

VOLUME 4 AIRCRAFT EQUIPMENT AND OPERATIONAL AUTHORIZATION**CHAPTER 1 AIR NAVIGATION, COMMUNICATIONS, AND SURVEILLANCE****Section 4 Class II Navigation****4-76 GENERAL.**

A. Concepts, Direction, and Guidance. This section provides concepts, direction, and guidance, which should be used by Federal Aviation Administration (FAA) inspectors to evaluate and approve or deny requests for authorization to conduct Class II navigation operations not previously approved for a particular operator. It also amplifies the general concepts, direction, and guidance provided in section 1 of this chapter. Specific “standard practices” are provided in this section for evaluating Class II navigation operations using navigation systems that, within particular areas of en route operation, have well known operational characteristics and limitations. When an operator requests initial approval to conduct Class II navigation using a special means of navigation or in areas not addressed by these standard practices, the principal operations inspector (POI) must forward a request for direction and guidance to the Flight Technologies and Procedures Division (AFS-400) with a copy to the Regional Flight Standards Division.

B. En Route Flight Operation or Portion of a Flight Operation. Class II navigation is any en route flight operation or portion of a flight operation that is not Class I navigation. Any operation or portion of an en route operation is Class II navigation if it takes place outside the officially designated operational service volumes of ICAO) standard ground-based NAVAIDs, such as VOR, VOR/DME, and NDB. Class II navigation is dependent on the use of a LRNS. An LRNS may be satellite-based (Global Positioning System (GPS)), self contained (e.g., inertial reference system (IRS)), or referenced to ground stations (e.g., long range navigation (LORAN-C)). Additional information on the concept of Class II navigation is provided in sections 1 and 2. The various types of Class II navigation and the evaluation and approval or denial processes for these specific types are discussed in the following paragraphs.

4-77 INSTRUMENT FLIGHT RULES (IFR) CLASS II NAVIGATION. IFR Class II navigation is any Class II navigation operation conducted under IFR. The primary generic IFR Class II navigation requirements are identical to generic IFR Class I navigation requirements. However, in many cases, the means of navigation and the procedures/techniques necessary to satisfy these generic requirements are significantly different for IFR Class II navigation.

4-78 EQUIPMENT FOR IFR CLASS II NAVIGATION.

A. Electronic Long-Range Navigation Systems (LRNS). The vast majority of IFR Class II navigation operations are conducted using automatic electronic navigation systems. An automatic long-range navigation system must contain sensors that either detect motion or changes in geographic position and a computational capability that generates the guidance information necessary to adhere to the selected route centerline and determine arrival at selected waypoints. Navigation equipment must be capable of enabling the aircraft to be navigated within the constraints of the ATS to the accuracy requisite for the control of air traffic. Navigation

systems can consist of a single unit or a combination of various sensors and computers. These various systems are collectively referred to as area navigation, or RNAV. Global Navigation Satellite System (GNSS), a space-based system (e.g., GPS), provides highly accurate coverage over most of the world. This section provides general direction and guidance that is appropriate to all automatic pilot-operated electronic LRNS. This equipment covers a wide range of capability and sophistication. The basic types of automatic LRNS are self-contained or position fixing and described in the following subparagraphs.

B. Self-Contained LRNS. These systems may be approved for IFR Class II navigation operations in accordance with Title 14 of the code of Federal Regulations (14 CFR) part 121, § 121.355.

1) IRS and inertial navigation systems (INS) function as high precision navigation instruments, but are not position-fixing devices.

a) An INS is self-contained and does not depend on input from sources external to the aircraft. The initial geographic position (alignment) must be inserted. The inertial sensors detect aircraft movement by measuring acceleration and velocity. These factors are applied to the initial position to calculate subsequent changes in position. The INS precisely measures any change in an aircraft's direction of flight and uses this information to determine position, ground speed, and the course to be flown to the destination airport.

b) Since an INS is not a position-fixing device, it does not have the ability to detect position errors in flight. Errors induced while inserting the initial position can remain undetected by the system. If such errors are made, navigational guidance from the system will be erroneous throughout the flight.

c) The major limitations associated with INS are related to sensor inaccuracies and the possible increase in drift rates based on flight time. Operators must develop procedures to recognize and document INS errors.

d) The more sophisticated multi-sensor equipment is seen in the advanced RNAV systems. The flight management system (FMS) and other multi-sensor systems are integrated systems consisting of airborne sensor, receiver, and computer with both navigation and aircraft performance databases that provide optimum performance guidance to a display and automatic flight control system. The sensors included in multi-sensor system position determination include IRS, DME/DME, GPS, and LORAN C. Using the information available from these systems, the navigation system can continuously examine its own calculations and determine their validity. If the navigation system notes a gross discrepancy, the pilot will be alerted. For more information, see AC 20-130 (latest edition), Airworthiness Approval of Navigation or Flight Management Systems Integrating Multiple Navigation Sensors.

C. Non Self-Contained LRNS (Position-Fixing). These systems may be approved for IFR Class II navigation operations in accordance with section 121.389.

1) LORAN-C.

a) An automatic LORAN-C is a position-fixing device. A LORAN-C system detects the aircraft's geographic position through measurements of the signals transmitted from ground-based stations. If usable signals can be received from at least four separate ground-based stations (three Lines of Position, or LOPs), position ambiguity can be detected and automatically resolved by the navigation system. Since LORAN-C is station-referenced, its accuracy can be affected by noise sources and signal irregularities. Since most automatic LORAN-C depend upon aircraft compass input, LORAN C cannot be used in areas of magnetic unreliability.

b) The accuracy of LORAN-C is not flight time-dependent. The accuracy of these systems is dependent on the signal quality, signal strength, and signal geometry (typical errors are less than 1 NM). The major limitation to the use of LORAN-C is inadequate signal coverage in most areas of the world. LORAN-C coverage is nonexistent in the Southern Hemisphere and only limited coverage exists in the Northern Hemisphere. See the following advisory circulars (latest editions) for more information:

- AC 20-101C, Airworthiness Approval of Omega/VLF Navigation Systems for use in the U.S. National Airspace System (NAS) and Alaska
- AC 20-121A, Airworthiness Approval of Loran-C Navigation Systems for use in the U.S. National & Airspace System (NAS) and Alaska
- AC 20-129, Airworthiness Approval of Vertical Navigation (VNAV) Systems for use in the U.S. National Airspace System (NAS) and Alaska
- AC 20-130A, Airworthiness Approval of Navigation or Flight Management Systems Integrating Multiple Navigation Sensors
- AC 23-15A, Small Airplane Certification Compliance Program
- AC 25-15, Approval of Flight Management Systems in Transport Category Airplanes
- AC 25-7A, Flight Test Guide for Certification of Transport Category Airplanes
- AC 61-89E, Pilot Certificates: Aircraft Type Ratings
- AC 90-92 CHG 1, Guidelines for the Operational Use of Loran-C Navigation Systems Outside the U.S. NAS
- AC 90-92, Guidelines for the Operational Use of Loran-C Navigation Systems Outside the U.S. NAS
- AC 90-94, 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
- AC 91-70, [Large AC] Oceanic Operations
- AC 97-2, Data Base Standardization for the Global Positioning System (GPS) Overlay Program
- AC 125-1, Operations of Large Airplanes Subject to 14 CFR Part 125

2) GPS is a satellite-based radio navigation system that uses precise range measurements from GPS satellites to determine a precise position anywhere in the world. (See AC 120-29A.)

a) The approval of GPS to provide the primary means of Class II navigation requires equipment approval, installation approval, and operational approval. This subparagraph provides inspectors with information on the performance standards, procedures, and operational restrictions for using the GPS as a primary means of Class II navigation and guidance in the process to be used in granting operational approvals for the use of GPS.

b) Operational references:

- AC 120-33, Operational Approval of Airborne Long-Range Navigation Systems for Flights Within The North Atlantic Minimum Navigation Performance Specification Airspace;
- Title 14 CFR part 91, § 91.703, Operations of Civil Aircraft of U.S. Registry Outside of the United States;
- Part 91, § 91.705, Operations Within The North Atlantic Minimum Navigation Performance Specifications Airspace;
- Part 91, appendix C, Operations in The North Atlantic (NAT) Minimum Navigation Performance Specifications (MNPS) Airspace;
- Title 14 CFR part 121, subparts N and O.

c) Definitions.

1. Primary means of navigation—Navigation equipment that provides the only required means on the aircraft of satisfying the necessary levels of accuracy, integrity, and availability for a particular area, route, procedure, or operation.

2. Class II navigation—Any en route flight operation or portion of an en route operation (irrespective of the means of navigation) which takes place outside (beyond) the designated operational service volume of ICAO standard airway navigation facilities (VOR, VOR/DME, NDB).

3. Fault detection and exclusion (FDE)—Capability of GPS to:

- a. Detect a satellite failure which effects navigation; and
- b. Automatically exclude that satellite from the navigation solution.

4. Algorithm—A step-by-step procedure for solving a problem.

d) The PAI must determine that the GPS equipment is approved and installed in accordance with the following:

1. The equipment must be approved by the FAA Aircraft Certification Office (ACO) in accordance with Advisory Circular (AC) 20-138, Airworthiness Approval of Global Positioning System (GPS) Navigation Equipment For Use As A VFR And IFR Supplemental Navigation System; or AC 20-130, Airworthiness Approval of Multi Sensor Navigation Systems for use in the U.S. National Airspace System (NAS) and Alaska; and Notice N8110.57, GPS As A Primary Means of Navigation For Oceanic/Remote Operations.

2. The applicant must obtain initial installation approval of GPS equipment for primary use on a specific make and model aircraft via the Type Certificate (TC) or the Supplemental Type Certificate (STC) certification process. The FAA Form 337 or forms acceptable to the Administrator for those operators with acceptable engineering organizations will be used for the installation of the same GPS equipment in the same make/model aircraft provided the data developed for the initial certification is used.

3. Once the installation has been approved, the Aircraft flight manual supplement (AFMS) must be updated to state: “The ____ GPS equipment as installed has been found to comply with the requirements for GPS primary means of Class II navigation in oceanic and remote airspace, when used in conjunction with the ____ prediction program. This does not constitute operational approval.” Detailed requirements for AFMS content are contained in FAA Notice—N8110.57.

e) The POI must use the following guidance in granting operational approval:

1. POIs should contact AFS-400 to obtain technical/operational assistance.

2. Crew training must be modified to include modules that ensure crews are familiar with navigation equipment operations, data base updating procedures, pre-departure procedures, standard en route procedures, and contingency procedures. (Reference: 14 CFR part 121, subpart N).

3. The required flight crew must have received training in the use of dual GPS as the only means of long-range navigation when completing PIC/SIC initial new hire and initial equipment flight training or when completing the latest recurrent training. (Reference: 14 CFR part 121, subpart O, and volume 3, chapter 19).

4. POIs must ensure that the following predeparture policies and procedures are incorporated into pilot and where appropriate, dispatcher training/qualification programs and manuals:

a. All operators conducting GPS primary means of Class II navigation in oceanic/remote areas under 14 CFR parts 91, 121, 125, or 135 must utilize an FAA-approved FDE prediction program for the installed GPS equipment that is capable of predicting, prior to departure, the maximum outage duration of the loss of fault exclusion, the loss of fault detection, and the loss of navigation function for flight on a specified route. The “specified route of flight” is defined by a series of waypoints (to include the route to any required alternates) with the time specified by a velocity or series of velocities. Since specific ground speeds may not be maintained, the pre-departure prediction must be performed for the range of expected ground speeds. This FDE prediction program must use the same FDE algorithm that is employed by the installed GPS equipment and must be developed using an acceptable software development methodology (e.g., RTCA/DO-178B). The FDE prediction program must provide the capability to designate manually satellites that are scheduled to be unavailable in order to perform the prediction accurately. The FDE prediction program will be evaluated as Part of the navigation system’s installation approval.

b. Any predicted satellite outages that affect the capability of GPS equipment to provide the navigation function on the specified route of flight requires that the flight be canceled, delayed, or rerouted. (See paragraph 5D(3).) If the fault exclusion capability outage (exclusion of a malfunctioning satellite) exceeds the acceptable duration on the specific route of flight, the flight must be canceled, delayed, or rerouted.

c. Prior to departure, the operator must use the FDE prediction program to demonstrate that there are no outages in the capability to navigate on the specified route of flight (the FDE prediction program determines whether the GPS constellation is robust enough to provide a navigation solution for the specified route of flight).

d. Once navigation function is ensured (the equipment can navigate on the specified route of flight), the operator must use the FDE prediction program to demonstrate that the maximum outage of the capability of the equipment to provide fault exclusion for the specified route of flight does not exceed the acceptable duration (fault exclusion is the ability to exclude a failed satellite from the navigation solution). The acceptable duration (in minutes) is equal to the time it would take to exit the protected airspace (one-half the lateral separation minimum) assuming a 35-nautical mile (NM) per hour cross-track navigation system error growth rate when starting from the center of the route. For example, a 60-NM lateral separation minimum yields 51 minutes acceptable duration (30 NM divided by 35 NM per hour). If the fault exclusion outage exceeds the acceptable duration, the flight must be canceled, delayed, or rerouted.

5. POIs must ensure that the following en route policies and procedures are incorporated into pilot and where appropriate, dispatcher training/qualification programs, and manuals:

a. If the GPS displays a loss of navigation function alert, the pilot should immediately begin using dead reckoning procedures until GPS navigation is regained. The pilot will report degraded navigation capability to air traffic control (ATC) in accordance with part 91, § 91.187. Additionally, flightcrew members operating under part 121 will notify the appropriate dispatch or flight-following facility of any degraded navigation capability in accordance with the air carrier's FAA-approved procedures.

b. If the GPS displays an indication of a fault detection function outage (RAIM is not available), navigation integrity must be provided by comparing the GPS position with a position computed by extrapolating the last verified position with true airspeed, heading, and estimated winds. If the positions do not agree to within 10 NM, the pilot should immediately begin using dead reckoning procedures until the exclusion function or navigation integrity is regained and report degraded navigation capability to ATC in accordance with § 91.187.

c. If the GPS displays a fault detection alert (failed satellite), the pilot may choose to continue to operate using the GPS-generated position if the current estimate of position uncertainty displayed on the GPS from the FDE algorithm is actively monitored. If this number exceeds 10 NM or is not available, the pilot should immediately begin using dead reckoning procedures until the failed satellite is excluded and report degraded navigation capability to ATC in accordance with § 91.187.

f) Until further notice, the Pass/Fail graphs contained in AC 120-33 should be used to confirm the operator's capability to meet the requirements of § 91.705 for operation in north Atlantic minimum navigation performance specifications airspace. The FAA navigation specialists will provide guidance on process and procedures for the Pass/Fail graphs and aid the POI in determining whether Figure 2 or Figure 3 of AC 120-33 should be utilized. The operator is not required to collect navigation performance data in NAT MNPS airspace to apply to the Pass/Fail graphs.

g) Validation tests.

1. General. validation tests are required. Such tests may consist of a single flight or series of flights. The following references are provided:

- a. Part 121, § 121.93, 121.113, and 135.13(a)(2).
- b. Volume 3, chapter 29, section 8
- c. Volume 4, chapter 1, Section 2

2. Program/document evaluation is required. As an element of the evaluation process, the POI should ensure that operator training programs and manuals contain the policies and procedures detailed in subparagraph e) of this paragraph. (See volume 4, chapter 1, section 2).

3. Whenever possible, one of the FAA navigation specialists should participate in the validation of operator programs and procedures for use of GPS as the primary means of Class II navigation.

4. Flight(s) required for validation tests.

a. The following is intended to provide broad guidance for the development of GPS/Class II navigation validation tests. The POI should consider each application on its own merit and apply judgment when developing validation test requirements. The POI should communicate the objective, duration and number of validation test flights required to the operator during Phase One of the approval process.

b. If an operator is requesting approval to conduct Class II Navigation with GPS, but has no previous experience in conducting Class II navigation, then the operator must conduct at least one flight in the Class II area of navigation where it intends to operate. This flight must be conducted as a nonrevenue operation with the exception that cargo may be carried.

c. If an operator is requesting approval to conduct Class II Navigation with an aircraft/GPS equipment combination with which it has not previously conducted Class II operations, the operator should be required to conduct a validation test flight(s). If the flight(s) is conducted in a Class I navigation area to simulate operation in a Class II Navigation area, then the flight(s) may be conducted in revenue operations. If the flight is conducted in a Class II navigation area, then it must be conducted as a nonrevenue flight with the exception that cargo may be carried.

- d. The following conditions apply to validation test flights:
- At least one flight should be observed by an FAA aviation safety inspector.
 - Dispatch procedures must be demonstrated for the Class II navigation area(s) where operations are intended to be conducted.
 - The flight(s) should be of adequate duration for the pilots to demonstrate knowledge of dispatch requirements, capability to navigate with the system, and to perform normal and non-normal procedures.

e. Requests to deviate from this policy should be forwarded to Flight Technology Requirements Branch, AFS-430, FAA National Headquarters, Washington, DC, for consideration.

h) Operation specifications (OpSpecs) authorizing flight in Class II airspace using GPS as the only means of long-range navigation must be issued or modified, as appropriate, prior to any air carrier operations being conducted in the Class II airspace. The appropriate operation specification paragraphs must be issued.

4-79 IFR CLASS II NAVIGATION APPROVALS. General direction and guidance on air navigation approvals are in sections 1 and 2 of this chapter. Specific direction and guidance for approving IFR Class II navigation is discussed in the following subparagraphs and other sections of this chapter.

A. Degree of Accuracy Required. Inspectors must determine that the navigation equipment and operational procedures/techniques used permit reliable IFR Class II navigation to the degree of accuracy required for the control of air traffic. The degree of accuracy required for any IFR Class II navigation operation must provide for the following criteria:

- Meets regulatory requirements
- Meets the standard practices in this order
- Meets the requirements of part B of OpSpecs
- Provides accepted, safe operating practices
- Permits the safe separation of aircraft
- Assures obstacle avoidance along the route of flight
- Assures adequate protection for persons and property on the ground
- Permits reliable navigation to the intended destination and any necessary alternate or diversionary airports
- Meets Required Navigation Performance (RNP) (if applicable)

B. Airworthiness of Navigation Equipment. Inspectors must determine that any required navigation equipment is airworthy for IFR flight and installed in accordance with approved data. The operator must provide written evidence that shows that any navigation system used for IFR Class II navigation meets the requirements of the intended operation. If the operation involves flight into special areas of operations (North Atlantic Tracks (NAT)/minimum

navigation performance specification (MNPS) airspace, Canadian MNPS airspace, Pacific Ocean airspace, areas of magnetic unreliability (AMU), etc.), the operator must also provide evidence that the installed equipment is airworthy in accordance with requirements for the special areas of operations. It is imperative that the operations inspectors coordinate the installation and certification validations with the maintenance and avionics inspectors.

C. LRNS.

1) Any intended flight or portion of a flight outside of Class I airspace requires a Class II-capable LRNS or a flight navigator, unless the aircraft position can be “reliably fixed” at least once each hour in accordance with the provisions of part 121, § 121.389. LRNS are the primary means by which the IFR Class II navigation requirements can be met (see section 5).

2) The use of LRNS or a flight navigator requires special navigation procedures/techniques.

3) All IFR Class II navigation operations using LRNS shall use the practices and procedures recommended in AC 91-70, latest edition, Oceanic Operations, or equivalent procedures. Any deviation from the procedures in AC 91-70, latest edition, must be coordinated through AFS-400 navigation specialists. Inspectors must determine that these practices and procedures are included in the certificate holder’s approved training programs and operating procedures.

4-80 PLOTTING AND SYSTEMATIC CROSS-CHECKING OF NAVIGATION INFORMATION. During all phases of flight in Class II navigation the standardized application of disciplined, systematic cross-checking of navigation information shall be required in each operator’s long-range navigation program. AC 91-70, latest edition, provides amplification of these procedures.

A. Plotting Procedures. Plotting procedures have had a significant impact on the reduction of gross navigational errors. There is a requirement to plot the route of flight on a plotting chart and to plot the computer position, approximately 10 minutes after waypoint passage. Plotting may or may not be required, depending upon the distance between the standard ICAO ground-based NAVAIDs.

1) Plotting procedures are *required* for all turbojet operations where the route segment between the operational service volume of ICAO standard ground-based navigational aids exceeds 725 NM.

2) Plotting procedures are *required* for all turboprop operations where the route segment between the operational service volume of ICAO standard ground-based navigational aids exceeds 450 NM.

3) The Administrator requires plotting procedures for routes of shorter duration that transit airspace where special conditions exist, such as reduced lateral and vertical separation standards, high density traffic, or proximity to potentially hostile border areas.

4) Any existing approvals that differ from the plotting requirements in this paragraph and Class II navigation procedures should be reviewed and revised as necessary. Direction and guidance is available from the navigation specialists in coordination with AFS-400.

RESERVED. Paragraphs 4-81 through 4-95.