U.S. Department of Transportation
Federal Aviation Administration

Advisory Circular

Subject:	Date: 03-20-98	AC No: 90-96
APPROVAL OF U.S. OPERATORS AND AIRCRAFT TO OPERATE UNDER INSTRUMENT FLIGHT RULES (IFR) IN EUROPEAN AIRSPACE DESIGNATED FOR BASIC AREA NAVIGATION (BRNAV/RNP-5)	Initiated By: AFS-400	Change:

1. PURPOSE.

a. This document provides guidance material regarding on-board Area Navigation (RNAV) equipment requirements for operators of U.S. registered civil aircraft, operating in a Basic Area Navigation (BRNAV) environment in the European region. This document identifies types of RNAV equipment that the Federal Aviation Administration (FAA) has determined to be acceptable for BRNAV and contains guidelines for operators using global positioning system (GPS) equipment as the primary means for BRNAV. 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.

b. 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 BRNAV airspace to meet the accuracy criteria of Required Navigation Performance Type 5 (RNP-5). The implementation date for this requirement will be announced in publications such as NOTAMs and Aeronautical Information Publications. 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 approval necessary for aircraft in a BRNAV environment.

2. RELATED CFR SECTIONS. Title 14 of the Code of Federal Regulations (14 CFR), part 91, sections 91.205 and 91.703; part 121, sections 121.345, 121.355, and Appendix G; part 125, section 125.203; and part 135, section 135.165.

3. DEFINITIONS.

a. 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 AC, 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 a desired 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 paragraph 7d.

b. Class - I Navigation. Class-1 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.

c. Basic RNAV (BRNAV). For the purposes of this AC, BRNAV is defined as RNAV, including the functions described in Appendix 2, that meets a track keeping accuracy equal to or better than +/- 5 NM for 95% of the 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.

d. Global Positioning System (GPS). This is a U.S. 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.

e. Pseudorange. 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.

f. Receiver Autonomous Integrity Monitoring (RAIM). A technique whereby a GPS receiver/processor monitors the GPS. This integrity determination is achieved by a consistency check among redundant measurements.

g. Required Navigation Performance (RNP). This is a statement of the navigation performance necessary for operation within a defined airspace.

h. Required Navigation Performance Type (RNP Type). RNP types are established according to navigational performance accuracy in the horizontal plane, that is, lateral and longitudinal position fixing. The type is identified as an accuracy value expressed in nautical miles (e.g., RNP-5).

4. RELATED READING MATERIALS.

a. AC 20-121A, Airworthiness Approval of Airborne LORAN-C Navigation Systems for Use in the U.S. National Airspace System (NAS).

b. AC 20-130A, Airworthiness Approval of Navigation or Flight Management Systems Integrating Multiple Navigation Sensors.

c. AC 20-138 (current edition), Airworthiness Approval of Global Positioning System (GPS) Navigation Equipment for Use as a VFR and IFR Supplemental Navigation System.

d. AC 25-15 (current edition), Approval of Flight Management Systems in Transport Category Airplanes.

e. AC 90-45A, Approval of Area Navigation Systems for Use in the U.S. National Airspace System.

f. AC 90-94 (current edition), Guidelines for Using Global Positioning System Equipment for IFR En Route and Terminal Operations and for Nonprecision Instrument Approaches In the U.S. National Airspace System.

5. BACKGROUND.

a. 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.

b. 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. The RNP-5 value includes signal source error, airborne receiver error, display system error, and flight technical error. This navigation performance standard assumes that the necessary coverage provided by satellite or ground based navigation aids is available for the intended route to be flown.

c. Joint Aviation Authorities (JAA) first published advisory material for the Airworthiness Approval of Navigation Systems for use in designated European airspace for BRNAV 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 BRNAV operations.

d. This Advisory Circular (AC) identifies eligible navigation system types and the criteria that may be used to determine acceptable means of compliance for U.S. operators conducting Class I navigation in European BRNAV airspace. FAA approval of U.S. operators for European BRNAV operations is based on consideration of existing systems and previously completed airworthiness approvals, as described in the Airplane Flight Manual (AFM), or an assessment process described in this AC.

6. APPROVAL PROCESS FOR BRNAV. Operators should address the guidance contained in paragraph 7 on RNAV system equipage, eligibility and usage limitations; the general operating procedures specified in paragraph 8, the pilot knowledge items in paragraph 9, the flight plan procedures in paragraph 10, and any policy or procedures related to BRNAV operations that are required by European civil aviation authorities. (Part 91, section 91.703, paragraph (a)(2) requires that the operator "when within a foreign country, comply with the regulations relating to the flight and maneuver of aircraft there in force"). Paragraphs 7b and 7c discuss the documents and the processes that should be used for approval of operators and RNAV systems.

7. OPERATOR/RNAV SYSTEM APPROVAL FOR BRNAV IN DESIGNATED EUROPEAN BRNAV AIRSPACE.

a. Aircraft Equipage. An aircraft may be considered eligible for BRNAV 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 BRNAV 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). Aircraft not suitably equipped will not be permitted to operate in the designated BRNAV airspace.

b. Operator/RNAV System Eligibility Based on the Airplane Flight Manual (AFM) (Supplement).

(1) Aircraft BRNAV System Eligibility. The aircraft should be considered eligible for BRNAV operations, if the AFM shows that the navigation system installation has received airworthiness approval in accordance with one of the following FAA AC's: AC 90-45A, AC 20-121A, AC 20-130A, AC 20-138, or AC 25-15. The guidance for airworthiness approval contained in these AC's provides aircraft navigation performance that is equivalent to RNP-5 or better. (See paragraph 7d for limitations on design and use of RNAV systems in European BRNAV airspace). Once equipment eligibility is established, operator approval should proceed in accordance with paragraph 7b(2) or (3), as appropriate.

(2) Part 91 Aircraft/Operator Approval. U.S. Part 91 operators should review their AFM to establish that it shows RNAV system eligibility as detailed in 7b(1). Once RNAV system eligibility has been established, the operator should take steps to ensure that BRNAV operations are conducted in accordance with the guidance contained in paragraphs 7d, 8, 9 and 10 as well as any other operational or airspace requirements that may be established by European authorities. When

the operator has completed these actions, it may begin to conduct BRNAV operations. A Letter of Authorization (LOA) is not required when eligibility is based on the AFM. See paragraph 7c for actions to take if the operator is not able to determine from the AFM that the aircraft RNAV system has been approved and installed in accordance with an appropriate FAA AC.

(3) U.S. Air Carrier Aircraft/Commercial Operator Approval. 14 CFR part 121, 125 or 135 operators should present the following documentation to their CHDO: sections of the AFM that document airworthiness approval in accordance with an appropriate FAA AC as detailed in paragraph 7b(1) and training and operations manuals that reflect the operating policies of paragraph 7d, 8, 9, 10 as well as any other operational or airspace requirements that may be established by European authorities. Once the operator has addressed the guidance in these paragraphs to the satisfaction of the CHDO, the CHDO should update the Operations Specifications to reflect RNP-5 approval. See paragraph 7c for guidance on actions to take if the operator is unable to determine from the AFM whether the aircraft RNAV system has been approved in accordance with an appropriate FAA AC.

c. Eligibility Not Based on the Airplane Flight Manual (Supplement).

(1) The operator may not be able to determine the airborne equipment's eligibility from the AFM, or may require a BRNAV time limit extension for non-radio updated INS-based RNAV systems beyond 2 hours. See paragraph 7d(1). In this case, the operator should request that the Flight Standards District Office (FSDO) or CHDO assess the RNAV equipment for BRNAV eligibility. The operator should provide the CHDO or FSDO with the RNAV system make, model and part number, evidence of meeting RNP-5 accuracy and the BRNAV requirements defined in Appendix 2, crew operating procedures, bulletins, and any other pertinent information. If the FSDO or CHDO is unable to determine equipment eligibility, it should forward the request and supporting data through the appropriate FAA Flight Standards Regional Division to the Flight Standards Service, Technical Programs Division, (AFS-400) for review. AFS-400 will advise the FSDO or CHDO of the suitability of the proposed equipment for BRNAV operations.

(2) For part 91 operations, after the FAA determines that the navigation equipment is eligible for BRNAV/RNP-5 operations based on the documentation provided by the operator, the FSDO will issue a letter documenting that finding to the operator. For part 121, 125, and 135 operators, the FAA will establish aircraft RNAV system eligibility and determine that the operator's training and operations manuals reflect the operating policies of paragraphs 7d, 8, 9, and 10. Once these steps are completed, the Operations Specifications for part 121, 125, and 135 operators may be revised to reflect RNP-5 approval.

d. Limitations on the Design and/or Use of Navigation Systems. Although the following navigation systems have RNAV capability, limitations are required for their use when conducting operations in designated BRNAV airspace.

(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 2-hour time limit for operation in designated BRNAV airspace from the time that the system is placed in the navigation mode (NAV SELECT). The

FAA will give consideration to extending the 2-hour time limit for specific INS configurations. The FAA will coordinate this effort with the JAA. Requests for time extensions should be submitted with supporting rationale and data through the appropriate FAA Flight Standards Regional Division to the Flight Standards Service, Technical Programs Division (AFS-400). AFS-400 will coordinate the evaluation of such requests with the FAA Aircraft Engineering Division (AIR-100).

> **NOTE: Certain INS's perform automatic radio navigation aid updating after the pilot makes a manual selection of navigation aids. Such systems are not limited to the 2-hour time limit discussed in 7d(1) provided that the operator has established procedures for pilots to follow.**

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

(3) GPS.

(a) GPS Design. GPS installed in accordance with AC 20-138 should 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:

1. A Statement in the AFM(s) that the GPS equipment meets the criteria for Primary Means of Navigation in Oceanic and Remote Airspace, or

2. A placard on the GPS receiver evidencing it meets TSO-129a, or

3. An 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 their Aircraft Certification office. Operators should keep this letter with the AFM entry as evidence of BRNAV eligibility. Any limitations included in the letter of design approval should be reflected in a letter of finding to part 91 operators, (see paragraph 7c(2) or in operations specifications for part 121,125, and 135 operators) or

4. 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 BRNAV. In this case, BRNAV 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 should not be extended beyond 5 minutes for TSO C-129 equipment.

(b) 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) should 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 considered acceptable to the Administrator after review of JAA comments on the method proposed. (Appendix 1 contains basic criteria for RAIM Prediction Programs). 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, canceled, or rerouted on a track where RAIM requirements can be met. Alternate methods should be submitted for approval through the appropriate FAA Flight Standards Regional Division to the Flight Standards Service, Technical Programs Division (AFS-400).

(c) 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 should notify ATC and revert to an alternative means of navigation (e.g., VOR, DME, or NDB).

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

(e) Availability of VOR, DME, OR ADF. VOR, DME or ADF capability should be installed and operative consistent with the applicable operating rules (e.g., parts 91, 121, 125, and 135) and intended route-of-flight to ensure availability of a suitable alternative means of navigation in the event of GPS/RNAV system failure.

8. BRNAV OPERATING PROCEDURES (GENERAL). For BRNAV operations, the flight crew should be familiar with the normal operating procedures and the contingency procedures detailed in paragraphs 8a and 8b.

a. Normal Procedures. The procedures for the use of navigational equipment on BRNAV routes should include the following:

(1) When a navigation database is installed, the database validity should be checked before the flight.

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

b. Contingency Procedures. The flightcrew should be familiar with the following general provision: Pilots should 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 BRNAV airspace. In this case, flight crews should 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 BRNAV airspace, the flight crew should follow established contingency procedures, as defined by the region of operation, and obtain an ATC clearance as soon as possible.

9. PILOT KNOWLEDGE. Pilots should be knowledgeable in the following areas:

a. RNP definition as it relates to BRNAV requirements in European airspace;

b. Airspace where RNP-5 is required;

c. Changes to charting and documents to reflect RNP-5;

d. Navigation equipment required to be operational for flight in designated BRNAV airspace, limitations associated with the RNAV equipment;

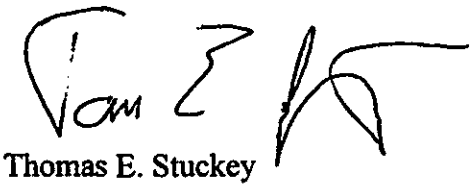
e. Flight planning requirements;

f. Contingency procedures (e.g., for equipment failure);

g. En route, terminal, and approach procedures applicable to RNAV; and

h. The information in this advisory circular.

10. FLIGHT PLANS. U.S.-registered aircraft filing flight plans into European BRNAV designated airspace are expected to meet the European BRNAV airspace requirements. Operators should indicate approval for BRNAV/RNP-5 operations by annotating block 10 (Equipment) of the ICAO flight plan with the letter "R." If there are any other flight plan annotations required by individual States, operators should make appropriate annotations.



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APPENDIX 1. GPS INTEGRITY MONITORING (RAIM) PREDICTION PROGRAM

Where a GPS Integrity Monitoring (RAIM) Prediction Program is used as a means of compliance with paragraph 7d(3)(b) it should meet the following criteria:

1. The program should provide prediction of availability of the integrity monitoring (RAIM) function of the GPS equipment, suitable for conducting RNP-5 (BRNAV) operations in designated European airspace.

2. The prediction program software should be developed in accordance with at least RTCA DO 178B/EUROCAE 12B, level D guidelines.

3. The program should 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 should 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 Administrator.

5. The program should have the capability to manually designate GPS satellites which have been notified as being out-of-service for the intended flight.

6. The program should allow the user to select:

a. The intended route and declared alternates;

b. The time and duration of the intended flight.

APPENDIX 2. REQUIRED FUNCTIONS

The following system functions are the minimum required to conduct BRNAV/RNP-5 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 must 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.

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