CIVIL AVIATION SAFETY AUTHORITY AUSTRALIA

CIVIL AVIATION ADVISORY PUBLICATION

April 1998 **CAAP B-RNAV-1**

APPROVAL OF AUSTRALIAN OPERATORS AND AIRCRAFT TO OPERATE UNDER INSTRUMENT FLIGHT RULES IN EUROPEAN AIRSPACE DESIGNATED FOR BASIC AREA NAVIGATION

---

1. PURPOSE

This Civil Aviation Advisory Publication (CAAP) provides guidance material for the approval of operators of Australian registered civil aircraft, and operators of foreign registered aircraft and whose principal place of business is in Australia, operating in a Basic Area Navigation (B-RNAV) environment in the European region.

This CAAP identifies types of RNAV equipment that the Civil Aviation Safety Authority (CASA), Australia has determined to be acceptable for B-RNAV and contains guidelines for operators using global positioning system (GPS) equipment as the primary means for B-RNAV. It does not address communications or surveillance requirements that may be specified for a particular route or airspace.

This document is one means, but not the only means, of satisfying the intent of ICAO Doc 9613-AN/937, Manual on RNP, First Edition, 1994.

2. REFERENCES

This CAAP should be read in conjunction with ICAO Doc 7030/4, EUR/RAC.

3. STATUS OF THIS CAAP

This is the first issue of CAAP B-RNAV-1. It will remain current until withdrawn or superseded.

4. BACKGROUND

Regional Supplementary Procedures contained within International Civil Aviation Organization (ICAO) Doc 7030/4-EUR, part 1, *Rules of the Air, Air Traffic Services and Search and Rescue*, have been amended to require aircraft operating under Instrument Flight Rules (IFR) in designated European B-RNAV airspace to meet the accuracy criteria of Required Navigation Performance Type 5 (RNP 5).

The amendment also requires the State of Aircraft Registry or State of the Operator to verify conformance of the Air Operators Navigation System to RNP 5 and provide the approval necessary for aircraft to operate in a B-RNAV environment.

Implementation of RNAV is one of the key elements to obtain system capacity improvements and should allow airspace users to benefit from more direct routings and greater fuel savings. In European airspace, RNAV will allow greater flexibility in airspace design and reduce the need to depend totally on ground-based point source navigation aids when planning Air Traffic Services (ATS) routes.

RNP 5 was chosen for the initial stage of RNAV operations in European airspace to take account of existing aircraft equipage and the current navigation infrastructure. Only RNAV equipped aircraft having a navigation accuracy meeting RNP 5 may plan for operations under IFR on the ATS routes of the Flight Information Regions (FIR)/Upper Information Regions (UIR) and/or designated Standard Instrument Departures (SID) and Standard Terminal Arrival Routes (STAR) in/out of Terminal Management Areas identified in ICAO Regional Supplementary Procedures Doc 7030/4, paragraph 14.2.1.

Joint Aviation Authorities (JAA) first published advisory material for the Airworthiness Approval of Navigation Systems for use in designated European airspace for B-RNAV operations in July 1996. This material was developed by EUROCAE WG-13 and was commonly referenced as AMJ 20X2. In May 1997, Revision 1 to AMJ 20X2 was expanded to include specific guidance on the approval and use of GPS-based equipment for the purposes of conducting B-RNAV operations.

In accordance with ICAO regional agreements, operators must obtain a B-RNAV approval from the appropriate State of Registry or State of the Operator before conducting operations in European B-RNAV airspace.

This CAAP identifies those navigation system types and the criteria that may be used to determine acceptable means of compliance. CASA approval of Australian operators for European B-RNAV operations is based on consideration of existing systems and previously completed airworthiness approvals, as described in the Aircraft Flight Manual (AFM), or an assessment process described in the following sections.

5. APPLICABILITY

This guidance material applies to all operations in European B-RNAV airspace or on B-RNAV routes.

Australian registered aircraft, when operating outside Australian territorial airspace (i.e. beyond the 12 NM territorial limit) must comply with ICAO Annex 2 when over the high seas (Civil Aviation Regulation 3 (3)) and other State's regulations when operating within their airspace (CAR 223).

6. RELATED PUBLICATIONS

(1) Civil Aviation Safety Authority, Australia

- Civil Aviation Advisory Publications (CAAPs): 35-1, 35-2, 35-3 and RNP 10-1.

(2) Civil Aviation Authority of New Zealand

- AC91-7 Required Navigation Performance (RNP 10)
- AC91-8 Required Navigation Performance in European Airspace Designated for Basic RNAV (BRNAV) Operations (RNP 5).

(3) European Organisation for the Safety of Air Navigation (EUROCONTROL)

- EUROCONTROL Doc 003-93 Area Navigation Equipment - Operational Requirements and Functional Requirements.
- European Air Traffic Control Harmonisation and Integration Program (EATCHIP) On Target: The First Six Years 1990-1996.

(4) Federal Aviation Administration (FAA)

- AC 20-121A Airworthiness Approval of Airborne LORAN C Navigation Systems for Use in the US National Airspace System (NAS).
- AC 20-130 and AC 20-130A Airworthiness Approval of Navigation or Flight Management Systems Integrating Multiple Navigation Sensors.
- AC 20-138 (current edition) Airworthiness Approval of Global Positioning System (GPS) Navigation Equipment for use as a VFR and IFR Supplemental Navigation System.
- AC 25-15 (current edition) Approval of Flight Management Systems in Transport Category Airplanes.
- AC 90-45A Approval of Area Navigation Systems for Use in the U.S. National Airspace System.
- AC 90-94 (current edition) Guidelines for Using Global Positioning Systems Equipment for IFR En Route and Terminal Operations and for Nonprecision Instrument Approaches In U.S. National Airspace System.
- Notice 8110.60 (current edition) GPS as a Primary Means of Navigation For Oceanic/Remote Operations.
- Order 8400.12A Required Navigation Performance 10 (RNP-10) Operational Approval.

(5) International Civil Aviation Organization (ICAO)

- Manual on Required Navigation Performance, ICAO Doc 9613-AN937.

(6) Joint Aviation Authorities (JAA)

- Temporary Guidance Leaflet No. 2, Revision 1: AMJ 20X2 JAA Guidance Material on Airworthiness Approval and Operational Criteria for the use of Navigation Systems in European Airspace Designated for Basic RNAV Operations.

(7) RTCA

- Minimum Aviation System Performance Standards (MASPS): Required Navigation Performance for Area Navigation, RTCA.

7. DESCRIPTION OF TERMS USED

7.1 AREA NAVIGATION (RNAV)

This is a method which permits aircraft navigation along any desired flight path within the coverage of the associated navigation aids or within the limits of the capability of self-contained aids, or a combination of these methods. For the purpose of this CAAP, RNAV equipment is considered to be that equipment which operates by automatically determining aircraft position from one, or a combination, of the following sensors with the means to establish and follow an intended path:

(1) VOR/DME;

(2) DME/DME;

(3) INS* or IRS*;

(4) LORAN C;

(5) GPS*.

NOTE: Equipment marked with an asterisk (*) is subject to the limitations contained in Section 8.5.

7.2 CLASS I NAVIGATION

Class I navigation is any en route flight operation or portion of a flight operation conducted in an area entirely within the officially designated operational service volumes of ICAO standard airways navigation facilities. The term 'Class I navigation' is used extensively in FAA documentation. Further explanation can be found in FAA Order 8400.10, Air Transportation Operations Inspector's Handbook.

7.3 BASIC RNAV (B-RNAV)

B-RNAV is defined as RNAV, including the functions described in Appendix 2, that requires an aircraft to meet a horizontal track keeping accuracy of 5 NM or better from its planned position for 95% of its flight time - RNP 5. This value includes signal source error, airborne receiver error, display system error, and flight technical error. This navigation performance assumes the necessary coverage provided by satellite or ground based navigation aids is available for the intended route to be flown.

7.4 GLOBAL POSITIONING SYSTEM (GPS)

This is a US space-based positioning, velocity, and time system composed of space, control, and user elements. The space element, nominally is composed of 24 satellites in six orbital planes. The control element consists of five monitor stations, three ground antennas and a master control station. The user element consists of antennas and receiver processors that provide positioning, velocity, and precise timing to the user.

7.5 PSEUDORANGE

This is the determination of position, or the obtaining of information relating to position, for the purposes of navigation by means of the propagation properties of radio waves. Pseudorange is the distance from the user to a satellite plus an unknown user clock offset distance. With four satellite signals it is possible to compute position and offset distance. If the user clock offset is known, three satellite signals would suffice to compute a position.

7.6 RECEIVER AUTONOMOUS INTEGRITY MONITORING (RAIM)

This is a technique whereby a GPS receiver/processor monitors the GPS. This integrity determination is achieved by a consistency check among redundant measurements (refer to CAAP 35-1).

7.7 REQUIRED NAVIGATION PERFORMANCE (RNP)

This is a statement of the navigation performance accuracy necessary for operation within a defined airspace.

7.8 REQUIRED NAVIGATION PERFORMANCE TYPE

RNP type is a description of an RNP by number. The number refers to the navigational performance accuracy in the horizontal plane and is expressed in nautical miles. For example, RNP 5 means that an aircraft must be able to navigate within 5 NM of its intended position (both across-track and along track) for at least 95% of its total flying time.

8. OPERATIONAL APPROVAL PROCESS FOR B-RNAV

8.1 INTRODUCTION

The following sections provide guidance for operators on: RNAV system equipment, eligibility and usage limitations; the documents and processes that should be used when seeking a B-RNAV operational approval; general operating procedures; pilot knowledge requirements; and flight plan procedures.

As well, operators must address any policy or procedures related to B-RNAV operations that are required by European civil aviation authorities.

8.2 AIRCRAFT EQUIPMENT

An aircraft may be considered eligible for B-RNAV approval if it is equipped with one or more RNAV systems approved and installed in accordance with the guidance contained in this document. The minimum level of availability and integrity required for B-RNAV systems for use in designated European airspace can be met by a single installed system comprising one or more sensors, RNAV computer, control display unit, and navigation display(s) (e.g. HSI, or CDI), provided that the system is monitored by the flight crew and that in the event of a system failure, the aircraft retains the capability to navigate relative to ground based navigation aids (e.g. VOR, DME, and NDB).

8.3 ELIGIBILITY FOR AN OPERATIONAL APPROVAL BASED ON THE AIRCRAFT FLIGHT MANUAL (AFM)

8.3.1 Aircraft B-RNAV System Eligibility

The aircraft can be considered eligible for B-RNAV operations, if the AFM shows that the navigation system installation has received airworthiness approval in accordance with one of the following Australian CAAPs or FAA ACs: CAAP 35-1, CAAP 35-3, AC 90-45A, AC 20-121A, AC 20-130, AC 20-130A, AC 20-138, or AC 25-15.

The guidance for airworthiness approval contained in these CAAPs and ACs provides aircraft navigation performance that is equivalent to RNP 5 or better (see Section 8.5 for limitations on design and use of RNAV systems in European B-RNAV airspace).

Once the operator has determined that the equipment is eligible, the operator should apply for an approval as shown in Appendix 3-A and proceed in accordance with Section 8.3.2 or 8.3.3, as appropriate.

8.3.2 Approval of Air Operator Certificate (AOC) Holders

AOC holders must present the following documentation to the appropriate CASA district office:

(1) sections of the AFM that document airworthiness approvals in accordance with an appropriate CASA CAAPs or FAA ACs as detailed above in Section 8.3.1;

(2) training and operations manuals that reflect the operating policies of Sections 8.5, 9, 10, 11; and

(3) any other operational or airspace requirements that may be established by European authorities.

A sample *Letter of Request* for a B-RNAV approval is in Appendix 3-A.

Provided the AOC holder has satisfactorily addressed the guidance in these paragraphs, the CASA district office will then issue a *Letter of Approval* (see Appendix 3-B) to reflect B-RNAV approval.

8.3.3 Approval of Private Operators

Private operators should review the AFM to establish that it shows RNAV system eligibility as detailed in Section 8.3.1. Once RNAV system eligibility has been

established, the operator must take steps to ensure that the B-RNAV operations will be conducted in accordance with the guidance material contained in Sections 8.5, 9, 10 and 11, as well as any other operational or airspace requirements that may be established by European authorities.

When applying to a CASA district office for an approval, private operators must not only provide sections of the AFM that document airworthiness approvals in accordance with an appropriate CASA CAAPs or FAA ACs as detailed above in Section 8.3.1, but also evidence that the issues covered in Sections 8.5, 9, 10 and 11, and any other operational or airspace requirements that may be established by European authorities, have been addressed.

A sample *Letter of Request* for a B-RNAV approval is in Appendix 3-A.

Provided the operator has satisfactorily addressed the guidance in these paragraphs, the CASA district office will then issue a *Letter of Approval* (see Appendix 3-B) to reflect B-RNAV approval.

8.4 ELIGIBILITY FOR AN OPERATIONAL APPROVAL NOT BASED ON THE AFM

The operator may not be able to determine the airborne equipment's eligibility from the AFM, or may require a B-RNAV time limit extension for non-radio updated INS-based RNAV systems beyond 2 hours (see Section 8.5.1 below). In this case, the operator should request that the appropriate CASA district office assess the RNAV equipment. The operator should provide the CASA with details of the RNAV system make, model and part number, evidence of the system meeting RNP 5 accuracy and the B-RNAV requirements defined in Appendix 2, crew operating procedures, bulletins, and any other pertinent information.

8.5 LIMITATIONS ON THE USE OF NAVIGATION SYSTEMS

Although the following navigation systems have RNAV capability, limitations are required for their use when conducting operations in designated B-RNAV airspace.

8.5.1 Inertial Navigation Systems (INS)

Those approved INS system installations which meet the required functions of Appendix 2, but do not have automatic radio navigation updating of INS position, are limited to a maximum two hour time limit for operation in designated B-RNAV airspace from the time that the system is placed in the navigation mode (NAV SELECT). The CASA will give consideration to extending the two hour time limit for specific INS configurations.

Requests for time extensions should be submitted with supporting rationale and data through the appropriate CASA district office to the CASA Airways and Airspace Standards Branch and Airworthiness Branch in Central Office. These central office branches will coordinate the evaluation of such requests with the FAA Aircraft Engineering Division (AIR).

NOTE: Certain INSs perform automatic radio navigation aid updating after the pilot makes a manual selection of navigation aids. Such systems are not limited to the two hour time limit discussed above, provided that the operator has established procedures for pilots to follow.

8.5.2 Loran C

Use of Loran C, in compliance with AC 20-121A, is considered an acceptable means to comply with B-RNAV in those areas of European airspace and on routes having acceptable Loran C coverage. Loran users should refer to the AFM to determine if operational use of the Loran system is limited to a specified Loran C Operational Area.

8.5.3 GPS

(1) GPS Design. GPS installed in accordance with CAAP 35-1 must provide pseudorange step detection and health word checking functions in accordance with TSO-C129a, paragraphs (a)(5)(vii)6 and a(6). Compliance with these requirements can be established by one of the following:

(a) a statement in the AFM(s) that the GPS equipment meets the criteria for Primary Means of Navigation in Oceanic and Remote Airspace; or

(b) a placard on the GPS receiver evidencing it meets TSO-129a; or

(c) an CASA/FAA letter of design approval for the applicable equipment. Operators should contact the avionics installer or manufacturer to determine if the equipment complies and if a letter of design approval is available. Manufacturers may obtain a letter by submitting appropriate documentation to the relevant FAA Aircraft Certification Office. Operators should keep this letter with the AFM entry as evidence of B-RNAV eligibility. Any limitations included in the letter of design approval should be reflected in a letter of finding to operators; or

(d) GPS equipment that has been approved in accordance with TSO C-129, but which does not satisfy the step detection and health word checking, may still obtain a letter of design approval for B-RNAV. In this case, B-RNAV operations are limited to flights where RAIM outages do not exceed 5 minutes. With this restriction, TSO C-129 equipment is equivalent to equipment that provides step detection and health word checking. The maximum RAIM outage must not be extended beyond 5 minutes for TSO C-129 equipment.

(2) Flight Planning Restrictions for GPS. During pre-flight planning, if 24 satellites (23 if baro aiding is incorporated into the GPS installation) are projected to be operational for the flight, then the aircraft can depart without further action. If, however, 23 or fewer satellites (22 if baro aiding incorporated), are projected to be operational, then the availability of GPS integrity (RAIM) must be confirmed for the intended flight (route and time). This should be obtained from a prediction program that is provided in the GPS unit installed in the aircraft, a prediction program run outside the aircraft (such a program should use the same algorithms as those in the aircraft GPS units), or from an alternative method that is acceptable to the CASA (see Appendix 1). Information on alternative methods will be coordinated with the FAA and JAA. In the event of a predicted continuous loss of RAIM of more than 5 minutes for any part of the intended flight, the flight should be delayed, cancelled, or rerouted on a track where RAIM requirements can be met. Alternate methods should be

submitted for approval through the appropriate CASA district office to central office Airways and Airspace Standards Branch and the Airworthiness Branch.

(3) Loss Of RAIM En Route. In the event of loss of the RAIM detection function, the GPS stand-alone equipment may continue to be used for navigation as long as the flight crew determines, by cross checking other on-board navigation systems, that the GPS system is continuing to provide an acceptable level of IFR navigation performance. Otherwise, the flight crew must notify ATC and revert to an alternative means of navigation (e.g. VOR, DME, or NDB).

(4) Actions When Failure Detected. In the event of a detected failure (including detected failure of satellites for GPS-based RNAV systems), the flight crew must notify ATC and revert to an alternative means of navigation.

(5) Availability of VOR, DME, OR ADF. VOR, DME or ADF capability should be installed and operative consistent with the applicable operating rules and intended route-of-flight to ensure availability of a suitable alternative means of navigation in the event of GPS/RNAV system failure.

9. GENERAL OPERATING PROCEDURES FOR B-RNAV

For B-RNAV operations, the flight crew must be familiar with the normal operating procedures and the contingency procedures detailed below.

9.1 NORMAL PROCEDURES

The procedures for the use of navigational equipment in B-RNAV airspace or on B-RNAV routes must include the following:

(1) when a navigation database is installed, the database validity must be checked before the flight; and

(2) other NAVAIDs (e.g. VOR, DME, and ADF) must be selected so as to allow immediate cross-checking or reversion in the event of loss of RNAV capability.

9.2 CONTINGENCY PROCEDURES

The flight crew must be familiar with the following general provision. Pilots must notify ATC of conditions (e.g. equipment failures and weather conditions) that may affect the ability of the aircraft to maintain position within the designated B-RNAV airspace. In this case, flight crews must state their intentions, coordinate a plan of action, and obtain a revised ATC clearance. If unable to obtain an ATC clearance prior to deviating from the B-RNAV airspace, the flight crew must follow established contingency procedures, as defined by the region of operation, and obtain an ATC clearance as soon as possible.

10. PILOT KNOWLEDGE

Pilots must be knowledgeable in the following areas:

(1) RNP definition as it relates to B-RNAV requirements in European airspace;

(2) airspace where RNP 5 is required;

(3) changes to charting and documents to reflect RNP 5;

(4) navigation equipment required to be operational for flight in designated B-RNAV airspace, limitations associated with the RNAV equipment;

(5) flight planning requirements;

(6) contingency procedures (e.g. for equipment failure);

(7) en route, terminal, and approach procedures applicable to RNAV; and

(8) the information in this CAAP.

11. FLIGHT NOTIFICATION

Australian registered aircraft or aircraft of operators whose principal place of business is in Australia, who file flight plans into European B-RNAV designated airspace, must meet the European B-RNAV airspace requirements. Operators must indicate that the aircraft is approved for B-RNAV operations and can meet RNP 5 by annotating Field 10 (Equipment) of the ICAO flight plan with the letter 'R.' If there are any other flight plan annotations required by individual States, operators must make appropriate annotations.

****

APPENDIX 1

GPS INTEGRITY MONITORING (RAIM)

PREDICTION PROGRAM

Where a GPS Integrity Monitoring (RAIM) Prediction Program is used as a means of compliance with Section 8.5.3 (2) of this CAAP, it must meet the following criteria:

(1) the program must provide prediction of availability of the integrity monitoring (RAIM) function of the GPS equipment, suitable for conducting RNP 5 (B-RNAV) operations in designated European airspace;

(2) the prediction program software must be developed in accordance with at least RTCA DO 178B/EUROCAE 12B, level D guidelines;

(3) the program must use either a RAIM algorithm identical to that used in the airborne equipment, or an algorithm based on assumptions for RAIM prediction that give a more conservative result;

(4) the program must calculate RAIM availability based on a satellite mask angle of not less than 5 degrees, except where use of a lower mask angle has been demonstrated to be acceptable to the CASA;

(5) the program must have the capability to manually designate GPS satellites which have been notified as being out-of-service for the intended flight; and

(6) the program must allow the user to select:

(a) the intended route and declared alternates; and

(b) the time and duration of the intended flight.

APPENDIX 2

REQUIRED FUNCTIONS

The following system functions are the minimum required to conduct B-RNAV operations:

(1) continuous indication of aircraft position relative to track to be displayed to the pilot flying on a navigation display situated in his primary field of view;

NOTE: In addition, where the aircraft type certificate requires more than one pilot, information to verify aircraft position should be displayed in the non-flying pilot's primary field of view.

(2) display of distance and bearing to the active (TO) waypoint;

(3) display of ground speed or time to the active (TO) waypoint;

(4) storage of waypoints - minimum of 4; and

(5) appropriate failure indication of the RNAV system, including the sensors.

APPENDIX 3-A

SAMPLE 'LETTER OF REQUEST' FOR B-RNAV APPROVAL

File Reference

District Flight Operations Manager
Civil Aviation Safety Authority
(Address)

Dear Sir

APPLICATION FOR B-RNAV OPERATIONAL APPROVAL

(Aircraft operator) requests that operational approval be given to conduct en route operations on designated B-RNAV routes and in designated B-RNAV airspace with a maximum time of (number) hours between navigation system updates.

The following (aircraft operator) aircraft meet the requirements and capabilities as defined/specified in Civil Aviation Advisory Publication B-RNAV-1 for B-RNAV operations.

AIRCRAFT TYPE/SERIES	NAVIGATION EQUIPMENT	COMMUNICATIONS EQUIPMENT	B-RNAV TIME LIMIT
B747-400	List nav equipment by name and type/manuf/model	List comms equipment by type/manuf/model	Number of hours or unlimited
B767-	As above	As Above	As above
B737-	As above	As above	As above
etc			

Flight crews have been trained in accordance with the requirements of the ICAO Manual on RNP (Doc 9613) and guidance material in CAAP B-RNAV-1.

Yours sincerely

Signature
(Name)
(Appointment/Title)
(Date)

APPENDIX 3-B

SAMPLE 'LETTER OF APPROVAL' FOR B-RNAV OPERATIONS

LETTER OF APPROVAL NO.: BRNAV-1 LOA.....(insert sequential number)

I,..... District Flight Operations Manager, ...District Office, am satisfied that the following operator, aircraft and navigation systems meet the requirements for operations on designated B-RNAV routes and in designated B-RNAV airspace with the stated B-RNAV time limit, in accordance with ICAO Regional Supplementary Procedures (Doc 7030/4) EUR/RAC.

OPERATOR: .....

AIRCRAFT: (Make, Model, and Registration Mark).....

NAVIGATION SYSTEMS: (Type, Manufacturer, Model, and Time Limit).....

.....

.....

.....
For and on behalf of the Civil Aviation Safety Authority

(Date)

****