U.S. Department of Transportation
Federal Aviation Administration

Advisory Circular

Subject: 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

Date: 12/14/94 **AC No:** 90- 94
Initiated By: AFS-800/400 **Change:**

1. PURPOSE. This advisory circular (AC) contains guidance for pilots to use Global Positioning System (GPS) equipment during instrument flight rules (IFR) navigation. It includes operating en route, in the terminal environment, during nonprecision instrument approach procedures in the U.S. National Airspace System (NAS), and in oceanic areas. Emphasis is placed on the GPS approach overlay program. This document is advisory only and not mandatory.

2. RELATED READING MATERIAL. The guidelines within this AC complement the following documents:

a. RTCA No. RTCA/DO-200, November 18, 1988, "Preparation, Verification and Distribution of User-Selectable Navigation Data Bases."

b. RTCA No. RTCA/DO-208, July 1991, "Minimum Operational Performance Standards for Airborne Supplemental Navigation Equipment Using Global Positioning System (GPS)."

c. Technical Standard Order (TSO) C129, December 10, 1992, "Airborne Supplemental Navigation Equipment Using the Global Positioning System (GPS)."

d. FAA Advisory Circular 20-138, May 25, 1994, "Airworthiness Approval of Global Positioning System (GPS) Navigation Equipment for Use as a VFR and IFR Supplemental Navigation System."

e. FAA Order 8260.38, December 14, 1993, "Civil Utilization of Global Positioning System."

3. BACKGROUND. The Department of Defense (DOD) originally developed and deployed GPS as a space-based positioning, velocity, and time system for the military. The DOD is responsible for operating the GPS satellite constellation and constantly monitors the satellites to ensure proper operation. The GPS system permits earth-centered coordinates to be determined and provides aircraft position referenced to the DOD World Geodetic System of 1984 (WGS-84). Navigational values, such as

distance and bearing to a waypoint and ground speed, are computed from the aircraft's current position (latitude and longitude) and the location of the next waypoint. Course guidance is provided as a linear deviation from the desired track of a Great Circle route between defined waypoints.

(1) The rapid development of this technology and the establishment of Technical Standard Order (TSO) C129, "Airborne Supplemental Navigation Equipment Using the Global Positioning System (GPS)", has made possible the first civil aviation use of GPS in IFR procedures.

(2) TSO C 129 sets the minimum performance standards that GPS airborne supplemental area navigation equipment must meet to operate in the U.S. NAS during en route, terminal, and nonprecision approach procedures. ***Note:*** *equipment approved to TSO C115a does not meet the requirements of TSO C129.*

(3) The Department of Defense (DOD) declared initial operational capability (IOC) of the U.S. GPS on December 8, 1993. The FAA then issued a notice to airmen (NOTAM) on February 17, 1994, declaring GPS operational for certain civil IFR applications. A NOTAM, issued March 3, 1994, specified the applications.

4. DEFINITIONS. Since this AC contains several technical terms which may not be familiar to the new GPS user, a list of definitions can be found in the Glossary, Appendix 2.

5. COMMENTS INVITED. Comments regarding this publication should be directed to the following address:

Federal Aviation Administration
General Aviation and Commercial Division, AFS-800
Flight Standards Service
800 Independence Avenue, S.W.
Washington, D.C. 20591

Comments may not require a direct acknowledgment to the commentor; however, they will be considered in the development of upcoming revisions to AC's or other related technical material.

CONTENTS

SECTION 1. GENERAL.

1. BACKGROUND. Satellite navigation systems provide global navigation that fully meets the civil aviation requirements for use as the primary means of navigation. Developments in satellite technology and its use for aircraft navigation are such that it may be expected that several satellite navigation systems will evolve in the future, each with its own unique characteristics. The International Civil Aviation Organization (ICAO) has adopted "Global Navigation Satellite System (GNSS)" as an umbrella term to identify any satellite navigation system where the user performs onboard position determination from satellite information. When this Advisory Circular (AC) was written, only two systems had filed with the International Frequency Registration Board (IFRB): the Global Positioning System (GPS) developed by the United States and the Global Orbiting Navigation Satellite System (GLONASS) now under development by the Federation of Russia. This AC provides guidance for the use of satellite navigation in the U.S. National Airspace System (NAS) and oceanic navigation. The terminology and guidelines are limited to the U.S. developed GPS technology. This document does not address the use of other GNSS systems in the U.S. NAS, nor the use of GPS in other civil aviation authority airspace.

2. SYSTEM DESCRIPTION. GPS consists of three distinct functional elements: space, control, and user. GPS utilizes range measurements from the satellites to determine a position anywhere in the world.

a. The space element consists of 24 Navstar satellites. This group of satellites is called a constellation. The satellites are in six orbital planes (with four in each plane) at about 11,000 miles above the earth. At least four satellites are in view at all times. The GPS constellation broadcasts a pseudo-random code timing signal and data message that the airborne equipment processes to obtain satellite position and status data. By knowing the precise location of each satellite and precisely matching timing with the atomic clocks on the satellites, the airborne receiver can accurately measure the time each signal takes to arrive at the receiver and, therefore, determine aircraft position.

b. The control element consists of a network of GPS monitoring and control stations that ensure the accuracy of satellite positions and their clocks. In its present form, it has five monitoring stations, three ground antennas, and a master control station.

c. The user element consists of antennas and receiver-processors onboard the aircraft that provide positioning, velocity, and precise timing to the user.

d. A minimum of three satellites must be in view to determine lateral guidance (2D position). Four satellites must be in view to provide both lateral and vertical guidance (3D position).

3. GPS IN THE NATIONAL AIRSPACE SYSTEM (NAS)

a. General. GPS Instrument Flight Rules (IFR) operations for en route (oceanic and domestic), terminal, and nonprecision approach phases of flight can be conducted when GPS avionics approved for IFR are installed in the aircraft. This equipment should be installed in accordance with AC 20-138 and the provisions of the applicable Approved Flight Manual (AFM) or Flight Manual supplement should be met. The required integrity for these operations is provided by Receiver Autonomous Integrity Monitoring (RAIM), or an equivalent method. For air carrier operations, operations specification approval is required to use GPS.

b. Oceanic En Route. Aircraft using GPS equipment under IFR must be equipped with an approved and operational alternate means of navigation (such as VOR, NDB, or an approved long range navigation system such as LORAN or OMEGA) appropriate for the intended route to be flown. Active monitoring (cross checking) of the alternate equipment is not necessary for installations which use RAIM for integrity monitoring. For these systems, active monitoring by the flightcrew is only required when the RAIM capability is lost.

Note: Outside of the National Airspace System (NAS), GPS may be used as a Long Range Navigation System (LRNS). On those routes requiring two long range navigation systems, a GPS installation with TSO C-129 authorization in Class A1, A2, B1, B2, C1, or C2 may be used to replace or supplement one of the other approved means of LRNS's, such as one unit of a dual INS or one unit of a dual Omega system. On those routes requiring a single LRNS, a GPS unit which provides for integrity monitoring may be used as the LRNS and active monitoring of the alternate equipment is only required when the RAIM capability is lost. GPS may not be approved in other countries. Pilots should ensure that GPS is authorized by the appropriate sovereign state prior to its use within that state.

c. Domestic En Route. The aircraft must also have navigational equipment installed and operational that can receive the ground-based facilities required for the route to the destination airport and any required alternate. The ground-based facilities necessary for these routes must also be operational. These ground-based systems do not have to be actively used to monitor the GPS avionics unless RAIM failure occurs. Within the contiguous United States, Alaska, Hawaii, and surrounding coastal waters, this requirement may be met with an operational independent VOR, NDB, TACAN, or LORAN-C receiver in addition to the GPS system for IFR operation.

***Note:** GPS may not be approved for IFR use in other countries. Pilots should ensure that GPS is authorized by the appropriate sovereign state prior to its use.*

d. Terminal. GPS IFR operations for the terminal phases of flight, Standard Instrument Departures (SIDs), and Standard Terminal Arrival Routes (STARs) should be conducted the same as existing RNAV procedures dictate. The aircraft also must have navigational equipment installed and operational that can receive all the ground-based facilities appropriate to the route of flight. The ground-based facilities necessary for these routes must also be operational; however, they do not have to be actively used to monitor the GPS avionics unless the RAIM fails.

e. Approach Overlay Program. To accelerate the availability of instrument approach procedures to be flown using certified GPS equipment, the FAA developed the GPS Approach Overlay Program. This program allows pilots to use GPS equipment to fly existing VOR, VOR/DME, NDB, NDB/DME, TACAN, and RNAV nonprecision instrument approach procedures. The approach overlay program is limited to U.S. airspace. GPS instrument approach operations outside the U.S. must be authorized by the appropriate sovereign state. The purpose of the approach overlay program is to permit pilots to transition from ground-based to satellite-based navigation technology for instrument approaches. GPS equipment may be used to fly all nonprecision instrument approach procedures that are retrieved from a database, except localizer, localizer directional aid (LDA), and simplified directional facility (SDF) approach procedures. Any required alternate airport must have an approved instrument approach procedure, other than GPS or LORAN-C, which is anticipated to be operational at the estimated time of arrival. The approach overlay program consists of three phases. Each phase has specific provisions and limitations as presented below.

(1) Phase I. This phase ended in February 1994, the date when the FAA declared GPS operational for civil operations.

(2) Phase II. This phase began on February 17, 1994 when the FAA declared the system suitable for civil operations. Certified GPS equipment can be used as the primary IFR flight guidance to fly an overlay to an existing nonprecision approach without actively monitoring the applicable navaid(s) which define the approach being used. However, the underlying ground-based navaid(s) required for the published approach must be operational and the associated avionics must be installed and operational. The avionics need not be operating during the approach if RAIM is providing integrity. Pilots can tell that Phase II applies because "GPS" is not included in the title of the approach.

(3) Phase III. Phase III began April 28, 1994, when the first instrument approach procedures were published to include "or GPS" in the title of the published approach procedure. Neither the aircraft traditional avionics nor the underlying ground station navaid(s) need be installed, operational, or monitored to fly the nonprecision approaches at the destination airport. For GPS systems that do not use RAIM for integrity, the ground-based navaid(s) and the airborne avionics that provide the equivalent integrity must be installed and operating during the approach. For any required alternate airport, the traditional ground-based and airborne navigational equipment that defines the instrument approach procedure and route to the alternate must be installed and operational.

f. GPS Stand Alone Approaches. Stand alone nonprecision approaches, which are not overlaid on an existing approach, are the next step beyond the overlay program. The first stand alone GPS approaches were published on July 21, 1994. The airborne and ground-based navaid requirements are the same for GPS stand alone approaches as for Phase III overlay approaches.

g. Overlay and Stand Alone Approaches. There will continue to be a mixture of nonprecision Phase II, Phase III, and GPS stand alone approaches in the U.S. NAS for some time. Most nonprecision instrument approach procedures in the U.S. (except localizer, LDA, and SDF) are available under Phase II of the overlay program. Eventually, these approaches may become Phase III approaches as they change to include "or GPS" in their titles. Additionally, the FAA will continue to develop and authorize stand alone GPS approaches.

4. GPS EQUIPMENT CLASSES A(), B(), AND C(). GPS equipment is categorized into the following classes:

a. Class A(). Equipment incorporating both the GPS sensor and navigating capability. This equipment incorporates Receiver Autonomous Integrity Monitoring (RAIM). Class A1 equipment includes en route, terminal, and nonprecision approach (except localizer, localizer directional aid (LDA), and simplified directional facility (SDF)) navigation capability. Class A2 equipment includes en route and terminal navigation capability only.

b. Class B(). Equipment consisting of a GPS sensor that provides data to an integrated navigation system (i.e. flight management system, multi-sensor navigation system, etc.). Class B1 equipment includes RAIM and provides en route, terminal, and non-precision approach (except localizer, LDA, and SDF) capability. Class B2 equipment includes RAIM and provides en route and terminal capability only. Class B3 equipment requires the integrated navigation system to provide a level of GPS integrity equivalent to RAIM and provides en route, terminal, and non-precision approach (except localizer, LDA, and SDF) capability. Class B4 equipment requires the integrated navigation system to provide a level of GPS integrity equivalent to RAIM and provides en route and terminal capability only

c. Class C(). Equipment consisting of a GPS sensor that provides data to an integrated navigation system (i.e., flight management system, multi-sensor navigation system, etc.) which provides enhanced guidance to an autopilot or flight director in order to reduce flight technical errors Class C1 equipment includes RAIM and provides en route, terminal, and nonprecision approach (except localizer, LDA, and SDF) capability. Class C2 equipment includes RAIM and provides en route and terminal capability only. 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 (except localizer, LDA, and SDF) capability. Class C4 equipment requires the integrated navigation system to provide a level of GPS integrity equivalent to RAIM and provides en route and terminal capability only.

GPS IFR EQUIPMENT CLASSES/CATEGORIES (TSO-C129)						
Equipment Class	RAIM	Integrated Navigation System to Provide RAIM Equivalent	Oceanic	En Route	Terminal	Non-Precision 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 nav. system (as in Class B) which provide enhanced guidance to an autopilot, or flight director, to reduce flight technical errors enhanced guidance to an autopilot, or flight director, to reduce flight technical errors						
C1	yes		yes	yes	yes	yes
C2	yes		yes	yes	yes	no
C3		yes	yes	yes	yes	yes
C4		yes	yes	yes	yes	no

Figure 1. GPS Equipment Classes

5. GPS SYSTEM ACCURACY/ERRORS. GPS equipment determines its position by precise measurement of the distance from selected satellites in the system, and the satellites' known location. Accuracy measurements are affected by satellite geometry which multiplies the effect of other errors in the system, slight inaccuracies in the satellite clocks, receiver processing, signal reflections, and predictions of current satellite position that are transmitted to the receiver in the satellite data message.

a. Selective Availability (SA). A method by which the DOD can artificially create errors in the signals from the satellites. This feature is designed to deny a potential enemy the use of precise GPS positioning data. This is the largest source of error in the GPS system. When SA is active, the DOD guarantees that the horizontal position accuracy will not be degraded beyond 100 meters (328 feet) 95 percent of the time and 300 meters (984 feet) 99.99 percent of the time.

b. Reducing Errors. The accuracy of GPS position data can be affected by equipment and the satellite geometry being received. Many of these errors can be reduced or eliminated with mathematics and sophisticated modeling provided by the airborne receiver. Other sources of error cannot be corrected.

SECTION 2. AIRBORNE NAVIGATION DATABASES.

1. REQUIREMENT FOR A DATABASE. To conduct IFR operations using GPS equipment to navigate in the U.S. NAS and oceanic airspace, the aircraft GPS equipment must include an updatable navigation database. That database will support en route and terminal operations; or en route, terminal, and nonprecision instrument approach (except localizer, LDA, and SDF) operations.

a. Geographic Area of Content. Airborne navigation databases contain data covering the geographic areas where GPS navigation systems have been certified for IFR use. Data may cover large geographic areas or small user-defined areas within the U.S. NAS and related oceanic areas.

b. Database Description. GPS airborne navigation databases are provided initially by the receiver manufacturer and updated by the manufacturer or a designated data agency. The databases contain records of location information by latitude and longitude to a resolution of 0.01 minutes or better for the area(s) in which IFR operations are approved. The database is user selectable which allows the pilot to make specific selections during flight operations to support navigational needs. The database may also be user defined in that the information is tailored to the requirements of a user.

Note: *Manual entry/update of data in the navigation database shall not be possible. (This requirement does not prevent the storage of "user-defined data" within the equipment.)*

c. Update of Data. Waypoint information is provided and maintained by the National Flight Data Center (NFDC). The data is typically updated at regular intervals such as the internationally agreed upon Aeronautical Information Regulation and Control (AIRAC) cycle of every 28 days.

d. Geodetic Reference Datum. The GPS equipment derives position information referenced to the World Geodetic System of 1984 (WGS-84). Databases produced for use in the contiguous United States, Alaska, and Hawaii contain coordinates of location information referenced to the North American Datum of 1983 (NAD 83). For this Advisory Circular, coordinates of locations referenced to NAD 83 are compatible with the coordinates of the same locations referenced to WGS-84.

2. EN ROUTE (OCEANIC AND DOMESTIC) AND TERMINAL NAVIGATION. Navigation databases supporting GPS equipment certified for en route (including en route oceanic and en route domestic) and terminal operations contain, as a minimum, all airports, VORs, VORTACs, NDBs, and all named waypoints and intersections shown on en route and terminal area charts, SIDs, and STARs. The databases incorporate information from the geographic areas of the contiguous United States, Alaska, Hawaii, and surrounding coastal waters including waypoints and intersections for oceanic flight between the United States and Hawaii. For oceanic flights outside the NAS, user selectable data is available for most GPS receivers.

a. In the terminal area, the database will include waypoints for SIDs and STARs as well as other flight operations from the beginning of a departure to the en route structure or from an en route fix to the beginning of an approach procedure.

b. All named waypoints are identified with a five-letter alpha character name provided by the NFDC. Waypoints unnamed by the NFDC, such as a DME fix, are assigned a coded name in the database (refer to the sample approach plates in Appendix 1)..

c. Waypoint latitude and longitude coordinates are typically displayed in degrees, minutes, and tenths of minutes or hundredths of minutes. However, this may vary between equipment manufacturers.

3. INSTRUMENT APPROACH PROCEDURE NAVIGATION. In addition to the data which supports en route and terminal operations, a navigation database that supports GPS overlay nonprecision instrument approaches (except localizer, LDA, and SDF) contains coordinates for the waypoints, fixes, and navaids published in FAR Part 97, Standard Instrument Approach Procedures. Special instrument approach procedure data may be included at the request of those operators authorized to use the procedures. Data for approach procedures into military airports also may be included if the procedures are available, and authorized for civil operations. In addition, all waypoints to support GPS stand alone approaches are also contained in the database.

4. THE GPS APPROACH OVERLAY PROGRAM. The navigation database coding should not change during any phase of the GPS Approach Overlay Program, except for modifications necessary to support changing rules and/or technology. Approaches coded into the database are limited to U. S. airspace. Approaches for other airspace will not be included until authorized by the FAA as well as the appropriate sovereign authority. Whether or not an approach is included in the database depends on its codability and flyability using GPS equipment. Therefore, FAR Part 97, military, and special approaches are classified into codable and non-codable nonprecision instrument approaches.

Note: *An aircraft is not authorized to fly any IFR approach using GPS unless that instrument approach procedure is retrievable from the navigation database.*

a. Codable Approach Procedures. The navigation database contains latitude and longitude coordinates for waypoints, fixes, and navaids for those FAR Part 97 civil use, and military, nonprecision approaches considered codable for database purposes and considered safe to fly by the FAA using normal piloting techniques. Special approaches may be included at authorized user request.

b. Non-Codable Approach Procedures. Certain FAR Part 97 nonprecision instrument approaches as well as some military and special procedures may present an unresolvable coding situation relating to database or equipment interface constraints. An approach may be determined to be not codable or not flyable by the regulatory agency having jurisdiction (FAA), by the database coding agency, or by the manufacturer of the navigation equipment. In addition, some procedures may, in the opinion of the FAA, present a potential safety hazard to normal piloting techniques using GPS equipment. These procedures will not be included in navigation databases. Approach procedures that are omitted from the database can not be legally flown using GPS navigation equipment.

c. Waypoints. As a minimum, the GPS Approach Overlay Program requires that the databases contain waypoints representing the IAF, FAF, MAP, and the missed approach holding point for each VOR, VOR/DME, NDB, NDB/DME, TACAN, and RNAV nonprecision instrument approach procedure. Intermediate Fixes (IFs) and all named fixes are also included. All waypoints are displayed in the same sequence as they are presented on the published nonprecision instrument approach procedure charts.

Note: *User modification or entry of data associated with published instrument approach procedures is not possible, and not authorized.*

(1) Waypoint data utilized in nonprecision instrument approach procedures is stored by name or ident, and latitude and longitude. The waypoints are not designated in terms of bearing (or radial) and distance to/from a reference location.

(2) Waypoints that define the MAP and Missed Approach Holding Point (MAHWP) are always coded as "fly over." This type of waypoint requires the aircraft to pass directly over it.

(3) When turn anticipation is expected at an IAF or other waypoint the waypoint is coded as "fly by."

d. Waypoint Names Coded in the Navigation Database. Flying an FAR Part 97 or military nonprecision instrument approach procedure using GPS equipment should be transparent to air traffic control. Therefore, if a pilot has a clearance for the VOR/DME to runway 35, the same track is flown whether using GPS equipment or VOR and DME equipment. Therefore, waypoints coded in the navigation database reflect exactly those names appearing on the instrument approach procedure. For example, if an IAF or other fix is assigned a pronounceable five-letter alpha character name, it will be the same name coded in the database, the name which will appear on the avionics display, the name appearing on a chart, and the name verbally used by ATC. If no five character name is published for the approach waypoint or fix, it will normally be coded with a database identifier. A pilot must associate the coded name appearing on the display with the position shown on the chart. However, these coded names may not be known or used by ATC.

(1) Initial Approach Waypoint.

(i) If the IAF is a named waypoint or fix, then the same name is used for the IAF waypoint in the database. If the IAF is a navaid, the IAF waypoint is coded with the navaid identifier.

(ii) A database identifier is provided for an unnamed IAF.

(iii) When an IAF is the beginning of a DME arc segment, the IAF is often unnamed, but is marked by a radial intersecting the arc. In these cases, the unnamed IAF waypoint is coded in the database to represent the beginning of the DME arc. An example of one method of identifying the beginning of the arc is shown in the Lake Charles, LA chart example in Appendix 1.

(2) Turnings points in the Initial Segment. An initial segment may incorporate a named or unnamed turn point to intercept a course.

(i) In some cases, a waypoint may be established at a turn point where a dead reckoning heading intersects the course. This waypoint is coded into the waypoint sequence for GPS navigation, but may not be named on a chart.

(ii) A turn point may be defined by the intersection of two navaid radials or bearings. In this case, a waypoint name appears in the sequence.

(3) Intermediate Waypoint. If the IF is a named waypoint or fix, then the same name is used for the IF waypoint in the database. If the IF is a navaid, the IF waypoint is coded with the navaid identifier. An unnamed IF is assigned a database identifier.

(4) Final Approach Waypoint.

(i) Procedures With a Final Approach Fix (FAF). If the FAF is a named waypoint or fix, the same name is used for the FAF waypoint in the database sequence. If the FAF is a navaid, the waypoint is coded with the navaid identifier in the waypoint sequence. An unnamed FAF, such as a DME fix, is coded with a descriptive FAF waypoint related to the navaid providing final approach course guidance. It also appears in the waypoint sequence.

(ii) Procedures Without a Final Approach Fix. Procedures without a FAF and without a stepdown fix have a Sensor FAF waypoint coded in the database at least 4nm to the MAP waypoint. (The MAP, in this case, is always located at the navaid facility.) A Sensor FAF is a final approach waypoint created and added to the database sequence of waypoints to support GPS navigation of an FAA published, no-FAF, nonprecision instrument approach procedure. The coded name or Sensor FAF appears in the waypoint sequence. If a stepdown fix exists on the published procedure and it is greater than 2nm to the MAP, the stepdown fix is coded in the database as the Sensor FAF waypoint for the waypoint sequence. If a stepdown fix distance is 2nm or less to the MAP, a Sensor FAF waypoint is coded at least 4nm to the MAP.

(5) Missed Approach Waypoint. When a missed approach point is located at the navaid, the MAP waypoint is coded in the sequence at the navaid position using the navaid identifier. When the missed approach is initiated near the runway threshold (timed approach) or at a specified DME distance from a navaid, a MAP waypoint is created and coded in the database (see approach plates in Appendix 1).

(6) Missed Approach Holding Points. Missed approach holding points are normally at a navaid or named fix. Therefore, the navaid identifier or the fix name is coded in the database as the missed approach holding waypoint and appears in the waypoint sequence.

(7) Waypoints and Fixes not Coded for the GPS Approach Overlay Program. A Visual Descent Point (VDP) is a fix appearing on some published nonprecision approach procedures that is not included in the sequence of waypoints. Pilots are expected to use normal piloting techniques for beginning the visual descent. In addition, unnamed stepdown fixes in the final approach segment will not be coded in the waypoint sequence unless the stepdown fix is used as a Sensor FAF on a no-FAF procedure.

e. Approach Selection Process/Menu Sluing. Pilots normally retrieve instrument approach procedures from the database through a menu selection process. An example of a menu selection is included in the Pilot Operations/Procedures section of this AC. No manual waypoint loading will be required or allowed, although some pilot action is required during certain segments of the approach.

Note: *This process may vary from one avionics manufacturer to another; therefore, pilots must be thoroughly familiar with the FAA Approved Flight Manual or Flight Manual supplement.*

f. Waypoint Sequence. The sequence of waypoints in the database and those displayed by the equipment will consist of, as a minimum, waypoints representing the selected IAF and its associated IFs (when applicable), FAF, MAP, and the MAHWP.

g. Relationship of Avionics Displayed Waypoints to Charted Data. The GPS Approach Overlay Program waypoints contained in the database represent the waypoints, fixes, navaids, and other points portrayed on a published approach procedure beginning at the initial approach fix. Certain unnamed points and fixes appearing on a chart are assigned a database identifier. There is no requirement to furnish charts with these database identifiers; however, charting agencies may incorporate them at their discretion.

Note: *Database identifiers should not be used for pilot/controller communications and flight planning.*

h. Differences Between Displayed and Charted Navigation Information. There may be slight differences between the navigation information portrayed on the chart and the GPS navigation display. Course differences will occur due to an equipment manufacturer's application of magnetic variation. Distance differences will occur due to the mismatch between GPS ATD values and the DME values published on underlying procedures.

5. THE GPS STAND ALONE APPROACH. A sequence of waypoints defining the point to point track to be flown will be coded in the database including the initial approach waypoint, intermediate waypoint, final approach waypoint, missed approach waypoint, missed approach turning waypoint, and missed approach holding waypoint. All waypoints, except a missed approach waypoint at the runway threshold, will be named with a five-letter alpha character name. Missed approach waypoints at the threshold will be assigned a database identifier. The sequence of waypoints appearing in the display should be identical to the waypoint sequence appearing on an associated approach chart.

SECTION 3. PILOT OPERATIONS/PROCEDURES.

1. APPLICABILITY.

a. The guidance provided in this AC applies to instrument rated pilots using GPS and operating under Federal Aviation Regulations (FAR) Part 91.

b. Pilots conducting GPS IFR operations under FAR Parts 121, 129, and 135 should meet the appropriate provisions of their approved operations specifications.

2. PREFLIGHT.

a. General. All GPS IFR operations should be conducted in accordance with the FAA Approved Flight Manual (AFM) or Flight Manual Supplement. Prior to an IFR flight using GPS, the pilot should ensure that the GPS equipment and the installation are approved and certified for the intended IFR operation. The equipment should be operated in accordance with the provisions of the applicable AFM. All pilots must be thoroughly familiar with the GPS equipment installed in the aircraft and its limitations.

b. GPS Receivers. The pilot should follow the specific start-up and self-test procedures for the GPS receiver as outlined in the FAA AFM or Flight Manual Supplement.

c. NOTAMs. Prior to any GPS IFR operation, the pilot should review the appropriate NOTAMs. NOTAMs will be issued to announce outages for specific GPS satellite vehicles, by pseudo random noise (PRN) number and satellite vehicle number (SVN). GPS NOTAMs are issued under the identifier "GPS". Pilots may obtain GPS NOTAM information by request to the FSS briefer or by requesting NOTAMs, using the identifier "GPS", through the Direct User Access Terminal System (DUATS). Pilots should review the NOTAMs for the underlying approach procedure. When executing a Phase II approach, pilots should ensure the ground-based facilities upon which the approach is based are operational. If an approach is not authorized due to an inoperative navigation facility, the associated Phase II GPS approach is not authorized.

d. The pilot must select the appropriate airport(s), runway/approach procedure, and initial approach fix on the aircraft's GPS receiver to determine RAIM integrity for that approach. Air Traffic Control specialists are not provided any information about the operational integrity of the system. This is especially important when the pilot has been "Cleared for the Approach." Procedures should be established by the pilot in the event that GPS navigation outages are predicted or occur. In these situations, the pilot should rely on other approved equipment, delay departure, or cancel the flight.

e. Aircraft that are navigating by GPS are considered to be RNAV-equipped aircraft and the appropriate equipment suffix should be included in the Air Traffic Control (ATC) flight plan. Most GPS equipment would file as a /R. Users should consult the latest edition of the Airmen's Information Manual (AIM) for the proper equipment suffix. If the GPS avionics becomes inoperative, the pilot should advise ATC and amend the equipment suffix.

3. EN ROUTE OCEANIC. Oceanic operation is defined as that phase of flight between the departure and arrival terminal phases with an extended flight path over oceanic areas. In addition to the

criteria outlined in paragraph 3.b.(1), the aircraft should be equipped with other approved means of navigation appropriate for the intended route of flight, such as INS or Omega. This navigation equipment must be operational, but it does not have to be actively monitored unless the RAIM capability of the system fails. The purpose of the backup system is to ensure that the flight has the capability to continue to the destination if something unforeseen occurs to the GPS constellation.

4. EN ROUTE DOMESTIC AND TERMINAL. Domestic en route operations are defined as that phase of flight between departure and arrival terminal phases, with departure and arrival points within the U.S. NAS. Terminal area operations include those flight phases conducted on charted Standard Instrument Departures (SIDs), on Standard Terminal Arrival Routes (STARs), or during other flight operations between the last en route fix/waypoint and an initial approach fix/waypoint. In addition to the criteria outlined in paragraph 3.b.(1), the following criteria applies:

a. Other navigation equipment should be installed and operational to receive the intended ground-based facilities which define the route to be flown to the destination and any required alternate.

b. Ground-based facilities which define these routes must also be operational.

c. Aircraft should be equipped with an approved and operational alternate means of navigation appropriate to the route being flown. This navigation equipment must be operational, but it does not have to be actively monitored unless the RAIM capability of the system fails. The purpose of these backup systems is to ensure that the aircraft can continue to the destination if something unforeseen occurs to the avionics or GPS constellation.

5. OVERLAY APPROACH. In order to accelerate the availability of nonprecision instrument approach procedures that can be flown using certified GPS equipment, the FAA has authorized the GPS Approach Overlay Program. This program allows pilots to use GPS equipment to fly existing VOR, VOR/DME, NDB, NDB/DME, and RNAV nonprecision instrument approach procedures. The purpose of this program is to permit pilots to transition from ground-based to satellite-based navigation technology for instrument approaches. Approach operations are defined as that phase of flight from the Initial Approach Fix (IAF) to the Missed Approach Point (MAP) when flying an established nonprecision procedure. The approaches to be flown with GPS must be retrieved from the avionics database. (Refer to Section 2, "Airborne Navigation Databases" for a more detailed description of the required database.) GPS equipment may be used to fly all codable nonprecision instrument approach procedures, except localizer (LOC), localizer directional aid (LDA), and simplified directional facility (SDF) approach procedures. Any required alternate airport should have an approved instrument approach procedure (other than GPS or LORAN-C) which is anticipated to be operational at the estimated time of arrival. The program has progressed through three phases. Each phase has specific provisions and limitations.

a. Phase I. This phase ended in February 1994 when the FAA declared GPS operational for civil operations.

b. Phase II. This phase began on February 17, 1994 when the FAA declared the system suitable for civil IFR operations. GPS equipment can be used as the primary IFR flight guidance during a nonprecision approach without actively monitoring the applicable navaid(s) which define the approach being used. However, the traditional ground-based navaid(s) required for the published approach and alternate should be operational and the associated avionics should be installed and operational. The avionics need not be operating during the approach if RAIM provides integrity for the approach.