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BULLETIN TYPE: Flight Standards Information Bulletin for Airworthiness (FSAW)

BULLETIN NUMBER: FSAW 94-32C (Amended)

BULLETIN TITLE: Guidance for Performing Field Approvals of Installation and Operational Use of Global Positioning Systems (GPS) or GPS with Wide Area Augmentation Systems (GPS-WAAS), Referred to as Global Navigation Satellite Systems (GNSS) Equipment

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NOTE: THIS BULLETIN REQUIRES PTRS INPUT. SEE PARAGRAPH 9.

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1. PURPOSE. This bulletin provides guidance to supplement handbook instructions for a qualified Airworthiness aviation safety inspector (ASI) to perform field approvals of the installation and operational use of global positioning systems (GPS) or GPS with wide area augmentation system (GPS-WAAS) equipment for specified flight phases. It also clarifies procedures prescribed within Federal Aviation Administration (FAA) Advisory Circular (AC) 20-138A, Airworthiness Approval of Global Navigation Satellite System (GNSS) Equipment, for approving an operating limitation placard or an Airplane Flight Manual Supplement (AFMS) or Rotorcraft Flight Manual Supplement (RFMS) describing operational limitations and other elements affecting use of an aircraft with GPS or GPS-WAAS equipment.

2. BACKGROUND. GPS or GPS-WAAS equipment may be operationally limited for use as a supplemental means of navigation under visual flight rules (VFR), or can be operationally approved for navigation under instrument flight rules (IFR) within domestic

en route and terminal areas and for instrument approach flight phases. GPS or GPS-WAAS equipment can also be approved to provide primary means of navigation for oceanic/remote area operations provided additional criteria are satisfied. (Check the Aeronautical Information Manual (AIM) for specifics)

3. DEFINITIONS.

A. Approach Procedures with Vertical Guidance (APV). An instrument approach based on a navigation system that is not required to meet the precision approach standards of ICAO Annex 10 but provides course and glidepath deviation information. For example, Baro-VNAV, LDA with glidepath, LNAV/VNAV, and lateral approach procedures with vertical guidance (LPV) are APV approaches.

B. Course Deviation Indicator (CDI). A CDI typically contains at least an electromechanical lateral deviation "bar," warning flag, and to/from pointer for display of navigation information. Another form of CDI may also contain an electromechanical vertical deviation bar and warning flag.

C. Electronic Horizontal Situation Indicator (EHSI). An EHSI may be independent from or part of an Electronic Flight Instrumentation System (EFIS). An EHSI contains one or more microprocessors used to process and display information, including vertical and lateral deviation, flag, and to/from information from GNSS equipment or other compatible airborne navigation equipment.

D. Flight Guidance System (FGS). An FGS is commonly referred to as an autopilot or automatic flight control system (AFCS), which may be independent of or combined with a flight director system or instrumentation.

E. Global Navigation Satellite Systems (GNSS). GNSS equipment is, for the purpose of this guidance, GPS equipment or augmented GPS with wide area augmentation system (GPS-WAAS) signals intended to satisfy civil aviation requirements for accuracy, availability, continuity, coverage, and integrity. GNSS equipment may use or require altimeter aiding and can provide navigation information to various compatible CDI, EHSI, or horizontal situation indicator (HSI) instruments, multi-function displays (MFD), and FGS.

F. Global Positioning Systems (GPS). GPS equipment uses the space-based radionavigation system developed and operated by the

U.S. Department of Defense (DoD) and managed by the Interagency GPS Executive Board (IGEB). GPS equipment may use or require altimeter aiding and can provide navigation information to various compatible CDI, EHSI, or HSI instruments, MFD, and FGS.

G. Horizontal Situation Indicator (HSI). An HSI consists of an electromechanical lateral deviation "bar," warning flag, and to/from pointer for display of navigation information, as well as electromechanical vertical deviation bar and warning flag. An HSI also displays compass heading and possibly other navigation information. A Pictorial Navigation Indicator (PNI) is another name for an HSI.

H. Multi-Sensor Navigation System. This type navigation system computes and displays one independent or blended position and other navigation data combined from one or more navigation sensors, which provide independent positions (e.g., GPS or GPS-WAAS, long-range navigation-C system (Loran-C), very high frequency (VHF) omnidirectional range/distance measuring equipment (VOR/DME), DME/DME, or inertial navigation system/inertial reference system/inertial reference units (INS/IRS/IRU)). AC 20-130A, Airworthiness Approval of Navigation or Flight Management Systems Integrating Multiple Navigation Sensors, describes such systems and their integration techniques. Such systems may be approved for IFR to monitor or "cross-check" GPS position when a GPS sensor does not meet the requirements of Technical Standard Order (TSO)-C129 or TSOC129a, Airborne Supplemental Navigation Equipment Using the Global Positioning System (GPS). GPS equipment (or sensors) that meets the requirements of TSO-C129 or TSO-C129a, Class B1/C1 or B2/C2, or GPS-WAAS sensor that meets the requirements of TSO-C145a, Airborne Navigation Sensors Using the Global Positioning System (GPS) Augmented by the Wide Area Augmentation System (WAAS), or TSO-C146a, Stand-Alone Airborne Navigation Equipment Using the Global Positioning System (GPS) Augmented by the Wide Area Augmentation System (WAAS), may be used as the only sensor within an approvable multi-sensor navigation system.

I. Non-Precision Approach (NPA). An instrument approach based on a navigation system, which provides course deviation information, but no glidepath deviation information, e.g., VOR, NDB, and LNAV. Some approach procedures may provide a vertical descent angle as an aid in flying a stabilized approach, without requiring its use to fly the procedure. This does not make the approach an APV procedure, since it must still be flown to an MDA and has not been evaluated with a glide path.

J. Precision Approach. An instrument approach based on a navigation system that provides course and glidepath deviation information meeting the precision standards of ICAO Annex 10. For example, PAR, ILS, and GLS are precision approaches.

K. Primary-Means Navigation System. A navigation system approved for a given operation or phase of flight that must meet accuracy and integrity requirements, but need not meet full availability and continuity of service requirements. Safety is achieved by limiting flights to specific time periods and through appropriate procedural restrictions. Examples of systems that satisfy primary means of navigation include:

(1) VOR/DME or GPS-WAAS for domestic en route and above flight level (FL) 240, terminal area, and non-precision approach where it is available.

(2) Dual INS or dual GPS (or dual GPS-WAAS) for oceanic and remote area operations.

L. Receiver Autonomous Integrity Monitoring (RAIM). A technique used by a GPS receiver/processor to determine the integrity of the GPS navigation signals without reference to external system or equipment other than the GPS satellite signals themselves or to an independent input of pressure or barometric altitude from an altimeter or altitude sensor. This determination is achieved by a consistency check (over-solution) among redundant pseudorange measurements.

M. Stand-Alone Equipment. Stand-alone equipment, as addressed in AC 20-138A and this bulletin refer to equipment incorporating a GPS or GPS-WAAS (i.e., GNSS) position sensor and a navigation function, so that the equipment provides path deviations relative to a selected path. Stand-alone equipment may interface with compatible pressure or barometric altitude sensors or altimeters for correction or compensation, or to aid in vertical path guidance. Stand-alone GPS or GPS-WAAS equipment may be interfaced with compatible CDI, EHSI, or HSI, MFD, FGS, Terrain Awareness and Warning Systems (TAWS), or Automatic Dependent Surveillance-Broadcast (ADS-B). Stand-alone GPS or GPS-WAAS receivers may be combined with VOR, localizer, and glideslope receivers, and/or communications transceivers configured in panel-mounted equipment. These are commonly referred to as “multi-function systems.” Approval for installation and operational use of such multi-function systems may be considered separately dependent upon their functionality and effects to airworthiness.

N. Supplemental-Means Navigation System. The term "supplemental" requires that other navigation equipment be installed and approved for use as a primary means consistent with the route to be flown when navigation is predicated on the use of GPS (or GPS-WAAS) equipment. GPS equipment may be installed and approved if it meets the requirements of RTCA/DO-208, Minimum Operational Performance Standards for Airborne Supplemental Navigation Equipment Using Global Positioning System (GPS), as modified by TSO-C129 or TSO-C129a. GPS-WAAS equipment may be installed and approved if it meets the requirements of RTCA/DO-229C, Minimum Operational Performance Standards for Global Positioning System/Wide Area Augmentation System Airborne Equipment, as modified by TSO-C146a. GPS or GPS-WAAS equipment that does not meet requirements for TSO, but has been awarded Parts Manufacturer Approval (PMA), Replacement and Modification Parts (Ref. Title 14 of the Code of Federal Regulations (14 CFR) part 21, § 21.303), can be field-approved as supplemental means of navigation for VFR use only. If such equipment has been issued a "multiple" aircraft Supplemental Type Certificate (STC), so that a PMA could be awarded, the PMA restricts the installation eligibility to a specific type approval or to one make or model aircraft, except by approved model list (AML). Such restriction should not prevent installation and operational approval using field approval procedures of GPS equipment with a multi-sensor navigation system for IFR use for which such equipment can be shown to meet applicable environmental qualifications, performance, and interface compatibility.

4. RESPONSIBILITIES IN SUBSTANTIATING ALTERATIONS AND APPROVALS

A. Applicant Responsibilities.

(1) The person who intends to, or has performed the alteration (applicant) should adhere to the installation considerations for GPS and GPS-WAAS navigation equipment described within AC 20-138A, paragraphs 15 through 19, Installation Issues. These paragraphs discuss technical interface parameters and other criteria, which when applicable and satisfied, should be referenced by paragraph or subparagraph as accomplished, in block 8 of FAA Form 337, Major Repair and Alteration. The applicant should also comply with test and evaluation criteria included within AC 20-138A, paragraphs 21 through 23, Installed Performance, and the applicable elements contained within paragraph 5, Applicant's Required Performance Integrity Tests and Evaluations subparagraphs A through J of

this bulletin. When complete, the applicant must include statements of satisfaction in block 8 of Form 337.

(2) In addition to the above, the applicant who has declared a major alteration on Form 337 must ascertain, through analysis, that:

(a) GPS or GPS-WAAS equipment intended to be installed is compatible with other installed equipment and systems; and

(b) No certificated properties, which could adversely impact continued safe flight and landing in any type operation for which the aircraft is approved, have been exceeded. These properties include weight, balance, structural strength, reliability, operational flight characteristics, performance, and other characteristics/qualities affecting airworthiness of the product (Ref. 14 CFR part 1, § 1.1 and part 21, § 21.93(a)).

(3) The applicant must certify on the Form 337 that the GPS or GPS-WAAS equipment, as installed, performs its intended function(s) (Ref. 14 CFR §§ .1301 of part 23, 25, 27, or 29); that the alteration is compatible with all previous alterations; and that the weight and balance or operating limitation changes have been entered in the appropriate aircraft record (Ref. 14 CFR part 43, § 43.9 and AC 43-210, Standardized Procedures for Requesting Field Approval of Data, Major Alterations, and Repairs).

B. ASI Responsibilities.

(1) The ASI performing a field approval is responsible for determining that both descriptive and substantiating data for the alteration, as submitted and declared in block 8 of Form 337, is adequate, appropriate, and conforms to the aircraft intended to be altered, prior to issuance of a field approval. Additionally, the ASI must ensure that the applicant has conducted an analysis using the basis of type certification (TC) for the aircraft to determine the effects of possible major changes to its type design. A field approval can be granted only if the alteration can be accomplished as a minor change to the aircraft's type design (Ref. part 21, §§ 21.95 and 21.97(a), and AC 43-210).

(2) The ASI performing a field approval is responsible for assessing the applicant's analysis to ensure compatibility of GPS or GPS-WAAS equipment with other equipment and systems as described in block 8 of Form 337. Such analysis may include

approved data or acceptable data, such as installation wiring diagrams, systems, and equipment descriptions; lists of compatible equipment or systems provided by the GPS or GPS-WAAS equipment manufacturer; or the “General” section of a proposed AFMS/RFMS.

(3) With this bulletin and its predecessor, ASIs are granted authority to review and approve an AFMS/RFMS for operational use of GPS or GPS-WAAS equipment, based on an original AFMS/RFMS approved by the FAA for an initial TC or one-aircraft or multiple STC. ASIs may grant this approval after establishing that the installed GPS or GPS-WAAS equipment and the systems and equipment to which either is interfaced meets the appropriate airworthiness requirements for compatibility and performance. The AFMS/RFMS must contain the elements of operating limitations placed on the aircraft, abnormal/emergency procedures, normal operating procedures, aircraft performance, and aircraft weight and balance. The AFMS/RFMS should also contain a “General” or “Systems Description” section that may be approved (or may not) at the discretion of the ASI. The ASI must be familiar with the airworthiness standards in §§ .1525 and .1581 through .1589 of parts 23, 25, 27, or 29 when approving the AFMS/RFMS. The AFMS/RFMS must denote the aircraft manufacturer’s name, model number, serial number, and registration number, which limits the FAA-approved AFMS/RFMS to one aircraft only for configuration control purposes.

(4) The ASI must ensure that deviations or differences from the originally issued TC or STC are properly documented and recorded in accordance with part 43, § 43.9 when issuing a field approval for an installation and approval of an AFMS/RFMS for operational use of the GPS or GPS-WAAS equipment.

C. Alterations Using Data Approved by STC or TC.

(1) An alteration performed using data approved by STC for the same GPS or GPS-WAAS equipment on the same aircraft model and type when documented on Form 337 needs no further approval. (The ASI need not sign block 3 of the Form 337.)

(2) The STC number, STC holder of the type design data, and reference to the approved data used to perform the alteration must also be documented in block 8 of Form 337. The applicant must obtain authorization from the STC holder to apply the data to perform the alteration and to satisfy operational approval. The previously FAA-approved AFMS/RFMS must identify

the compatible equipment or systems used in the approved configuration with no deviations.

(3) An alteration performed using data approved by TC or STC, installed in a different aircraft model and type, that is similar to the initial TC or one aircraft only or multiple STC, may be eligible for field approval. The applicant must document the TC or STC number and the holder of the type design data, in addition to the work performed, and describe all deviations to or differences from the original TC or STC in block 8 of Form 337.

D. Minor Alterations.

(1) If the applicant can substantiate that the installation of the stand-alone GPS or GPS-WAAS equipment, including the antenna installation, does not exceed the certificated properties of a simple, non-pressurized, small airplane weighing less than 6,000 pounds, such installation may be accomplished and documented as a minor alteration. An example of a minor alteration is one in which the GPS or GPS-WAAS equipment interfaces only with its antenna, power, and ground, possibly a simple navigation selector switch to choose information from another navigation source for display on an HSI or CDI, and possibly an FGS. The FGS interface is limited to lateral deviation input only that is designed to accept navigation signals common to VOR coupled mode use and be bank angle limited, accordingly. The person performing the alteration may return the altered aircraft to service using only data acceptable to the Administrator without obtaining field approval of the alteration. Acceptable data must include reference to an initial TC or STC obtained by the GPS or GPS-WAAS equipment manufacturer or other STC holder and completion of the installation must be accomplished in accordance with the manufacturer's installation instructions that adequately address all compatible equipment interfaces, GPS or GPS-WAAS equipment performance assurance, and mutual equipment and systems interference testing instructions and expectations.

(2) If the person performing the alteration cannot substantiate that the entire alteration is minor, the ASI may need to review FAA-approved data or perform a field approval for one or more of the components of an installation. For example, alterations that may be subject to a major alteration and, therefore, require declaration on Form 337 for field approval consideration, would include but are not limited to:

- Interfaces with an FGS requiring composite roll steering

- Multiple navigation system input source selection other than VOR or localizer, and GPS or GPS-WAAS, usually referred to as “complex” switching or source selection

- Connection with a barometric altimeter source required specifically for reduced vertical separation minimum (RVSM) station keeping (which is considered flight critical), rather than connection with an independent pressure or barometric altimeter or altitude sensor essential for aiding instrument approach performance

- GPS or GPS-WAAS antenna that is mounted on a composite surface or penetrates through the aircraft hull, requiring an analysis to substantiate structural strength (such analysis is often performed by and approved by an FAA Designated Engineering Representative (DER))

- Location of navigation displays or controls outside of the recommended field-of-view guidelines

- Integration with a GPS or GPS-WAAS antenna that was not used for the initial STC and which is not specifically identified in the manufacturer’s installation instructions as being compatible

- Operational limitation that is imposed (affixed placard, AFMS, or RFMS)

- Prior approval that was substantiated dependent upon an FAA-approved AFMS or RFMS

E. Determining Operational Performance and/or Limitations.

(1) Every person performing an alteration or person responsible for returning an aircraft to service must determine if other qualities affecting airworthiness are impacted by the installation of GPS, GPS-WAAS, or any other equipment. This includes the determination of whether limitations are imposed on the operational use of the aircraft or equipment.

(2) Operating limitations are often imposed on an aircraft’s use and are detailed in the basic Aircraft Flight Manual (AFM) or pilot’s operating handbook (POH), or are

conveyed by affixing an operating limitation placard in a position discernible by the pilot (Ref. §§ .1559 of part 23, 25, 27, or 29, and part 43, § 43.5(c)). One example of such limitation is restricting use of the GPS or GPS-WAAS to en route and terminal area navigation only, if the CDI does not contain a to/from pointer. In this example, an operating limitation placard is required because of GPS or GPS-WAAS equipment performance degradation making the alteration major with respect to the interface with the CDI, and therefore must be documented on Form 337, which requires approval by the FAA. Alternatively, the operating limitation may be included in a supplemental flight manual or AFMS/RFMS, which must be declared on Form 337 and submitted by the applicant to the FAA for field approval consideration by an ASI. If GPS or GPS-WAAS equipment and all peripheral equipment to which it is interfaced can be determined to be minor, there is no requirement to list the installed equipment, including the GPS or GPS-WAAS on Form 337. Only the AFMS, RFMS, or operating limitation placard needs to be field-approved.

(3) The installer or person returning the aircraft to service following the alteration is ultimately responsible for ensuring that operational performance requirements of the GPS or GPS-WAAS equipment are satisfied. Normally, only a GPS or GPS-WAAS equipment manufacturer or a peripheral equipment manufacturer has the resources or test equipment to conduct such tests or analysis to establish satisfactory performance. Compatibility can be affected by changes to either equipment that otherwise is considered a minor modification (e.g., under a TSO authorization one of the vendors may change the design in a way that negatively impacts compatibility). When the GPS or GPS-WAAS manufacturer has not ensured specific interfaces and equipment compatibility, tests or analysis must be performed to determine functional or dynamic performance. For example, GPS and GPS-WAAS equipment may meet the requirements for deviation update rates of five times per second, but the processed deviation by an EHSI or by an FGS designed to accept analog inputs may lag as much as 1 to 2 seconds (data latency). Operating limitations may be imposed on the use of GPS or GPS-WAAS equipment, within less critical phases of flight, such as en route or terminal area only, thus requiring a placard or an AFMS/RFMS to be FAA-approved.

F. Responsibility for Testing Equipment Before Return to Service.

(1) Whether the installation is performed as a major or minor alteration, the applicant or person performing the alteration must conduct ground tests for interoperability and electromagnetic immunity of installed GPS or GPS-WAAS equipment interfaced with other equipment and systems. These tests are similar to those conducted for issuance of an initial TC or STC, to ensure mutual equipment compatibility before return to service of the aircraft. An alteration that has been determined to be major may require that an operational flight check to verify performance integrity be conducted in accordance with 14 CFR part 91, § 91.407(a) and (b) by the applicant or a designee. Installations intended for IFR approved use may be initially limited to VFR use, thus not requiring issuance of an experimental airworthiness certificate before conducting an operational flight check per part 43, § 43.13(a).

(2) The aircraft can be approved for return to service for IFR operations following successful completion of the required ground tests; however, the GPS or GPS-WAAS equipment cannot be approved for IFR flight until the operational flight checks have been successfully accomplished. At a minimum, the applicant must perform the tests and evaluations described in paragraph 5 to establish performance integrity and to identify any operating limitations that may result from failure to satisfy requirements for IFR approval for use within intended flight phases.

5. APPLICANT'S REQUIRED PERFORMANCE INTEGRITY TESTS AND EVALUATIONS.

A. Conduct tests for continuity of navigation during normal aircraft maneuvering for the different navigation modes to be validated. For example, bank angles of up to 30 degrees and pitch angles associated with takeoff, departures, approaches, landing, and missed approaches, as applicable, to ensure that quality of received signal is unperturbed while maneuvering and during operations at low altitudes, such as during an approach when a greater likelihood of signal or satellite degradation caused by effects of multi-path is likely to be experienced with low elevation satellites in view. Operating limitations may be imposed for one or more flight phases if GPS or GPS-WAAS performance is degraded.

B. Verify the overall operation of the GPS or GPS-WAAS equipment, including at least the following: hold at a designated waypoint, intercept and track to or from a waypoint on a selected course, turn anticipation, waypoint sequencing, selection of an approach, and the general presentation of

navigational data (depiction of the “TO” waypoint, distance to waypoint, estimated time of arrival, estimated time en route, ground speed, etc.). Evaluate the overall operation on all of the types of procedures or paths that the equipment supports (e.g., straight legs, DME arcs, and radius to fix legs).

C. Verify that flight technical error (FTE) can be maintained at less than 1.0 nautical mile (nm) for en route and approach transition operating modes, and less than 0.25 nm for non-precision approach, both with and without autopilot and/or flight director use, as applicable. One acceptable way of assessing FTE is to monitor the measured cross-track deviation using the navigation display provided. FTE cannot usually be estimated or determined without directly measuring control loops with respect to notable data latency between GPS or GPS-WAAS equipment and FGS responses, particularly while maneuvering in vertical modes. Airspeed, aircraft loading, aerodynamics, engine performance, etc., can influence FTE. Depending on GPS or GPS-WAAS equipment position and cross-track deviation output data processing rates, CDI or EHSI display, or FGS response rates, some lag or delay may be observed in leg changes or overshoot in turns, thus larger airspace consumption can result. Within en route and terminal area airspace, such delay may not result in a penalty for airspace consumption. However, within approach and departure airspace, the GPS or GPS-WAAS equipment and its peripheral equipment and systems response times may exceed allowable airspace tolerances. Therefore, the applicant should ensure and the ASI must verify that limitations are documented for the GPS or GPS-WAAS equipment, which may restrict the GPS or GPS-WAAS equipment use to IFR en route and terminal area flight phases only.

D. Evaluate the GPS or GPS-WAAS equipment when interfaced with an FGS. The objective is to ensure that the GPS or GPS-WAAS equipment interface is compatible with the aircraft, not to verify FGS performance. If these evaluations cannot be addressed for a particular FGS (e.g., because the autopilot does not respond to flag indications), the GPS or GPS-WAAS equipment may still be installed but either should not be connected to the autopilot or, if the discrepancy is consistent with the rest of the aircraft’s navigation capabilities, a limitation can be included in the AFMS/RFMS through consistent crew procedures for all types of navigation. It is unrealistic to expect a person performing the installation of GPS or GPS-WAAS equipment interfaced with an FGS to assess total compatibility. For example, it would be difficult to measure the effects of instability at nominal approach speeds when the FGS fails to

observe a trip signal that would ordinarily be received when passing over the middle marker beacon facility. Some FGS depend upon such input trip to enable “glideslope extension” function to reduce “porpoising” or aerodynamic instability when coupled to a glideslope signal during the final approach phase. Neither GPS nor GPS-WAAS equipment designs provide such trip signal. FGS responses must be individually evaluated to determine compatibility with the GPS or GPS-WAAS. Further evaluation may require referral to FAA Aircraft Engineering.

E. Evaluate steering response while the flight director and/or autopilot (FGS) is coupled to the GPS or GPS-WAAS equipment during a variety of different track and mode changes. This evaluation should include, as applicable, transition from en route to approach transition to approach to missed approach modes, and vice-versa. Additionally, evaluate all available display sensitivities. Many FGS (with or without flight director instrumentation) respond differently with respect to en route navigation modes and approach navigation modes transitions. FGS response results for each of the selected modes must be documented in the aircraft records and AFMS or RFMS with limitations applied to GPS or GPS-WAAS use, if appropriate.

F. Execute several fly-by turns with varying wind conditions for flight director and/or autopilot (FGS) when coupled to GPS or GPS-WAAS equipment. Verify that the GPS or GPS-WAAS equipment accomplishes the turn as a fly-by waypoint and discourages overshoot. Fly-by turns are turns where the equipment initiates the turning maneuver before sequencing the waypoint by an amount equal to the turn anticipation distance. Each FGS will react differently based upon crosswind compensation design, and command and servo loop responses. FGS turn anticipation responses in varying wind conditions must be documented and limitations applied to GPS or GPS-WAAS use, if appropriate.

G. Verify that the lateral maneuver anticipation supplied by the GPS or GPS-WAAS equipment is appropriate for the aircraft type. Verify that an appropriate annunciation of impending waypoint crossing is provided. Maneuver anticipation performance varies with aerodynamic airframe response and airspeed. Although subjective, typically, impending waypoint annunciation occurs 2 minutes before waypoint crossing.

H. Verify that execution of the Direct-To function with a resultant aircraft heading change does not overshoot and cause

“S” turns. Reinitialization of the Direct-To function after completion of most of the required track change may be an acceptable means of compliance for equipment that does not inherently account for the change in aircraft heading.

I. Many GPS or GPS-WAAS equipment interfaces with electromechanical CDIs and HSIs do not “autoslew” with a change in computed desired track, or they interface only with analog or digital desired track (DTK) outputs. Therefore, if a leg change results in a large heading change, the pilot must adjust the selected course to the “new” desired track, which may result in “S” turns or overshoots. This is especially apparent with DTK processing delays and human response delays in rotating the selected course knob on the CDI or HSI. Responses may vary with EHSI autoslew caused by data latency. The applicant or the ASI must impose limitations if the GPS or GPS-WAAS equipment and/or the pilot cannot maintain course centerline, especially when intercepting the final approach course in a coupled precision approach. The person performing the test must declare these limitations within the AFMS/RFMS.

J. Evaluate the autopilot (FGS) response to GPS or GPS-WAAS fault by pulling the circuit breaker for the GPS or GPS-WAAS equipment. This test should be done in all of the GPS and GPS-WAAS en route and approach modes. Each FGS will react differently, since some are designed to establish “wings level” condition in loss of valid navigation inputs, and others are designed to revert to heading or to roll command, and pre-established pitch attitude. The person performing the test must declare these limitations within the AFMS/RFMS.

K. Electromagnetic/Radio Frequency Interference Testing. Installation instructions for each model of GPS or GPS-WAAS equipment and multi-sensor navigation system, which employs a GPS or GPS-WAAS sensor, require verifying adequate isolation from harmonic interference potentially caused by very high frequency (VHF) transmitters operating at selected 25 kilohertz (kHz)-spaced frequencies identified in the table below. In addition, if 8.33 kHz-spaced VHF transmitters are installed, it is necessary to test the transmitted frequencies listed in the table below, regardless of whether those frequencies are normally activated or selectable for operational use. Conduct tests by tuning each VHF transmitter to the frequencies listed below and transmitting for 35 seconds while observing the signal status of each or all satellites actively being received. Degradation of individually received or all satellite signals below a point where navigation using GPS or GPS-WAAS is no

longer possible will be unacceptable for use under IFR, and will require that additional isolation or filter techniques be included in the aircraft installation. Proper radio procedures must be observed when performing harmonic interference tests.

25 kHz-Spaced Frequencies		8.33 kHz-Spaced Frequencies
121.150 MHz	131.250 MHz	121.185 MHz
121.175 MHz	131.275 MHz	121.190 MHz
121.200 MHz	131.300 MHz	130.285 MHz
		131.290 MHz

6. OTHER INSTALLATION AND OPERATIONAL APPROVAL CONSIDERATIONS.

A. If it is determined that the performance integrity or mutual compatibility of the installed GPS or GPS-WAAS equipment cannot meet the requirements for use under IFR as a supplemental or primary means of navigation, the applicant must affix a placard in a position discernable by the pilot stating: “Use of GPS (or GPS-WAAS) not approved for IFR.” The placard installation (Ref. part 23, 25, 27, or § 29.1559 and § 43.5(c)) restricting the use of the aircraft to operations under VFR when navigating with GPS or GPS-WAAS must be declared on Form 337 and be FAA-approved (Ref. part 23, 25, 27, or § 29.1525). In addition, the ASI must ensure the following:

(1) That the operational limitation imposed on the GPS or GPS-WAAS equipment, if part of a multi-function system as defined in paragraph 3M, Stand-Alone Equipment, does not adversely impact the suitability for use under IFR of the VOR, localizer, and glideslope receivers, and/or communications transceivers contained within the multi-function system. If such suitability can be assured, a separate entry on Form 337 is required to declare acceptability of those functions.

(2) That such interface applications with weather radar or TCAS as required equipment under 14 CFR part 121, §§ 121.356 or 121.357, or 14 CFR part 135, §§ 135.175 or 135.180 meet the appropriate requirements for display, as well as ensure that such applications are detailed in an AFMS/RFMS and documented separately on another Form 337 that may be field-approved.

B. The ASI should review with the applicant other factors that might impose operating limitations during certain phases of flight, which must be documented in an AFMS/RFMS. The ASI, upon finding compliance (Ref. §§.1525 and .1581 through .1589 of parts 23, 25, 27, or 29) with such operating limitations placed

on the aircraft, as well as abnormal and emergency procedures, normal operating procedures, aircraft performance, and aircraft weight and balance contained within the applicant's proposed AFMS/RFMS, may approve those sections, as appropriate.

C. The ASI may approve the installation and the AFMS/RFMS for operational use of a multi-function system, as defined in paragraph 3M, Stand-Alone Equipment after ensuring satisfactory interoperability. The AFMS/RFMS must describe the GPS or GPS-WAAS receiver's functionality as combined with the VOR, localizer, and glideslope receivers, and/or communications transceivers contained within the multi-function system.

D. The ASI may also approve the installation and the same AFMS/RFMS for a multi-function system that interfaces with and performs control functions of an EHSI or, for example, display of terrain or TAWS, weather data, traffic alert and collision avoidance system (TCAS), or other traffic information. The functions of each interface must be independently assessed by the applicant to determine if operating limitations need to be placed on the aircraft, or if any abnormal and emergency procedures, normal operating procedures, and aircraft performance are affected.

E. The applicant should also assess the interface applications, such as with weather radar or TCAS as required equipment under §§ 121.356 or 121.357, or §§ 135.175 or 135.180, to determine if the multi-function system meets the appropriate requirements for display of such information. The ASI may either approve (or disapprove) those portions of the AFMS/RFMS that apply to such interfaces.

F. GPS-WAAS equipment Classes 3 and 4 may be used to conduct instrument approaches to near Category I minima similar to certificated ILS by commissioning LPV to runways without marker beacon facilities. The ASI should be cautious in approving such alterations or limiting operational use of the GPS-WAAS to lateral coupled modes only, thus reserving LPV operational approval to STC procedures only. The approval of interfaces of GPS-WAAS systems with FGS intended for LPV or other vertical navigation operations should be performed by the respective Aircraft Certification Office.

7. FIELD APPROVAL OF GPS OR GPS-WAAS EQUIPMENT FOR OCEANIC OR REMOTE AREA NAVIGATION.

A. An ASI may perform a field approval for installation and operational use of GPS equipment intended for navigation in oceanic and remote areas if such equipment meets the requirements of TSO-C129 or TSO-C129a, as well as the criteria of Notice 8110.60, GPS as a Primary Means of Navigation for Oceanic/Remote Operations, and subsequent Avionics Systems Branch (AIR-130) memorandum, or appendix 1 of AC 20-138A. GPS-WAAS equipment need not be evaluated against these criteria. If GPS equipment has not received approval for use as a primary means of navigation in oceanic or remote area operation by TC or STC process, then the respective Aircraft Certification Office should issue a separate letter of design approval stating that the equipment (including part number) and approved software prediction program (including revision number) meet the criteria stated in appendix 1 of AC 20-138A.

B. GPS-WAAS equipment meeting the requirements of TSO-C146a is inherently capable of supporting navigation in oceanic and remote areas, if the aircraft operator obtains an approved fault detection and exclusion (FDE) prediction program; no additional evaluation is necessary. The ASI must ensure that the aircraft operator has obtained such FDE program and ensure that the aircraft contains other required navigation equipment, in accordance with Notice 8110.60 or appendix 1 of AC 20-138A, before performing a field approval of GPS-WAAS equipment for operational use.

8. USE OF DER IN THE FIELD APPROVAL PROCESS.

A. The ASI should refer to FAA Order 8110.45, Use of Data Approved by Designated Engineering Representatives to Support Major Alterations, dated 08/30/02, if a properly delegated DER is authorized to approve data to support major alterations to TC'd products in cases where the alterations are to be approved by means other than TC or STC. A DER will find compliance with the regulations by determining that the applicable airworthiness standards have been satisfied during all processes of alteration to the aircraft.

B. Refer to AC 43-210, chapter 2, paragraph 202 for further details on the use of DERs in the field approval process.

9. PROGRAM TRACKING AND REPORTING SUBSYSTEM (PTRS) ENTRY. Use PTRS codes 5414, 5416, and 5446. Avionics ASIs responsible for reviewing data for all future GPS installations are requested to fill out the "National Use" block by inserting the letters "GPS" and a brief description of the type of GPS activity accomplished

in the “Comment Text” column. Alterations adding WAAS functionality should include the letters “WAAS” in addition to “GPS.”

10. INQUIRIES. This bulletin was developed by the Airmen and Avionics Branch, AFS-350. For questions or comments regarding this bulletin, contact AFS-350 at 202-267-3922.

11. EXPIRATION. This bulletin will remain in effect until further notice.

ORIGINAL SIGNED BY
Ferrin Moore for

David E. Cann, Manager
Aircraft Maintenance Division