1. Objective

1.1. This directive contains direction and guidance to be used by certification teams and inspectors when approving operator requests for air navigation operations. Inspectors approve these operations by issuing appropriate operations specifications (OpSpecs). Except for Class I navigation, the approval process normally requires validation testing. This section provides guidance specifically related to air navigation requirements.

1.2. This is a common directive for Airworthiness and Operation

1.2.1. Close coordination between AW and OPS inspectors executing this directive is required.

1.2.2. The OI will be the lead inspector in executing this directive.

1.2.3. Any amendments to this directive must be made to both AW Inspector Handbook and OPS Inspector Handbook

2. General

2.1. **SUBJECT FAMILIARIZATION AND APPROVAL REQUIREMENTS.**
Once an operator has requested approval for air navigation operations, it is essential that inspectors fully understand the concepts, national policies, standard practices, direction, and guidance related to the area of proposed operations. In addition, navigation technical specialists may be retained by the CAAI to assist principal inspectors in understanding, evaluating, and approving air navigation operations.

2.1.1. **Section Layout.** Section 4.1 and subsequent sections of this chapter contain much of this information and additional references for more detailed information and guidance.

- **Processing Initial Requests.** When processing initial requests for any air navigation operations involving Class II navigation, certification teams and principal inspectors must request guidance from a navigation specialist. Certification teams and principal inspectors must also request guidance from a navigation specialist for any operations involving “special areas of operation (e.g., Reduced Vertical Separation Minimum (RVSM), Required Navigation Performance (RNP), minimum navigation performance specification (MNPS), West Atlantic Route System (WATRS)).”

3. Reference Material, Forms & Job-Aids

3.1. Reference Material

3.1.1. AP 1.1.058

3.1.2. FAA AC 20-130

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

3.1.4. FAA AC 20-138

3.1.5. FAA AC 25-4, Inertial Navigation Systems

3.1.6. FAA AC 25-15

3.1.7. FAA AC 90-94

3.1.8. TSO C-129

3.1.9. TSO C-145b

3.1.10. TSO C-146b

4. Process

4.1. **DETERMINING THE CLASS OF NAVIGATION.**

The first determination that must be made concerning an air navigation approval request is the category of operation proposed. The inspector must determine whether the proposed operation is Class I navigation, Class II navigation, or both. The decisive factor in this determination is the operational service volume of International Civil Aviation Organization (ICAO) standard ground-based navigational aids (NAVAIDs) within the proposed area of operation. If the minimum en route flight altitudes specified and the locations of the ICAO standard ground-based NAVAIDs ensure that the flight will always be within the operational service volume, the entire en route operation is Class I navigation. In situations where the entire area of operation (at the minimum flight altitude specified) is outside (beyond) the operational coverage volume of ICAO standard ground-based NAVAIDs, the operation is Class II navigation. When portions of the proposed area of operation ensure that flights are continuously within the operational service volumes of ICAO standard ground-based NAVAIDs, that portion of the flight is Class I navigation and the remaining portion is Class II navigation (see sections 4.3 and 4.4 of this directive for in-depth discussions of Class I and Class II navigation). The

Global Positioning System (GPS) has been accepted by ICAO as a standard NAVAID; however, a distinction is made between standard ground-based NAVAIDs and standard NAVAIDs. Standard ground-based NAVAIDs have an operational service volume and standard NAVAIDs do not. The NAS of ICAO contracting member States are based on the operational service volume of these ground-based facilities but GPS, by virtue of its universal signal coverage, is not restricted to an operational service volume. Navigational performance within the operational service volume and ATC separation minima can be predicated on the use of both ICAO standard ground NAVAIDs and ICAO standard NAVAIDs.

4.1.1. **Flight Altitude.**

It is important to understand that the minimum flight altitude is a key factor in the determination of the category of navigation (Class I or Class II). The operational service volume of a particular standard ground-based NAVAID is heavily influenced by flight altitude. For example, at high altitude (above flight level (FL) 180), most very high frequency omnidirectional range stations (VOR) published for use at these altitudes have an operational service volume that extends to a radius of at least 130 nautical miles (NM) from the facility. However, at low altitudes (below 10,000 feet mean sea level (MSL)), the operational service volume of many VORs seldom exceeds 40 NM. Therefore, it is highly probable that for a route length of 260 NM between VORs, operations above FL 180 would be Class I navigation and operations conducted below 10,000 feet MSL would include both Class I and Class II navigation. The Class II navigation portion would begin at the edge of the operational service volume of the first VOR and end at the edge of the operational service volume of the second VOR. If the inspector determines that the proposal only involves Class I navigation, the direction and guidance in section 3 of this chapter will be used. If the proposal involves both Class I and Class II navigation, the direction and guidance in sections 3 and 4 of this chapter will be used for evaluation and approval or denial of the proposal.

NOTE: Refer to the AIP for a more extensive discussion of operational service volume.

4.1.2. **Range of Standard Ground-Based NAVAIDs.**

Generally, determination of the exact range (operational service volume) of the ground-based NAVAIDs intended to be used is not necessary. For example, a flight departing from the continental United States with a destination in Europe would obviously perform Class I and Class II

navigation and require equipment appropriate for both. In other situations, it can be readily determined that flight operations will be conducted entirely within the operational service volume of standard ground-based NAVAIDs. However, sometimes a determination of the exact range of a NAVAID is required to evaluate compliance with the requirement for a reliable fix once each hour. In the United States, the frequency management branch (of Airways Facilities) in each region may be contacted to determine if a particular NAVAID has been flight checked to a range greater than standard.

4.1.3. **Foreign/Remote Operations.**

In foreign countries and in oceanic/remote areas, this determination is more complex. In these cases, the determination is based on an equivalence to Israeli standards. In general, VOR, VOR/distance measuring equipment (DME) routes and fixes published in those areas are within the operational service volume (or foreign equivalent) of the ground-based NAVAIDs specified. However, most air traffic service (ATS) routes based on nondirectional radio beacons (NDBs) in oceanic/remote areas are Class II navigation over a considerable portion of the route. For example, the standard service volume (or coverage) of high powered NDBs seldom exceeds 75 NM. In special cases, a few NDBs have been evaluated by flight inspection and have an officially designated extended service volume significantly greater than 75 NM. National/regional Aeronautical Information Publications (AIP) and foreign flight inspection offices are the best and most up to date sources of information on the operational service volume of these NAVAIDs.

4.2. **SPECIAL OPERATIONS.**

After determining whether a particular operation is Class I navigation, Class II navigation, or a combination of both, another important step is to determine if the operation involves any specific navigation authorizations to operate into special areas of operation or to use equipment or special navigation techniques.

4.2.1. **Special Areas of Operation.** Examples of special areas of operation include the following:

- Areas of Magnetic Unreliability (AMU)
- Polar operations
- North Atlantic Minimum Navigation Performance Specification (NAT/MNPS) airspace
- Canadian MNPS airspace
- Central East Pacific (CEPAC) airspace

- North Pacific (NOPAC) airspace
- Pacific Organized Track System (PACOTS)
- Restricted international areas
- Arctic Ocean or Antarctic Ocean
- West Atlantic Route System (WATRS) and the Caribbean Sea
- South Atlantic (Atlantic routes)
- Gulf of Mexico control areas (Gulf routes)
- Reduced Vertical Separation Minimum(RVSM)
- Required Navigation Performance (RNP)-x (x is the value in nautical miles associated with an airspace or route that requires a specific RNP)

4.2.2. **Special Navigation Equipment**.
Examples include:

- Private (non-Government) NAVAIDs or broadcast stations
- Area Navigation (RNAV)
- LORAN-C
- Inertial navigation systems (INS) and inertial reference systems (IRS)
- GPS

4.2.3. **Special Navigation.**
Methods of special navigation include the following:

- Pilotage
- Use of a flight navigator
- Celestial
- Free gyro or grid

4.3. **NAVIGATION EQUIPMENT.**

4.3.1. **Written Aircraft Eligibility Documentation.**
In all cases, it is necessary for the operator to provide written aircraft eligibility documentation that explicitly states that the aircraft is properly certificated, equipped, and maintained to perform the required functions for the specific type of navigation and other requirements related to any special operations.

4.3.1.1 The written evidence may take the form of a type certificate (TC), supplemental type certificate (STC), Aircraft Flight Manual (AFM), AFM Supplement (AFMS), or Flight Standardization Board (FSB) Report. In certain cases involving special areas of operation, such as AMU, RNP airspace, RVSM, and NAT/MNPS, the airworthiness

approval must reflect that these special requirements are also met.

4.3.1.2 The eligible aircraft must have equipment where the aircraft documentation explicitly states that the installation has received airworthiness approval for the type of operations in accordance with a Field Approval airworthiness certificate, or other applicable documentation.

4.3.1.3 This determination must be coordinated closely with the principal avionics inspector (PAI). It is CAAI policy and guidance that the principal inspectors shall coordinate with one of the CAAI navigation specialists. If the certificate holder or operator is not able to provide the principal inspectors with specific eligibility from the AFM, AFMS, or the FSB Report, official written equipment eligibility must be attained.

4.3.1.4 If CAAI is unable to determine equipment eligibility from the approved documentation, it should forward the request and supporting data to the appropriate Aircraft Evaluation Group (AEG). The AEG will verify that the aircraft and equipment meet the criteria for the specific operations and that the system can safely fly the specified operation. The AEG will provide written documentation (e.g., amend FSB Report or other official documentation) to verify the eligibility of that equipment.

4.3.2. **Conventional Navigation Equipment.** In the case of Class I navigation with conventional navigation equipment, such as VOR, VOR/DME, NDB, a statement in the CAAI-approved AFM or STC that the navigation system and/or equipment is approved for instrument flight rules (IFR) flight is usually sufficient. For Class I navigation with other types of RNAV equipment, the equipment must be certified for IFR operations and installed and maintained in accordance with the CAAI-approved documentation appropriate for that specific RNAV equipment.

4.3.3. **Area Navigation (RNAV).** RNAV provides enhanced navigational capability. RNAV equipment can automatically compute the airplane position, actual track, and ground speed and then provide meaningful information relative to a route of flight selected by the pilot. Typical equipment will provide the distance, time, bearing, and crosstrack error relative to the selected “TO” or “active” waypoint and the selected route. Several RNAV systems with different navigational performance characteristics are capable of providing area navigational functions. Present day RNAV equipment is considered to be equipment that 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:

4.3.3.1 VOR/DME,

4.3.3.2 DME/DME, or

4.3.3.3 INS must be approved. This approval is not specifically required for ANR.OPS Chap 12, but the same approval criteria apply.

4.3.3.4 LORAN-C systems must be approved for the area of operation under the provisions of FAA AC 20-121, Airworthiness Approval of Airborne Loran-C Navigation Systems . See AC 90-92, Guidelines for the Operational Use of Loran-C Navigation Systems Outside the U.S. National Airspace System (NAS).

4.3.3.5 GPS systems must be approved in accordance with:

- AC 20-130 (latest edition), Airworthiness Approval of Navigation or Flight Management Systems Integrating Multiple Navigation Sensors,
- AC 20-138 (latest edition), Airworthiness Approval of Global Positioning System (GPS) Navigation Equipment for Use as a VFR and IFR Supplemental Navigation System, and
- AC 90-94 (latest edition), Guidelines for Using GPS Equipment for IFR En route and Terminal Operations and for Nonprecision Instrument Approaches in the U.S. National Airspace System, as applicable.
- Technical Standard Order (TSO) C-129, Airborne Supplemental Navigation Equipment Using the Global Positioning System (GPS),
- TSO C-145, Airborne Navigation Sensors Using the Global Positioning System (GPS) Augmented by the Wide Area Augmentation System (WAAS), or
- TSO C-146, Stand-Alone Airborne Navigation Equipment Using the Global Positioning System (GPS) Augmented by the Wide Area Augmentation System (WAAS), and other installation criteria.

4.3.3.6 Modern multi-sensor systems (such as IRS/flight management system (FMS)) can integrate one or more of the above sensors to provide a more accurate and reliable navigational system (see AC 20-130 and AC 25-15, Approval of Flight Management Systems in Transport Category Airplanes).

4.3.3.7 RNAV systems used for visual flight rules (VFR) operations (Class I and/or Class II) must reflect an approval for VFR use. RNAV systems used for IFR Class I navigation and Class II navigation must reflect a statement that the system meets the reliability and performance

criteria, that the system is approved for IFR flight, and if required, approved for any special areas of operation in accordance with the following ACs (latest editions) and TSOs, as applicable:

- AC 20-130
- AC 20-121, Airworthiness Approval of Airborne Loran-C Navigation Systems for Use in the U.S. National Airspace System (NAS)
- AC 20-138
- AC 25-4, Inertial Navigation Systems
- AC 25-15
- AC 90-94
- TSO C-129
- TSO C-145b
- TSO C-146b

4.4. **TRAINING PROGRAMS AND MANUALS.**

Other important areas that must be considered are approved/ accepted training programs and approved/accepted company manuals for the equipment used. The training programs and company manuals must adequately address the special characteristics of the proposed area of operation and the operational (navigation) practices and procedures that must be used. Other sections of this chapter provide additional direction and guidance on some specific requirements for training programs and company manuals for the various navigation systems and/or areas of operation.

4.5. **MINIMUM EQUIPMENT LISTS (MEL).**

Additionally, most approvals of navigation equipment and/or areas of operation new to a particular operator also require changes to the company MEL. In all cases, principal inspectors must review the company MEL to ensure that complete and accurate direction and guidance are provided to company personnel.

4.6. **NAVIGATION PRACTICES, TECHNIQUES, AND PROCEDURES.**

Navigation practices, techniques, and procedures are other important parts of the approval process. They are especially significant in long range navigation systems and in operations using RNAV systems. The approval of these operations almost always necessitates changes in cockpit checklists and operating practices and procedures. Due to the complexity of these operations, the necessary changes must be determined on a case-by-case basis considering the operator, the equipment, and the area of operations.

4.7. **VALIDATION TESTING REQUIREMENTS.**

It is essential for the inspector to evaluate the need for validation testing. In a simple case, such as approving Class I navigation in additional areas within the United States using conventional VOR/DME systems, a validation test is not necessary. However, in more complex cases, validation testing is essential to demonstrate the operator's capability and competence to safely conduct the proposed operation.

4.8. **APPROVAL OF GLOBAL POSITIONING SYSTEM (GPS) EQUIPMENT AND OPERATIONS.**

4.8.1. **Portable Units.**

Portable GPS receivers can only be used as a supplemental aid to VFR in conjunction with an approved primary means of navigation. All portable electronic systems and portable GPS units must be handled in accordance with the provisions of IANR.OPS. The operator of the aircraft must determine that each portable electronic device will not cause interference with the navigation and communications systems of the aircraft on which it is to be used. Yoke mounts usually sold with a portable GPS unit must be mounted as to not interfere with the operation of the aircraft controls. Permanent mounts and externally mounted antennas for use with a portable GPS unit must be installed in an CAAI-approved manner. A critical aspect of any GPS installation is the installation of the antenna. Shadowing by the aircraft structure can adversely affect the operation of the GPS equipment. Operators should be aware that a GPS signal is weak, typically below the value of the background noise. Electrical noise or static in the vicinity of the antenna can adversely affect the performance of the system.

4.8.2. **GPS Equipment Classes.**

GPS equipment is categorized into classes A, B, and C (refer to TSO-C129, TSO-C145, and TSO-C146). See Table 1.

Table 1 - GPS Equipment Classes

TSO-C129						
EQUIPMENT CLASS	**RAIM**	**INTEGRATED NAVIGATION SYSTEM TO PROVIDE RAIM EQUIVALENT**	**OCEANIC**	**EN ROUTE**	**TERMINAL**	**NONPRECISION APPROACH CAPABLE**
Class A—GPS sensor and navigation capability						
A1	Yes		Yes	Yes	Yes	Yes
A2	Yes		Yes	Yes	Yes	No
Class B—GPS sensor data to an integrated navigation system (i.e., FMS, multi-sensor navigation system, etc.)						
B1	Yes		Yes	Yes	Yes	Yes
B2	Yes		Yes	Yes	Yes	No
B3		Yes	Yes	Yes	Yes	Yes
B4		Yes	Yes	Yes	Yes	No
Class C—GPS sensor data to an integrated navigation system (as in Class B) that provides enhanced guidance to an autopilot or flight director to reduce flight technical errors. Limited to part 121 or equivalent criteria.						
C1	Yes		Yes	Yes	Yes	Yes
C2	Yes		Yes	Yes	Yes	No
C3		Yes	Yes	yes	Yes	Yes
C4	Yes	Yes	Yes	Yes	No	

GPS APPROVAL REQUIRED FOR AUTHORIZED USE					
EQUIPMENT TYPE	INSTALLATION APPROVAL REQUIRED	OPERATIONAL APPROVAL REQUIRED	IFR EN ROUTE	IFR TERMINAL	IFR APPROACH
Hand Held	X				
VFR Panel Mount	X				
IFR En Route and Terminal	X	X	X	X	X
IFR Oceanic/ Remote	X	X	X	X	
IFR En Route, Terminal, and Approach	X	X	X	X	X

4.8.2.1 Class A is equipment incorporating both the GPS sensor and navigation capability. This equipment incorporates receiver autonomous integrity monitoring (RAIM). See subparagraph E for more discussion in regard to RAIM.

4.8.2.1.1. Class A1 equipment includes en route, terminal, and nonprecision approach navigation capability.

4.8.2.1.2. Class A2 equipment includes only en route and terminal navigation capability.

4.8.2.2 Class B is equipment consisting of a GPS sensor that provides data to an integrated navigation system (i.e., Flight Management System (FMS), multi-sensor navigation system, etc.).

4.8.2.2.1. Class B1 equipment includes RAIM and provides en route, terminal, and nonprecision approach capability.

4.8.2.2.2. Class B2 equipment includes RAIM and provides only en route and terminal capability.

4.8.2.2.3. Class B3 equipment requires the integrated navigation system to provide a level of GPS integrity equivalent to RAIM and provides en route, terminal, and nonprecision approach capability.

4.8.2.2.4. Class B4 equipment requires the integrated navigation system to provide a level of GPS integrity equivalent to RAIM and provides only en route and terminal capability.

4.8.2.3 Class C is equipment consisting of a GPS sensor that provides data to an integrated navigation system (FMS, multisensor navigation system, etc.) that provides enhanced guidance to an autopilot or flight director in order to reduce flight technical error.

4.8.2.3.1. Class C1 equipment includes RAIM and provides en route, terminal, and nonprecision approach capability.

4.8.2.3.2. Class C2 equipment includes RAIM and provides only en route and terminal capability.

4.8.2.3.3. Class C3 equipment requires the integrated navigation system to provide a level of GPS integrity equivalent to RAIM and provides en route, terminal, and nonprecision approach capability.

4.8.2.3.4. Class C4 equipment requires the integrated navigation system to provide a level of GPS integrity equivalent to RAIM and provides only en route and terminal capability.

4.8.3. **Avionics-Initial Installations and Continued Airworthiness.**

The operator must ensure that the equipment is properly

installed and maintained. No special maintenance requirements, other than the standard practices currently applicable to navigation or landing systems, have been identified that are unique to GPS (e.g., Airworthiness Directives, Service Bulletins.)

4.8.3.1 Documentation must be provided that validates approval of the installed GPS airborne receiver FAA AC 20-129 (latest edition), Airworthiness Approval of Vertical Navigation (VNAV) Systems and AC 20-130 (latest edition), as appropriate, or other applicable airworthiness criteria established for GPS installations. When it has been established that the airborne system has been certified for GPS IFR operations, the following criteria should be used to determine the operational suitability of airborne systems for GPS IFR use.

4.8.3.2 A GPS installation with a TSO C-129 (or TSO C-145a or TSO C-146a, as applicable) authorized navigation system in Class A1, A2, B1, B2, C1, or C2 may be used in combination with other approved LRNS for unrestricted operations in NAT MNPS airspace or may be used as the primary means of long-range navigation on the special routes that have been developed for aircraft equipped with only one LRNS and on the special routes developed for aircraft equipped with short-range navigation equipment. The basic integrity for these operations must be provided by RAIM or an equivalent method. A single GPS installation in Class A1, A2, B1, B2, C1, or C2, that provides RAIM for integrity monitoring, may also be used on those short oceanic routes that have only one required means of long-range navigation.

4.8.4. **GPS Equipment Approval and Installation for Class II Navigation and Remote Areas.**

The approval of GPS to provide the primary means of Class II navigation requires equipment approval, installation approval, and operational approval. Primary means of navigation equipment is that which 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.

4.8.4.1 In addition to specific aircraft certification requirements, dual long-range GPS receivers are required for GPS (TSO C-129) to be approved as a primary means of navigation in oceanic airspace. The equipment must be approved by the CAAI Aircraft Certification Branch in accordance with AC 20-138 (latest edition) or AC 20-130 (latest edition).

4.8.4.2 The applicant must obtain initial installation approval of GPS equipment for primary use on a specific make and model aircraft via the TC or STC certification process. Appropriate forms 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.

4.8.4.3 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.”

4.8.5. **System Availability.**

4.8.5.1 Receiver autonomous integrity monitoring (RAIM) is a technique whereby a civil GPS receiver/processor determines the integrity of the GPS navigation signals using only GPS signals or GPS signals augmented with altitude. This determination is achieved by a consistency check among a series of satellites being tracked. At least one satellite in addition to those required for navigation must be in view for the receiver to perform the RAIM function.

4.8.5.2 Fault detection exclusion (FDE) is the capability of GPS to detect a satellite failure that effects navigation and automatically exclude that satellite from the navigation solution. All operators conducting GPS primary means of Class II navigation in oceanic/remote areas must utilize an CAAI-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 predeparture prediction must be performed for the range of expected ground speeds. This FDE prediction program must use the same FDE algorithm (a step-by-step procedure for solving a problem) that is employed by the installed GPS equipment and must be developed using an acceptable software development methodology. The FDE prediction program must provide the capability to manually designate 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.

4.8.5.3 Operational control restrictions for Class II Navigation in oceanic and remote areas.

4.8.5.3.1. Prior to departure, the operator must use the FDE prediction program to demonstrate that there are no outages in the capability to navigate 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). 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.

4.8.5.3.2. 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 NM per hour cross-track navigation system error growth rate when starting from the center of the route. For ateral 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. 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.

4.8.6. **En Route Procedures for GPS Class II Navigation in Oceanic and Remote Areas**.

4.8.6.1 If the GPS displays a loss of navigation function alert, the pilot should maintain heading and altitude until GPS navigation is regained. The pilot will report degraded navigation capability to ATC. Additionally, flightcrew members operating under IANR.OPS Chap 13 will notify the appropriate dispatch or flight following facility of any degraded navigation capability in accordance with the air carrier’s CAAI-approved procedures. For at least one hour, the approved long-range GPS units have the ability to

automatically provide electronic dead reckoning navigation solutions based on last known information. There are strict procedural requirements for dispatch and en route RAIM to ensure satellite coverage along the oceanic routes and that no outages are scheduled to occur during the planned flight. The standardized application of disciplined, systematic cross-checking of navigation information during all phases of flight during Class II navigation should be required in each operator's long-range navigation program. AC 91-70, latest edition, Oceanic Operations, provides amplification of these procedures.

4.8.6.2 If the GPS displays an indication that a fault detection function outage (e.g., 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 maintain heading and altitude until the exclusion function or navigation integrity is regained and report degraded navigation capability to ATC.

4.8.6.3 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 maintain heading and altitude until the failed satellite is excluded and report degraded navigation capability to ATC.

4.8.6.4 Validation tests are required. Such tests may consist of a single flight or series of flights.

4.8.7. **Approved GPS Navigation System.**

An approved GPS navigation system may be substituted for both an automatic direction finder (ADF) and DME receiver, provided facility or fix coordinates can be called up from the current GPS airborne database. Waypoints, fixes, intersections, and facility locations used for these operations must be retrieved from the current GPS airborne database. If the required positions cannot be retrieved from the airborne database, the substitution of GPS for ADF and DME is not authorized.

4.8.7.1 For all operators, using GPS in lieu of DME does not preclude any equipage requirements of the applicable regulations. To provide navigation performance equivalent to ADF or DME avionics, the GPS navigation systems must be properly certified, installed, and authorized for use under IFR, as described above.

4.8.7.2 This approval does not alter the conditions and requirements for use of GPS when GPS is used to provide lateral course guidance to fly GPS or GPS RNAV standard instrument approach procedures.

4.8.7.3 For those operations where the operating rules require that DME be installed, the operator's MEL should include provisions for authorizing continued operations using a certified GPS when the installed DME is inoperative. Operators in the NAS may be authorized to use GPS equipment certified for IFR operations in lieu of ADF and DME equipment for the following operations:

- Determining the aircraft position over a DME fix.
- Flying a DME arc
- Navigating to/from an NDB/compass locator
- Determining the aircraft position over an NDB/compass locator
- Determining the aircraft position over a fix made up of a crossing NDB/compass locator bearing
- Holding over an NDB/compass locator
- The ground-based NDB or DME facility may be temporarily out of service

4.8.7.4 For further information on the use of GPS in lieu of DME, refer to the AIP.

4.9. FAA APPROVAL OF GPS/WIDE AREA AUGMENTATION NAVIGATION SYSTEMS (WAAS).

4.9.1. General.

GPS/Wide Area Augmentation System (WAAS)-capable navigation systems are approved under TSO-C145a or TSO-C146a.

4.9.1.1 TSO-145a applies to GPS/WAAS sensors incorporated as a component of a flight management system (FMS).

4.9.1.2 TSO-146a applies to stand-alone GPS/WAAS units.

4.9.1.3 This GPS/WAAS equipment constitutes a significant improvement over the older GPS (non-WAAS) standards provided by TSO-C129 equipment, with technology that provides:

- Enhanced signal integrity using GPS/WAAS, FDE, and RAIM.
- Improved navigation accuracy, availability, and flexibility that will ultimately produce an increase in both system capacity and overall flight safety.

- Performance capabilities for new IFR RNAV routes that are currently under development for navigation in domestic and remote airspace.
- Performance accuracy to meet Required Navigation Performance (RNP)-2, RNP-1, and RNP-0.3; and the equivalent containment values in Table 2 below.

Table 2 - RNP Types or RNAV Containment Values

RNP Type	Required Accuracy (95 percent Containment)	Description
0.3	± 0.3 NM	Nonprecision, LNAV, VNAV, and some LPV approaches using GPS/WAAS
1	± 1.0 NM	Supports Arrival, Initial/Intermediate Approach, Departure and some En route applications
2	± 2.0 NM	Supports ATS routes and airspace

4.9.2. **GPS/WAAS Equipment.**

Table 3, GPS/WAAS Equipment Classes, should be used to authorize the phase of flight (modes) and intended operational use when approving GPS/WAAS navigation systems.

4.9.2.1 TSO-C145a provides the certification standards for airborne navigation GPS/WAAS sensors, as part of an FMS, that is categorized into three classes.

4.9.2.2 TSO-C146a GPS/WAAS equipment refers to a GPS/WAAS stand-alone airborne navigation system that is categorized into four classes.

4.9.2.3 TSO-C145a/C146a equipment must be installed in accordance with Advisory Circular (AC) 20-138, Airworthiness Approval of Global Navigation Satellite System (GNSS) Equipment, latest edition.

4.9.2.4 For TSO-C145a GPS/WAAS sensors, the parent FMS must comply with TSO-C115b (installed in accordance with AC 20-130).

Table 3 - GPS/WAAS Equipment Classes

	For TSO-C145a Sensors and TSO-C146a Receivers		
Equipment Class	Oceanic and Domestic En route, Terminal Area Operations, Nonprecision Approach	LNAV/VNAV Approaches	Lateral Path Vertical Guidance (LPV) Approaches
			GPS/WAAS Sensor [TSO-C145a]
Class 1	Yes	No	No
Class 2	Yes	Yes	No
Class 3	Yes	Yes	Yes
			GPS/WAAS Navigation Equipment [TSO-C146a]
Class 1	Yes	No	No
Class 2	Yes	Yes	No
Class 3	Yes	Yes	Yes
Class 4	No	No	Yes

4.9.3. **IFR Operations in the NAS.**

GPS/WAAS equipment meets the performance accuracy for operations over all existing published or approved air traffic service routes including air traffic clearances “direct to” fixes or navigation aids. These routes, NAVAIDs, or fixes must be retrievable from the navigation database. When all applicable provisions outlined in this directive are met, including the installation of dual independent systems appropriate to the route of flight, GPS/WAAS equipment may be authorized for use as the only means of navigation in conducting IFR navigation. This requirement may be met with:

4.9.3.1 Dual Class 1, 2, or 3 (see subparagraph B and Table 3 above) GPS/WAAS TSO-C146a units; or

4.9.3.2 Dual independent FMSs that comply with TSO-C115b (installed in accordance with AC 20-130, latest edition) with dual TSO-C145a, Class 1, 2 or 3 sensors (installed in accordance with AC 20-138, latest edition), or

4.9.3.3 A combination of one GPS/WAAS TSO-C146a unit and one FMS with a GPS/WAAS TSO-C145a sensor.

NOTE: The CAAI has certified GPS/WAAS systems as primary navigation systems and they can be used as the only means of navigation as long as the IANR.OPS operating rules do not prohibit this use. Whereas, GPS navigation systems certified under TSO-C129 are limited as a supplemental means of navigation except for certain operation in oceanic and remote areas when TSO-C129 systems meet HBAT 95-09.

4.9.4. **GPS/WAAS, TSO-C145a, or TSO-C146a (and subsequent revisions)**

Equipment Can Be Approved for Operations Where an Accuracy Performance of RNP-2, -1, or -0.3 is Required.

4.9.4.1 GPS/WAAS systems certified under TSO-C145a or TSO-C146a and installed in accordance with AC 20-138, latest edition, perform to the accuracy requirements of RNP-2, RNP-1, or RNP-0.3; and the equivalent containment values in Table 2 above.

4.9.4.2 A flight management system with a TSO-C145a sensor, and TSO-C146a units with documentation in the AFM or AFMS of the RNP types for the installed GPS/ WAAS navigation system of RNP-2, -1, and -0.3 can be authorized for operations requiring those RNP types.

4.9.4.3 TSO-C145a and TSO-C146a GPS/WAAS equipment meet the performance requirements for operations over all existing published air traffic service routes and “direct to” routes authorized in an air traffic clearance. Navigation databases used in conjunction with these routes must be current and include the applicable published procedures.

4.9.4.4 TSO-145a and TSO-C146a equipment without an RNP statement in the AFM or Aircraft Flight Manual Supplement (AFMS), performs to the accuracy requirements of RNP-2, RNP-1, and RNP-0.3 when in en route mode, terminal mode, or nonprecision approach modes respectively and the installed equipment provides annunciation to the pilot of the mode that is in use. If the TSO-C146a equipment meets this requirement, it can be authorized for operations requiring those RNP types.

4.9.4.5 Operational approvals may be issued to authorize an operator to conduct approved or published en route, terminal, and approach procedures that require these specific RNP values if they meet the following general requirements. (This authorization could apply to any published or special en route, terminal, or approach procedure.)

4.9.4.5.1. The approved GPS/WAAS system must be installed and operating when conducting flights over the published or approved route segments or procedures.

4.9.4.5.2. Operators approved for en route segments using these RNP types should include modules in their training program that ensure the pilot’s ability to accurately maintain the aircraft’s position within the protected portions of the route or procedure using reduced course deviation indicator (CDI) guidance cues.

4.9.4.6 Questions concerning the operational approval for en route, terminal, or approach procedures requiring a published RNP should be directed to the appropriate CAAI departmemt

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5. Task Outcomes

5.1. Using this directive will guide the inspector in approving different navigation systems.