documents and records, or copies of them or extracts from them, available for inspection by the AACM.

## **6. Flight Procedure Designer Qualifications and Training**

### **6.1 Flight Procedure Designer Qualifications**

- 6.1.1 The PDSP shall ensure that a person designing or amending an instrument flight procedure demonstrates required competency level for flight procedure design. Flight procedure designers shall acquire and maintain this competency level through training and supervised on-the-job training (OJT). This is to ensure that the quality assurance in the procedure design process and its output, including the quality of aeronautical information/data, meets the requirements of ICAO Annex 4 – Aeronautical Charts and Annex 15 – Aeronautical Information Services.

### **6.2 Training for Flight Procedure Designers**

- 6.2.1 The training for flight procedure designers shall include an initial training and recurrent training at periodic intervals.

- 6.2.2 The PDSP shall ensure that the flight procedure designer is able to demonstrate a basic level of competency through initial training that includes at least the following elements:

- a) overview of ICAO Standards and Recommended Practices (SARPs) relating to instrument flight procedure design and promulgation;
- b) knowledge of information contained in ICAO Doc 8168 – PANS-OPS, and other related ICAO provisions relevant to procedure designs;
- c) general criteria in instrument flight procedure designing;
- d) non-precision approach design;
- e) precision approach design;
- f) instrument departure design;
- g) criteria for RNAV, GNSS and RNP; and
- h) practical exercises in the design of procedures.

- 6.2.3 The PDSP shall ensure that the flight procedure designer is able to demonstrate a basic level of competency through recurrent training that includes at least the following elements:

- a) knowledge about updates in ICAO provisions and other provisions pertaining to procedure design; and
- b) maintenance and enhancement of knowledge and skills in the design of procedures.

- 6.2.4 OJT is aimed at permitting the new flight procedure designer to integrate his basic knowledge with actual practice. The PDSP shall ensure that new flight procedure designers undergo an adequate, supervised OJT.
- 6.2.5 The competency of the flight procedure designer shall be subject to periodic verification by the AACM to ensure continued compliance with the requirements in this AC.
- 6.2.6 The PDSP shall maintain training records for their flight procedure designers.

## **7. Procedure Design Information Acquisition**

### **7.1 Information Acquisition**

- 7.1.1 Current and complete survey data and information is crucial to the design of safe instrument flight procedure. The PDSP shall ensure that the survey and subsequent instrument flight procedure design activities are controlled and monitored by a person(s) trained in procedure design.
- 7.1.2 In the obstacle survey for procedure design, the flight procedure designer shall consider that:
  - a) all obstacles be accounted for. Items, such as trees and heights of tall buildings shall be accounted for either by physical examination of the site or by addition of a suitable margin above terrain contours; and
  - b) the accuracy of the vertical and horizontal data obtained may be adjusted by adding an amount equal to the specified survey error to the height of all measured obstructions and by making a corresponding adjustment for specified horizontal error.
- 7.1.3 The procedure design information shall be coordinated with all relevant stakeholders. As input for the procedure design process the following aspects need to be assessed:
  - a) airport, navigation aid, obstacle, terrain coordinate and elevation data, based on verified surveys and complying with ICAO Annex 11, 14 and 15 requirements;
  - b) airspace requirements;
  - c) user requirements – the needs of Air Traffic Service provider and operators who will use this procedure;
  - d) airport infrastructure such as runway classification, lighting, communications, runway markings, and availability of local altimeter setting;
  - e) environmental considerations;

- f) comments of relevant airspace authority if the procedures involve airspace other than Macao ATZ; and
- g) any other potential issue associated with the procedure.

## **8. Instrument Flight Procedure Design Process**

### **8.1 Introduction**

- 8.1.1 The Instrument Flight Procedure Design process encompasses the acquisition of data, design and promulgation of procedures. It starts with compilation and verification of the many inputs and ends with ground and/or flight validation of the finished product, and documentation for publication.
- 8.1.2 Instrument flight procedure shall be accompanied by a narrative, which describes the procedure in textual format.

### **8.2 Procedure Design**

- 8.2.1 Procedures shall be designed according to applicable criteria in the ICAO document(s) listed in paragraph 1.2. Coordination with all concerned parties shall continue throughout the procedure design and validation process to ensure that the procedure meets the needs of the user and the community.
- 8.2.2 The aerodrome operating minima prescribed for instrument flight procedure shall be established.
- 8.2.3 Each new or revised procedure shall be verified by a person(s) trained in procedure design other than the one who designed the procedure, to ensure compliance with applicable criteria.
- 8.2.4 Published procedures shall be subject to periodic review to ensure that they continue to comply with changing criteria, and meets user requirements. The maximum interval for this review is five years.

### **8.3 Procedure Design Documentation**

- 8.3.1 The documentation provided by the flight procedure designer is divided into three categories and includes:
  - a) documentation required for publication in the AIP in accordance with ICAO Annexes 4 and 15;
  - b) documentation required to maintain transparency concerning the details and assumptions used by the flight procedure designer, which shall include the following supporting information/data used in the design, as appropriate:

- (i) controlling obstacle for each segment of the procedure;
  - (ii) effect of environmental considerations on the design of the procedure;
  - (iii) infrastructure assessment;
  - (iv) airspace constraints;
  - (v) for modifications or amendments to existing procedures, the reasons for any changes; and
  - (vi) for any deviation from existing standards, the reasons for such a deviation and details of the mitigations applied to assure continued safe operations.
- c) additional documentation required to facilitate ground and flight validation of the procedure and the results of the ground and flight validation.

8.3.2 All calculations and results of calculations shall be presented in a manner that enables the reader to follow and trace the logic and resultant output. A record of all calculations shall be kept in order to prove compliance to or variation from the standard criteria.

8.3.3 Formulae used during calculation shall be the standard formulae as stated in ICAO Doc 8168 and related ICAO publications. Units of measurement and conversion factors between such units shall be in accordance to ICAO Annexes 4, 5 and 6.

8.3.4 Rounding of results shall follow the standard guidelines in ICAO Doc 8168 and related ICAO publications. Rounding shall only be made at the publication stage to facilitate usable figures on maps and charts. Where rounding is required at earlier stages rounding shall be made to the pessimistic consideration, i.e. obstacles heights rounded up, speeds rounded up, turn altitudes rounded down etc.

8.3.5 All documentation shall undergo a final verification for accuracy and completeness prior to validation and publication.

8.3.6 All documentation shall be retained to assist in recreating the procedure in the future in the case of incidents and for periodic review and maintenance. The periodic retention shall not be less than the operational lifetime of the procedure.

## 8.4 Ground and Flight Validation

### 8.4.1 Validation

8.4.1.1 Validation is the necessary final quality assurance step in the procedure design process, prior to publication. The purpose of validation is the verification of all obstacle and navigation data, assessment of flyability of the



procedure. Validation normally consists of ground validation and flight validation.

8.4.1.2 Ground validation shall always be undertaken.

8.4.1.3 When ground validation can verify the accuracy and completeness of all obstacle and navigation data considered in the procedure design, and any other factors normally considered in the flight validation under paragraph 8.4.3, then the flight validation requirement may be dispensed with.

8.4.1.4 Flight validation is required under the following conditions:

- a) the flyability of a procedure cannot be determined by other means;
- b) the procedure requires mitigation for deviations from design criteria;
- c) the accuracy and/or integrity of obstacle and terrain data cannot be determined by other means;
- d) new procedures differ significantly from existing procedures;
- e) for helicopter Point-in-Space (PinS) procedures; and
- f) for Required Navigation Performance Authorization Required (RNP AR) procedures.

8.4.2 Ground Validation

8.4.2.1 Ground validation is a review of the entire instrument flight procedure package by a person(s) trained in procedure design and with appropriate knowledge of flight validation issues. It is meant to arrest errors in criteria and documentation, and evaluate on the ground, to the extent possible, those elements that will be evaluated in a flight validation. Issues identified in the ground validation shall be addressed prior to any flight validation.

8.4.2.2 The ground validation will also determine if flight validation is needed for modifications and amendments to previously published procedures.

8.4.3 Flight Validation

8.4.3.1 Subject to paragraph 8.4.1.3 and 8.4.1.4, flight validation of instrument flight procedures shall be carried out as part of the initial record and shall also be included as part of the periodic quality assurance programme. It shall be accomplished by qualified flight crew.

8.4.3.2 The objectives of the flight validation of instrument flight procedures are to:

- a) provide assurance that adequate obstacle clearance has been provided;
- b) verify that the navigation data to be published, as well as that used in the design of the procedure, is correct;
- c) verify that all required infrastructure, such as runway markings, lighting, and communications and navigation sources, are in place and operative;
- d) conduct an assessment of flyability to determine that the procedure can be safely flown; and

- e) evaluate the charting, required infrastructure, visibility and other operational factors.
- 8.4.3.3 For complex procedures including helicopter PinS and RNP AR, flyability checks are required in the proponent's aircraft or simulator.
- 8.4.3.4 Flight validation should be apart from flight inspection. Flight inspection of instrument flight procedure is required to assure that the appropriate radio navigation aids adequately support the procedure and ensures obstacle clearance. This is carried out as part of a formal flight inspection programme and is performed by a qualified flight inspector using an appropriately equipped aircraft.
- 8.4.3.5 The flight procedure designer shall be the originator of all data applicable to conducting a flight validation provided to the flight validation or the flight inspection operations activity. The flight procedure designer should be prepared to provide briefings to the flight validation or flight inspection crews in those cases where flight procedures have unique application or special features.
- 8.4.3.6 The flight procedure designer may participate in the initial validation flight to assist in its evaluation and obtain direct knowledge of issues related to the procedure's design from the flight validation crew, flight inspection pilot and/or inspector.

## **9. Safety Assessment**

### **9.1 Safety Assessment**

- 9.1.1 The PDSP shall carry out a safety assessment in respect of proposals for new flight procedure designs or any significant changes in a revised procedure. Proposals shall be implemented only when the assessment has shown that an acceptable level of safety will be met.
- 9.1.2 The safety assessment shall consider relevant factors determined to be safety-significant, including but not limited to:
  - a) types of aircraft and their performance characteristics, including navigation capabilities and navigation performance;
  - b) traffic density and distribution;
  - c) airspace complexity; ATS route structure and classification of the airspace;
  - d) aerodrome layout;
  - e) type and capabilities of ground navigation systems;
  - f) any significant local or regional data (e.g. obstacles, infrastructures, operational factors, etc).

- 9.1.3 Each RNP AR procedure shall be supported by a Flight Operations Safety Assessment (FOSA) specifically developed to address RNP AR procedure operational safety risks. The assessment shall give proper attention to the inter-dependence of the elements of procedure design, aircraft capability, crew procedures and operating environment.
- 9.1.4 Safety risk control/mitigation process shall include hazard/consequence identification and safety risk assessment. Once hazards and consequences have been identified and safety risks assessed, the effectiveness and efficiency of existing aviation system defenses relative to the hazards and consequences should be evaluated. As a consequence of this evaluation, existing defenses shall be reinforced, new ones introduced, or both.
- 9.1.5 As part of the safety assurance, the risk control/mitigation process shall include a system of feedback. This is to ensure integrity, efficiency and effectiveness of the defenses under the new operational conditions.
- 9.1.6 The PDSP shall ensure that the results and conclusions of the safety assessment and mitigation process of a new or changed procedure are specifically documented, and that this documentation is maintained throughout the life of the instrument flight procedure.

## **10. Procedure Design Automation**

### **10.1 General**

- 10.1.1 Procedure design automation tools have the potential to reduce errors in the procedure design process, as well as to standardize the application of the criteria prescribed in the ICAO documents listed in paragraph 1.2.
- 10.1.2 ICAO produces several tools automating elementary portions of the procedure design criteria, where the consequences of error are particularly significant to safety. Included in these tools are the PANS-OPS Obstacle Assessment Surface (OAS) Software and the PANS-OPS Software (CD-101), providing a means to evaluate the total risk of impact with an obstacle or the ground on precision approaches.

### **10.2 Procedural Design Automation**

- 10.2.1 The PDSP shall ensure that the software packages used in the design of procedures have been validated. A description of the procedures to be used to ensure that all equipment, including software is operated in accordance with the manufacturer's operating instructions and manuals, shall be made readily available to the flight procedure designer.

## **11. Design Submission – Format and Content**

11.1 Instrument flight procedure designs submitted by the sponsor for evaluation and approval by the AACM are to provide:

- a) A complete record of the design process including copies of all source data, information, calculations and drawings used in the project;
- b) A record of quality assurance;
- c) A record of safety assessment;
- d) A statement of compliance with the criteria prescribed in the applicable ICAO documents listed in paragraph 1.2 from the PDSP;
- e) A narrative, which unambiguously describes the procedure in textual format and table according to related ICAO publications;
- f) A graphical representation which accurately reflects the content of the narrative provided;
- g) Relevant signed validation reports;
- h) A comprehensive design rationale in text format, including references to applicable ICAO documents listed in paragraph 1.2 where a deviation from the standard criteria has been employed.

## **12. Publication of Instrument Flight Procedures**

12.1 The sponsor shall ensure that instrument flight procedures designs/charts, are provided to the AACM for publication in the AIP.

12.2 The obstacle clearance altitude/height (OCA/H) shall be determined in the flight procedures.

12.3 The intended effective date for operational use of the instrument flight procedure may be included in the document narrative.

12.4 The designs/charts to be published in the AIP shall be produced in accordance with the provisions contained in the documents listed below:

- a) ICAO Annex 4 – Aeronautical Charts
- b) ICAO Doc 8168 Volumes I and II – Procedures for Air Navigation Services – Aircraft Operations (PANS-OPS)
- c) ICAO Doc 9905 – RNP AR Procedure Design Manual, if applicable
- d) ICAO Doc 8697 – Aeronautical Chart Manual

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