CHANGE

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

Change 8 to 8200.1C

09/29/2013

SUBJ: United States Standard Flight Inspection Manual

1. Purpose of This Change. This change transmits revisions to the United States Standard Flight Inspection Manual (USSFIM), FAA Order 8200.1C; Department of the Army Technical Manual TM 95-225; Department of the Navy Manual NAVAIR 16-1-520; and Department of the Air Force Manual AFMAN 11-225, dated October 1, 2005.

2. Audience. Air Traffic Technical Operations Eastern, Central, and Western Service Areas; Flight Inspection Operations Offices and crewmembers in Aviation System Standards; Flight Standards Flight Technologies and Procedures Division; NAS Implementation Centers; and special military addressees.

3. Where Can I Find This Change? Go to http://www.faa.gov/regulations_policies/orders_notices/#browseTopics. Distribution within the Department of Defense is handled by the National Geospatial Intelligence Agency. For the U.S. Air Force, this revision is included in the AF STDPUBs CD-ROM and is available on the Internet (http://afpubs.hq.af.mil/).

4. Explanation of Policy Changes.

a. General: Incorporates the concept of "flight validation" in Chapters 6 and 13. Flight validation is a flight assessment of an instrument flight procedure concerned with factors other than the performance of a navigation aid or system. Evaluation of ARINC 424 coding is a prime focus of the validation process. Multiple paragraphs in Chapter 6 were moved and renumbered. A new section 6.11, "The Validation Process" was added, and all subsequent sections renumbered. The list below uses paragraph references as they appear in the new change.

b. Chapter 6, Paragraph 6.10 and 6.11. Defines the Validation Process, including the Preflight and Flight Validation of Instrument Flight Procedures. This brings Flight Inspection guidance up to date with current Flight Standards and ICAO practices.

c. Chapter 6, Paragraph 6.12a, b. Expanded and reorganized guidance on reviewing a procedure package.

d. Chapter 6, Paragraph 6.12c. Added details for conducting evaluations of RNAV IFPs using a flight simulator.

e. Chapter 6, Paragraph 6.12e. Changed guidance for verifying obstacle heights in flight to improve the accuracy code. It is no longer a routine action, and should only be done when all other avenues have been exhausted.

f. Chapter 6, Paragraph 6.13b (Checklist). Added Checklist item, "Runway Markings, Lighting, and Supporting Infrastructure." This was always required if you read the text, but not included in the checklist explicitly. Also moved the "Obstacle Verification" to the top to mirror the new organization in the chapter.

g. Chapter 6, Paragraph 6.13b (Checklist). Reworded Note 2 to improve clarity. Added Note 3 to emphasize conducting a surveillance check of associated VGSIs when possible. This is in keeping with the safety mitigations when VGSI periodics were eliminated.

h. Chapter 6, Paragraph 6.13c(1)(e). Removes the requirement to conduct an airborne obstacle verification when the entire procedure segment is above a *previously* established minimum IFR altitude.

i. Chapter 6, Paragraph 6.13c(2). Added guidance for obstacle evaluations of new or amended approach procedures.

j. Chapter 6, Paragraph 6.13c(3). Added guidance for obstacle evaluation during periodic inspections.

k. Chapter 6, Paragraph 6.13c(9)(c). Updated guidance for estimating the height of newly discovered obstacles. Do not attempt to measure obstacle heights in flight when other means are practical. If it is measured in flight, the preferred method is to use GNSS avionics to determine the altitude.

l. Chapter 6, Paragraph 6.13c(13). Added instructions for checking Advisory Vertical Guidance on non-precision approaches.

m. Chapter 6, Paragraph 6.13d. Expanded guidance for Airways, Routes, and Terminal Route Segments.

n. Chapter 6, Paragraph 6.13g. Allows for some segments of RNAV SIAP(s) based on GNSS to not be flown per the instructions found in Chapter 13.

o. Chapter 6, Paragraph 6.13g(3)(b). Flying to 100 feet below the MDA does not apply to GNSS-only RNAV SIAPs.

p. Chapter 6, Paragraph 6.13h. Expanded information on assessing flyability per AFS and ICAO guidance.

q. Chapter 6, Paragraph 6.13i. Moved and expanded paragraph on Departure Procedures. Updated terminology for departure procedures and graphical and textual obstacle departure procedures. Additional guidance for “low, close-in obstacles.”

r. Chapter 6, Paragraph 6.14b(3)(a). Added statement that “minor changes [to approach lighting] may not require a night evaluation.”

s. Chapter 6, Paragraph 6.14c. Changed assessment standard for human factors from, “a minimally qualified sole pilot flying an aircraft with basic IFR instrumentation…” to “the target user with the minimum required IFR instrumentation.” The intent is to allow for procedures designed for specific aircraft capabilities, and/or specific crew training. The wording still allows for the target user to be that minimally qualified sole pilot with basic instrumentation when applicable.

t. Chapter 6, Paragraph 6.15. Expanded language in general tolerance guidance to include factors associated with data-based RNAV instrument flight procedures.

u. Chapter 13, Paragraph 13.11.c. Pilot Defined Procedure requires FIS Technical Services guidance.

v. Chapter 13, Paragraph 13.11.d. Expands guidance for use of desk-top evaluation of ARINC 424 coding. With an in-depth ARINC 424 evaluation, with an approved desktop software and documentation, some procedural segments may not have to be flown.

w. Chapter 13, Paragraph 13.12.a. Checklist note (4) added requiring two miles of the intermediate segment to be flown for proper avionics approach activation.

x. Chapter 13, Paragraph 13.12.c.(1) "Low, close-in" obstacles addressed on departure procedures.

y. Chapter 13, Paragraph 13.12.c.(2) Updated radar coverage requirements.

z. Chapter 13, Paragraph 13.12.c.(3) Corrected wording on positioning aircraft for STAR vertical flyability from "steepest" to "shallowest descent path".

aa. Chapter 13, Paragraph 13.12.c.(4) Deleted requirement to fly 100' below MDA. This was a holdover from ground based navaids to check coverage. GPS coverage is from the surface of the earth and above. Added requirement to evaluate ARINC 424 coding providing VDA below MDA per guidance in Chapter 6.

bb. Chapter 13, Paragraph 13.31. The change allows that previously verified DME/DME coverage along the same routing and altitudes may be used in lieu of a new flight inspection. The change also recognizes that a valid DME/DME coverage prediction-modeling tool may be used in lieu of flight inspection for coverage verification on procedure and route segments at and above 18,000 feet.

cc. Chapter 13, Paragraph 13.42.c. Added guidance for offset LPV and LP procedures.

dd. Appendix 1. Added definitions for preflight validation and deletes geostationary earth orbit satellite.

PAGE CONTROL CHART

REMOVE PAGES	DATED	INSERT PAGES	DATED
Pages 6-i thru 6-9(and 10)	Various	Pages 6-i thru 6-22	09/29/2013
Pages 13-1 thru 13-18	Various	Pages 13-1 thru 13-20	09/29/2013
Pages A1-1 thru 1-44	05/30/11	Pages A1-1 thru 46	09/29/2013

*Page did not change

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CHAPTER 6. FLIGHT INSPECTION AND FLIGHT VALIDATION OF INSTRUMENT FLIGHT PROCEDURES

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CHAPTER 6. FLIGHT INSPECTION OF INSTRUMENT FLIGHT PROCEDURES

6.10 INTRODUCTION.

Instrument flight procedures (IFP) specify standard routings, maneuvering areas, minimum and/or procedural altitudes, and visibility minimums for instrument flight rules (IFR) operations. All new and revised procedures are subject to flight inspection and flight validation requirements.

a. General. Broadly defined, Flight Inspection is the quality assurance program which verifies that the performance of air navigation services and associated instrument flight procedures conform to prescribed standards throughout their published service volume. It can also be described as the operation of a suitably equipped aircraft for the purpose of calibrating ground-based NAVAIDs or monitoring the local performance of navigation systems like GNSS. Flight inspection is not meant to verify the accuracy of space-based navigation systems, but does evaluate signals in space for local degradation and interference. Flight Validation (FV) is part of the validation process, and is concerned with factors other than the performance of a navigation aid or system. FV is a flight assessment of a new or revised IFP to confirm that the procedure is operationally acceptable for safety, flyability, and design accuracy, including obstacle and database verification. It includes evaluation of any required infrastructure like, runway markings, approach and runway lights, communications, charting; factors that may affect the suitability of an instrument flight procedure for publication.

b. Characteristics. Instrument flight procedures include airways, jet routes, off-airway routes, standard instrument approach procedures (SIAP(s)), Authorization Required (AR) procedures, departure procedures (DP(s)), standard terminal approach routes (STAR(s)), and charted visual flight procedures (CVFP(s)). Classic flight procedures like ILS, LOC, VOR, NDB, SIDs and STARs are now being coded into RNAV navigation databases. When practical, these classic flight procedures should have the ARINC 424 procedural segments evaluated in the same manner as GNSS-based RNAV procedures.

c. Data Accuracy and Integrity. Procedural data accuracy is extremely important. Flight procedures utilizing ground-based NAVAIDS can be referenced to a surveyed terrestrial fixed antenna location. In contrast, RNAV flight procedures like, RNAV (GPS), RNAV (RNP), and those that utilize a Space-Based Augmentation System (SBAS) like Wide Area Augmentation System (WAAS) deliver the aircraft to a point in space based on the World Geodetic System of 1984 (WGS-84) geodetic datum.

(1) ARINC 424 Coding. RNAV procedures consist of sequenced ARINC 424 coded path terminators and waypoints. Use of a combination of different ARINC 424 leg path and terminators provides the desired ground track and vertical path of a procedure. This requires a very high integrity of all survey data used in the flight procedure and the navigation database used by the aircraft. Data integrity must be maintained at the highest level throughout the instrument procedure development and publication processes.

(2) Data Errors. There are many potential sources for data errors. Survey data errors are the most common. Terrain and obstacle data may be incomplete. Particular attention should be paid to data accuracy in the precision FAS Data Block for SBAS and GBAS flight procedures. Corruption of ellipsoid height data can adversely affect the flight path by displacing the glidepath forward or aft along the track of the intended design. An in-flight data collection system that enables real time, or post-flight, analysis must be used to validate that FAS data elements are providing navigation guidance consistent with the procedure design to the physical runway threshold or the fictitious threshold point. Conversions between geodetic reference systems can induce errors. For example, vertical datum differences between NAD-83 and WGS-84 can result in positioning errors causing the actual threshold crossing height (TCH) for WAAS LPV procedures to be higher or lower than designed. All the procedural and design data used for a Ground-Based Augmentation System (GBAS) procedure must be referenced in the same datum. Input errors, especially to the Final Approach Segment (FAS) Data Block, can result in significant changes to the flight path in relation to the runway. Outdated data may be used by mistake. When a runway is shortened, lengthened, or moved the survey data must be updated. Using the wrong data may cause actual TCH and runway alignment to be different than intended by procedure design.

d. Inspector Authority. At commissioning, the flight inspector has the discretion to reject the procedure if it does not constitute a satisfactory maneuver from a human factors/ flyability standpoint. Concerns must be resolved with the procedure designer and/or supervisory personnel prior to commissioning. During subsequent checks of a commissioned procedure, new obstructions, signal problems, or other safety concerns constitute reason for a flight inspector to deny or modify a procedure by NOTAM. Human factors/ flyability concerns during subsequent checks must be resolved with the procedure designer and/or supervisory personnel before any changes are issued.

6.11 THE VALIDATION PROCESS

The purpose of validation is to obtain a qualitative assessment of procedure design including obstacle, terrain and navigation data, and provides an assessment of the procedure’s flyability. The validation process begins during the procedure development phase and includes an in-depth quality assurance (QA) review of the development criteria and documentation. Once the ground validation internal to the design organization is complete, the procedure is forwarded to the Flight Inspection organization to continue the process with Preflight Validation. The flight inspection validation process normally consists of Preflight Validation, Flight Validation, and Post-Flight Analysis.

a. Preflight Validation. Preflight Validation begins when the procedure package is received by flight inspection. In this phase of the process, the information provided is validated and potential errors in the procedure design are identified. The goal of Preflight Validation is to become familiar with the specific details of the procedure, identify potential errors in the procedure design from an operational perspective, and note deviations from criteria and documentation. The intention is to evaluate on the ground, to the extent possible, those elements that will be evaluated in the Flight Validation phase. When deemed necessary by Flight Standards, complex IFPs, or those utilizing non-standard criteria will be evaluated in a simulator. The simulator evaluation must be done in a FAA-qualified Level "C" or Level "D" flight simulator capable of flying the procedure. Simulator evaluations of other IFPs should be conducted where evaluation of special design or operational conditions are desired. Resolve any issues with the procedure designer before proceeding to Flight Validation.

b. Flight Validation. FV requires a flight assessment in a suitably equipped aircraft to confirm the procedure is operationally acceptable for safety, flyability, and design. The procedure must be flown in the relevant navigation mode required by the design. The objectives of FV include: flyability and overall safety; final assurance of adequate obstacle clearance; verification that the navigation data is correct and results in the designed flight path; and, verification that all required infrastructure is in place and operative. For complex procedures, additional flyability checks may be required in the proponent's aircraft or simulator.

c. Post-Flight Analysis. Post-flight analysis and documentation completes the validation process. Record the flight and navigational parameters during FV. RNAV procedures with FAS data blocks require data analysis to verify navigation data accuracy and integrity, as well as proper flight track performance, both laterally and vertically. See Chapter 13 and 17 of this order for SBAS and GBAS FAS data block analysis requirements. A determination of satisfactory or unsatisfactory results should be made, along with ensuring the completeness and correctness of the procedure package. All recorded electronic data and the final report should be archived.

6.12 PREFLIGHT REQUIREMENTS

a. Data and Procedure Package Requirements

(1) The procedure design organization initiating the procedure must provide all data necessary for conducting the flight inspection/validation. If there are special factors relative to the procedure, someone from the design organization should brief the flight inspector.

(2) Procedural data must include the following as a minimum:

(a) Charts of sufficient detail to safely navigate and identify considerable terrain, and obstructions.

(b) Identification of controlling terrain or obstructions for each segment.

(c) Minimum (and maximum where applicable) altitudes determined to be usable from map study and data base information for each segment of the procedure.

(d) Narrative description of the procedure.

(e) Plan and profile views for SIAP(s).

(f) Data for each fix, intersection, waypoint and holding pattern.

(g) Airport markings and any special local operational procedure. Examples include noise abatement, non-standard traffic patterns, lighting, and lighting activation.

(h) Training, operational, or equipment procedure specific requirements.

(i) ARINC 424 path/ terminator coding.

(j) FAS data, including CRC for SBAS or GBAS procedures.

(k) Identify "active," "pending," or "historical" status of data used. The effective dates of data used in the procedure design must coincide with the 56-day AIRAC charting date.

(3) The procedure package must contain the minimum data to conduct a validation. Data documented on FAA 8260-XX forms should be used as a baseline for required information. Flight procedures that are to be published in a navigation database must include an appropriate ARINC 424 coded record. Resolve any issues with the procedure developer prior to evaluating the procedure. Procedure packages with inadequate information will be returned to the developing organization along with a list of specific deficiencies.

A procedure package for a "Special" flight procedure must also contain any waiver requests, special equipment requirements, and other pertinent information. When checking a "Special" IFP, an understanding of the mitigating measures used to provide an equivalent level of safety for the deviations from standard procedure design criteria is necessary to make an effective evaluation of obstructions, flight path segments and any ARINC 424 coding for the flight procedure.

b. Review of the Procedure Package. The inspector should perform the following tasks as a minimum. More details for RNAV procedures can be found in Chapter 13 of this order.

(1) Ensure completeness of the package, all the forms, files and data included, and check for the use of any 'pending' data reflecting changes to the runway or landing area.

(2) Review the procedure design constraints, requirements and intended use, including any requirements for special aircraft equipment or flight conditions, and any waivers to standard design criteria.

(3) Verify procedure graphics and documented data are consistent.

(4) Ensure ARINC 424 coding, if applicable, is consistent between electronic data files and procedure design.

(5) Verify controlling and secondary obstacles are properly identified..

(6) Determine the need for flight inspection of NAVAIDS, including fixes using ground-based navigation aids, that may support the procedure, and review any pertinent flight inspection reports

(7) Ensure fix naming is not spelled or pronounced similarly in a way that can be confused by a pilot.

c. Simulator Evaluation. Instrument flight procedures will be evaluated in a FAA-qualified Level “C” or Level “D” flight simulator capable of flying the procedure, when deemed necessary by Flight Standards. In addition to an in-flight evaluation, a simulator evaluation is recommended for complex procedures or procedures not compliant with standard criteria. A simulator evaluation can provide an assessment of database coding and flyability. Preparation for the simulator evaluation should include a comprehensive plan with description of the conditions to be evaluated, profiles to be flown and objectives to be achieved. When a simulator evaluation is accomplished, the results should be reviewed prior to flying the procedure. Any simulator GPWS alerts should be noted for in-flight evaluation.

NOTE

For Special PBN IFP that are designed for a specific make/model/series of aircraft and a specific FMS, software part number, software version, and revision, the simulator must match those requirements exactly.

A simulator evaluation should include the following as a minimum:

- Comparison of FMS navigation database and source documents, including proper ARINC 424 coding
- Documentation of the simulator aircraft information, including FMS software version
- Assessment at maximum designed speeds
- Assessment of descent gradients and use of deceleration segments
- Assessment at maximum worse case designed wind limits
- Assessment at maximum and minimum designed temperature limits
- Confirmation that the flight track matches the procedure design
- Flyability and Human Factors considerations
- Note the maximum bank angle achieved during any RF segments
- For each approach segment document the wind component and temperature conditions, and as appropriate, the heading/ track, distance, GPWS alerts, and flight path angle in the final segment

d. Applicable Navigation System Support. The variation in systems dictates a progressive approach in determining evaluation methods. Study of the procedure by the flight crew prior to flight will normally reveal the type of system(s) requiring inspection. References in this chapter are for clarification only and do not supersede instructions, criteria, or tolerances for facilities or systems contained elsewhere in this order.

(1) The flight inspection of an instrument flight procedure and verification of the SIAP obstacle data may be conducted during the applicable system inspection if the inspection is conducted during daylight hours and in VMC conditions.

(2) A restricted NAVAID may still support an instrument flight procedure when the procedure does not use the out-of-tolerance area. Those areas must be reflected on the flight inspection report and on the facility data sheet where performance will restrict or limit the expected procedure.

(3) A DME arc segment may be used in areas of unusable VOR radial information, provided that the DME, the radial where the arc starts, the lead radial, the final approach radial, and any other radial used in the procedure meet required tolerances.

(4) Prior to flight, the flight inspector must verify that all supporting equipment or systems are in place and functioning, including NAVAID(s) and GNSS. NOTAM(s), GPS service interruptions and interference testing should be considered. Solar storm activity may adversely affect GBAS/WAAS availability. See Chapter 13 of this order for more guidance concerning GNSS based procedures.

e. Obstacle Accuracy Verification. A procedure package may include a request to verify a known obstacle's height and location in order to refine the accuracy code and possibly allow for lower approach minimums. Normally this task can be performed most accurately from the ground. However, the location of the obstacle or a lack of resources may have generated a request for an airborne evaluation. Only accomplish an airborne evaluation when all other avenues have been exhausted.

6.13 FLIGHT INSPECTION AND FLIGHT VALIDATION PROCEDURES. The inspector must evaluate all facets of the procedure to ensure compliance with safe operating practices. Evaluate the clarity and readability of the depiction. Workloads imposed on the aircrew to select or program the procedure must be reasonable and straightforward. The requirements to evaluate signal quality are detailed in individual chapters. Requirements in this chapter are primarily about procedural aspects. See Chapter 13 of this order for specific RNAV requirements, including DME/DME procedures.

a. General. The objective of evaluating instrument flight procedures is to ensure safety; verify navigation database coding; and evaluate flyability, human factors, and workload. The following items are included in this evaluation:

(1) Procedure design meets the required obstacle clearance per applicable FAA 8260.XX orders or approved criteria.

(2) The applicable navigation system(s) (NAVAID, Satellite, RADAR, etc.) supports the procedure, and there is no significant interference

(3) Procedure design must be simple. Chart complexity should be kept to a minimum for human memory considerations.

(4) Navigation charts must properly portray the procedure and be easily interpreted.

(5) Aircraft maneuvering must be consistent with safe operating practices for the performance capability of the aircraft intending to use the procedure. Verify flyability is satisfactory.

(6) Cockpit workload is acceptable.

(7) All required infrastructure is available and adequate, such as: runway marking, lighting, communications, and altimeter source.

(8) RADAR coverage is available, where required.

(9) The navigation data to be published is correct and provides the ground track and vertical guidance specified by the procedure.

(10) When applicable, the FAS data provides course, glidepath, and threshold or fictitious-threshold crossing height as specified by the procedure.

b. Checklist

Check	Ref. Para.	C	P
Obstacle Verification	6.13	X	X, 2
Final Approach Segment	6.13	X	X, 2
Missed Approach Segment	6.13	X	X, 2
Circling Segment	6.13	X	1
En route and Terminal Segments (i.e., SID, ODP, STAR)	6.13	X	1
Holding Pattern	6.13	X	1
Air/ Ground Communications	6.13	X	1
Runway Markings, Lighting, and Supporting Infrastructure	6.13	X, 3	X, 3
RADAR	6.13	X	1
Charted Visual	6.13	X	

NOTE:
1. Surveillance
2. Periodic inspections of RNAV SIAP(s) do not require flying the actual procedure; however, an obstacle assessment must be conducted in the final and missed approach segments.
3. Includes a surveillance check of any associated VGSI system when practical.

c. Obstacle Verification Evaluations. The following procedures apply to the obstacle check only and not to the facility inspection associated with the procedure.

(1) Identify the Controlling Obstacle:

(a) Confirm controlling obstacles in each segment by in-flight or ground observation during the commissioning of flight procedures, or when an amendment to an existing procedure may affect the controlling obstacles.

(b) Use appropriate FAA Order 8260 series procedure development criteria or equivalent guidance for ROC values. The minimum required obstacle clearance for each procedural segment can be located on FAA Form 8260-9, Standard Instrument Approach Procedure Data Record, contained in the procedure package.

(c) If the controlling obstacle is listed as terrain/trees or Adverse Assumption Obstacle (AAO), it is not necessary to verify which tree is controlling, only that no higher man-made obstacle is present in the protected airspace. If unable to confirm that the declared controlling obstacle is the highest obstacle in the segment, list the location, type, and approximate elevation of the obstacles the inspector desires the procedure developer to consider. Note that the controlling obstacle in a segment with a sloping surface may not be the highest, but will instead depend on its location relative to the sloping surface. The inspector will place special emphasis on discovered obstacles that may not be listed in the FAA database. If the inspector observes that the controlling obstacle has been eliminated or dismantled, the inspector must forward that information to the procedure developer.

(d) In general, conduct an obstacle assessment visually to the lateral limits of the procedure design segment. This may require flying the lateral limits in challenging terrain or airspace in order to confirm there are no penetrations of the protected area. Extra consideration should be given to non-surveyed areas.

(e) Exceptions to the requirement to verify obstacles. At the discretion of the flight inspector, obstacle verification does not have to be accomplished for procedure segments entirely at or above established Minimum IFR Altitudes (MIA). Determine the MIA by a study of the Off Route Obstruction Clearance Altitude (OROCA) published on IFR Enroute Low Altitude charts, Minimum En route Altitude (MEA) of established routes, or by adding 1000 ft (2000 ft in mountainous areas) to the Sectional Aeronautical Chart Maximum Elevation Figure (MEF). Minimum Vectoring Altitude (MVA) charts may be used, if available. Periodic inspections of IAPs only require an obstacle check for the final and missed approach segments.

(2) **For obstacle checks of new or amended approach procedures,** use the following guidance:

(a) **Feeder and Initial Segments** of a procedure. Fly the procedural azimuth in either direction, identifying the controlling obstacle and comparing its height with other obstacles in the segment. Maneuver as required to accomplish the evaluation.

(b) **Intermediate Segment** of a procedure. Fly the procedural azimuth in either direction, identifying the controlling obstacle and comparing its height with other obstacles in the segment. Maneuver as required to accomplish the evaluation.

(c) **Final Approach Segment** will be flown in the direction of intended use, unless traffic flow at a major airport makes it highly impractical. Maneuver as required to accomplish the evaluation while maintaining safe obstacle clearance.

(d) **Missed Approach Segment** will be flown beginning at the MDA/DH/DA in the direction of intended use, unless traffic flow makes it impractical. Climb and maneuver as required, and maintain safe obstacle clearance until reaching the designed altitude or altitude clear of any potential obstacles.

NOTE

Standard missed approach obstruction clearance surface rises at 152 ft/nm.

(3) **When conducting an obstacle assessment on a procedure segment that is already commissioned** and no change has been made to the controlling obstacle, such as during a periodic inspection, it is not necessary to visually identify the controlling obstacle, but rather only to verify there are no unsafe conditions throughout the primary and secondary areas of the procedure segment. Report any potential new controlling obstacles. However, when practical and if time permits, use official procedure data to identify controlling obstacles and verify required obstacle clearance values.

(4) **Assessing different approaches simultaneously for obstacles.** Part of the preflight preparation for the obstacle assessment of a runway at any given airport will include a determination by the inspector if multiple approaches to the same runway may be combined into one single obstruction assessment. If combining approaches into a “single obstruction check,” the altitude flown must be the lowest altitude of any of the combined approaches. The trapezoids of combined approaches should overlap, but under no circumstance can the approach azimuth of the different approaches differ by more than 10°.

(5) **For approach with vertical guidance segments** with sloping obstacle clearance surfaces, only surveyed data should be used when considering obstructions unless newly identified obstacles clearly penetrate such surfaces.

(6) **When attempting to identify the controlling obstacle,** if unable to confirm that the declared controlling obstacle is the highest obstacle in the segment, list the location, type, and approximate elevation of any obstacles and pass this information to the procedure designer for consideration. Also report if a controlling obstacle has been dismantled or eliminated.

(7) **The flight inspector retains the responsibility** to ensure that the procedure provides the required obstacle clearance and may use his or her discretion to vary the flight pattern to best suit the evaluation.

(8) **Conduct obstacle evaluations in VMC and daylight only.**

(9) **Identification of New Obstacles**

(a) In most instances, accurate information concerning the location, description, and heights of tall towers and other considerable obstacles is available from the FAA database and/or other governmental sources. When a new obstruction is identified and may become the controlling obstruction for the segment. The procedure will be denied until the procedure designer can analyze the impact of the obstacle on the overall procedure. Pass all information about newly identified obstacles to the procedure designer.

(b) **Obstacle locations should be noted in latitude/ longitude** as determined from aircraft or flight inspection equipment, or radial/ bearing and distance from a navigation facility. If these methods are not available, an accurate description on an aeronautical chart may be used.

(c) **Determine obstacle height by** a safe and expeditious method. Do not attempt to measure obstacle heights in flight when other means are practical. If in-flight height determination is required, GNSS is the preferred measurement tool; however, if barometric height determination is required, accurate altimeter setting and altitude references must be used to obtain precise results. Document the method of height determination used, and any corrections made. Where possible, note both the barometric and GNSS altitudes, and AGL elevation.

(10) **The Terminal Arrival Areas (TAA)** of some Area Navigation (RNAV) SIAP(s) may have controlling obstacles that do not lie within the primary or secondary areas of initial approach segments. There is no requirement to verify that the identified controlling obstacle is the highest obstacle in the entire TAA segment, but while transiting the segment, observe the area for obstacles that may exceed the height of the controlling obstacle. If any such obstacles are identified, pass this information to the procedure designer for consideration.

(11) **Ground Proximity Warning System (GPWS) Alerts.** Some GPWSs may alert while flying over irregular or rapidly rising terrain at altitudes providing the required obstacle clearance. If GPWS alerts are received while inspecting procedures at the minimum procedural altitude, repeat the maneuver at the designed true altitude. If the alert is repeatable, notify the procedure designer.

(12) **Notification.** In all cases where it is determined that the minimum procedural altitude of a published segment does not provide at least the required obstacle clearance, action must be taken by the inspector to notify the procedure designer and to ensure that a procedural NOTAM is issued to amend or deny the use of the procedural segment.

(13) **Advisory Vertical Guidance on Non-precision Approaches.**

(a) Non-precision instrument approach procedures can be published showing a Vertical Descent Angle (VDA) and Threshold Crossing Height (TCH) on the approach chart. This information can be coded by avionics database providers to provide advisory vertical guidance in the final segment. However, there are no TERPS criteria for obstacle clearance for the visual segment of the path below the IFR minimum descent altitude or MDA. Consequently, if the VDA is blindly followed below MDA, an aircraft may come too close to, or impact obstacles or terrain penetrating the 34:1 surface extending out from the runway. Published guidance warns pilots to delay descent from the MDA until it is safe to do so, even if this means destabilizing the established glide path. However, it is not appropriate to chart VDA and TCH information when there is a significant risk of collision with obstacles penetrating the 34:1 surface. Inadequate obstacle clearance on the advisory vertical guidance path below the MDA does not make the procedure unsatisfactory, it only indicates that the VDA and TCH data should not be charted.

(b) Validate the safety of any coded VDA for RNAV approach procedures (LNAV or LP) where no DA minima (e.g., LPV or LNAV/VNAV) are included. In accordance with TERPS criteria, RNAV approaches with LNAV minima that also include LNAV/VNAV and/or LPV lines of minima are not considered to have a VDA.

(c) When a non-RNAV instrument approach procedure package (commissioning, reconfiguration, or special to amend) is submitted for flight inspection, and it includes ARINC-424 coding, check the VDA under the following conditions: (1) there is a VDA for a non-precision approach; (2) it is not a Localizer with a corresponding ILS glideslope.

(d) Checking the VDA on existing procedures. All non-precision approaches with a published VDA should have the VDA checked for obstacle clearance under the following conditions: (1) it is not part of a RNAV procedure with LPV, LNAV/VNAV, or GLS lines of minima; and, (2) it is not a Localizer with a corresponding ILS glideslope, and (3) there is some evidence of a possible problem, like high terrain in the final segment, or indications of a 34:1 penetration like the absence of a published VDP or stipple shading.

(e) Fly the advisory vertical guidance in the final segment one-dot below on path and determine if the path provides reasonable clearance from all obstacles. There is no obstacle clearance criteria for the visual segment below MDA, ‘reasonable’ will be based on the inspector’s judgment. Only consider obstacles in the immediate vicinity of on course. There is no need to evaluate off-course obstacles. Give consideration to the weather conditions, remembering that very low temperatures can result in significantly lower flight paths. The VDA information should not be published if it is obvious that flying one-dot below path will result in contact with an object or terrain; or, a GPWS alert is triggered while flying on path. This assumes the airport is in the aircraft’s GPWS database.

d. Airways, Routes, and Terminal Route Segments. Evaluate each airway, route, or terminal segment during commissioning flight inspection to ensure that the proposed minimum obstacle clearance altitude (MOCA) is adequate. Route segments must be flown at the proposed MEA (true altitude), using the applicable navigation system(s) for guidance and to or from a point where course or obstacle clearance has been established.

The MEA and changeover points must be predicated on MOCA, minimum reception altitude (MRA), airspace, and communication requirements. If more than one of the above altitudes is procedurally required, the highest altitude as determined by flight inspection will become the minimum en route altitude. MRAs must be consistent with signal strength, facility service volume, air traffic requirements, air/ground communications, ROC and controlled airspace.

If a facility will not support an airway or route to the midpoint or specified changeover point, an effort will be made to determine a revised changeover point at the altitude requested. If a usable changeover point cannot be established, determine if raising the MEA can provide a usable airway or route. Under specific conditions, the use of a route MEA gap in facility signal reception may allow for a usable airway or route at a lower altitude. The development of a MEA gap must be coordinated with the procedure designer.

e. Holding Patterns. Controlling obstacles must be verified to ensure the adequacy of minimum holding altitude (MHA). System performance will be evaluated to ensure conformance with appropriate tolerance chapters of this manual. If system performance and obstacle clearance data are on file, flight inspection of the procedure is not required.

f. Standard Terminal Arrival Route (STAR) procedures must be evaluated to where the route intercepts a portion of an established SIAP or point from which a normal descent and landing can be accomplished.

g. Standard Instrument Approach Procedures (SIAP). SIAP(s) intended for publication must be in-flight evaluated. However, some segments of a given SIAP may not require an in-flight evaluation, as determined by a flight inspector consistant with the guidance in this order. Misalignment or inaccurate data indications will be forwarded to the procedure designer for further review prior to commissioning the procedure. Periodic inspections of Public RNAV SIAP(s) do not require flying the actual procedure; however, an obstacle assessment must be conducted in the final and missed approach segments. All SIAP(s) require a Periodic SIAP Review. Regardless of instructions in this paragraph and its sub-paragraphs, some segments of RNAV SIAP(s) based on GNSS, new or amended, may not have to be flown per the instructions in Chapter 13 of this order.

(1) General. Evaluate flyability with the aircraft coupled to the autopilot to the extent allowed by the aircraft flight manual or SOPs. This may require additional evaluation by hand flying.

(2) Feeder, Initial, and Intermediate Segments. Evaluate each new or amended terminal route for required obstacle clearance and flyability. Consider requirements for feeder segment transitions to initial/intermediate segments, including NAVAID performance requirements. 75 MHz markers are not authorized for procedure turns and holding, and must not be used to identify feeder route termination points.

(3) Final Approach Segment. Evaluate each new or amended final segment for required obstacle clearance and flyability. The final approach fix (FAF) to threshold of an instrument approach procedure must be flown in an approach/landing configuration, on profile, on speed with the GPWS active (if installed).

(a) The final approach course must deliver the aircraft to the desired aiming point. The aiming point varies with the type of system providing procedural guidance and will be determined by the procedure developer. After flight inspection verifies the aiming point, the course will not be changed without the concurrence of the procedure developer. When the system no longer delivers the aircraft to the established aiming point and the system cannot be adjusted to regain the desired alignment, consideration should be given to amending the procedure.

(b) The final approach segment must be flown to an altitude 100 ft below the proposed minimum descent altitude if navigational guidance depends on any ground-based NAVAID. Approaches with vertical guidance must be evaluated to the proposed decision or missed approach altitude.

(c) When conducting periodic inspections, complete an obstacle assessment. Reference controlling obstacle data if practical. Visually examine the final segment, primary and secondary areas if applicable, to ensure there are no hazards near the operational altitudes. Observe the general airport environment for potential hazards. Report any potential new controlling obstacles.

(4) Missed Approach Segment. Flight inspection/validation of a new or amended missed approach segment must assure that the designed procedural altitudes and climb gradient(s) provide required obstacle clearance. When conducting a periodic inspection, complete an obstacle assessment. Reference controlling obstacle data if practical. Visually examine the missed approach segment, both primary and secondary areas if applicable, to ensure there are no hazards near the operational altitudes; fly the missed approach procedure at least to a point where the flight inspector can identify any obstacles that could be a hazard.

(5) Circling. The flight inspector must verify that proposed circling maneuvers are safe and sound for the category of aircraft proposed. Circling maneuvers involving adverse obstructions/ terrain must be evaluated for day/ night operations and restricted if necessary. Ensure that required obstacle clearance is provided throughout the circling area.

(6) Visual Segment. Helicopter point-in-space and some other procedures have extensive visual segments between the MAP and the landing area. Evaluate the new or amended segment for operational suitability and safety. Recommend procedural adjustments when buildings or obstructions obscure access to the landing area. Each procedure with a “Fly visual” segment proposed for night use must be evaluated at night prior to commissioning, or must be restricted from night use until the evaluation is completed.

h. Flyability. Conduct an assessment of flyability to determine that all segments of the procedure can be safely flown. Lateral and vertical transitions from departure, en route, descent, and approach must produce a seamless path that ensures flyability in a consistent, smooth, predictable, and repeatable manner. Consider required speeds, descent and climb gradients, deceleration segments, etc. Fly the procedure on-course and on-path at or below the maximum intended speed on the developed lateral and vertical flight path. The assessment must be flown at speeds and in configurations consistent with normal IFR operations and the performance capability of the aircraft the procedure was designed for. For procedures with a note stating **"Applicable to Turbojet Aircraft Only",** an appropriately equipped jet aircraft or FAA approved flight simulator must be used for the flyability evaluation. For complex procedures, additional flyability evaluations may be required in a proponent's simulator or aircraft. Flyability should be evaluated with the aircraft coupled to the autopilot and may require additional evaluation by hand flying. When evaluating RNAV procedures, correct implementation of RNAV leg path/ terminator is critical for route containment and requires evaluation for meeting the intent of the procedure and flyability. In general, a flyability assessment should include the following:

- Fly on-course and on-path.
- Evaluate turn anticipation and the relationship to standard rate turns and bank angle limits.
- Check that the waypoint spacing and segment length are suitable for aircraft performance including deceleration segments.
- Check distance to runway at Decision Height/ Decision Altitude/ Minimum Descent Altitude that are likely to be applied by operators and evaluate the ability to execute a landing with normal maneuvering.
- Evaluate the aircraft maneuvering area for safe operations for each category of aircraft to use the IFP.
- Evaluate GPWS warnings.
- Evaluate required climb or descent gradients, if any.
- Evaluate the IFP complexity, required cockpit workload, any unique requirements, and the impact of any deviations from standards.
- Evaluate the proposed charting for correctness, clarity, and ease of interpretation.

(1) Departure Procedures including SID(s) and ODP(s):

(a) Climb gradient considerations should be applied throughout the departure procedure. Leg length in relation to altitude change versus altitude crossing restrictions (transitioning from "at" or "at or below" to "at" or "at above altitude") needs to be reviewed carefully. For FAA procedures, departure procedures requiring a climb gradient in excess of 500 ft/ nm require Flight Standards Service approval.

NOTE

USAF/ USN procedures do not require waiver action or approval of any departure climb gradient.

(b) Speed restrictions can also severely limit the usability of a procedure. Any speed restriction has to be compatible with the performance capability of the aircraft expected to comply with the departure. An airspeed restriction below 200 kts should be extremely limited in application as to airport, runway, and aircraft.

(c) "Track-to-Fix" (great circle) routes are the predominant leg path/ terminator used in RNAV procedure development. However, significant course/ track changes are being applied independently and in combination with climb gradients and/ or speed restrictions. Public procedures should be designed such that completion of turn limitations, minimum turn radii, and imposed bank angles allow for normal aircraft operating procedures in the accomplishment of the departure.

(2) Standard Terminal Arrival Route (STAR):

(a) The STAR procedure should be designed to standardize descents from the high altitude en route stratum to the terminal environment with a descent gradient of 318 ft per nautical mile (FPNM) or 3°. Below 10,000 ft MSL, the maximum descent gradient should not exceed 330 FPNM.

NOTE

Procedure design may require descent gradients that exceed 330 FPNM. Although not desirable, the procedure may be flyable if appropriate deceleration leg lengths are included to mitigate the effects of high descent gradients.

(b) In addition to using the recommended descent gradients identified in Paragraph (a), the procedure must also allow for deceleration at any waypoint that has a speed restriction and deceleration to transition below 10,000 ft MSL. As a general guideline, deceleration considerations should add 1 nm for each 10 kts of speed reduction required. The evaluation for flyability should be based on 300 – 310 KIAS at 10,000 ft and above and 250 KIAS below 10,000 ft. Where deceleration is necessary use a 10 kt per nautical mile rate of deceleration to arrive at the required speed. Vertical path should be easily tracked without use of aircraft drag devices. Use of drag devices should only be required with tailwind conditions in excess of 50 kts. Procedures requiring use of drag devices should have the vertical path redesigned. A STAR connecting to an initial approach should provide for deceleration to arrive at the initial fix at 200 kts.

(c) Standard Terminal Arrival Route (STAR) procedures must be evaluated to where the route intercepts a portion of an established SIAP or point from which a normal descent and landing can be accomplished. STAR design guidance can be found in FAA Order 7100.9( ), Appendix 2.

(3) Approach. Deceleration considerations should be applied through the initial and intermediate approach segments. The procedure should provide for deceleration to arrive at the FAF at 150 kts.

(a) For a straight-in approach, an initial/ intermediate segment descent gradient not exceeding 250 ft/ nm allows the aircraft to decelerate without having level segments. This provides a continuous, stable descent, and the aircraft can be configured without using extraordinary pilot actions. A straight-in initial/ intermediate segment designed with the maximum gradient of 318 ft/ nm requires the incorporation of a deceleration segment of 1 nm per 10 kts of deceleration to 150 kts at any FAF or an approach without a designated FAF.

(b) For any approach procedure incorporating a turn to the intermediate segment exceeding 35° of turn, the maximum descent gradient of the intermediate segment should not exceed 160 ft/ nm.

(4) Vertical Flyability and Calculating Deceleration Segment Length. FAA Order 7100.9( ), Standard Terminal Arrival Program and Procedures, provides guidance on arrival descent gradients and deceleration segments accepted by both the FAA and air transportation industry. Use this information as a baseline for evaluating the vertical flyability of arrival and approach procedures. Do not apply this standard to Special procedures that may be designed specifically for a proponent's aircraft and its capabilities.

For a STAR, apply the formula starting at the first waypoint with a minimum crossing altitude restriction all the way to the ending waypoint(s) with a minimum altitude restriction. Evaluate the overall deceleration allowance between the first and last waypoints, not between each individual segment. Some segments may be longer to mitigate descent gradients in short segments. If an altitude window is specified, fly the procedure using altitudes within the constraints that provide for the shallowest descent path to evaluate for excessive descent gradient and the ability to slow and configure.

Example: (may be applied to STAR or Initial/ Intermediate Approach Segments)

An RNAV STAR begins at waypoint ALPHA at 17,000 MSL and 310 kts and requires the aircraft to descent to and cross waypoint BRAVO at 9,000 MSL and 240 kts. The minimum leg length between ALPHA and BRAVO is computed as follows:

(17,000 – 9,000)/ 318 = Minimum leg length using a 3° descent gradient,
8,000/ 318 = 25.157 nm
Plus
(310 kts – 240 kts)/ 10 = Deceleration segment
70/ 10 = 7 nm
25.157 + 7 = 32.157 nm (round to 32.2 nm)

NOTE

A procedure segment may meet TERPS criteria and not provide the deceleration distance desired for vertical flyability.

i. Departure Procedures, SID(s) and ODP(s). For RNAV SID(s) and ODP(s), also see Chapter 13. Evaluate the departure procedure using the minimum climb gradients and altitudes specified. There are two types of departure procedures (DPs): those developed to assist pilots in obstruction avoidance, referred to as "Obstacle Departure Procedure" (ODP); and, those developed primarily to communicate air traffic control clearances, referred to as "Standard Instrument Departure" (SID). Both types provide obstacle protection beginning from the departure end of the runway (DER) to a point where the en route obstacle clearance is achieved. Textual ODPs are the simplest form of ODP. They are not named and they are not graphically depicted. A Graphic ODP is one that required a visual presentation to clearly communicate the departure instructions and desired flight paths. All graphic ODPs are named, and the word "OBSTACLE" will be included in the title. A "T" symbol will appear on appropriate IAP charts and SID charts whenever the Form 8260-15A indicates any data entries with other than standard takeoff minimums. Graphic ODPs must terminate at a fix/NAVAID located within the IFR en route structure. Textual ODPs may also end at an altitude that will allow random (diverse) IFR. SIDs may be designed to terminate at a fix/NAVAID depicted on an IFR en route chart, at an altitude that will allow random IFR flight, or at a position and altitude where ATC radar service is provided. Reference FAA Orders 8260.3 and 8260.46 for details.

If there are no takeoff obstacles or controlling obstacles that penetrate the OCS on departure, then standard takeoff minimums are authorized using the standard climb gradient (SCG), 200 ft/NM. An ODP and/or non-standard takeoff minimums must be developed when obstructions penetrate the 40:1 departure OCS. This may also include development of a visual climb over airport (VCOA) procedure where obstacles more than 3 statute miles from DER would require climb gradients greater than 200 ft/nm. Non-standard takeoff minimums must have a visibility (no more than 3 statute miles) that allows for visual identification of the obstacle from the DER, and a ceiling above any obstacles within the minimum visibility range.

When there is a penetration of the OCS by an obstacle 1 nautical mile or less from the DER that would require a climb gradient above the SCG to a height 200 feet or less above the DER elevation, then a non-standard climb gradient is NOT published. Obstacles that are located within 1 nm of the DER and penetrate the 40:1 OCS are referred to as "low, close-in obstacles." Any such low, close-in obstacles will be noted on forms 8260-15A or B, under "Takeoff Obstacle Notes." For existing procedures, they will be noted in the "Take-Off Minimums and (OBSTACLE) Departure Procedures" section of the Terminal Procedures Publication booklet. It is expected a departing aircraft will plan the takeoff to clear these obstacles. This can be accomplished in a variety of ways: see and avoid; early liftoff and climb; or preflight planning that takes into account turns or other maneuvers as necessary to avoid the obstacles.

j. Air/ Ground Communications. Air/ ground communications with ATC must be satisfactory at the initial approach fix (IAF) minimum altitude and at the missed approach altitude and holding fix. Satisfactory communications coverage over the entire airway or route segment at minimum en route IFR altitudes must be available with an ATC facility. Where ATC operations require continuity in communication coverage and ATC requests verification, flight inspection must evaluate that coverage in accordance with appropriate chapters of this order.

k. Runway Markings, Lighting, and Supporting Infrastructure. The inspector must evaluate the suitability of the airport to support the procedure. Unsatisfactory or confusing airport markings, non-standard or confusing lighting aids, or lack of communication at critical flight phases may be grounds for denying the procedure. In all cases, the procedure developer will be apprised of the conditions discovered during the flight inspection.

l. RADAR Coverage. RADAR coverage must be verified for any procedure which requires RADAR.

m. Charted Visual Approaches. A commissioning check of charted visual procedures is required. Determine flyability and ensure that depicted landmarks are visible in both day and night visual conditions. Flyability is determined by difficulty of aircraft placement, cockpit workload, landmark identification, location and visibility, and VFR obstacle clearance. A night evaluation must be completed prior to authorizing night use.

n. Maximum Authorized Altitudes (MAA). MAA(s) are limitations based on airspace restrictions, system performance characteristics, or interference predictions. If the MAA(s) are based on an interference problem, the source of the interference must be identified and corrective action initiated where possible.

o. Periodic SIAP Reviews. In addition to the in-flight evaluation of a SIAP during a periodic inspection, evaluate the following as a minimum: validity of altimeter setting source; validity of published notes; and a review of any published FDC NOTAM(s) on the approach procedure for currency and validity. Notify Aeronautical Navigation Products (AJV-3), and the originator of the procedure as applicable, of any discrepancies found for possible NOTAM action and/ or correction, and documentation as a remark will be made on the applicable flight inspection report. A similar review of military instrument approach procedures with available information will be conducted. The appropriate military authorities will be notified of any discrepancies found and documentation as a remark will be made on the applicable flight inspection report.

> **NOTE:** Instrument approach procedure discrepancies may not render a procedure unsafe or unusable; professional judgment and discretion in the evaluation of a procedure is expected.

6.14 ANALYSIS. Flight inspection determines that the procedure is safe and flyable. If a new procedure is unsatisfactory, the flight inspector must coordinate with the procedure developer to determine the necessary changes. When an existing procedure is found unsatisfactory due to obstructions, navigation source, charting error, etc., initiate NOTAM action immediately and advise the procedure developer.

a. Cartographic Standards. Changes to cartographic standards are the responsibility of the Interagency Air Cartographic Committee and the Intra-Agency Committee for Flight Information. Recommendations for changes to these standards should be sent to the Flight Inspection Services, Flight Inspection Operations Division, AJW-33, for consolidation and forwarding to the appropriate committee.

b. Night Evaluations

(1) Procedures developed for airports with no prior IFR service and procedures to newly constructed runways, and procedures to runways lengthened or shortened require a night evaluation to determine the adequacy of airport lighting systems prior to authorizing night minimums.

(2) Inspect *initial* installation of approach lighting systems during the hours of darkness. Evaluate the light system for:

(a) Correct light pattern as charted.

(b) Operation in the manner proposed (e.g., photocell, radio control);

(c) Local lighting patterns in the area surrounding the airport do not distract, confuse, or incorrectly identify the runway environment.

(3) Addition or reconfiguration of lights to an existing system already approved for IFR service.

(a) An **approach** lighting system requires a night evaluation. However, minor changes may not require a night evaluation; refer to Chapter 7 of this order.

(b) A **runway** lighting system may be evaluated day or night. First time installation of REIL systems will be evaluated at night to determine effectiveness.

c. **Human Factors** are concerned with optimizing the relationship between flight crews and their activities by systematic application of human sciences integrated within the framework of systems engineering. In the context of flight validation, it is a question of whether a flight procedure is operationally safe, practical, and flyable for the target user with the minimum required IFR instrumentation.

The criteria used to develop instrument flight procedures represent many factors such as positioning requirements, protected airspace, system and avionics capabilities, etc. Sensory, perceptual, and cognitive restrictions historically have been incorporated in the criteria only to a limited extent (e.g., length of approach segments, descent gradients, turn angles). These are products of subjective judgments in procedure development and cartographic standards. It is incumbent upon the flight inspector to apply the principles of human factors and professional judgment when certifying an original or amended procedure. The following factors must be evaluated:

(1) **Practical.** The procedure should be practical. Segment lengths for approach and missed approach segments should be appropriate for the performance capability of the aircraft using the procedure. Procedures must not require excessive aircraft maneuvering to remain on lateral and vertical path.

(2) **Complexity.** The procedure should be as simple as possible. It should not impose an excessive workload on the intended user. Complex procedures may be developed for use under specific conditions, for specific aircraft equipment, environment, and/or specialized training and authorizations.

(3) **Interpretability**

(a) The final approach course should be clearly identifiable, with the primary guidance system or NAVAID unmistakable;

(b) The procedure should clearly indicate which runway the approach serves and indicate which runway(s) circling maneuvers apply to;

(c) Fix naming must be readable and clearly understood. Fixes/ waypoints with similar sounding identifiers should not be used in the same procedure.

(d) Areas not to be used for maneuvering must be clearly defined.

(e) Significant terrain features must be displayed on approach charts.

(f) Operations into runways with significant visual illusions, for example, the *black hole effect*, should be noted.

(4) Human Memory Considerations. Pilots must be able to extract information quickly and accurately during an instrument approach. Multiple tasks complicate the memory process and tend to produce prioritization during stressful phases of flight. Workload reduction can be accomplished through methodical chart layout that encourages the pilot to periodically refer to the depicted procedure rather than trying to memorize complex maneuvers.

6.15 TOLERANCES. The procedure must be safe, practical, flyable, and easily interpreted with an acceptable cockpit workload. The resulting flight path must provide the required obstacle clearance from obstructions and terrain. Supporting facilities/ systems must meet tolerances of the appropriate chapters of this manual and not contribute to operational confusion. The navigation data to be published is correct and provides accurate lateral and vertical guidance as defined by the flight procedure design.

CHAPTER 13. AREA NAVIGATION (RNAV)

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CHAPTER 13. AREA NAVIGATION (RNAV)

SECTION 1. AREA NAVIGATION (RNAV)

13.10 INTRODUCTION. Area Navigation (RNAV) is a method of navigation which permits aircraft operation on any desired flight path within the coverage of ground- or space-based navigation aids or with in the limits of the capability of self contained aids, or a combination of these. RNAV includes performance-based navigation as well as other operations that do not meet the definition of performance-based navigation. Flight Management Systems (FMS) with multiple sensors and Global Positioning System (GPS) navigators are most common. These systems navigate with reference to geographic positions called waypoints. Multi-sensor RNAV equipment determines aircraft position by processing data from various input sensors. Unlike early RNAV systems which used only very high frequency omnidirectional range (VOR)/ distance measuring equipment (DME) Rho-Theta for position fixing, multi-sensor navigation systems employ a variety of sensors, such as:

- DME/ DME and VOR/ DME
- Inertial Reference Unit (IRU)
- Global Navigation Satellite System (GNSS), such as:
  - GPS
- Space-Based Augmentation System (SBAS), such as:
  - Wide Area Augmentation System (WAAS)
- Ground-Based Augmentation Systems (GBAS), such as:
  - Local Area Augmentation System (LAAS)

These various sensors may be used by the navigation computer individually, or combined in various ways (based on internal software programming) to derive aircraft position. Navigation values, such as distance and bearing to a waypoint (WP), are computed from the derived latitude/ longitude to the coordinates of the waypoint. Course guidance is generally provided as a linear deviation from the desired track of a great circle route. RNAV procedures consist of sequenced ARINC 424 coded path and terminators and waypoints. The desired course may be pilot selectable (e.g., pseudo course or go direct) or may be determined by the navigation database, based on the ground track coded between successive waypoints. Use of a combination of different ARINC 424 leg path and terminators provides the desired ground track and vertical path of a flight procedure.

Many RNAV procedures include vertical guidance (VNAV). Vertical guidance is provided as a linear deviation from the desired vertical path, defined by a line joining two waypoints with specified altitudes, or as a vertical angle from a specified waypoint. Computed positive vertical guidance is based on barometric, satellite elevation, or other approved systems. The desired vertical path may be pilot selectable, or may be determined by the VNAV computer, with computations based on the ARINC 424 coding in the navigation base. RNAV approaches with vertical guidance are classified as Approach with Vertical Guidance (APV).

13.11 PREFLIGHT REQUIREMENTS

a. Aircraft. The aircraft avionics configuration must be appropriate to support the procedure to be flight inspected.

Flight Inspection of RNAV Standard Instrument Departure (SID(s)), airways, and Standard Terminal Arrival Route (STAR(s)) may be accomplished with any flight inspection aircraft capable of the procedure's ARINC 424 path and terminators.

RNAV approach charts provide separate minima for Lateral Navigation (LNAV), Lateral and Vertical Navigation (LNAV/ VNAV), LP, and LPV. Inspection of an RNAV procedure with vertical guidance requires an appropriately equipped flight inspection aircraft.

b. Navigation Database. Verify a current navigation database is installed. Use waypoint data from the FMS/ GPS navigation database when available. When official government source ARINC 424 navigation data is available, it must be used for the flight inspection.

c. Pilot-Defined Procedure. For RNAV procedures that are not electronically packed into a navigation database, contact FIS Technical Services for guidance.

d. Evaluation of Procedure Data

Prior to the procedure being flown, the navigation database ARINC 424 path and terminator data accuracy must be evaluated by comparison to the official source procedural path/terminator data. This data is found on FAA Forms 8260-xx. The navigation database path and terminator coding must match the official source procedure coding documents.

(1) The ARINC 424 data evaluation may be completed by a desk-top method or by utilizing an RNAV system on board the flight validation aircraft. The desk-top data evaluation is the preferred method. A desk-top method involves a physical comparison, in combination with a computer software tool with the capability of displaying the navigation database path and terminator coding and other pertinent coding data in a detailed format, which permits the ARINC 424 coding to be verified against the official source documents. The desktop data evaluation should be detailed enough to include the following ARINC 424 elements for evaluation:

(1) Procedure Name, Runway

(2) Transition

(3) Fix /Waypoint Name

(4) Sequence Number

(5) Use (For Example: IAF, FACF, FAF)

(6) Leg Type (For Example: IF, TF, CF)

(7) Turn (R, L)

(8) Fly-Over (FO) /Fly-By (FB)

(9) Mag Course or True Course, RNAV Track

(10) Distance of leg

(11) Altitude

(12) Latitude

(13) Longitude

(14) Threshold Elevation

(15) Threshold Crossing Height

(16) Datum Check

(17) Vertical Angle

(18) FAS Data Block Check

(19) CRC Remainder Check

(20) Altitude /Speed Restrictions

(2) When approved desktop software and documenting process is used to validate the ARINC 424 coding, some segments of a procedure may not have to be flown. . In all cases, the final and missed approach segments of an approach procedure must be flown in an aircraft and checked for flyability and obstructions. In addition, at least two miles of the intermediate segment prior to the FAF must be flown for proper avionics activation of an approach. An approved desktop process for validating ARINC 424 coding satisfies all the requirements to check and validate the ARINC 424 coding without actually flying it in an aircraft. However, there are other conditions and requirements that must be considered before eliminating a segment of an IFP from the in-flight check.

(a) Consider the following when meeting the obstacle clearance, communications, and radar coverage requirements of Chapter 6.

Obstacle Clearance may be considered satisfactory for procedure segments at or above previously established Minimum IFR Altitudes as described in Chapter 6, paragraph 6.13c(1)(e).

1 Communications may be considered satisfactory for procedure segments when there are existing procedures in the same area that require communication with the servicing ATC. The controlling ATC facility may be contacted directly to confirm communication coverage at the specific locations and altitudes.

2 Radar coverage may be considered satisfactory for procedure segments when the controlling ATC facility confirms there is radar coverage in the area concerned at or below the required altitude. However, any radar fix identification requirements must be checked in accordance with procedures described in Chapter 14.

(b) A procedure segment may still require a flyability check during Flight Validation. Follow the steps in the checklist below for determining which additional segments must be checked for flyability in an aircraft.

Checklist

Step	Action	Result
1	Fly any segments recommended by the desktop evaluation.	Continue to Step 2
2	Is the Instrument Flight Procedure in question a complex procedure?[1]	No, checklist is complete Yes, continue with Step 3
3	Was the procedure flown in a FAA-certified Level C or D aircraft simulator?	No, continue with Step 4 Yes, checklist is complete
4	Fly any segments and transitions to/from those segments with any of the following characteristics: (1) RF segment (2) The descent gradient exceeds the normal limit as described in Chapter 6 (3) Multiple altitude and/or airspeed restrictions (4) Has a waiver to FAA or Pans Ops criteria. (5) An intermediate segment that is offset from the final segment	

[1]Complex IFPs are defined as those procedures with any of the characteristics listed in Step 4 above.

(3) When using aircraft avionics to validate ARINC 424 coding, an appropriately equipped aircraft would include a suitable RNAV system capable of displaying and identifying, to the flight inspector, each type of ARINC 424 path and terminator of the flight procedure. Aircraft RNAV systems contain their own magnetic variation data, which may not be current. When using an aircraft RNAV system, verify that **true** course to next waypoint, distances, and the Flight Path Angle (FPA) indicated on the RNAV system accurately reflects the procedure design. When evaluating RNAV course legs like CF, FC, CA, CI, FA, FC, FM and holding legs (HM, HF, HA), compare aircraft navigation performance with the instrument procedure design. Do not apply any tolerance to course-to-fix values. Out-of-tolerance values must be resolved with the procedure designer.

e. Navigation System Status. Determine the status of the required navigation system(s) (e.g., DME, GPS, GBAS, and WAAS) before every flight inspection and after an inspection that detects anomalies. NOTAM(s) and GPS Service Interruptions (interference testing) location and schedule should be considered.

13.12 FLIGHT INSPECTION PROCEDURES. The RNAV procedure must be inspected IAW Chapter 6 and appropriate sections of this chapter. The flight inspection of RNAV procedures will evaluate safety, flyability, human factors, navigation data, and workload. Any anomalies found during inspection must be resolved before the procedure is approved.

Use appropriate FAA Order(s) or approved guidance for required obstruction clearance criteria such as:

- FAA Order 8260.58, U.S. Standard for Performance Based Navigation (PBN) Instrument Approach Design
- FAA Order 8260.3, U.S. Standard for TERPS

a. Checklist

Type Check	**Reference Paragraph**	**C**	**P (2) (3)**
DP/ SID	13.12	X	
Route	13.12	X	
STAR	13.12	X	
Transition/ Feeder Route Segment	13.12	X	
Initial Approach Segment	13.12	X	
Intermediate Approach Segment	13.12	X	(4)
Final Approach Segment	13.12	X	X
Missed Approach Segment	13.12	X	X
SIAP	Chapter 6	X	X
RFI	Chapter 23	(1)	(1)

Footnotes:

(1) When Navigation System (DME, GPS, WAAS) parameters indicate possible radio frequency interference (RFI).

(2) Documentation of procedure-specified DME facilities is not required on a periodic inspection.

(3) Except for an obstacle evaluation, RNAV procedures have no periodic inspection requirement.

(4) As a minimum, two miles of the intermediate segment prior to the FAF must be flown for proper avionics activation of the approach.

b. Detailed Procedures. Ground track path error performance varies with mode of flight guidance system coupling. It is imperative to evaluate new procedures **coupled** to the flight director and autopilot to the maximum extent permitted by the aircraft flight manual.

Evaluate for lateral and vertical disconnects from the autopilot/ flight director. Lateral and vertical transitions from departure, en route, descent, and approach must produce a seamless path that ensures flyability in a consistent, smooth, predictable, and repeatable manner.

(1) Equipment Configuration. For RNAV procedures supported by GPS, do not deselect any navigational sensors. Align IRU(s) to GPS position.

(2) Commissioning. The RNAV procedure must be entered into the FMS/ GPS navigation system. Entered data must conform to the official source documentation. It may be on a supplied database, downloaded from an electronic media, or entered manually.

(3) Periodic. Periodic inspection of an RNAV approach does not require flying the actual procedure; however, an obstacle assessment must be conducted through the final and missed approach segments.

c. Aircraft Positioning

(1) RNAV DP/ SID

(a) RNAV Departures ARINC 424 Coded from the Runway. Verify the CDI is in terminal scaling. An RNAV DP/ SID can be evaluated by either taking off from the runway or by flying a low approach, crossing the Departure End of Runway (DER) at 35 ft; or 200 ft for runways with "low, close-in" obstacles, or the altitude as specified by the procedure.

Position the aircraft on course centerline. Fly at minimum climb gradient and altitudes specified by the procedure.

(b) RNAV Departures that use RADAR Vectors to Join RNAV Routes. Position the aircraft on course centerline beginning at the first waypoint. Fly at minimum altitudes specified by the procedure. See paragraph 13.32 for this type departure utilizing DME/DME and Pilot Nav Area.

(2) Routes. Fly routes at minimum procedural altitude. Program waypoints as "fly-by", unless otherwise designated. Confirm communications and RADAR coverage on RNAV Routes, where required. "T" Routes based on GNSS only do not require RADAR coverage, unless specifically requested.

(3) STAR. Vertical navigation/ descent gradients, leg combinations, leg lengths, and human factors involving use of FMS operations require evaluation. When altitude and/ or airspeed constraints are shown on the procedure, fly the procedure at the specified altitudes/ speeds. If an altitude window is specified, start at the lowest altitude and fly the procedure using altitudes within the constraints that provide the shallowest descent path. The arrival procedure must be flown through transition to an instrument approach procedure, if terminating at an intermediate fix (IF)/ initial approach fix (IAF).

(4) Approach. Initial and Intermediate segments must be flown at procedural altitudes.

The final approach segment must be flown to the proposed minimum descent altitude. Approaches with vertical guidance must be evaluated to the proposed decision or missed approach altitude.

The vertically guided RNAV approach procedure and the LNAV-only procedure are designed with different obstruction criteria. The final segment of the approach (final approach waypoint (FAWP) to missed approach waypoint (MAWP)) may have different obstructions controlling the vertically guided Decision Altitude (DA) and LNAV Minimum Descent Altitude (MDA). The final segment may require repeated flights for obstacle evaluation.

Non-precision RNAV instrument approach procedures are normally published showing a Vertical Descent Angle (VDA) and Threshold Crossing Height (TCH) on the approach chart. This information can be coded by avionics database providers to provide advisory vertical guidance in the final segment. However, it is not appropriate to chart VDA and TCH information when there is a significant risk of collision with obstacles penetrating the 34:1 surface. Inadequate obstacle clearance on the advisory vertical guidance path below the MDA does not make the procedure unsatisfactory; it only indicates that the VDA and TCH data should not be charted. Check the VDA for LNAV-only and LP-only approaches in accordance with Chapter 6, paragraph 6.13c(13).

(5) Missed Approach. During commissioning inspection, fly the missed approach segment(s) as depicted in the procedure.

13.13 FLIGHT INSPECTION ANALYSIS. Flight inspection of RNAV procedures determines if the procedure is flyable, safe, and navigation data is correct. ARINC 424 coded data will be used to compare coded path versus actual path to verify all data prior to release to the public and other database suppliers. If a new procedure is unsatisfactory, the flight inspector must coordinate with the procedures designer, ATC, and/ or the proponent of the procedure, as applicable, to determine the necessary changes. When existing procedures are found unsatisfactory, notify the procedure designer immediately for Notice to Airman (NOTAM) action. The inspector must evaluate the following items:

a. Waypoint spacing is sufficient to allow the aircraft to stabilize on each leg segment without jumping over waypoints/ legs. Leg length must be sufficient to allow for aircraft deceleration or altitude change, if required.

b. Procedural Design. The procedure must be evaluated to verify the geodetic coordinates (waypoints) and vertical path angles meet the requirements of Paragraph 13.14.

c. GPS Parameters. The following parameters must be documented at the time anomalies are found during any phase of the flight inspection. Forward recorded data to flight inspection policy for analysis.

Parameter	Expected Value
$HDOP_{GPS}$	1.0 – 4.0
$VDOP_{GPS}$	1.0 – 4.0
HIL_{GPS}	0.3 or less
HFOM	≤ 22 meters
Satellites Tracked	5 minimum
Signal-to-Noise Ratio (SNR)	30 dB/ Hz minimum

There are no flight inspection tolerances applied to these parameters. However, the values listed above provide a baseline for analysis of system signal anomalies or interference encountered.

d. Interference. The RF spectrum from 1,155 to 1,250 MHz and 1,555 to 1,595 MHz should be observed when GPS parameters indicate possible RF interference. Interfering signals are not restrictive, unless they affect the receiver/ sensor performance. The SNR values being recorded may indicate RF interference problems. The normal GPS signal strength is –130 to –123 dBm. Use the SNR values, along with the spectrum analyzer, to investigate the RF interference, the location of its occurrence, and possible sources. Particular attention must be given to harmonics on or within 20 MHz of GPS L1 (1,575.42 MHz), L5 (1,176.45 MHz), and those on or within 10 MHz of GPS L2 (1,227.6 MHz).

During an RNAV procedure, document all spectrum anomalies. Paper records **and** electronic collection of data are required.

> **NOTE:** Report interference to the FICO, who will in turn forward the report to the ATCSCC/ Spectrum Assignment and Engineering Office at Herndon, Virginia.

13.14 TOLERANCES

Parameter	Reference Paragraph	Tolerance/ Limit
Procedure Design (FMS or FIS calculated values)		
Route/ DP/ SID/ STAR **True Course** to next WP Distance to next WP	13.11	 ± 1° ± 0.1 nm
Initial/ Intermediate Approach Segment **True Course** to next WP Distance to next WP	13.11	 ± 1° ± 0.1 nm
Final Approach Segment **True Course** to next WP Distance to next WP	13.11	 ± 1° ± 0.1 nm
Missed Approach Segment **True Course** to next WP Distance to next WP	13.11	 ± 1° ± 0.1 nm
Vertical Path (VNAV)	13.11	± 0.1°
FMS/ GPS		
GPS Integrity	13.11	RAIM

13.15 ADJUSTMENTS. Reserved.

13.16 DOCUMENTATION. RNAV reports must be completed in accordance with FAA Order 8240.36, Flight Inspection Report Processing System. All recordings, documentation on paper and electronic data files must be retained and handled in accordance with FAA Order 8200.1.

SECTION 2. REQUIRED NAVIGATION PERFORMANCE (RNP) RNAV

This section provides additional guidance to Section 1 of this chapter for inspection of RNP RNAV procedures.

13.20 INTRODUCTION. RNP is a statement of the navigation performance accuracy necessary for operation within a defined airspace.

RNP is stated as a number in nautical miles. This specifies how tight the avionics must contain Total System Error (TSE). RNP applies to navigation performance and includes the capability of both the available infrastructure (navigation systems) and the aircraft equipment. For example, an aircraft may be equipped and certified for RNP 1.0 but may not be capable of RNP 1.0 operations due to limited NAVAID coverage.

RNP levels address obstacle protection associated with RNP accuracy values. The RNP level (RNP x, where x=0.3, 1, 2, etc.), when applied to instrument procedure obstacle evaluation areas, is a variable used to determine a segment primary area half-width value, i.e., total width is ± a multiple of the value used to identify the level. Parallel lines normally bound obstruction clearance areas associated with RNP.

13.21 FLIGHT INSPECTION/ VALIDATION PROCEDURES. Inspect RNP RNAV procedures per Section 1 of this chapter. Use appropriate FAA Order(s) or approved criteria, including FAA Order 8260.58, U.S. Standard for Performance Based Navigation (PBN) Instrument Approach Design, or other approved criteria for procedure design and required obstruction clearance criteria.
Obstacle Evaluation. When containment area obstacle verification is required, fly a 2xRNP (containment limit) offset each side of centerline (i.e., RNP-0.3 segment, fly a 0.6 nm offset each side of course centerline). Assign altitudes to the offset waypoints as required for the vertical profile. Use the offset to provide situational awareness of obstacles inside the containment boundary, which may affect the procedure integrity.

> **NOTE:** Containment limit obstacle verification is not required on segments which have the obstacle environment surveyed or on segments that obstacles against the RNP containment limit are not a factor. Use extreme caution when flying the containment limit. Obstructions (towers, terrain, etc.) may be against the edge of the containment limit.

SECTION 3. DISTANCE MEASURING EQUIPMENT (DME) DME/ DME-SUPPORTED RNAV

This section provides supplemental guidance to Section 1 of this chapter for inspection of RNAV procedures requiring a DME/ DME infrastructure.

13.30 INTRODUCTION. For most aircraft with FMS installations which do not have a GPS sensor, DME is used to calculate position. The primary method is to calculate position from the crossing angles of 2 or more DME facilities. The FMS chooses DME facilities which intersect the aircraft between 30° and 150° crossing angle. The optimum pair of DME facilities will have a crossing angle closest to 90°. The FMS database is searched every few minutes to choose the most optimum pair of DME facilities. The FMS may have a "Scanning DME" function. This function allows multiple DME facilities to be scanned in a few seconds. The more DME facilities and the more widely they are dispersed, the greater the positioning accuracy. DME positioning may be able to provide a positioning accuracy to 0.1 nm at a location of optimal DME geometry.

13.31 PREFLIGHT REQUIREMENTS. Previously verified DME/DME coverage may be used on procedural segments along the same routing and altitudes in lieu of a new flight inspection. A valid DME/DME coverage prediction modeling tool may be used in lieu of flight inspection for coverage verification on procedure and route segments at and above 18,000 feet. Flight inspection is not required to validate a DME ESV in support of DME/DME flight procedures at and above 18,000 feet.

Documentation of all identified DME facilities will be accomplished through paper recordings **or** electronic collection of data (FIS required).

a. DME Screening. A computer-screening model (such as RNAV-Pro) identifies DME facilities, predicted to possess the accuracy, coverage, and geometry requirements needed to provide a navigation solution to support the procedure. Results are documented to a comma separated value (CSV) file. The CSV file is loaded into FIS for the procedure inspection.

> **NOTE:** RNAV-Pro DME Screening CSV files are direction specific.
> The appropriate CSV file is required for **direction of flight.**

Flight inspection will verify DME coverage and accuracy for the FMS-equipped aircraft utilizing a DME sensor for primary navigation positioning.

b. Data Collection. FIS software may allow up to five (5) DME facilities to be monitored and recorded. DME(s) to be checked over a designated area are specified in the RNAV-Pro screening output file.

(1) Appropriate DME facility changes will be initiated based on the RNAV-Pro output file.

13.32 AIRCRAFT POSITIONING. All segments requiring vertical path change must be inspected in the intended direction of flight, using minimum climb gradients and minimum altitudes specified in the procedure package. Position the aircraft on course centerline. Use the Global Navigation Satellite System (GNSS) as the primary navigation sensor for the inspection.

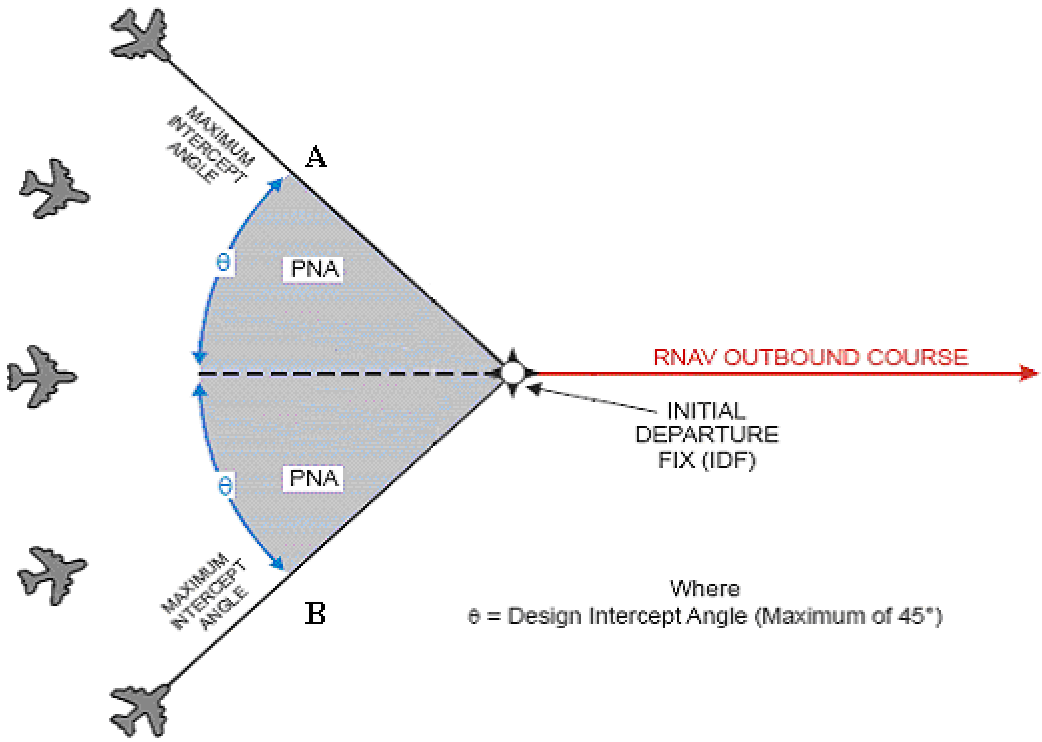
During the inspection, if a Critical, or expanded service volume (ESV) designated DME appears not to be transmitting, verify with Air Traffic or a local Flight Service Station that the facility is in service. If a DME designated Critical is off the air, the inspection must be terminated and resumed after the facility is returned to service. When there are three or less DME(s) and one of the three is out of service, the check should be rescheduled.

a. RNAV Departure Procedure/ Standard Instrument Departure (SID). Departures requiring a DME/ DME navigation solution at the earliest possible point from takeoff may be flown from an actual takeoff or a low approach, crossing the Departure End of Runway (DER) at 35 feet; or 200 feet for runways with “low, close-in” obstacles, or the altitude as specified by the procedure. Position aircraft IAW Section 1.

(1) Parallel Runways Departing to a Common Route. If parallel runways are separated by 3,400 ft or less, the DME evaluation may be accomplished by departing from either parallel, unless the DME screening identifies runway dependent DME(s).

(2) RNAV Departures that use RADAR Vectors to Join RNAV Routes (RDVA). The Pilot Navigation Area (PNA) is an area used to transition from radar vectoring to the area navigation route. It is defined by two perimeter boundaries and an arc radius referenced from the initial departure fix (IDF). See Figure 13-1. The PNA is developed by the procedures specialist and is specified on FAA Form 8260-15B, Graphic Departure Procedure, as bearings to the IDF with arc radius and minimum altitude. The bearings to the IDF are used as perimeter boundaries. See Figure 13-1. Record DME facility coverage along each perimeter boundary and along the arc radius at the minimum specified altitude. Refer to FAA Order 8260.53, Standard Instrument Departures That Use RADAR Vectors to Join RNAV Routes, for procedure development criteria.

Figure 13-1
SID Overview



b. **Routes** can be flown in either direction. All routes will be flown on centerline at the minimum altitude (true) specified in the procedure package.

c. **RNAV Standard Terminal Arrivals.** Aircraft positioning is in accordance with Section 1 of this chapter.

d. **Approach.** (Reserved)

e. **Missed Approach.** (Reserved)

13.33 ANALYSIS. DME coverage data collected during the flight inspection must be analyzed to verify that the DME infrastructure will support a DME/ DME RNAV position solution in accordance with FAA Advisory Circular AC90-100 (US TERMINAL AND EN ROUTE AREA NAVIGATION (RNAV) OPERATIONS) performance criteria. FIS software or an approved software analysis tool (i.e., RNAV-Pro) must be used to analyze the actual DME coverage and performance.

The adequacy and accuracy of the DME/ DME RNAV position solution is determined primarily by DME facility coverage and geometry to the aircraft as it tracks along the flight procedure. Analysis should include, but is not limited to:

- Failure of any critical DME coverage
- Coverage (lock-on) and range error for all DME(s) identified by the modeling software for each segment of the procedure
- Pass or fail of required ESV coverage.

Once the post-flight data analysis is completed, a final determination as to whether the procedure is satisfactory for DME/ DME or DME/ DME/ IRU RNAV can be made.

Confirmation of communications and radar coverage on all segments of "Q" Routes using DME/ DME supported RNAV is required

NOTE: "RNAV 2" procedures are equivalent to RNP 2.0, and "RNAV 1" procedures are equivalent to RNP 1.0 for analysis.

13.34 TOLERANCES

DME/ DME SUPPORTED RNAV		
Parameter	**Paragraph Reference**	**Tolerance**
DME Accuracy[1]	Chapter 11, Section 6	≤ 0.20 nm

[1]**NOTE.** DME facilities with range errors greater than 0.20 nm do not invalidate the DME/ DME procedure, unless it is a "critical" DME facility as identified in RNAV-Pro.

SECTION 4. WIDE AREA AUGMENTATION SYSTEM (WAAS) RNAV

This section provides supplemental guidance to Section 1 of this chapter for inspection of RNAV procedures requiring WAAS.

13.40 INTRODUCTION. The WAAS provides augmentation, including integrity broadcasts, differential corrections, and additional ranging signals to the standard GPS signal. It provides the accuracy, integrity, availability, and continuity required to support oceanic, remote-area, en route, terminal, non-precision approach, and APV approach phases of flight.

WAAS utilizes a network of wide-area reference stations (WRS) that receive and monitor the GPS signals. Data from these reference stations are transmitted to one of two wide-area master stations (WMS), where the validity of the signals from each satellite is assessed and wide-area corrections are computed. These validity (integrity) messages and wide-area corrections are transmitted to aircraft via Geostationary Earth Orbit (GEO) communications satellites that serve as additional sources of GPS ranging signals, increasing the number of satellites available to the system users. The WAAS signal is transmitted on the same frequency (L1 – 1,575.42 MHz) and with the same type of code-division multiplex modulation as the GPS Standard Positioning Service (SPS) signal. This allows a WAAS receiver to acquire and process both the GPS and WAAS broadcasts. An integrity message transmitted by the WAAS provides the user with a direct verification of the integrity of the signal from each satellite in view.

FAA Order 8260.58, The United States Standard for Area Navigation (RNAV), specifies design criteria for approach procedures. Approaches constructed under these criteria are termed “LP” or “LPV”. The lateral protection area is based on precision approach trapezoid dimensions criterion. RNAV WAAS LP procedures can be supported to HAT values ≥ 250 feet. LPV procedures can be supported to HAT values ≥ 200 feet.

In addition to LP/ LPV procedures, WAAS supports LNAV and LNAV/ VNAV approaches. WAAS can be used to support the vertical guidance requirements for RNAV LNAV/ VNAV approach procedures at airports where BARO-VNAV is not authorized. Avionics systems using WAAS for vertical guidance are not limited by approach procedure BARO-VNAV temperature restrictions.

13.41 PREFLIGHT REQUIREMENTS

a. LP/ LPV FAS Data Block Verification. The LP/ LPV FAS data (data specified on FAA Form 8260-10) is developed and coded into binary files by the procedure developer. The FAS data files are saved into a network file for flight inspection access. Download the FAS data blocks files required for the scheduled itinerary onto removable disk media.

Prior to mission departure, confirm FIS access to the removable disk media. Access each individual FAS data file and confirm the CRC Remainder matches the FAA Form 8260-10 data. This ensures no errors occurred during data transfer (data file integrity). Any corruption must be resolved prior to conducting the inspection. The FIS uses the FAS data to calculate course alignment, glide path angle, and threshold crossing height.

b. WAAS Status. Determine WAAS status before every flight inspection and after an inspection that detects anomalies. WAAS/ GPS NOTAM(s) and GPS Service Interruptions (interference testing) location and schedule should be considered. Severe solar storm activity may adversely affect WAAS availability for approach.

13.42 FLIGHT INSPECTION PROCEDURES. The RNAV WAAS LP/ LPV procedure must be inspected IAW Chapter 6, Flight Inspection of Instrument Flight Procedures, and this chapter. FAA Order 8260.54, The United States Standard for Area Navigation (RNAV), contains required obstruction clearance criteria.

a. Checklist (See Section 1, Paragraph 13.12, a)

b. Detailed Procedures

(1) For RNAV WAAS LP/ LPV, do not deselect any navigation sensors.

(2) Paper recordings **and/or** electronic collection of data are required. During an RNAV WAAS LP/ LPV approach, document WAAS data starting from the intermediate waypoint inbound to the Landing Threshold Point (LTP)/ Fictitious Threshold Point (FTP). A flight inspection "low approach" is required to provide back corrections for data analysis. Also, document WAAS data on below-glide-path runs.

c. Aircraft Positioning

(1) Commissioning

(a) The FAS positioning must be on course, on path. Evaluate the Glide Path Angle (GPA) course guidance, WAAS positioning, and delivery alignment throughout the final approach segment.

(b) Confirm WAAS glidepath full scale fly-up.

(c) Offset LPV Aircraft Positioning. Final Approach Segment positioning must be on course, on path; so as to overfly the FTP.

(d) Offset LP Aircraft Positioning. Final Approach Segment positioning must be on course, at procedural altitude(s), so as to over fly the LTP/ FTP.

(2) Periodic. Periodic inspection of RNAV WAAS LP/LPV approaches do not require flying the actual procedure; however, an obstacle assessment must be conducted through the final and missed approach segments.

(3) WAAS Interference. If interference is suspected, record additional data from the two following runs. Evaluation of the final approach segment for interference is accomplished by flying along the left and right edges of primary FAS obstruction trapezoid. (Create a route using 90° offset waypoints 0.3 nm from the PFAF and 0.1 nm from the Missed Approach Waypoint (MAWP), respectively, with a vertical angle at least 1° less than the procedure GPA (full scale fly-up) for LPV or at MDA for LP. This will provide lateral/ vertical guidance slightly outside the "W" obstacle clearance surface.) Assure that a full fly-up indication is provided below the approach GPA on FAS centerline and along edges of the primary FAS obstruction trapezoid.

13.43 FLIGHT INSPECTION ANALYSIS

a. CRC Remainder. The FAS data block integrity must be confirmed by a perfect match of the CRC remainder documented on FAA Form 8260-10 (or equivalent) and the CRC remainder as computed by FIS.

b. WAAS Signal. To the extent possible, monitor WAAS signal while en route and during approach for anomalies. Document and/or record anomalies.

If GPS interference is suspected, annotate on the flight inspection report any visual observation of radio, cellular or other facilities, which may be a possible source for emitting RFI.

NOTE: Report interference to the FICO, who will in turn forward the report to the ATCSCC/ Spectrum Assignment and Engineering Office at Herndon, Virginia.

c. Parameters. There are no flight inspection tolerances applied to the parameters. However, the values listed below (Table 13-1) provide a baseline for analysis of any WAAS signal anomalies or interference.

The parameters in Table 13-1 must be documented throughout the Intermediate and Final Approach Segments and whenever anomalies are found during any phase of the flight inspection.

Table 13-1. GPS WAAS Parameters

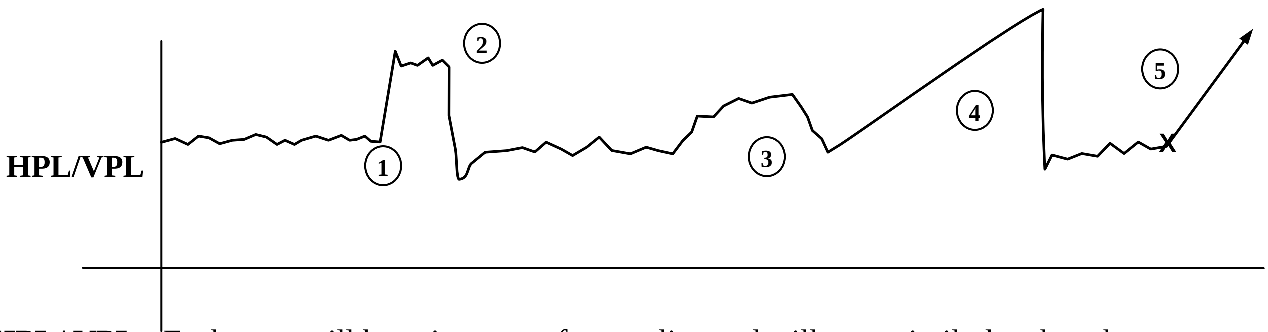
Parameter	**Expected Value**
HPL (1)	≤ 40 meters
VPL (1)	≤ 50 meters
HDOP	1.0 – 1.5
VDOP	1.0 – 1.5
WAAS Healthy Satellites	4 GPS & 1 GEO minimum
Satellites Tracked	4 GPS & 1 GEO minimum
Satellites in View	4 GPS & 1 GEO minimum
Geostationary Satellite SNR (2)	≥ 30 dB/ Hz
WAAS Sensor Status	“SBAS”

Footnotes:

(1) Extreme solar storm activity may affect horizontal protection level (HPL)/ vertical protection level (VPL) values and other WAAS signal parameters.

(2) SNR is not received from a WAAS GEO if it is not sending ranging messages.

Example trace of flight inspection recording of WAAS HPL/ VPL anomalies:



HPL/ VPL: Each trace will have its own reference line and will react similarly when the following parameters change during check:

1. Loss of a GPS satellite.
2. Acquire a new GPS satellite.
3. Weak interference will inflate HPL/ VPL a little. Strong interference will cause loss of GPS or SBAS signals.
4. Ramp caused by missing some key SBAS messages.
5. Loss of GEO – HPL/ VPL ramps up to undefined/ infinite.

13.44 TOLERANCES

Table 13-2. FIS Announced Data for LP/ LPV

Parameter	Tolerance
WAAS Horizontal Protection Level (HPL)	≤ 40 m
WAAS Vertical Protection Level (VPL)(1)	≤ 35 meters (200 – 249' approach minima) ≤ 50 meters (≥250' approach minima)
CRC Remainder	Perfect Match (No CRC Error)
Course Alignment	± 0.1° of true course
Glide Path Alignment (1)	± 0.09°
Threshold Crossing Height (1)	+ 12 ft - 10 ft

Footnote:
(1) Not applicable to LP. LP does not provide vertical guidance.

Table 13-3. FIS Announced Data

(WAAS Supported LNAV/ VNAV without FAS Data)

Final Approach Segment (FAS)	
Parameter	**Tolerance**
WAAS Horizontal Protection Level (HPL)	≤ 556 m
WAAS Vertical Protection Level (VPL)	≤ 50m

APPENDIX 1. SUPPLEMENTAL INFORMATION

SECTION 1. GLOSSARY

Definitions and Symbols. The use of italics within a definition denotes another definition contained within this section.

Actual Glidepath Alignment or Actual Glidepath Angle. The straight line arithmetic mean of all deviations around the *on-path* position derived in ILS Zone 2.

Actual Course (Alignment). The straight line arithmetic mean of all deviations around the *on-course* position derived from the area in which alignment was taken.

Actual Navigation Performance (ANP). Sometimes called Estimated Position Error (EPE) or "Q" factor, is an onboard computation of the estimated 95% Navigation System Error using knowledge of the real world navigation environment, i.e., number of satellites tracked, number/ geometry of ground facilities, and statistical error models of the various navigation sources. ANP is continuously compared to RNP, and the crew is alerted if ANP exceeds RNP.

AFIS Corrected Error Trace. A graphical presentation of deviation about the mean of all points measured in ILS Zone 2 for glidepaths and Zones 2 and 3 for localizers.

Automatic Gain Control (AGC). A process of electronically regulating the gain in the amplification stages of a receiver so that the output signal tends to remain constant though the incoming signal may vary in strength.

AGC Current or Voltage. A current or voltage responding to the action of the AGC circuit that may be interpreted in terms of signal intensity.

Air Traffic Control Radar Beacon System (ATCRBS). The general term of the ultimate in functional capability afforded by several automation systems. Each differs in functional capabilities and equipment. ARTS IA, ARTS II, ARTS III, and ARTS IIIA (see AIM).

Airway/ Federal Airway. A control area or portion thereof established in the form of a corridor, the centerline of which is defined by navigational aids (refer to FAR Part 71, AIM).

Alert. An indication provided to other aircraft systems or annunciation to the pilot to identify an operating parameter of a navigation system is out of tolerance.

Alert Limit. For a given parameter measurement, the error tolerance not to be exceeded without issuing an alert.

Alignment. Coincidence of a positional or directional element with its nominal reference.

Alignment, Azimuth. The azimuth or actual magnetic bearing of a course.

Alignment, Elevation. The actual angle above a horizontal plan originating at a specific point of a course used for altitude guidance.

Alignment Error. The angular or linear displacement of a positional or directional element from its normal reference.

Alignment Error, Azimuth. The difference in degrees between the position of a selected course and the correct magnetic azimuth for this course.

> **NOTE:** The error is positive when the course is clockwise from the correct azimuth.

Alignment Error, Elevation. The difference in degrees between the measured angle of the course and the correct angle for the course.

> **NOTE:** The error is positive when the course is above the correct angle.

ALTITUDES:

a. **Absolute Altitude.** The altitude of the aircraft above the surface it is flying (AC 00-6A). It may be read on a radio/ radar altimeter.

b. **Calibrated Altitude.** Indicated altitude corrected for static pressure error, installation error, and instrument error.

c. **Indicated Altitude.** The altitude as shown by an altimeter on a pressure or barometric altimeter. It is altitude as shown uncorrected for instrument error and uncompensated for variation from standard atmospheric conditions (AIM).

d. **Pressure Altitude.** Altitude read on the altimeter when the instrument is adjusted to indicate height above the standard datum plane (29.92" Hg.)(AC 61-27 latest revision).

e. **True Altitude.** The calibrated altitude corrected for nonstandard atmospheric conditions. It is the actual height above mean sea level (AC 61-27).

Ampere. A unit of electric current such as would be given with an electromotive force of one volt through a wire having a resistance of one OHM. See Symbols. See Crosspointer.

Amplitude (Peak). The maximum instantaneous value of a varying voltage or current measured as either a positive or negative value.

Anomalous Propagation. Weather phenomena resulting in a layer in the atmosphere capable of reflecting or refracting electromagnetic waves either toward or away from the surface of the earth.

Angle Voltage. The alignment points of the azimuth and elevation electronic cursors are expressed in angle voltage or dial divisions.

Antenna. A device used to radiate or receive electromagnetic signals.

Antenna Reflector. That portion of a directional array, frequently indirectly excited, which reduces the field intensity behind the array and increases it in the forward direction.

Approach Azimuth. Equipment which provides lateral guidance to aircraft in the approach and runway regions. This equipment may radiate the Approach Azimuth function or the High Rate Approach Azimuth function along with appropriate basic and auxiliary data.

Approach Elevation. The equipment which provides vertical guidance in the approach region. This equipment radiates the Approach Elevation function.

Approach Reference Datum (ARD). A point at a specified height located vertically above the intersection of the runway centerline and the threshold.

Approach with Vertical Guidance (APV). RNAV procedures with vertical guidance are termed "APV" (approach with Vertical Guidance). APV is a classification of approach capability between Non-Precision and Precision. APV landing minimums are based on the performance criteria and technology related to the Navigation System Error (NSE), Flight Technical Error, and Total System Error (TSE).

Area Navigation (RNAV). A method of navigation that permits aircraft operations on any desired course within the coverage of station referenced navigation signals or within the limits of self-contained system capability (AIM).

Area VOT. A facility designed for use on the ground or in the air. It may be located to provide the test signal to one or more airports.

ARINC Specification 424. ARINC Specification 424 is a standard by which a navigation is created to interface with an airborne navigation computer (i.e., FMS, GPS receiver, etc.) The navigation database will provide paths and termination points for the navigation computer to follow. ARINC 424 defines 23 leg path and terminators. A limited number of the leg types can be used to define RNAV procedures. The leg types used to define RNP RNAV procedures are further limited in order to provide repeatable aircraft ground tracks.

Attenuation. The reduction in the strength of a signal, expressed in decibels (dB).

Auxiliary Data. Data, transmitted in addition to basic data, that provide Facilities Maintenance equipment siting information for use in refining airborne position calculations and other supplementary information.

Availability. The ability of the navigation system to provide the required function and performance at the initiation of the intended operation. Short-term system availability is the probability that the aircraft can conduct the approach at the destination, given that the service at the destination was predicted to be available at dispatch. Long-term service availability is the probability that the signal-in-space from the service provider will be available for any aircraft intending to conduct the approach.

Average Course Signal. The course determined by drawing the mean of the maximum course deviations due to roughness and scalloping.

Azimuth. A direction at a reference point expressed as the angle in the horizontal plane between a reference line and the line joining the reference point to another point, usually measured clockwise from the reference line.

Auxiliary Data. Data, transmitted in addition to basic data, that provide Facilities Maintenance equipment siting information for use in refining airborne position calculations and other supplementary information.

Barometric Vertical Navigation (BARO VNAV). A navigation system which presents computed vertical guidance to the pilot. The computer-resolved Glidepath Angle (GPA) is based on barometric altitude, and is either computed as a geometric angle between two waypoints, or an angle from a single waypoint.

Baseline Extension (Loran-C). The extension of the baseline beyond the master or secondary station. Navigation in this region may be inaccurate due to geometrical considerations resulting in ambiguous position solutions.

Basic Data. Data transmitted by the Facilities Maintenance equipment that are associated directly with the operation of the landing guidance system.

Bearing. The horizontal direction to or from any point usually measured clockwise from true north or some other reference point (see Non-Directional Beacon)(AIM).

Bends. Slow excursions of the course.

Bits per second (BPS). Refers to digital data transfer rate, usually by modem or direct cable.

Black Hole. An area in the vicinity of an airport, which visually appears void of features normally used by the pilot for situational awareness. This term is normally associated with nighttime operations.

Blind Speed. The rate of departure or closing of a target relative to the radar antenna at which cancellation of the primary target by MTI circuits in the radar equipment causes a reduction or complete loss of signal (AIM).

Blind Zones (Blind Spots). Areas from which radio transmissions and/or radar echoes cannot be received.

Broadband. Nonautomated signal processing.

Capture Effect. A system in which coverage is achieved by the use of two independent radiation field patterns spaced on separate carrier frequencies.

Change/ Reversal in Slope of the Glidepath. A long term (1,500 ft or more) change in the direction of the *on-path* position as determined by the graphic averaging of the short term (roughness, high frequency scalloping) deviations as represented by the differential/ corrected error trace.

Checkpoint. A geographical point on the surface of the earth whose location can be determined by reference to a map or chart.

Circular Polarization (CP). An electromagnetic wave for which the electronic and/or the magnetic field vector at a point describes a circle.

NOTE: Circular Polarization reduces or eliminates echoes from precipitation.

Clearance. The preponderance of the modulation signal appropriate to the area on one side of the reference line or point to which the receiver is positioned, over the modulation signal appropriate to the area on the other side of the reference line.

Clearance Guidance Sector. The volume of airspace, inside the coverage sector, within which the azimuth guidance information provided is not proportional to the angular displacement of the aircraft but is a constant fly-left or fly-right indication of the direction relative to the approach course the aircraft should proceed in order to enter the proportional guidance sector.

Close-in Courses. That portion of a course or radial which lies within 10 miles of the station.

Code Train. A series of pulses of similar characteristics and specific spacing. Applicable to the group of pulses transmitted by a transponder each time it replies to an interrogator.

Coded Instrument Flight Procedures (CIFP): A dataset published by the FAA, previously known as the National Flight Database (NFD). The CIFP is modeled to the Airlines Electronic Engineering Committee (AEEC) Aeronautical Radio Incorporated (ARINC) Navigation System Data Base (NDB) international standard (ARINC 424).

Comma-Separated Values (CSV) file. In computers, a CSV file contains the values in a table as a series of ASCII text lines organized so that each column value is separated by a comma from the next column's value and each row starts a new line. A CSV file is a way to collect the data from any table so that it can be conveyed as input to another table-oriented application.

Common Digitizer Data Reduction Program (CD). A computer data recording of raw narrowband radar data (minimal filtering ability is provided).

Cone of Ambiguity. Airspace over a VOR or TACAN station, conical in shape, in which the To/ From ambiguity indicator is changing positions.

Constant False Alarm Rate (CFAR). PAR electronic circuitry which allows search video clutter reduction on the radar display presentation.

Continuity. The ability of the total system (comprising all elements necessary to maintain aircraft position within the defined airspace) to perform its function without interruption during the intended operation. More specifically, continuity is the probability that the specified system performance will be maintained for the duration of a phase of operation, presuming that the system was available at the beginning of that phase of operation.

Control Electronic Unit (CEU). Mobile MLS computer transmitter and monitoring system.

Control Motion Noise (CMN). Those fluctuations in the guidance which affect aircraft attitude, control surface, column motion, and wheel motion during coupled flight but do not cause aircraft displacement from the desired course or glidepath.

Cooperating Aircraft. Aircraft which cooperate by flying courses required to fulfill specific portions of the flight inspection and which meet the requirements for a small aircraft.

Cosecant-Squared Beam. A radar beam pattern designed to give approximately uniform signal intensity for echoes received from distant and nearby objects. The beam intensity varies as the square of the cosecant of the elevation angle.

Course Coincidence. The measured divergence of the designated radials of two adjacent facilities in the airway structure. (ICAO Document 8071).

Course Displacement. The difference between the actual course alignment and the correct course alignment. (ICAO Document 8071).

Course Error. The difference between the course as determined by the navigational equipment and the actual measured course to the facility. This error is computed as a plus or minus value, using the actual measured course to the facility as a reference.

Course Line Computer. Airborne equipment which accepts bearing and distance information from receivers in an aircraft, processes it, and presents navigational information enabling flight on courses other than directly to or from the ground navigation aid being used. (Used in Area Navigation--RNAV.)

Course Roughness. Rapid irregular excursions of the course usually caused by irregular terrain, obstructions, trees, power lines, etc.

Course Scalloping. Rhythmic excursions of the electromagnetic course or path.

Course Width (Course Sensitivity). The angular deviation required to produce a full-scale course deviation indication of the airborne navigation instrument.

Coverage. The designated volume of airspace within which a signal-in-space of specified characteristics is to be radiated.

Critical DME. For RNAV operations, a DME facility that, when unavailable, results in navigation service which is insufficient for DME/ DME/IRU supported operations along a specific route or procedure. The required performance assumes an aircraft's RNAV system meets the minimum standard (baseline) for DME/ DME RNAV systems or the minimum standard for DME/ DME/IRU systems found in Advisory Circular 90-100x, U.S. Terminal and En route Area Navigation (RNAV) Operations. For example, terminal RNAV DP(s) and STAR(s) may be published with only two DME(s), in which case, both are critical.

Crosspointer (Deflection Indicator Current (ICAO)). An output current proportional to: ILS-- Difference in depth of modulation measured in microamperes. VOR/ VORTAC/ TAC -- The difference in phase of two transmitted signals measured in degrees of two audio navigation components for a given displacement from a navigation aid.**Cycle Skip.** The receiver uses the incorrect cycle of the 100 kHz carrier of the Loran-C signal, for time measurements. Normally the third cycle of a given carrier pulse is used for time measurements. Each cycle slip will result in a 10-microsecond error in time measurement and a corresponding error in navigation.

Cyclic Redundancy Check (CRC). The CRC is an error detection algorithm capable of detecting changes in a block of data. Navigation databases require high integrity of the data. The CRC performs a mathematical calculation of the navigation data and returns a number that uniquely identifies the content and organization of the data. The actual number that is used to identify the data is called a checksum or CRC remainder code. CRC values are stored and transmitted with their corresponding data. By comparing the CRC code of a GBAS or WAAS RNAV FAS data block to the FAA Form 8260-10 procedural data CRC code, determination can be made if FAS data has been corrupted.

Data Continuity. Refers to the continuous availability of both an indication of GBAS status on the FIS annunciator (or equivalent in-flight/ post-flight indication) and positive course guidance in the cockpit for the purpose of verifying the reception of required VDB message types at rates that meet the minimum message rate requirement, including consideration of the allowed message-failure rate. More specifically, the probability that the navigation signal-in-space supports accuracy and integrity requirements for duration of intended operations, presuming that the system was available at the beginning of the phase of operation.

Datum Crossing Height (DCH). The relative height at which the Final Approach Segment passes over the Runway Datum Point.

Datum Crossing Point (DCP). The point on the Final Approach Segment directly above the Runway Datum Point.

Dedicated TRIAD. Three specific Loran-C stations from one CHAIN. Dedicated TRIAD selection is utilized to ensure that receiver positioning is determined only by these stations.

Designed Procedural Azimuth. The azimuth determined by the procedure specialist that defines the desired position of a course or bearing.

DF Course (Steer). The indicated magnetic direction of an aircraft to the DF station and the direction the aircraft must steer to reach the station.

DF Fix. The geographical location of an aircraft obtained by the direction finder.

Difference in Depth of Modulation (DDM). The percentage modulation of the larger signal minus the percentage modulation of the smaller signal.

Dilution of Precision (DOP). (HDOP - horizontal, VDOP - vertical, PDOP - position, i.e., the combination of horizontal and vertical) Dilution of precision is the mathematical representation of the quality of GPS satellite geometries. The number and location of the visible satellites control DOP. A value of 1.0 would be optimum satellite constellation and high quality data (1.5 or less is normal). A value of 8.0 would be poor constellation and data.

Discrepancy. Any facility operating parameter which is not within the given tolerance values (prescribed in the U.S. Standard Flight Inspection Manual) as determined by flight inspection measurements.

Displaced Threshold. A threshold located on the runway at a point other than the designated beginning of the runway (AIM).

Distance Measuring Equipment (DME). Electronic equipment used to measure, in nautical miles, the slant range of the aircraft from the navigation aid. (AIM)

Distance Measuring Equipment/ Precision (DME/ P). The range function associated with the MLS. It is a precision distance measuring equipment providing accurate range (20 to 40 ft at a 2-sigma probability).

DME Electronic Unit (DEU). Mobile MLS transmitter and monitoring system.

Doppler VOR (DVOR). VOR using the Doppler frequency shift principle.

Dual-Frequency Glidepath System. An ILS glidepath in which coverage is achieved by the use of two independent radiation field patterns spaced on separate carrier frequencies within the particular glidepath channel, e.g., Capture Effect Glidepath.

Dual-Frequency Localizer System. A localizer system in which coverage is achieved by the use of two independent radiation frequencies within the particular localizer VHF channel.

Earth-Centered, Earth-Fixed (ECEF) is a non-inertial system that rotates with the Earth. Its origin is fixed at the center of the Earth (see Ellipsoid).

Ellipsoid (WGS-84). WGS-84 ellipsoid is used by DoD for mapping, charting, surveying, and navigation needs, including its GPS “broadcast” and “precise” orbits. The absolute positions that are obtained directly from GPS are based on the 3D, earth-fixed WGS-84 ellipsoid.

Ellipsoid Height. Ellipsoid height is the vertical distance of a point above the WGS-84 ellipsoid.

Envelope to Cycle Discrepancy (ECD). The discrepancy between the desired and actual zero phase crossing at the end of the third cycle of the Loran-C 100 kHz carrier pulse.

Essential Data. Essential data words are Basic Data Words 1, 2, 3, 4, and 6; and Auxiliary Data Words A1, A2, and A3.

Expanded Service Volume (ESV). (See Service Volume.)

Fault Detection & Exclusion (FDE). If six or more space vehicles are received, the GPS avionics will determine any errors, which space vehicle is providing faulty data, and exclude it. FDE is required for remote/ oceanic operations.

Feed Horn. Radar antenna focal point. Also reference point in antenna elevation measurements.

Fictitious Threshold Point (FTP). The FTP is the equivalent of the landing threshold point (LTP) when the final approach course is offset from runway centerline. It is defined as the intersection of the final course and a line perpendicular to the final course that passes throughout the LTP. FTP elevation is the same as the LTP. For the purposes of this document, where LTP is used, FTP may apply as appropriate.

Figure of Merit (FOM). Horizontal and Vertical FOM are the current assessment of the 95% accuracy of the reported position in these dimensions for WAAS.

Final Approach Path (FAP). The prescribed straight three-dimensional path in space to be flown for final approach. For GPS/ GBAS, this path is defined in the FAS Path Data by the Runway Datum Point (RDP), the Datum Crossing Height (DCH), the Flight Path Alignment Point (FPAP), and the Glide Path Angle.

Final Approach Segment. This is the segment in which alignment and descent for landing are accomplished. The final approach segment considered for obstacle clearance begins at the final approach fix or point and ends at the runway or missed approach point, whichever is encountered last. A visual portion within the final approach segment may be included.

Final Approach Segment (FAS) Data Block. The FAS Data Block contains data for a single operation. It is self-contained and utilizes a cyclic redundancy check (CRC) to preserve integrity. The FAS Data Block contains the parameters that define a single straight-in **precision** approach. Parameters include:

a. **Operation Type.** A number from 0 to 15 that indicates the types of the final approach segment.

b. **SBAS Service Provider Identifier.** A number from 0 to 15 that associates the approach procedure to a particular satellite-based approach system service provider. For GBAS applications, this data is ignored.

c. **Airport Identifier.** The four-character ICAO location identifier assigned to an airport. Where there is a national airport identifier but no ICAO location identifier, the three- or four-character national identifier is used. Where only three characters are provided, the trailing space is to be left blank.

d. **Runway Number.** Runways are identified by one or two numbers with a valid range of 1 – 36. Use of "0" in the runway number is obsolete.

e. **Runway Letter.** A runway letter [left (L), right(R), or center (C)] is used to differentiate between parallel runways. The valid range is 00 through 11. The convention for coding is as follows:

00 = no letter	10 = C (center)
01 = R (right)	11 = L (left)

f. Approach Performance Designator (APD). A number from 0 to 7 that identifies the type of approach. A "0" is used to identify an LPV/ LP approach procedure, and a "1" indicates a Category I approach procedure. Leave blank (null) for GBAS procedures.

g. Route Indicator. A single alpha character (A through Z or blank, omitting I and O) used to differentiate between multiple final approach segments to the same runway or heliport. The first approach to a runway is labeled "Z". Additional alpha characters are incrementally assigned.

h. Reference Path Data Selector (RPDS). A number (0 – 48) that enables automatic tuning of a procedure by GBAS avionics. The number is related to the frequency of the VHF data broadcast and a 5-digit tuning identifier. Always "0" for WAAS operations.

i. Reference Path Identifier (RPI). A four-character identifier that is used to confirm selection of the correct approach procedure. This identifier is defined with a "W" signifying WAAS, followed by the runway number. For a GBAS system, the identifier is defined with a "G", followed by the runway number. The last character, beginning with the letter "A", excluding the letters "C", "L", and "R", will be used to define the first procedures, followed by a succeeding letter for each procedure to a particular runway.

j. Landing Threshold Point (LTP) or Ficticious Threshold Point (FTP) Latitude. Represents the latitude of the threshold defined in WGS-84 coordinates and entered to five ten-thousandths of an arc second. (The last digit must be rounded to either a 0 or 5). Use the FTP Latitude for offset procedures. The most significant bit is the sign bit: 0 = Positive (Northern Hemisphere); 1 = Negative (Southern Hemisphere).

k. Landing Threshold Point (LTP) or Ficticious Threshold Point (FTP) Longtitude. Represents the longtitude of the threshold defined in WGS-84 coordinates and entered to five ten-thousandths of an arc second. (The last digit must be rounded to either a 0 or 5). Use the FTP Longtitude for offset procedures. The most significant bit is the sign bit: 0 = Positive (Western Hemisphere); 1 = Negative (Eastern Hemisphere).

l. LTP or FTP Height Above Ellipsoid (HAE). The height expressed in meters reference the WGS-84 ellipsoid. The first character is a + or -, and the resolution value is in tenths of a meter with the decimal point suppressed. Use the LTP HAE for offset procedures.

m. Flight Path Alignment Point (FPAP) – Latitiude. A point located on a geodesic line or an extension of a geodesic line calculated between the LTP and the designated center of the opposite runway-landing threshold. It is positioned at a distance from the LTP to support a prescribed procedure design angular splay and course width, as well as functionality associated with an aircraft. It is used in conjunction with LTP to determine the lateral alignment of the vertical plane containing the path of the RNAV final approach segment. On shorter runways, the FPAP may be located off the departure end of the landing runway. The latitude of the runway FPAP is defined in WGS-84 coordinates and entered to five ten-thousandths of an arc second (the last digit must be rounded to either a 0 or 5). The most significant bit is the sign bit: 0 = Positive (Northern Hemisphere); 1 = Negative (Southern Hemisphere).

n. Flight Path Alignment Point (FPAP) – Longitude. The longitude of the runway FPAP is defined in WGS-84 coordinates and entered to five ten-thousandths of an arc second. (The last digit must be rounded to either a 0 or 5). The most significant bit is the sign bit: 0 = Positive (Eastern Hemisphere); 1 = Negative (Western Hemisphere).

o. Threshold Crossing Height (TCH). The designated crossing height of the flight path above the LTP (or FTP).

p. TCH Units Selector. This character defines the units used to describe the TCH.

F= feet M = meters

q. Glidepath Angle (GPA). The angle of the approach path (glidepath) with respect to the horizontal plane defined according to WGS-84 at the LTP/ FTP. It is specified in degrees.

r. Course Width at Threshold. The semi-width (in meters) of the lateral course at the LTP/ FTP, defining the lateral offset at which the receiver will achieve full-scale deflection. In combination with the distance to the FPAP, the course width defines the sensitivity of the lateral deviations though the approach. The allowable range varies from 80 meters to 143.75 meters. When the LPV procedure is designed to overlie the ILS/ MLS procedure, use the course width at the threshold value from the flight inspection report of the underlying (ILS/ MLS) system. If the localizer course width at the threshold is less than 80 meters, use 80 meters as the default value. For offset procedures, use the course width at the FTP.

s. Delta Length (Δ Length) Offset. The distance from the stop end of the runway to the FPAP. It defines the location where lateral sensitivity changes to the missed approach sensitivity. The value is in meters with the limits being 0 to 2,032 meters. The distance is rounded to the nearest 8-meter value. If the FPAP is located at the designated center of the opposite runway end, the distance is zero. For offset procedures, the length of the offset is coded as zero.

t. Precision Approach Path Point CRC Remainder. An 8-character hexadecimal representation of the calculated remainder bits used to determine the integrity of the FAS Data Block during the transmission and storage. This information will be computed electronically with the use of the electronical transmittal software and documented on FAA Form 8260-10, or equivalent.

u. ICAO Code. The first two designators of the ICAO location identifier. In the Continental United States, the country code will begin with the letter "K" followed by a numerical character.

v. Othometric Height. The height of the LTP or FPAP, as related to the geoid and presented as an MSL elevation defined to a tenth of a meter resolution with the decimal point suppressed. For the purpose of documenting this in the "Additional Path Point Record Information", the LTP and FPAP orthometric height will be the same and based on the LTP elevation. The value is preceeded by a "+" or "-".

w. Horizontal Alert Limit (HAL). The HAL is the radius of a circle in the horizontal plane (the local plane tangent to the WGS-84 ellipsoid), with its center being at the true position, that describes the region which is required to contain the indicated horizontal position with the required probability for a particular navigation mode assuming the probability of a GPS satellite integrity failure being included in the position solution is less than or equal to 10^{-4} per hour. The range of values is 0 to 50.8 meters with a 0.2 resolution. The HAL for LPV procedures is a fixed value of 40.0 meters.

Note: An HAL is not part of the FAS data block/ CRC wrap for GBAS procedures.

x. Vertical Alert Limit (VAL). The VAL is half the length of a segment on the vertical axis (perpendicular to the horizontal plane of the WGS-84 ellipsoid), with its center being at the true position, that describes the region which is required to contain the indicated vertical position with a probability of $1 – 10^{-7}$ per approach, assuming the probability of a GPS satellite integrity failure being included in the position solution is less than or equal to 10^{-4} per hour. The range of values is 0 to 50.8 meters with a 0.2 resolution. The VAL for LPV procedures is a fixed value at 50.0 meters where the HATh/ HAT is 250 ft or greater. If an LPV procedure has been established to support a HATh/ HAT less than 250 ft (no less than 200 ft), a VAL of 35 meters will be used.

Note 1: A VAL of 00.0 indicates that the vertical deviations should not be used (i.e., a lateral-only [LP] approach).

Note 2: A VAL is not part of the FAS data block/ CRC wrap for GBAS procedures.

Final Approach Segment Lateral Alert Limit (FASLAL). This parameter is the lateral alert limit broadcast by the GBAS ground system associated with the approach defined by the FAS Data. The maximum value in the FASLAL field must be 40 meters.

Final Approach Segment Vertical Alert Limit (FASVAL). This parameter is the vertical alert limit broadcast by the GBAS ground system associated with the approach defined by the FAS Data. The maximum value in the FASVAL field must be 10 meters.

FAS LAL and FAS VAL values relavent to the GCID

GCID	FASLAL	FASLAL
1	≤ 40 m	≤ 10 m
2	≤ 17 m	≤ 10 m
3	≤ 17 m	≤ 10 m
4	≤ 17 m	≤ 10 m

Note: The FASVAL and FASLAL for any FAS data block may be coded as “1111 1111” to limit the approach to lateral only or to indicate that the approach must not be used, respectively. These numbers will linearly increase from the DA out to a distance greater than 7500 meters from the LTP.

Fixed Map. A background map on the radar display produced by one of the following methods:

(1) Engraved marks on an overlay illuminated by edge lighting

(2) Engraved fluorescent marks on an overlay illuminated by means of ultraviolet light.

(3) Projected on the display by means of film and a projector mounted above and in front of the scope.

(4) Electronically mixed into the display as generated by a "mapper" unit

Flag (Flag Alarm). A warning device in certain airborne navigation equipment and flight instruments indicating: (1) instruments are inoperative or otherwise not operating satisfactorily, or (2) signal strength or quality of the received signal falls below acceptable values. (AIM)

Flag Alarm Current. The d.c. current flowing in the Flag Alarm Circuit, usually measured in microamperes, which indicates certain characteristics of the modulation of the received signal.

Flight Inspection (Flight Check). Inflight investigation and evaluation of air navigation aids and instrument flight procedures to ascertain or verify that they meet established tolerances and provide safe operations for intended use. It involves the operation of a suitably equipped aircraft for the purpose of calibrating ground based NAVAIDS or monitoring the performance of navigation systems.

> **Note:** *Flight checked* describes the procedure to accomplish the function of flight inspection. The two terms are interchangeable.

Flight Inspector. Flight crewmember certified by FAA's Aviation System Standards (AVN) to perform flight inspection.

Flight Inspection Standard Service Volume (FISSV) (see Service Volume).

Flight Inspection System (FIS). The inflight evaluation tool used for investigation and evaluation of air navigation aids and instrument flight procedures to ascertain or verify compliance with established tolerances and safety of flight.

Flight Path Alignment Point (FPAP). A surveyed position used in conjunction with the Runway Datum Point to define the along-track direction for the Final Approach Segment. The FPAP is specified in terms of (latitude, longitude), with height equal to the WGS-84 height of the RDP. The FPAP is used in conjunction with the LTP/ FTP and the geometric center of the WGS-84 ellipsoid to define the geodesic plane of a precision final approach, landing, and flight path. The FPAP may be the LTP/ FPT for the reciprocal runway.

Flight Path Control Point (FPCP). The FPCP is a 3D point defined by the LTP or FTP latitude/ longitude position, MSL elevation, and a threshold crossing height (TCH) value. The FPCP is in the vertical plane of the final approach course and is used to relate the glidepath angle of the final approach track to the landing runway. It is sometimes referred to as the TCH point or reference datum point (RDP).

Flight Validation (FV): Part of the instrument flight procedure validation process to confirm that the procedure is operationally acceptable for safety, flyability and design accuracy. It is an inflight evaluation concerned with factors that may affect the suitability of an instrument flight procedure for publication, other than those associated with the performance of a navigation aid or system. *{A mixture of what it says in ICAO and AFS 8900.1, but mostly ICAO.}*

Fly-By Waypoint. A waypoint that requires the use of turn anticipation to avoid overshoot of the next flight segment.

Fly-Over Waypoint. A waypoint that precludes any turn until the waypoint is overflown.

Geoid. The geoid is a gravitational equi-potential surface. The geoid is referenced to equate to the mean sea surface shaped by density distributions in the earth’s crust. The density distributions in the earth’s crust cause variations in gravitational pull; therefore, causing an irregular surface.

Geodial Height. Geoidal height is how far the geoid is above or below the **WGS-84 ellipsoid.**

Geometric Dilution of Precision (GDOP). A factor used to express navigational error at a position fix caused by divergence of the hyperbolic lines of position as the aircraft's receiver distance from the baseline increases. The larger the GDOP, the larger the standard deviation of position errors.

Geostationary Satellite. Geostationary is a satellite, which appears to remain perfectly stationary in the sky as seen from earth. In order for this to happen, its orbital period must perfectly match the earth's 23 hour 56 minute day. As an added qualifier, it must also be exactly above the equator (inclination of 0). To keep a satellite perfectly geostationary for a long amount of time would require too much fuel (in compensation for the gravity fields of other non-stationary bodies, the sun and moon); therefore, most satellites are geosynchronous, which allows for some deviation.

Glidepath. See ILS Glidepath.

Glidepath Angle (GPA). The angle between the downward extended straight line extension of the ILS glidepath and the horizontal. GBAS and SBAS glide path angle is an angle, defined at a calculated point located directly above the LTP/ FTP that establishes the intended descent gradient for the final approach flight path of a precision approach procedure. It is measured from the plane containing the LTP/ FTP that is parallel to the surface of WGS-84 ellipsoid.

Glidepath Intercept Point (GPIP). The point at which the extension of the final approach segment intercepts the plane containing the LTP/ FTP that is parallel to the surface of WGS-84 ellipsoid.

Glidepath Structure. Characteristics of a glidepath including bends, scalloping, roughness, and width.

Glide Slope. A facility which provides vertical guidance for aircraft during approach and landing.

Glide Slope Intercept Altitude. The true altitude (MSL) proposed or published in approved let-down procedures at which the aircraft intercepts the glidepath and begins descent.

Global Positioning System (GPS) Service Volume. The terrestrial service volume is from the surface of the Earth up to an altitude of 3,000 kilometers.

Graphical Average Path. The average path described by a line drawn through the mean of all crosspointer deviations. This will usually be a curved line which follows long-term trends (1,500 ft or greater) and averages shorter term deviations.

Ground-Based Augmentation System (GBAS). A safety-critical system that augments the GPS Standard Positioning Service and provides enhanced levels of service. GBAS provides two services: a precision approach service and a positioning service, which provide horizontal position information to support RNAV operations in the terminal area. GBAS refers to any system compliant with the existing ICAO standards.

GBAS Ground Facility (GGF). The GGF consists of four GPS reference receivers, equipment to process corrected GPS message, and a VHF data broadcast transmitter.

GBAS Service Level. The GBAS Approach Service performance is classified in terms of defined levels of service. A GBAS Service Level defines a specific level of required accuracy, integrity, and continuity. The Service Level is related to the operation which may be supported (e.g., Precision Approach to CAT I minima, Precision Approach to CAT II/ IIIa minima, etc.)

Ground Point of Intercept (GPI). A point in the vertical plan on the runway centerline at which it is assumed that the *downward straight line extension* of the glide path intercepts the runway approach surface baseline. (FAA Order 8260.3, latest revision)

Group Repetition Interval (GRI). The time interval (microseconds divided by 10) between one group of 100 kHz carrier pulses and the next, from any transmitter within a Loran-C CHAIN. All stations in a specific CHAIN use the same GRI.

Hertz (Hz). A unit of frequency of electromagnetic waves which is equivalent to one cycle per second. See Symbols in this Appendix.

Kilohertz (kHz). A frequency of 1,000 cycles per second.

Megahertz (MHz). A frequency of one million cycles per second.

Gigahertz (GHz). A frequency of one billion cycles per second.

HLOM. An H Class NDB facility installed as a compass locator at the outer marker. The standard service volume extends to 50 nm.

Hole (Null). An area of signal strength below that required to perform the necessary function or furnish the required information, which is completely surrounded by stronger signal areas of sufficient strength to perform required functions.

Horizontal Integrity Limit (HIL). The radius of a circle in the horizontal plane, with its center being at the indicated position, which describes the region which is assured to contain the true position. It is the horizontal region for which the missed alert and false alert requirements can be met. It is only a function of the satellite and user geometry and the expected error characteristics; it is not affected by actual measurements. Therefore, this value is predictable.

ILS--Back-Course Sector. The *course sector* which is the appropriate reciprocal of the front *course sector.*

ILS--Commissioned Angle--Glide Slope. The glidepath angle calculated by a qualified procedure specialist which meets obstruction criteria (FAA Order 8260.3, latest revision). This nominal angle may be increased to meet additional criteria, i.e., engineering, noise abatement, site deficiencies, etc.

ILS--Commissioned Width--Localizer. The nominal width of a localizer. In practice the width is computed by using the criteria prescribed in Chapter 15 of FAA Order 8200.1 (latest revision).

ILS--Course Sector. A sector in a horizontal plane containing the course line and limited by the loci of points nearest to the course line at which 150 μA is found.

ILS--Differential Corrected Trace. The trace on the recording which is the algebraic sum of the Radio Telemetering Theodolite (RTT) crosspointer (DDM) and the aircraft receiver crosspointer (DDM) and which is produced by the differential amplifier within the airborne Theodolite Recording System.

ILS--Downward Straight Line Extension. The mean location of the ILS Glidepath in Zone 2.

ILS--Facility Reliability. The probability that an ILS ground installation radiates signals within the specified tolerances.

ILS--Front Course Sector. The course sector which is situated on the same side of the localizer as the runway.

ILS--Glidepath. The locus of points in the vertical plane (containing the runway centerline) at which the DDM is zero, which of all such loci is the closest to the horizontal plane.

> **NOTE:** Offset ILS(s) do not contain the runway centerline.

ILS--Glidepath Sector. The sector in the vertical plane containing the ILS glidepath at which 150 µA occurs.

> **NOTE:** The ILS glidepath sector is located in the vertical plane containing the localizer *on-course* signal and is divided by the radiated glidepath called upper sector and lower sector, referring respectively to the sectors above and below the path.

ILS--Glidepath Sector Width (Normal Approach Envelope). The width of a sector in the vertical plane containing the glidepath and limited by the loci of points above and below the path at which reading of 150 µA is obtained.

ILS--Half Course Sector. The sector, in a horizontal plane containing the course line and limited by the loci of points nearest the course line at which 75 µA occurs.

ILS—Glidepath Rate of Change. A change in the trend, or direction, of the glidepath.

ILS—Glidepath Reversal. A glidepath rate of change that meets or exceeds 25 µA at the divergence measurement point.

ILS—Half ILS Glidepath Sector. The sector in the vertical plane containing the ILS glidepath and limited by loci of points nearest to the glidepath at which 75 µA occurs.

ILS--Localizer Back Course Zone 1. The distance from the coverage limit to 4 miles from the localizer antenna.

ILS--Localizer Back Course Zone 2. From 4 miles from the localizer antenna to 1 mile from the localizer antenna.

ILS--Localizer Back Course Zone 3. One mile from the localizer antenna to the missed approach point, which may be as close as 3,000 ft from the localizer antenna.

ILS--Localizer Clearance Sector 1. From 0° to 10° each side of the center of the localizer *on-course.*

ILS--Localizer Clearance Sector 2. From 10° to 35° each side of the center of the localizer *on-course*.

ILS--Localizer Clearance Sector 3. From 35° to 90° each side of the center of the localizer *on-course*.

ILS--Localizer Course Sector Width. The sum of the angular distances either side of the center of the course required to achieve full scale (150 μA) crosspointer deflection.

ILS--Performance Category I. An ILS which provides acceptable guidance information from the coverage limits of the ILS to the point at which the localizer course line intersects the glidepath at a height of 100 ft or less above the horizontal plane containing the runway threshold.

ILS--Performance Category II. An ILS which provides acceptable guidance information from the coverage limits of the ILS to the point at which the localizer course line intersects the glidepath at a point above the runway threshold.

ILS--Performance Category III. An ILS, which, with the aid of ancillary equipment where necessary, provides guidance information from the coverage limit of the facility to, and along, the surface of the runway.

ILS--Point "A". An imaginary point on the glidepath/ localizer *on-course* measured along the runway centerline extended, in the approach direction, 4 nm from the runway threshold.

> **NOTE:** For back course and installations sited to project a course substantially forward of threshold as in Figure 15-1B(2), this point is 4 nm from the antenna.

ILS--Point "B". An imaginary point on the glidepath/localizer *on-course* measured along the runway centerline extended, in the approach direction, 3,500 ft from the runway *threshold.*

> **NOTE:** For back course as in Figure 15-1B(3), this point is 1 nm from the antenna. For installations sited to project a course substantially forward of threshold as in Figure 15-1B(2), this point is 1 nm from the threshold.

ILS--Point "C". A point through which the *downward extended straight portion* of the glidepath (at the commissioned angle) passes at a height of 100 ft above the horizontal plane containing the *runway threshold*.

> **NOTE:** Localizer only, Back Course, LDA, and SDF only facilities, Point C is the missed approach point and may not necessarily be the runway threshold.

ILS Point "D". A point 12 ft above the runway centerline and 3,000 ft from the runway threshold in the direction of the localizer.

ILS Point "E". A point 12 ft above the runway centerline and 2,000 ft from the stop end of the runway in the direction of the *runway threshold*.

ILS Point "T". A point at specified height located vertically above the intersection of the runway centerline and the *runway threshold* through which the *downward extended straight line* portion of the ILS glidepath passes.

ILS Reference Datum. Same as ILS Point "T".

ILS--Zone 1. The distance from the coverage limit of the localizer/ glidepath to Point "A" (four miles from the *runway threshold).*

ILS--Zone 2. The distance from Point "A" to Point "B"

ILS--Zone 3. CAT I - The distance from Point "B" to Point "C" for evaluations of Category I ILS. CAT II and III - The distance from Point "B" to the *runway threshold* for evaluations of Category II and III facilities.

> **NOTE:** Localizer Only, Back Course, LDA, and SDF facilities will have no Zone 3 if Point "C" occurs prior to Point "B." Structure tolerance remains defined by Points "A" to "B."

ILS--Zone 4. The distance from runway threshold to Point "D".

ILS--Zone 5. The distance from Point "D" to Point "E".

Initial Approach Segment. In the initial approach, the aircraft has departed the en route phase of flight, and is maneuvering to enter an intermediate segment. This is the segment between the initial approach fix/ waypoint and the intermediate fix/ waypoint or the point where the aircraft is established on the intermediate course or final approach course.

Intermediate Approach Segment. This is the segment which blends the initial approach segment into the final approach segment. It is the segment in which aircraft configuration, speed, and positioning adjustments are made for entry into the final approach segment. The intermediate segment begins at the intermediate fix (IF) or point, and ends at the final approach fix (FAF).

In-Phase. Applied to the condition that exists when two signals of the same frequency pass through their maximum and minimum values of like polarity at the same time.

Integrity. That quality which relates to the trust which can be placed in the correctness of the information supplied by the facility.

Integrity (WAAS). The integrity of a system is that quality, which relates to the trust, which can be placed in the correctness of the information, supplied by the total system. Integrity risk is the probability of an undetected (latent) failure of the specified accuracy. Integrity includes the ability of the system to provide timely warnings to the user when the system should not be used for the intended operation.

Integrators. Received target enhancement process used in primary radar receivers.

Interrogator. The ground-based surveillance radar transmitter-receiver which normally scans in synchronism with a primary radar, transmitting discrete radio signals which repetitiously request all transponders, on the mode being used, to reply. The replies are displayed on the radar scope. Also applied to the airborne element of the TACAN/ DME system. (AIM)

Investigator-in-Charge (IIC). Person responsible for on-site aircraft investigation procedure.

Ionosphere. A band of charged particles 80 – 120 nm above the earth, which represent a non-homogeneous and dispersive medium for radio signals. Signal phase delay depends on the electron content and affects carrier content. Group delay depends on dispersion in the ionosphere and affects signal modulation. Propagation speed (refraction) is changed as it passes through the ionosphere. SBAS and GBAS systems are designed to mitigate much of the error induced into GNSS signal as it passes through the ionosphere.

Joint Acceptance Inspection (JAI). Inspection at culmination of facility installation and preparation. System is technically ready for commissioning after successful JAI.

Joint Use. For this document, refer to radar sites used by both the FAA and military.

L1/ L2/ L5 Satellite Frequency. L1 (1575.42 MHz), L2 (1227.60 MHz), L5 (1176.45 MHz).

Landing Threshold Point (LTP). The LTP is used in conjunction with the FPAP and the geometric center of the WGS-84 ellipsoid to define the geodesic plane of a precision final approach flight path to touchdown and rollout. It is a point at the designated center of the landing runway defined by latitude, longitude, ellipsoidal height, and orthometric height. The LTP is a surveyed reference point used to connect the approach flight path with the runway. The LTP may not be coincident with the designated runway threshold.

Lateral/ Vertical Protection Level (LPL/ VPL). Integrity (uncertainty) associated with the 3-dimensional position accuracy that is output by the receiver. The number of satellites, geometry of satellites, tropospheric delay, and airborne receiver accuracy affect these levels. HPL/ VPL are compared to the LAL/ VAL. If exceeds the associated alert limit, the receiver will flag either part or all of the approach.

Line-of-Position (LOP). LOP is a hyperbolically curved line defined by successive but constant time difference measurements using the signals from two Loran-C transmitters. Two LOP(s) from two station pairs define the location of a receiver and establish a position fix.

Local Area Augmentation System (LAAS). The FAA ground-based augmentation system (GBAS). LAAS refers to the system proposed for use and development by RTCA to meet operational objectives for the United States National Airspace System. The LAAS focuses its service on the airport area to provide for departure, terminal, precision approach, and surface navigation operations. The coverage area is within approximately a 20 – 30 nm radius of the LGF. The LAAS broadcasts a GPS correction message via a very high frequency data link from a ground transmitter. LAAS will provide extremely high accuracy, availability, and integrity necessary for Category I, II, and III precision approaches. LAAS positioning service may also support Approach with Vertical Guidance (APV) and LAAS approach procedures to adjacent airports.

LAAS Ground Facility (LGF). The LGF consists of four GPS reference receivers, equipment to process corrected GPS messages, and a VHF data broadcast transmitter.

Local Area Monitor (LAM). A stationary receiver designed to monitor and record Loran-C signals and time difference (TD) data. TD information obtained by this unit is used for calculating receiver TD calibration values.

Localizer Type Directional Aid (LDA). A facility of comparable utility and accuracy to a LOC, but which is not part of a full ILS and may not be aligned with the runway. (FAA Order 8260.3, latest revision)

Localizer (LOC). The component of an ILS which provides lateral guidance with respect to the runway centerline. (FAA Order 8260.3, latest revision).

Localizer Zones. See ILS-Zones or ILS-Localizer Back Course Zones.

Lock-On. The condition during which usable signals are being received by the airborne equipment and presentation of steady azimuth and/or distance information starts.

Loran-C CHAIN. Loran-C stations are grouped into sets of stations called CHAIN(s). Each CHAIN consists of a master station and two or more secondary stations that repeat transmissions over a specific period of time (see GRI).

Loran Signal Evaluation System (LSES). The LSES is a Loran-C receiver and a time difference data device used to evaluate approach sites. The device determines if usable signals are present and establishes the time difference relationship with the local area monitor.

Loran-C Time Difference (TD). The elapsed time, in microseconds, between the arrival of two signals.

Localizer Performance (LP). FAA Order 8260.54 specifies criteria for RNAV WAAS LPV approach procedures. An LP approach is an RNAV NPA procedure evaluated using the lateral obstacle evaluation area dimensions of the precision localizer trapezoid, with adjustments specific to the WAAS. These procedures are published on RNAV GPS approach charts as the LP minima line. An RNAV approach procedure with a published line of minima titled “LP” requires a WAAS sensor to fly to those minima.

Localizer Performance with Vertical guidance (LPV). FAA Order 8260.54 specifies criteria for RNAV WAAS LPV approach procedures. Approaches constructed under these criteria are termed “LPV”. The lateral protection area is based on the precision approach trapezoid dimensions, and the vertical surfaces are structured around WAAS vertical performance. The lateral criterion is based on the WAAS Horizontal Alert Limit (HAL) being $\leq$ 40 meters. The vertical criterion is based on the WAAS Vertical Alarm Limit (VAL) being $>$ 12 meters and $\leq$ 50 meters. RNAV WAAS LPV procedures can be supported to HAT of $\geq$ 200 feet. An RNAV approach procedure with a published line of minima titled “LPV” requires a WAAS sensor to fly to those minima.

MLOM. An MH Class NDB facility installed as a compass locator at the outer marker. The standard service volume extends to 25 nm.

Mask Angle Elevation. A fixed elevation angle referenced to the user’s horizon below which satellites are ignored by the receiver software. Mask angles are used primarily in the analysis of GNSS performance, and are employed in some receiver designs. The mask angle is driven by the receiver antenna characteristics, the strength of the transmitted signal at low elevations, receiver sensitivity, and acceptable low elevation errors.

Maximum Authorized Altitude (MAA). A published altitude representing the maximum usable altitude or flight level for an airspace structure or route segment. It is the highest altitude on a Federal airway, Jet route, area navigation low or high route, or other direct route for which an MEA is designated in FAR Part 95, at which adequate reception of navigation and signals is assured.

Maximum Error. The maximum amplitude of course alignment from zero, either in the clockwise or counterclockwise direction.

Maximum Use Distance (D_{max}). The range from the GGF within which the required integrity for the differentially-corrected position can be assured. D_{max} is the maximum distance lateral, and vertical guidance is provided from the GGF antenna (Service Volume). D_{max} is broadcast in Message Type 2. GGF D_{max} distance value is dependent on the specific operations intended and must be defined on a case-by-case basis. Depending on requirments, the GGF may or may not broadcast a D_{max}.

Mean Course Error (MCE). The mean value of azimuth or elevation error along the approach course or specified glidepath.

Message Type 0 (GBAS). Message type broadcast from the GGF when the facility is in test mode. This message prevents an aircraft's avionics system from being able to use the GGF. AVN flight inspection aircraft have a unique capability to override "Message Type 0" in order to perform inspection and evaluation while the GGF is in test mode.

Microampere(s). (Microamps)--One millionth of an ampere (amp). In practice, seen on a pilot's omnibearing selector (OBS), oscillograph recordings, and/or flight inspection meters, as a deviation of the aircraft's position in relation to a localizer on-course (zero DDM) signal or glidepath on-path (zero DDM) signal, e.g., "5 microamperes (μA) right" (localizer); "75 μA low" (glidepath). See Crosspointer and Symbols in this appendix.

Microwave Landing System (MLS). The international standard microwave landing system.

Milliampere (mA). One one-thousandth of an ampere.

Minimum Crossing Altitude (MCA). The lowest altitude at certain fixes at which an aircraft must cross when proceeding in the direction of a higher minimum en route IFR altitude (MEA). (AIM)(See Minimum En Route IFR Altitude).

Minimum Descent Altitude (MDA). The lowest altitude, expressed in feet above mean sea level, to which descent is authorized on final approach or during circle-to-land maneuvering in execution of a standard instrument approach procedure where no electronic glidepath is provided. (AIM)

Minimum En Route IFR Altitude (MEA). The lowest published altitude between radio fixes which assures acceptable navigational signal coverage and meets obstacle clearance requirements between those fixes. The MEA prescribed for a Federal airway or segment thereof, area navigational low or high route, or other direct route applies to the entire width of the airway, segment, or route between the radio fixes defining the airway, segment, or route. (AIM) (FAR Parts 91 and 95).

Minimum Glide Path (MGP). The lowest angle of descent along the zero degree azimuth that is consistent with published approach procedures and obstacle clearance criteria.
Minimum Holding Altitude (MHA). The lowest altitude prescribed for a holding pattern which assures navigational signal coverage, communications, and meets obstacle clearance requirements. (AIM)

Minimum Obstruction Clearance Altitude (MOCA). The lowest published altitude in effect between radio fixes on VOR airways, off-airway routes, or route segments which meets obstacle clearance requirements for the entire route segment and which assures acceptable navigation signal coverage only within 25 statute miles (22 nm) of a VOR. (AIM) (Refer to FAR Parts 91 and 95)

Minimum Radar Range. The shortest distance from the radar at which the aircraft can be clearly identified on each scan of the radar antenna system.

Minimum Reception Altitude (MRA). The lowest altitude at which an intersection can be determined. (AIM) (Refer to FAR Part 95)

Minimum Safe Altitude Warning (MSAW). A software function of the air traffic ARTS II/ III computer that is site specific. MSAW monitors Mode-C equipped aircraft for obstacle separation. It is designed to generate both aural and visual alerts at the air traffic controller's display when an aircraft is at or predicted to be at an unsafe altitude.

Misleading Information. For GBAS and SBAS, misleading information is defined to be any data output to other equipment or displayed to the pilot that has an error larger than the current protection levels (HPL/ VPL) for the current operation. This includes all output data, such as position and deviations.

MSAW Approach Path Monitor (APM). Automation software used to generate low altitude alert warnings for aircraft within a narrow approach path corridor

MSAW General Terrain Monitor (GTM). Automation software used to generate low altitude alert warnings for aircraft outside the areas designated for approach monitoring.

MSAW Bin. A 2 nm square area within an MSAW General Terrain Map; 4,096 bins make up an MSAW General Terrain Map.

MSAW Bin Altitude. An altitude that is determined by the highest obstacle within the MSAW bin, plus 500 ft.

Minimum Vectoring Altitude (MVA). The lowest MSL altitude at which an IFR aircraft will be vectored by a radar controller, except as otherwise authorized for radar approaches, departures, and missed approaches. The altitude meets IFR obstacle clearance criteria. It may be lower than the published MEA along an airway or J-route segment. It may be utilized for radar vectoring only upon the controllers' determination that an adequate radar return is being received from the aircraft being controlled. Charts depicting minimum vectoring altitudes are normally available only to the controllers and not to pilots. (AIM)

Missed Approach Point (MAP). A point prescribed in each instrument approach procedure at which a missed approach procedure must be executed if the required visual reference does not exist. (AIM: See Missed Approach and Segments of an Instrument Approach Procedure.)

Missed Approach Segment. The missed approach segment is initiated at the decision height in precision approaches and at a specified point in non-precision approaches. The missed approach must be simple, specify an altitude, and whenever practical, a clearance limit (end of the missed approach segment). The missed approach altitude specified in the procedure must be sufficient to permit holding or en route flight.

MLS Approach Reference Datum. A point at a specified height located vertically above the intersection of the runway centerline and the threshold.

MLS Auxiliary Data. Data, transmitted in addition to basic data, that provide Facilities Maintenance equipment siting information for use in refining airborne position calculations and other supplementary information.

MLS Basic Data. Data transmitted by Facilities Maintenance equipment that are associated directly with the operation of the landing guidance system.

MLS Coverage Sector. A volume or airspace within which service is provided by a particular function and in which the signal power density is equal to or greater than the specified minimum.

MLS Datum Point. The point on the runway centerline closest to the phase center of the approach elevation antenna.

MLS Function. A particular service provided by the MLS (e.g., approach azimuth guidance, approach elevation guidance, or basic data).

MLS Mean Course Error. The mean value of the azimuth error along a specified radial of the azimuth function.

MLS Mean Glidepath Error. The mean value of the elevation error along a specified angle of the elevation function.

MLS Minimum Glidepath. The lowest angle of descent along the zero-degree azimuth that is consistent with published approach procedures and obstacle clearance criteria.

MLS-Point "A". An imaginary point on the minimum glidepath and commissioned azimuth radial, 4 nm from the runway threshold.

MLS-Point "B". An imaginary point on the minimum glidepath and commissioned azimuth radial, 3,500 ft from the runway threshold.

MLS-Point "C". A point through which the downward extended straight portion of the glidepath passes at a height of 100 ft above the horizontal plane containing the runway threshold.

> **NOTE:** Azimuth only facilities, Point C is the missed approach point.

MLS-Point "D". A point 12 ft above the runway centerline and 3,000 ft from the runway threshold in the direction of the azimuth station.

MLS-Point "E". A point 12 ft above the runway centerline and 2,000 ft from the stop end of the runway in the direction of the runway threshold.

MLS Proportional Guidance Sector. The volume of airspace within which the angular guidance information provided by a function is directly proportional to the angular displacement of the airborne antenna with respect to the zero angle difference.

MLS Reference Point. The point at which flight inspection begins to apply facility budget error tolerances. This will normally be either the ARD or MAP.

Mode. The letter or number assigned to a specific pulse spacing of radio signals transmitted or received by ground interrogator or airborne transponder components of the Air Traffic Control Radar Beacon System (ATCRBS). Mode A (military Mode 3), Mode C (altitude reporting), and Mode S (data link) are used in air traffic control. (See transponder, interrogator, radar.) (AIM)

ICAO-Mode (SSR) Mode. The letter or number assigned to a specific pulse spacing of the interrogation signals transmitted by an interrogator. There are five modes: A, B, C, D, and M--corresponding to five different interrogation pulse spacings.

Moving Target Detection (MTD). Type of moving target detection system (like MTI) based on digital storage map techniques. Used in newer primary radars.

Moving Target Indicator (MTI). Electronic circuitry that permits the radar display presentation of only targets which are in motion. A partial remedy for ground clutter.

MTI Reflector. A fixed device with electrical characteristics of a moving target which allows the demonstration of a fixed geographic reference on a MTI display. (Used to align video maps, azimuth reference, etc.)

Multi-Mode Receiver (MMR). A navigation receiver with multiple capabilities in one unit (i.e., ILS, VOR, WAAS, and GBAS).

Narrowband Radar Display. Computer-generated display of radar signals.

National Flight Data Center (NFDC). A facility in Washington, D.C., established by FAA to operate a central aeronautical information service for the collection, validation, and dissemination of aeronautical data in support of the activities of government, industry, and the aviation community. The information is published in the National Flight Data Digest. (AIM: See National Flight Data Digest.)

National Transportation Safety Board (NTSB). Office responsible for aircraft accident investigations.

NAVAID. Any facility used in, available for use in, or designated for use in aid of air navigation, including landing areas, lights, any apparatus or equipment for disseminating weather information, for signaling, for radio direction finding, or for radio or other electronic communication, and any other structure or mechanism having a similar purpose for guiding or controlling flight in the air or the landing or takeoff of aircraft. (Re: Federal Aviation Act of 1958, as amended.) (AIM)

Nondirectional Beacon/ Radio Beacon (NDB). An L/ MF or UHF radio beacon transmitting nondirectional signals whereby the pilot of an aircraft equipped with direction finding equipment can determine his bearing to or from the radio beacon and "home" on or track to or from the station. When the radio beacon is installed in conjunction with the Instrument Landing System marker, it is normally called Compass Locator. (AIM)

Nonprecision Approach Procedure/ Nonprecision Approach. A standard instrument approach procedure in which no electronic glide slope is provided (e.g., VOR, TACAN, NDB, LOC, ASR, LDA, or SDF approaches). (AIM)

Notices to Airmen/ Publication. A publication designed primarily as a pilot's operational manual containing current NOTAM information (see Notices to Airmen - NOTAM) considered essential to the safety of flight, as well as supplement data to other aeronautical publications. (AIM)

Notices to Airmen/ NOTAM. A notice containing information (not known sufficiently in advance to publicize by other means) concerning the establishment, condition, or change in any component (facility, service, or procedure of, or hazard in the National Airspace System) the timely knowledge of which is essential to personnel concerned with flight operations. (AIM)

a. **NOTAM (D) -** A NOTAM given (in addition to local dissemination) distant dissemination via teletypewriter beyond the area of responsibility of the Flight Service Station. These NOTAM(s) will be stored and repeated hourly until canceled.

b. **NOTAM (L) -** A NOTAM given local dissemination by voice (teletypewriter where applicable), and a wide variety of means such as: TelAutograph, teleprinter, facsimile reproduction, hot line, telecopier, telegraph, and telephone to satisfy local user requirements.

c. **FDC NOTAM** A notice to airmen, regulatory in nature, transmitted by NFDC and given all-circuit dissemination.

d. **ICAO NOTAM**. A notice, containing information concerning the establishment, condition, or change in any aeronautical facility, service, procedure, or hazard, the timely knowledge of which is essential to personnel concerned with flight operations. (AIM)

Null. That area of an electromagnetic pattern where the signal has been intentionally canceled or unintentionally reduced to an unacceptable level.

Obstacle. An existing object, object of natural growth, or terrain at a fixed geographical location, or which may be expected at a fixed location within a prescribed area, with reference to which vertical clearance is or must be provided during flight operation. (AIM)

Obstacle Clearance. The vertical distance between the lowest authorized flight altitude and a prescribed surface within a specified area. (FAA Order 8260.19, latest revision)

Obstruction. An object which penetrates an imaginary surface described in FAR Part 77. (AIM) (Refer to FAR Part 77).

Omnibearing Selector (OBS). An instrument capable of being set to any desired bearing of an omnirange station and which controls a course deviation indicator.

On-Course. The locus of points in the horizontal plane in which a zero or on-course reading is received.

On-Path. Same as on-course but in the vertical plane. See ILS--Glidepath.

Operational Advantage. An improvement which benefits the users of an instrument procedure. Achievement of lower minimums or authorization for a straight-in approach with no derogation of safety are examples of an operational advantage. Many of the options in TERPS are specified for this purpose. For instance, the flexible final approach course alignment criteria may permit the ALS to be used for reduced visibility credit by selection of the proper optional course. (FAA Order 8260.3, latest revision)

Optimum Error Distribution. Best overall facility alignment error distribution to achieve maximum operational benefits (not necessarily a perfect balance of the errors).

Orbit Flight. Flight around a station at predetermined altitude(s) and constant radius.

Orthometric Height. Elevation above the geoid.

Oscilloscope. An instrument for showing visually, graphic representations of the waveforms encountered in electrical circuits.

Out-of-Coverage Indication (OCI). A signal radiated into areas outside the intended coverage sector where required to specifically prevent invalid removal of an airborne warning indication flag in the presence of misleading guidance information.

Out of Tolerance Condition. See Discrepancy.

Path Following Error (PFE). The guidance perturbations which the aircraft will follow. It is composed of a path following noise and of the mean course error in the case of azimuth functions or the mean glidepath error in the case of elevation functions.

Path Following Noise (PFN). That portion of the guidance signal error which could cause aircraft displacement from the mean course line or mean glidepath as appropriate.

Pilot-Controlled Lighting. Airfield lighting systems activated by VHF transmissions from the aircraft.

Pilot-Defined Procedure. Any data entered into an FMS or GPS navigator by the pilot, including waypoints, airports, runways, SID(s), routes, STAR(s), and approaches. For flight inspection of procedures, data must be entered from official source documentation.

Pilot Navigation Area (PNA). An area used to transition from RADAR vectoring to the area navigation route. The PNA is bounded by two lines, represented by the design maximum intercept courses leading to the inital departure fix, enclosed by an arc of specified radius centered on the intial departure fix.

Planned View Display (PVD). A display presenting computer-generated information such as alphanumerics or video mapping.

Polarization Error. The error arising from the transmission or reception of a radiation having a polarization other than that intended for the system.

Position Estimation Error (PEE). The difference between true position and estimated position.

Preflight Validation (PV). Begins when the flight validation organization receives the procedure package. The procedure package data is verified and the procedure is reviewed from an operational perspective. The intention of preflight validation is to evaluate on the ground, to the extent possible, those elements that will be evaluated during Flight Validation, and may require an assessment in an appropriately equipped aircraft simulator.

Primary Area. The area within a segment in which full obstacle clearance is applied. (FAA Order 8260.3, latest revision)

Proportional Guidance Sector. The volume of airspace within which the angular guidance information provided by a function is directly proportional to the angular displacement of the airborne antenna with respect to the zero angle reference.

Protection Level. The statistical error value which bounds the actual error (navigation sensor error in particular) with a specified confidence.

Pseudolite. A pseudolite (pseudo-satellite) is a ground-based GNSS augmentation which provides, at GNSS ranging source signal-in-space frequencies, an additional navigation ranging signal. The augmentation may include additionally differential GNSS corrections. (Adapted from the FANS GNSS Technical Subgroup).

Pseudo Random Noise (PRN). A signal coded with random-noise-like properties consisting of a repeating sequence of digital ones and zeros. The GPS C/ A code consists of 1,023 bits transmitted at a 1.023 MHz rate and, therefore, repeats every millisecond. Each GPS satellite has a unique PRN code. This code structure provides a low auto-correlation value for all delays or lags, except when they coincide exactly. Each space vehicle has a unique pseudo-random noise code.

"Q" Factor. See Actual Navigation Performance.

Quadradar. Ground radar equipment named for its four presentations.

a. **Height Finding**

b. **Airport Surface Detection**

c. **Surveillance**

d. **Precision Approach**

Radar Bright Display Equipment (RBDE). Equipment at the ARTCC which converts radar video to a bright raster scan (TV type) display.

Radar Data Analysis Software (RDAS). A generic term referring to many types of terminal and en route radar data analysis tools. (COMDIG, RARRE, DRAM, etc.)

Radar Plan Position Indicator (RAPPI). Maintenance display used with CD-1 common digitizers.

Radar/ Radio Detecting and Ranging. A device which, by measuring the time interval between transmission and reception of radio pulses and correlating the angular orientation of the radiated antenna beam or beams in azimuth and/or elevation, provides information on range, azimuth, and/or elevation of objects in the path of the transmitted pulses.

a. **Primary Radar.** A radar system in which a minute portion of a radio pulse transmitted from a site is reflected by an object and then received back at that site for processing and display at an air traffic control facility.

b. **Secondary Radar/ Radar Beacon/ ATCRBS.** A radar system in which the object to be detected is fitted with cooperative equipment in the form of a radio receiver/ transmitter (transponder). Radar pulses transmitted from the searching transmitter/ receiver (interrogator) side are received in the cooperative equipment and used to trigger a distinctive transmission from the transponder.

This reply transmission, rather than a reflected signal, is then received back at the transmitter/ receiver site for processing and display at an air traffic control facility. (See Transponder, Interrogator.) (AIM**)**

c. **ICAO-Radar.** A radio detection device which provides information on range, azimuth, and/or elevation of objects.

(1) **Primary Radar.** A radar system which uses reflected radio systems.

(2) **Secondary Radar.** A radar system wherein a radio signal transmitted from a radar station initiates the transmission of a radio signal from another station.

Radar Resolution - Azimuth. The angle in degrees by which two targets at the same range must be separated in azimuth in order to be distinguished on a radar scope as individual returns.

Radar Resolution - Range. The distance by which two targets at the same azimuth must be separated in range in order to be distinguished on a radar scope as individual returns.

Radar Route. A flight path or route over which an aircraft is vectored. Navigational guidance and altitude assignments are provided by ATC. (See Flight Path, Route.) (AIM)

Receiver Autonomous Integrity Monitoring (RAIM). A technique whereby a civil GPS receiver/ processor determines the integrity of the GPS navigation signals without reference to sensors or non-DoD integrity systems other than the receiver itself. This determination is achieved by a consistency check among redundant pseudorange measurements.

Range of Validity. Area around a local area monitor where published Loran-C receiver TD calibration values are valid.

Radial. A magnetic bearing extending from a VOR/ VORTAC/ TACAN navigation facility. (AIM)

Range, Azimuth, Radar, Reinforced Evaluator (RARRE). An IBM 9020 radar diagonistic program which is used to evaluate narrowband radar.

Real Time Quality Check (RTQC). Internally generated test target in automated target processing devices (common digitizers, etc.)

Receiver Check Point. A specific point designated and published, over which a pilot may check the accuracy of his aircraft equipment, using signals from a specified station.

Recorder Event Mark. A galvo mark on a recorder related to a position or time, required for correlation of data in performance analysis.

Reference Radial. A radial, essentially free from terrain and side effects, designated as a reference for measuring certain parameters of facility performance.

Reference Receiver. A GNSS receiver incorporated into the GBAS ground subsystem, used to make pseudo-range measurements that support generation of pseudo-range corrections.

Reference Voltage (VOR Reference Voltage). A 30 Hz voltage derived in the reference phase channel of the aircraft VOR receiver.

Required Navigation Performance (RNP). A statement of the navigational performance accuracy, integrity, continuity, and availability necessary for operation within a defined airspace.

RHO/ THETA Position. Coordinate position described by distance and angle.

Ring-Around. A display produced on the scope by front, side, or back antenna lobes of the secondary radar system. It appears as a ring around the radar location and may occur when an aircraft transponder replies to ground interrogations while in close proximity to the antenna site.

RNAV DME/ DME Infrastructure. DME facilities, meeting accuracy, coverage, and geometry requirements for a Flight Management System to compute a navigation solution for the intended operation.

Rotation (Correct Rotation). A condition wherein the transmitted azimuth angle increases in a clockwise direction.

Roughness. Rapid irregular excursions of the electromagnetic course or path.

Runway Approach Surface Baseline. An imaginary plane down the runway at the height of the runway surface at threshold.

Runway Datum Point (RDP). A surveyed position on the ground over which the Final Approach Segment passes at a relative height specified by the Datum Crossing Height.

Runway Environment. The runway threshold or approved lighting aids or other markings identifiable with the runway. (FAA Order 8260.3)

Runway Point of Intercept (RPI). The point where the extended glide slope intercepts the runway centerline on the runway surface.

Runway Reference Point (RRP). Where VGSI angle of visual approach path intersects runway profile (see Runway Point of Intercept).

Runway Threshold. The beginning of that portion of the runway usable for landing. (AIM) (When used for flight inspection purposes, displaced threshold(s) or threshold mean the same thing.)

Scalloping. See Course Scalloping.

Search (DME/ TACAN). Rapid movement of the distance or bearing indicators during the period in which either is unlocked.

Secondary Area. The area within a segment in which required Obstruction Clearance (ROC) is reduced as distance from the prescribed course is increased (FAA Order 8260.3, latest revision).

Segment. The basic functional division of an instrument approach procedure. The segment is oriented with respect to the course to be flown. Specific values for determining course alignment, obstacle clearance areas, descent gradients, and obstacle clearance requirements are associated with each segment according to its functional purpose. (FAA Order 8240.3, latest revision)

Sensing (Correct Sensing). A condition wherein the ambiguity indicator gives the correct To/ From indication.

Sensitivity Time Control (STC). Procedure used to vary receiver sensitivity with range. Gain is reduced as a function of decreasing range, in an attempt to make all radar replies uniform. (Gain would be maximum to maximum range in this event.)

Service Volume/SV. That volume of airspace surrounding a NAVAID within which a signal of usable strength exists and where that signal is not operationally limited by co-channel interference.

NOTE: For VOR/ TACAN/ DME and ILS, the following definitions are used:

a. **Standard Service Volume (SSV) -** That volume of airspace defined by the national standard.

b. **Flight Inspection Standard Service Volume (FISSV)** is defined as follows: On "T" class facilities, this FISSV is 25 nm and 1,000 ft (2,000 ft in designated mountainous areas) above site elevation or intervening terrain. On "L" and "H" class facilities, the distance extends to 40 nm, and the altitudes are the same as for the "T" class. The FISSV is used to determine the performance status of VOR/ TAC/ DME facilities.

c. **Expanded Service Volume (ESV) -** That additional volume of airspace outside the standard service volume requested by the FAA's Air Traffic Service or procedure specialist and pre-approved by frequency management of the Air Traffic Technical Operations (ATO) Service Area and flight inspection for operational use.

d. **Operational Service Volume (OSV) -** The airspace available for operational use. It includes the following:

(1) **The SSV** excluding any portion of the SSV which has been restricted.

(2) **The ESV**

Short-Term Excursions. Excursion characteristics of a navigation on-course or on-path signal which includes scalloping, roughness, and other aberrations but excludes bends.

Side Bands. The separated and distinct signals that are radiated whenever a carrier frequency is modulated. In terms of most air navigation facilities, double sidebands are present. This means that frequencies above and below the carrier frequency differing by the amount of the modulating frequencies are present. These sidebands contain intelligence for actuating navigation instruments.

Simplex. Single channel operation usually referred to at those sites using a single channel where dual channel (diplex) operation is available.

Splits. Two or more beacon targets generated from a single target reply. An undesirable condition due to problems in the beacon transmitter, antenna, propagation, aircraft transponder, or processing equipment.

Simplified Directional Facility/ SDF. A NAVAID used for nonprecision instrument approaches. The final approach course is similar to that of an ILS localizer.

Slant Range. The line-of-sight distance between two points not at the same elevation.

Space-Based Augmentation System (SBAS) – The ICAO term applies to all wide-area augmentation systems. Corrected GPS data is transmitted to the aircraft by a geostationary satellite(s).

Stagger. A feature used with primary MTI radar systems to vary the PRF at pre-selected intervals. This moves the inherent blind speed to a less troublesome value.

Standard Service Volume for GBAS. The service volume for a particular GGF is dependent on the specific operations intended and may be adjusted accordingly. Typical service volume is approximately 20 – 30 nm.

Standard VOT. A facility intended for use on the ground only (See VHF Omnidirectional test range).

Structure. Excursion characteristics of a navigation on-course or on-path signal which includes bends, scalloping, roughness, and other aberrations.

Structure Below Path. An angular measurement of clearance below path.

Subclutter Visibility. A performance characteristic of the system to detect a moving target in the presence of relatively strong ground clutter.

Symbols:

- G 10^9 times (a unit); giga
- M 10^6 times (a unit); mega
- k 10^3 times (a unit); kilo
- h 10^2 times (a unit); hecto
- dk 10 times (a unit); deca
- d 10^{-1} times (a unit); deci
- c 10^{-2} times (a unit); centi
- m 10^{-3} times (a unit); milli
- µ 10^{-6} times (a unit); micro
- n 10^{-9} times (a unit); nano
- pµ 10^{-12} times (a unit); micromicro
- θ Commissioned angle
- Σ Sum; Sum of; algebraic sum of:
- > Greater than:
- < Less than
- ≥ Equal to or greater than:
- ≤ Equal to or less than:
- = equals:
- : ratio; ratio of:
- ∴ therefore:

Symmetry. (ILS)—ICAO. Displacement sensitivity. A ratio between individual width sectors (90 Hz and 150 Hz) expressed in percent.

Systems Performance Analysis Rating (SPAR). A rating based on performance or expected performance. These ratings are related to flight inspection intervals as follows:

SPAR Class 1, 90-day interval; Class 2, 180-day interval; Class 3, 270-day interval.

TACAN Distance Indicator (TDI). A unit of airborne equipment used to indicate distance from a selected facility.

Target of Opportunity. An itinerant aircraft operating within the coverage area of the radar and which meets the requirements for a small aircraft as described in FAA Order 8200.1 (latest revision) Chapter 14.

Target Return. The return signal transmitted by a beacon-equipped aircraft in reply to the ground facility interrogator. Also, indication shown on a radar display resulting from a primary radar return.

Terminal Area Path (TAP). A terminal procedure utilizing GBAS for lateral and vertical path definition, which is attached to a GBAS final approach segment. The path is defined by using ARINC 424 track-to-fix and radius-to-fix leg types.

Threshold. See Runway Threshold.

Touchdown Zone (TDZ). The first 3,000 ft of runway beginning at the threshold. (See FAA Order 8260.3, latest revision).

Touchdown Zone Elevation. The highest runway centerline elevation in the touchdown zone.

Total System Error (TSE). The position error is represented by the Total System Error (TSE), which is a combination of the Flight Technical Error (FTE) and the Navigation System Error (NSE). The NSE is the error in position due to navigation, such as Global Positioning System (GPS), Distance Measuring Equipment (DME/ DME), or Very High Frequency Omni Directional Range (VOR/ DME). FTE is the difference between the position estimated by the Flight Management System (FMS) and the desired aircraft position.

Tracking. Condition of continuous distance or course information.

Transponder. The airborne radar beacon receiver/ transmitter portion of the Air Traffic Radar Beacon System (ATCRBS) which automatically receives radio signals from interrogators on the ground, and selectively replies with a specific reply pulse or pulse group only to those interrogations being received on the mode to which it is set to respond. (See Interrogator.) (AIM)

Trend. The general direction or incline of a segment of the glidepath which persists for a distance of 1,500 ft or more along the approach course.

Un-Lock. Condition at which the airborne interrogator (TACAN) discontinues tracking and starts search.

Usable Distance. The maximum distance at a specified altitude at which the facility provides readable identification and reliable bearing or glidepath information under average atmospheric condition.

Validation: Confirmation through the provision of objective evidence that the requirements for a specific intended use or application have been fulfilled.

Validation Process: A process for a qualitative assessment of instrument flight procedure design including obstacle, terrain and navigation data, and provides an assessment of the procedure's flyability. Validation begins with the quality assurance process during the procedure development phase, and continues through the Preflight, Flight, and Post-flight Validation phases.

Variable Voltage (VOR Variable Voltage). A 30 Hz voltage derived in the variable phase channel of the aircraft VOR receiver.

Verification: Activity whereby the current value of a data element is checked against the value originally supplied.

Vertical Alert Limit (VAL). Half the length of a segment on the vertical axis, with its center being at the true position, which describes the region, which is required to contain the indicated vertical position with a probability of $1\text{-}10^{-7}$ per flight hour.

Vertical Angle. An angle measured upward from a horizontal plane.

VHF Omnidirectional test range (VOT). A radio transmitter facility in the terminal area electronic navigation systems, radiating a VHF radio wave modulated by two signals having the same phase relationship at all azimuths. It enables a user to determine the operational status of a VOR receiver. (See Standard VOT and Area VOT.)

Video Map. An electronic displayed map on the radar display that may depict data such as airports, heliports, runway centerline extensions, hospital emergency landing areas, NAVAID(s) and fixes, reporting points, airway/ route centerlines, boundaries, hand-off points, special use tracks, obstructors, prominent geographic features, map alignment indicators, range accuracy marks, and minimum vectoring altitudes (AIM).

Visual Descent Point (VDP). The visual descent point is a defined point on the final approach procedure from which normal descent from the MDA to the runway touchdown point may be commenced, provided visual reference is established. (AIM)

VORTAC. A facility composed of azimuthal information from both VOR and TACAN, plus distance information of TACAN.

VOT—Standard. See Standard VOT.

VOT—Area Use. See Area VOT.

VOT Reference Point. A point on or above an airport at which the signal strength of a VOT is established and subsequently checked (applies to both standard and area VOT(s)).

Waveform. The shape of the wave obtained when instantaneous values of an a.c. quantity are plotted against time in rectangular coordinates.

Waveguide. A hollow pipe usually of rectangular cross-section used to transmit or conduct RF energy.

Wavelength. The distance, usually expressed in meters, traveled by a wave during the timer interval of one complete cycle. Equal to the velocity divided by the frequency.

Wide Area Augmentation System (WAAS). A system comprised of two Wide-Area Master Control Stations (WMS), Geostationary Earth Orbit (GEO) communications satellites, Ground Uplink Stations (GUS), and 25 Wide-area Reference Stations (WRS). The WAAS provides improved accuracy, integrity, and availability over the standard GPS signal. Future addition of WSR(s), GEO(s), and other WAAS enhancements are expected to increase WAAS capability to support full CAT I approach requirements.

9960 Hz Voltage. A voltage derived from the VOR 9960 amplitude modulation by the reference channel of the VOR receiver. The 9960 Hz AM is a subcarrier which is frequency modulated by the 30 Hz reference. Also referred to the 10 kHz sub-carrier.

SECTION 2. ABBREVIATIONS, ACRONYMS, AND LETTER SYMBOLS

A : Ampere
a.c. : alternating current
AC : advisory circular
ADF : automatic direction finding
ADP : automatic data processing
AER : approach end of runway
AF : Airway Facilities
AFB : Air Force Base
AFC : automatic frequency control
AFIS : automated flight inspection system
AGC : automatic gain control
AGL : above ground level
AIM : Aeronautical Information Manual
air : airborne
align : alignment
ALS : approach lighting system
ALSF : approach lighting system with sequenced flashing lights
am. : ammeter
AM : amplitude modulation
amp : Ampere
ANF : air navigation facility
ANP : actual navigation performance
ant : antenna
APD : Approach Performance Designator
APL : Airport Pseudolites
APM : Approach Path Monitor
APPCON : approach control
APV : non-standard approach with vertical guidance
ARAC : Army radar approach control
ARD : approach reference datum
ARG : auxiliary reference group
ARR : automated flight inspection system reference radial
ARSR : air route surveillance radar
ARTCC : air route traffic control center
ARTS : automated radar terminal system
ASBL : approach surface baseline
ASIS : Aviation Standards Information System
ASOS : automated surface aviation observing system
ASR : airport surveillance radar
AT : air traffic
ATC : air traffic control
ATCALS : Air Traffic Control and Landing System
ATCRBS : Air Traffic Control Radar Beacon System
ATCU : Air Traffic Control Unit

ATIS : Automatic Terminal Information Service
ATKER : along track error
AVN : Office of Aviation System Standards
AWOS : automatic weather observation system
az : azimuth
Az-El : azimuth-elevation

Baz : back azimuth horizontal guidance
BCM : back course marker
bcn : beacon
BFTA : beacon false target analysis
BPS : bits per second
BIT : a digit in a binary coded decimal
BRITE : brite radar indicator tower equipment
BUEC : backup emergency communications
BW : beam width

c : centi (=10^{-2})
C : Celsius
°C : degrees Celsius
C/A code : coarse/ acquisition code
cal : calibrate, calibrated
CAS : calibrated airspeed
CAT : category
CCW : counterclockwise
CD : common digitizer
CDI : course deviation indicator
CDU : control display unit
CEU : control electronic unit
CHAIN : a group of Loran C stations
chan : channel
chg : change
CIC : combat information center
CL : centerline
Comm : Commission
CMLSA : Commercial MLS Avionics
CMN : control motion noise
COMDIG : common digitizer data reduction
COMLO : compass locator
CONUS : continental United States
COP : change-over-point
CP : circular polarization
CRC : cyclic redundancy check
CSV : comma-separated values file
CTOL : conventional takeoff and landing
CP : circular polarization
CW : clockwise

d	: deci (=10^{-1})
DA	: decision altitude
DAME	: distance azimuth measuring equipment
db	decibel
dB/Hz	: Decibel/ Hertz
dbm	: decibel referred to 1 milliwatt
DBRITE	: Digital Bright Radar Indicator Tower Equipment
DCH	: datum crossing height
dbw	: decibel referred to 1 watt
d.c.	: direct current
DDM	: difference in depth of modulation
DER	: Departure End of Runway
DEU	: DME electronic unit
DF	: direction finding
DFL	: Daily Flight Log
DGPS	: differential global positioning system
DH	: decision height
disc	: discrepancy
D_{max}	: maximum use distance of GBAS Differential Corrections
DME	: distance measuring equipment
DME/ N	: distance measuring equipment/ non precision (standard DME)
DME/ P	: distance measuring equipment/ precision
DOD	: Department of Defense
DOP	: dilution of precision
DOT	: Department of Transportation
DP	: departure procedure
DPSK	: differential phase shift keying
DVOR	: doppler very high frequency omni-directional range
E.	: East
EARTS	: en route automated radar tracking service
ECD	: envelope to cycle discrepancy (difference)
ECEF	: earth center earth fixed
ECOM	: en route communications
ECM	: electronic counter measures
EFIS	: electronic flight instrument system
e.g.	: exempli gratia (for example)
el	: elevation
EMI	: electromagnetic interference
EOA	: end-of-approach
ESV	: expanded service volume
et al.	: et alibi (and elsewhere; et alii (and others)
etc.	: etcetera (and the rest; and so forth)

F	: Fahrenheit
°F	: degrees Fahrenheit
FAA	: Federal Aviation Administration
FAC	: final approach course
FAF	: final approach fix
FANS	: Future Air Navigation System (ICAO)
FAP	: final approach point
FAR	: Federal Aviation Regulations
FAS	: final approach segment
FASAP	: fictitious approach sector alignment point
FASLAL	: FAS lateral alert limit
FASLTP	: fictitious approach sector landing threshold point
FASVAL	: FAS vertical alert limit
FAWP	: final approach waypoint
FBWP	: flyby waypoint
FICO	: Flight Inspection Central Operations
fig.	: figure
FIP	: Flight Inspection and Procedures (staff)
FISSV	: flight inspection standard service volume
FM	: fan marker
FM	: frequency modulation
FMO	: Frequency Management Office
FMS	: flight management system
FOM	: figure of merit
FOWP	: flyover waypoint
FPA	: flight path angle
FPAP	: flight path alignment point
freq	: frequency
FSS	: flight service station
FTC	: fast time constant
FTP	: fictitious threshold point
G	: giga (=10^9)
galv	: galvanometers
GBAS	: ground-based augmentation system
GCA	: ground controlled approach
GCID	: ground continuity and integrity designator
GDOP	: geometric dilution of precision
GEO	: Geostationary Earth Orbit
GGF	: GBAS ground facility
GHz	: gigahertz
GLS	: GBAS landing system
govt.	: government
Gnd	: ground
GNSS	: Global Navigation Satellite System
GPA	: glide path angle
GPI	: ground point of intercept
GPIP	: glide path intercept point
GPS	: Global Positioning System
GRI	: ground repetition interval

GS	: glide slope
GSI	: glide slope intercept altitude (Point)
GTC	: gain time control
GTM:	: General Terrain Monitor
h	: hecto (-10^2); hour
H	: homer
HAA	: height above airport elevation
HaE	: height above ellipsoid
HAL	: horizontal alert limit
HAT	: height above touchdown
H-Class	: high altitude
HDOP	: horizontal dilution of precision
HF	: high frequency
HF/ DF	: high frequency/ direction finding
HFOM	: horizontal figure of merit
HIL	: horizontal integrity limit
HIRLS	: high intensity runway lighting system
HLOM	: H Class compass locator at outer marker
HIWAS	: Hazardous Inflight Weather Advisory Service
HPL	: horizontal protection level
Hz	: Hertz
IAC	: initial approach course
IAF	: initial approach fix
IAS	: indicated airspeed
IAWP	: initial approach waypoint
IC	: intermediate course
ICAO	: International Civil Aviation Organization
ICD	: interface control document
IIC	: investigator-in-charge
ID	: identification
IDF	: initial departure fix
i.e.	: id est (that is)
IF	: intermediate fix
IFIO	: International Flight Inspection Office
IFR	: Instrument Flight Rules
IFSS	: international flight service stations
ILS	: instrument landing system
IM	: inner marker
INS	: inertial navigation system
IO	: input-output
IRU	: inertial reference unit
ips	: inches per second
ISLS	: improved side lobe suppression
IWP	: intermediate waypoint

JAI : joint acceptance inspection
JSS : joint surveillance site

k : Kilo (=10^3)
kHz : kilohertz
KIAS : knots indicated airspeed
kn : knots
kW : kilowatt

LAAS : local area augmentation system
LAL : lateral alert limit
LAM : local area monitor
lat. : latitude
LBAP1 : left boundary alignment point 1
LBAP2 : left boundary alignment point 2
L-Class : low altitude VOR
LDA : localizer directional aid
LDIN : lead-in lights
LEPP : live environment performance program
LF : low frequency
LGF : LAAS ground facility
LMM : compass locator at middle marker
LOC : localizer
LNAV : lateral navigation
LOM : compass locator at outer marker
long. : longitude
LOP : line-of-position
Loran : long range navigation
LOS : line of site
LP : linear polarization
LPL : lateral protection level
LRCO : limited remote communications outlet
LSES : loran signal evaluation system
LSP : local status panel
LTP : landing threshold point

m : meter
M : mega (=10^6)
mA : milliampere
MAA : maximum authorized altitude
MAHP : missed approach holding point
MAHWP : missed approach holding waypoint
MALS : medium intensity approach lights—5,000 cp
MALSF : medium intensity approach lights; sequenced flashing lights
MALSR : same as MALSF; runway alignment indicator lights

MAP : missed approach point
MATWP : missed approach turning waypoint
MAWP : missed approach waypoint
MB : marker beacon
MCA : minimum crossing altitude
MCE : mean course error
MDA : minimum descent altitude
MDP : MLS datum point
MDT : maintenance data terminal
MEA : minimum en route altitude
MEARTS : micro en route automated radar tracking system
MF : medium frequency
MGP : minimum glide path
MHA : minimum holding altitude
Mhz : megahertz
MIRL : medium intensity runway lights
MLOM : MH Class compass locator at outer marker
MLS : microwave landing system
MM : middle marker
MOCA : minimum obstruction clearance altitude
MRA : minimum reception altitude
MOPS : minimum operational performance standards
MRG : main reference group
MSAW : minimum safe altitude warning
MSG : minimum selectable glidepath
MSL : mean sea level
MTD : moving target detection
MTI : moving target indicator
MTR : mission test report
MUA : maximum usable altitude
mV : millivolt
MVA : minimum vectoring altitude
MVAR : magnetic variation

n : nano (=10^{-9})
N. : North
NA : not applicable or not authorized (when applied to instrument approach procedures)
NACO : National Aeronautical Charting Office
NAS : National Airspace System
NASE : Navigational Aids Signal Evaluator
NAVAID : air navigation facility
NDB : nondirectional beacons
NFDC : National Flight Data Center

Nm	: nautical mile
NOTAM	: Notice to Airmen
NRKM	: nonradar keyboard multiplexer
NTSB	: National Transportation Safety Board
OBS	: omnibearing selector
OCI	: out of coverage indication
ODALS	: omnidirectional approach lighting system
OM	: outer marker
orb.	: orbit
OVLY XTKER	: GPS overlay crosstrack error
PAPI	: precision approach path indicator
P code	: precision code
PAR	: precision approach radar
PD	: power density
PDOP	: precision dilution of position
PE	: permanent echo
PEE	: position estimation error
PFE	: path following error
PFN	: path following noise
PIDP	: programmable indicator data processor
PNA	: pilot navigation area
PPI	: plan position indicator
PPS	: precise positioning service, P-code
PRF	: pulse-repetition frequency
PRN	: pseudo-range number
PT	: procedure turn
PVD	: plan view display
PVT	: position velocity time
QARS	: quick analysis of radar sites
RADAR or radar	: radio range and detecting
RADES	: Radar Evaluation Squadron (military)
RAG	: range and azimuth gating
RAIL	: runway alignment indicator light
RAIM	: receiver autonomous integrity monitoring
RAPCON	: radar approach control (USAF)
RAPPI	: Radar plan position indicator
RARRE	: range, azimuth radar reenforced evaluator
RATCC	: radar approach control center (USN)

RBAP1	: right boundary alignment point 1
RBAP2	: right boundary alignment point 2
RBDE	: radar bright display equipment
RCAG	: remote, center air/ ground communication facility
RCO	: remote communication outlet
RDAS	: radar data analysis software
RDH	: reference datum height
RDP	: runway datum point
rec	: receiver
ref	: reference
REIL	: runway end identifier light
RF	: radio frequency
RFI	: radio frequency interference
RMI	: radio magnetic indicator
RML	: radar microwave link
RNAV	: area navigation
RNP	: required navigation performance
ROC	: required obstruction clearance
RPDS	: reference path data selector
RPI	: reference path identifier (GBAS)
RPI	: runway point of intercept (SIAP)
RPM	: revolutions per minute
RRP	: runway reference point
RSCAN	: radar statistical coverage analysis system
RSP	: remote status panel
RTQC	: real time quality check
R/T	: receiver-transmitter
RTT	: radio telemetering theodolite
RVR	: runway visual range
RVV	: runway visual value
RWY	: runway
s	: second
S.	: South
SA	: selective availability
SAAAR	: special aircraft and aircrew authorization required
SALS	: short approach light system
SAVASI	: simplified abbreviated visual approach slope indicator system
SBAS	: space-based augmentation system
SDF	: simplified directional facility
sec	: second
SECRA	: secondary radar
SER	: stop end of runway
SIAP	: standard instrument approach procedure
SID	: standard instrument departure

SINE : site integration of NAS equipment
SLS : side lobe suppression
SNR : Signal-to-noise ratio
SNR-FS : Signal-to-noise ratio-field strength
SNR-PH : Signal-to-noise ratio-phase
SPAR : system performance analysis rating
SPS : standard positioning service, C/ A code
SSALF : simplified short approach light system; sequenced flashing lights
SSALR : same as SSALF; runway alignment indicator lights
SSV : standard service volume
STAR : standard terminal arrival route
STC : sensitivity time control
STOL : short takeoff and landing
SV : service volume

TACAN : tactical air navigation
TAP : terminal area path
TAR : test analysis report
TCH : threshold crossing height
T-Class : terminal VOR, TACAN, or VORTAC
TCOM : terminal communications
TD : time difference
TDI : TACAN distance indicator
TDM : time division multiplex
TDR : touchdown reflector
TDZ : touchdown zone
TDZL : touchdown zone lights
TERPS : terminal instrument procedures
TH : threshold
TLS : Transponder Landing System
TOWP : take-off waypoint
T/R : transponder-radar (system)
TRACALS : traffic control and landing systems
TRACON : terminal radar approach control (FAA)
TRIAD : 3 Loran C stations of a specific chain
TRSB : time reference scanning beam
TSE : total system error
T-VASI : T (configuration)—visual approach slope indicator
TVOR : terminal VOR
TWEB : transcribed weather broadcast equipment

μ	: micro
UDF	: ultra high frequency direction finder
UHF	: ultra high frequency
USA	: United States Army
USAF	: United States Air Force
USN	: United States Navy
USSFIM	: United States Standard Flight Inspection Manual
UTC	: universal coordinated time
V	: volt
VAL	: vertical alert limit
var.	: variation
VASI	: visual approach slope indicator
VDB	: VHF data broadcast
VDF	: very high frequency direction finder
VDL	: VHF data link
VDOP	: vertical dilution of precision
VDP	: visual descent point
VFIP	: VFR flight inspection program
VFR	: visual flight rules
VGSI	: visual glide slope indicator
VHF	: very high frequency
VLF	: very low frequency
VNAV	: vertical navigation
VOR	: very high frequency omnidirectional range
VORDME	: very high frequency omnidirectional range, distance measuring equipment
VOT	: very high frequency omnidirectional range test
VP	: vertical polarization
VPL	: vertical protection level
V/ STOL	: vertical/ short takeoff and landing
VORTAC	: very high frequency omnidirectional range, tactal air navigation
W	: watt
W.	: West
WAAS	: wide area augmentation system
WGS-84	: World Geodetic Survey of 1984
WPDE	: waypoint displacement error
WP	: waypoint
WRS	: wide-area reference stations
Xmtr	: transmitter
XTK	: receiver cross-track information
XTKER	: crosstrack error
Z	: zulu time (Greenwich mean time)

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