



U.S. Department
of Transportation
**Federal Aviation
Administration**

Advisory Circular

Subject: Use of Suitable Area Navigation
(RNAV) Systems on Conventional
Routes and Procedures

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1. **PURPOSE.** This advisory circular (AC) is intended for the following purposes.

a. Operational and Airworthiness Guidance. Provides operational and airworthiness guidance regarding the suitability and use of RNAV systems while operating on, or transitioning to, conventional, i.e., non-RNAV, routes and procedures within the United States (U.S.) National Airspace System (NAS). This guidance material applies to two broad categories:

(1) Use of a suitable RNAV system as a *Substitute Means of Navigation* when a very high frequency (VHF) Omni-directional Range (VOR), Distance Measuring Equipment (DME), Tactical Air Navigation (TACAN), VOR/TACAN (VORTAC), VOR/DME, non-directional radio beacon (NDB), or compass locator facility including locator outer marker and locator middle marker is out-of-service, i.e., the Navigation Aid (NAVAID) information is not available; an aircraft is not equipped with an automatic direction finder (ADF) or DME; or the installed ADF or DME on an aircraft is not operational. For example, if equipped with a suitable RNAV system, a pilot may hold over an out-of-service NDB.

(2) Use of a suitable RNAV system as an *Alternate Means of Navigation* when a VOR, DME, VORTAC, VOR/DME, TACAN, NDB, or compass locator facility including locator outer marker and locator middle marker is operational and the respective aircraft is equipped with operational navigation equipment that is compatible with conventional NAVAIDs. For example, if equipped with a suitable RNAV system, a pilot may fly a procedure or route based on operational VOR using that RNAV system without monitoring the VOR.

b. Qualified RNAV Systems. Describes the types of RNAV systems that qualify as “suitable RNAV systems” as adopted in the final rule titled, Area Navigation (RNAV) and Miscellaneous Amendments, published in the Federal Register (FR) on June 7, 2007, which amended the Title 14 of the Code of Federal Regulations (14 CFR) sections listed in paragraph 2 of this AC.

c. Operations on Certain Segments of ILS Procedures. Describes a “suitable RNAV system” for operations on published RNAV segments of certain instrument landing system (ILS) procedures.

d. Alternative Compliance Method. In lieu of following the methods described in this AC, i.e., the operating requirements detailed in this document, without deviation, operators may

follow an alternative method, provided the alternative method is acceptable by the Federal Aviation Administration (FAA).

NOTE: This AC does not address the use of RNAV systems on RNAV routes and RNAV terminal procedures. The current edition of AC 90-100, U.S. Terminal and En Route Area Navigation (RNAV) Operations, applies to those operations. This AC also does not address the use of RNAV systems on instrument approach procedures (IAP) titled RNAV (GPS) and GPS. The current edition of AC 90-105, Approval Guidance for RNP Operations and Barometric Vertical Navigation in the U.S. National Airspace System, applies to those operations. The RNAV systems and procedures specified in this AC and the current edition of AC 90-45, Approval of Area Navigation Systems for Use in the U.S. National Airspace System, are appropriate references for off-airway RNAV, “random” RNAV routes, or the Navigation Reference System (NRS).

2. RELATED 14 CFR PARTS.

- Part 1, Definitions and Abbreviations, § 1.1, General Definitions.
- Part 91, General Operating and Flight Rules, § 91.131, Operations in Class B Airspace, § 91.175, Takeoff and Landing under IFR, § 91.205, Powered Civil Aircraft with Standard Category U.S. Airworthiness Certificates: Instrument and Equipment Requirements, § 91.711, Special Rules for Foreign Civil Aircraft.
- Part 121, Operating Requirements: Domestic, Flag, and Supplemental Operations, § 121.349, Radio Equipment for Operations under VFR Over Routes Not Navigated by Pilotage or for Operations under IFR or Over-the-Top.
- Part 125, Certification and Operations: Airplanes Having a Seating Capacity of 20 or More Passengers or a Maximum Payload Capacity of 6,000 Pounds or More and Rules Governing Persons On Board Such Aircraft, § 125.203, Communication and Navigation Equipment.
- Part 129, Operations: Foreign Air Carriers and Foreign Operators of U.S.-Registered Aircraft Engaged in Common Carriage, § 129.17, Aircraft Communication and Navigation Equipment for Operations under IFR or Over-the-Top.
- Part 135, Operating Requirements: Commuter and On Demand Operations and Rules Governing Persons On Board Such Aircraft; § 135.165, Communication and Navigation Equipment: Extended Over-Water or IFR Operations.

3. DEFINITIONS. For the purposes of this AC, the following definitions are provided.

a. Alternate Means of Navigation. The use of information from a RNAV system in lieu of that from operating conventional NAVAIDs and navigation equipment that is installed, operational and compatible with conventional NAVAIDs.

b. Area Navigation (RNAV). A method of navigation which permits aircraft operation on any desired flight path within the coverage of ground or spaced-based navigation aids or within the limits of the capability of self-contained aids, or a combination of these.

c. DME/DME/Inertial (DME/DME/IRU) RNAV. Refers to navigation using DME ranging from at least two DME facilities to determine position along with use of an integrated Inertial Reference Unit (IRU). DME/DME/IRU airworthiness performance criteria is provided in the current edition of AC 90-100.

d. Global Navigation Satellite System (GNSS). A worldwide position and time determination system, which includes one or more satellite constellations, aircraft receivers, and system integrity monitoring. GNSS is augmented as necessary to support the required navigation performance for the actual phase of operation.

e. Global Positioning System (GPS). The U.S. GNSS core satellite constellation providing space-based positioning, velocity, and time. GPS is composed of space, control, and user equipment elements.

f. Receiver Autonomous Integrity Monitoring (RAIM). A technique used within a GPS receiver/processor to monitor GPS signal performance. This integrity determination is achieved by a consistency check among redundant measurements.

g. Substitute Means of Navigation. The use of information from an RNAV system in lieu of that from out-of-service conventional NAVAIDs and/or inoperative or not-installed navigation equipment compatible with conventional NAVAIDs.

h. Suitable RNAV System. An RNAV system that (1) meets the required performance established for a type of operations, for example, instrument flight rules (IFR); and (2) is suitable for operation over the route to be flown in terms of any performance criteria (including accuracy) established by the air navigation service provider for certain routes, for example, oceanic, ATS routes, and IAPs. An RNAV system's suitability is dependent upon the availability of ground and/or satellite NAVAIDs that are needed to meet any route performance criteria that may be prescribed in route specifications to navigate the aircraft along the route to be flown.

i. Terminal Procedure. Means an instrument departure procedure (DP) or Standard Terminal Arrival Route (STAR).

j. Wide Area Augmentation System (WAAS). The U.S. implementation of Space Based Augmentation System (SBAS), a satellite navigation system, which augments the GPS Standard Positioning Service (SPS).

4. RELATED READING MATERIAL (current editions). The following documents relate to this AC.

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

- AC 20-138, Airworthiness Approval of Positioning and Navigation Systems.
- AC 25-15, Approval of Flight Management Systems in Transport Category Airplanes.
- AC 90-45, Approval of Area Navigation Systems for Use in the U.S. National Airspace System.
- AC 90-100, U.S. Terminal and En Route Area Navigation (RNAV) Operations.
- AC 90-105, Approval Guidance for RNP Operations and Barometric Vertical Navigation in the U.S. National Airspace System.
- Technical Standard Order (TSO)-C115b, Airborne Area Navigation Equipment Using Multi-Sensor Inputs.
- TSO-C129a, Airborne Supplemental Navigation Equipment Using the Global Positioning System (GPS).
- TSO-C145c, Airborne Navigation Sensors Using the Global Positioning System (GPS) Augmented by the Satellite Based Augmentation System.
- TSO-C146c, Stand-Alone Airborne Navigation Equipment Using the Global Positioning System (GPS) Augmented by the Satellite Based Augmentation System (WAAS).

5. BACKGROUND. In 1998, the FAA developed and published criteria and guidance for the use of GPS, in lieu of an ADF and DME. Since that time, a number of questions surfaced regarding the use of different technologies, equipage requirements, and potential situations for conventional NAVAID substitution. Based on data gained from operational experience, the FAA amended its regulations to allow for greater use of RNAV systems, and this AC updates the applicable guidance material.

6. TYPES OF RNAV SYSTEMS THAT QUALIFY AS A SUITABLE RNAV SYSTEM.

When installed in accordance with appropriate airworthiness installation requirements *and* operated in accordance with this AC, the following systems qualify as suitable RNAV systems:

a. Systems Using TSO-C129/-C145/-C146 Equipment. An RNAV system with TSO-C129/-C145/-C146 (all revisions), equipment, installed in accordance with AC 20-138 (all revisions), Airworthiness Approval of Positioning and Navigation Systems, or AC 20-130A, Airworthiness Approval of Navigation or Flight Management Systems Integrating Multiple Navigation Sensors, and authorized for IFR en route and terminal operations (including those systems previously qualified for “GPS in lieu of ADF or DME” operations), or

b. Systems Using DME/DME/IRU. An RNAV system with DME/DME/IRU inputs that is compliant with the equipment provisions of the current edition of AC 90-100, U.S. Terminal and En Route Area Navigation (RNAV) Operations, for RNAV routes. A table of compliant equipment is available at the following Web site:

http://www.faa.gov/about/office_org/headquarters_offices/avs/offices/afs/afs400/afs470/policy_guidance/.

NOTE: Approved RNAV systems using DME/DME/IRU, without GPS or WAAS position input, may only be used as a substitute means of navigation when specifically authorized by a Notice to Airmen (NOTAM) or other FAA guidance for a specific procedure. The NOTAM or other FAA guidance authorizing the use of DME/DME/IRU systems will also identify any required DME facilities based on an FAA assessment of the DME navigation infrastructure.

NOTE: Specific approval is required for operators operating under 14 CFR parts 91 subpart K (part 91K), 121, 125, 129, and 135.

7. USES OF SUITABLE RNAV SYSTEMS.

a. Usage of Suitable RNAV Systems. Subject to the operating requirements in this AC, operators may use a suitable RNAV system in the following ways.

(1) *Determine aircraft position relative to or distance from a VOR* (see first note in subparagraph 7b), TACAN, NDB, compass locator (see second note in subparagraph 7b), DME fix; or a named fix defined by a VOR radial, TACAN course, NDB bearing, or compass locator bearing intersecting a VOR or Localizer (LOC) course.

(2) *Navigate to or from a VOR, TACAN, NDB, or compass locator.*

(3) *Hold over a VOR, TACAN, NDB, compass locator, or DME fix.*

(4) *Fly an arc based upon DME.*

b. Specific Allowances. The allowances described in this section apply even when a facility is identified as required on a procedure (for example, "Note ADF required").

NOTE: For the purpose of this AC, "VOR" includes VOR, VOR/DME, and VORTAC facilities.

NOTE: For the purpose of this AC, compass locator includes locator outer marker and locator middle marker.

8. USES OF SUITABLE RNAV SYSTEMS NOT ALLOWED BY THIS AC. An otherwise suitable RNAV system cannot be used for the following:

a. NOTAMed Procedures. Unless otherwise specified, navigation on procedures that are identified as not authorized ("NA") without exception by a NOTAM. For example, an operator may not use a RNAV system to navigate on a procedure affected by an expired or unsatisfactory flight inspection, or a procedure that is based upon a recently decommissioned NAVAID.

b. Substitution on a Final Approach Segment. Substitution for the NAVAID (for example, a VOR or NDB) providing lateral guidance for the final approach segment.

c. Lateral Navigation on LOC-Based Courses. Lateral navigation on LOC-based courses (including LOC back-course guidance) without reference to raw LOC data.

9. OPERATING REQUIREMENTS AND CONSIDERATIONS.

a. General Considerations.

(1) Pilots must comply with the guidelines contained in their Aircraft Flight Manual (AFM), AFM supplement, operating manual, or pilot's guide when operating their aircraft RNAV system.

(2) Pilots may not use their RNAV system as a substitute or alternate means of navigation if their aircraft has an AFM or AFM supplement with a limitation to monitor the underlying NAVAIDs for the associated operation.

(3) Pilots of aircraft with an AFM limitation that requires the aircraft to have other equipment appropriate to the route to be flown may only use their RNAV system as a substitute means of navigation in the contiguous U.S., and only for out-of-service NAVAIDs, not for inoperable or not-installed aircraft equipment.

b. RNAV System Database Considerations.

(1) Pilots must ensure their onboard navigation data is current, appropriate for the region of intended operation, and includes the waypoints, NAVAIDs, and fixes for departure, arrival, and alternate airfields.

NOTE: The navigation data should be current for the duration of the flight. If the Aeronautical Information Regulation and Control (AIRAC) cycle will change during flight, operators and pilots should establish procedures to ensure the accuracy of navigation data, including suitability of navigation facilities used to define the routes and procedures for flight. Traditionally, this has been accomplished by verifying electronic data against paper products.

(2) Pilots must extract waypoints, NAVAIDs, and fixes by name from the onboard navigation database and comply with the charted procedure or route. Heading-based legs associated with procedures may be flown using manual technique (based on indicated magnetic heading) or, if available, extracted from the aircraft database and flown using RNAV system guidance.

c. Operating Requirements.

(1) For the purposes described in this AC, pilots may not manually enter published procedure or route waypoints via latitude/longitude, place/bearing, or place/bearing/distance into the aircraft system.

(2) Pilots are expected to accurately track procedure and route centerlines (CL), as depicted by onboard lateral deviation indicators, displays, and/or flight guidance during all operations described in this AC unless otherwise authorized to deviate by air traffic control (ATC) or in the instance of an emergency condition.

d. Equipage Considerations.

(1) Operators operating under 14 CFR parts 91K, 121, 125, 129, and 135 must also be equipped with at least one other independent navigation system in addition to an installed and operable RNAV system. This additional system must be suitable, in the event of loss of navigation capability of the RNAV system, for proceeding safely to a suitable airport and completing an instrument approach. For example, an acceptable installation would include single- and dual-RNAV systems based upon the use of GNSS, in combination with onboard VOR and ILS navigation equipment for terminal, en route, and approach operations.

(2) ADF equipment need not be installed and operational, although operators of aircraft without an ADF will be bound by the operational requirements defined in this AC and not have access to some procedures (that is, there may be instances when some operations might not be conducted without ADF equipment).

(3) Operators of aircraft equipped with RNAV systems based solely upon GPS may experience some operational limitations in the future as conventional NAVAIDs are decommissioned. In addition, operators of aircraft with single-RNAV systems may expect some operational limitations as a result of considerations such as continuity of function. As with current operations, reversionary and backup capability will remain important considerations.

(4) Use of an RNAV system as a substitute means of navigation may be applicable to normal in-flight use, to continuation of flight after failure, or to dispatch with inoperative conventional capability if consistent with the applicable Master Minimum Equipment List (MMEL) for the aircraft type.

e. Alternate Airport Considerations. For the purposes of flight planning, any required alternate airport must have an available instrument approach procedure that does not require the use of GPS. This restriction includes conducting a conventional approach at the alternate airport using a substitute means of navigation that is based upon the use of GPS. For example, these restrictions would apply when planning to use GPS equipment as a substitute means of navigation for an out-of-service VOR that supports an ILS missed approach procedure at an alternate airport. In this case, some other approach not reliant upon the use of GPS must be available. This restriction does not apply to RNAV systems using TSO-C145/-C146 WAAS equipment.

10. SPECIFIC REQUIREMENTS TO FLY RNAV SEGMENTS PUBLISHED ON ILS PROCEDURES. In order to fly RNAV transitions to an ILS final approach or RNAV missed approach segments of an ILS procedure, pilots must comply with the operating requirements of this AC. RNAV systems used for this type of operation must allow for a means to become established on the ILS final approach course with minimal overshoot or undershoot.

NOTE: Charts for ILS procedures with RNAV transitions will contain notes specifying the requirement for suitable RNAV capability. These RNAV transitions are also identified by the use of waypoint symbols on the procedure.

NOTE: Operators must ensure information from the correct navigation source (for example, RNAV source for RNAV segment) is displayed.

NOTE: Qualification criteria for operation on radius to a fix (RF) transitions to an ILS, outside the Final Approach Segment (FAS), are covered in the current edition of AC 90-105.

11. OPERATIONAL REQUIREMENTS FOR SPECIFIC SENSOR INPUTS. The following sensor inputs have some associated operational requirements. For all RNAV systems, substitute and alternate means of navigation must be discontinued upon loss of integrity (for example, RAIM alert) or unacceptable degradation of system performance.

a. GPS.

(1) RNAV systems using GPS input may be used as an alternate means of navigation without restriction.

(2) Operators planning to use TSO-C129 equipment as a substitute means of navigation must perform a RAIM prediction during preflight. GPS RAIM availability must be confirmed for the applicable operation and time using current GPS satellite information. Operators may satisfy the predictive RAIM requirement through any one of the following methods:

- Operators may monitor the status of each satellite in its plane/slot position, by accounting for the latest GPS constellation status (for example, NOTAM or Notice Advisory to Navstar Users (NANU)), and compute RAIM availability using model-specific RAIM prediction software, or
- Operators may use the FAA en route and terminal RAIM prediction Web site: www.raimprediction.net, or
- Operators may contact a Flight Service Station (FSS)(not Direct User Access Terminal (DUAT)) to obtain non-precision approach RAIM, or
- Operators may use a third party interface, incorporating FAA/VOLPE RAIM prediction data without altering performance values, to predict RAIM outages for the aircraft's predicted flight path and times, or
- Operators may use the receiver's installed RAIM prediction capability (for TSO-C129a/Class A1/B1/C1 equipment) to provide non-precision approach RAIM, accounting for the latest GPS constellation status (for example, NOTAM or NANU). Receiver non-precision approach RAIM should be checked at airports spaced at intervals not to exceed 60 NM along the applicable procedure flight track.

“Terminal” or “Approach” RAIM must be available at the ETA over each airport checked, or

- Operators not using model-specific software or FAA/VOLPE RAIM data will need FAA operational approval.

NOTE: The planned use of ground-based NAVAIDs for equivalent RAIM is not acceptable.

(3) Operators of aircraft with RNAV systems that use GPS input but do not automatically alert the pilot of a loss of GPS, must develop procedures to verify correct GPS operation.

(4) Use of GPS should not be planned for in areas affected by a *GPS Unreliable* NOTAM.

b. WAAS.

(1) RNAV systems using WAAS input may be used as an alternate means of navigation without restriction.

(2) Operators planning to use TSO-C145-146 equipment as a substitute means of navigation must check WAAS NOTAMs and confirm WAAS availability for the applicable operation and time.

(3) Use of WAAS should not be planned for in areas affected by a *GPS Unreliable* NOTAM.

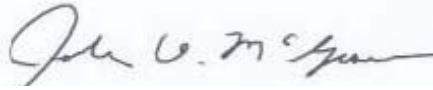
c. DME/DME/IRU.

(1) RNAV systems using DME/DME/IRU, without GPS input, may be used as an alternate means of navigation where valid DME/DME position updating is published as available (for example, by NOTAM or authorization).

(2) In order to use a substitute means of navigation on departure procedures, pilots of aircraft with RNAV systems using DME/DME/IRU, without GPS input, must ensure their aircraft navigation system position is confirmed, within 1,000 feet, at the start point of takeoff roll. The use of an automatic or manual runway update is an acceptable means of compliance with this requirement. A navigation map display may also be used to confirm aircraft position, if pilot procedures and display resolution allow for compliance with the 1,000-foot tolerance requirement.

12. PILOT KNOWLEDGE AND TRAINING. Pilots should be familiar with the information in this AC prior to conducting the operations discussed herein. For 14 CFR parts 91K, 121, 125, 129, and 135 operators, the approved operating procedures and training program should address the elements listed in this AC. A review of applicable portions of the Pilot Knowledge Requirements and Training section in the current edition of AC 90-100 is also recommended.

/s/



for

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