

ORDER

**U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION**

VN 8200.8

8/20/07

SUBJ: FLIGHT INSPECTION PROGRAM STANDARDS

- 1. PURPOSE.** This order specifies Aviation System Standards (AVN) flight inspection standards and certification requirements for conducting flight inspections within the National Airspace System (NAS). It incorporates and documents a number of existing requirements, procedures, and standards that define the baseline flight inspection environment as specified in the August 2006 version of Order 1100.161, Air Traffic Safety Oversight.
- 2. DISTRIBUTION.** This order is distributed to the National Flight Procedures Group, Flight Inspection Operations Group, and Aircraft Maintenance & Engineering Group in Air Traffic Technical Operations Aviation System Standards Office. It is available on the Internet (<http://www.avn.faa.gov>).
- 3. SCOPE.** This order applies to AVN in the conduct of flight inspection of air navigation services within the United States (U.S.) National Airspace System (NAS), and flight inspection of air navigation services for the FAA outside the U.S. It applies to all types of flight inspections as defined in Chapter 4 of Order 8200.1, United States Standard Flight Inspection Manual. This order does not apply to a site evaluation or other airborne measurements activities which do not commission or certify instrument approach procedures or navaids, or are solely engineering in nature.
- 4. BACKGROUND.** The creation of the FAA Air Traffic Organization (ATO) as a service provider, the establishment of its Air Traffic Safety Oversight Service (AOV), and various international trends together require the documentation of Flight Inspection Program standards.

 - a.** Flight inspection of U.S. NAS facilities and flight procedures has been accomplished wholly by the FAA. AVN, the FAA's flight inspection organization, has a long history of mission accomplishment, including procurement and operation of aircraft, development of measurement procedures, application of specialized avionics, and oversight of the development of advanced flight inspection systems. To date, the mission has primarily focused on measurements of signals-in-space (SIS) from ground-based navigational aids located within the U.S.

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Initiated By: Air Traffic Operations (ATO-W)
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- b. In recent years, however, various technical, political, and international developments have made the flight inspection environment more diverse. For example, satellite-based navigation functions are becoming common. Modern airframes use a combination of sensors to achieve the required airspace performance and are increasingly autonomous of the traditional ground-based navigation and surveillance service environment. These technical developments are changing the nature of the flight inspection mission. In many countries, the regulatory and service provision functions of a single national aviation entity have been split, and the service provision function privatized to varying degrees. Throughout Europe, for example, the flight inspection function is often conducted by private corporations regulated by the civil aviation authorities. AVN aircraft and personnel routinely operate and may even compete for flight inspection work in such airspace.
- c. As a result of these developments and changes in the flight inspection environment, and the incorporation of a baseline safety standard prescribed in Order 1100.161, the need exists to define the standards that AVN maintains in order to provide flight inspection services. This order defines those standards.

5. **DEFINITIONS.** For the purposes of this order, the following acronyms and definitions apply.

- a. **Flight Inspection** -- An activity comprising (1) flight testing or flight check (i.e., measurement of aeronautical facility characteristics in an airborne environment), and (2) flight validation (i.e., the assessment of aeronautical procedures and the airspace environment).
- b. **Must** -- Denotes compulsory or mandatory action that the person being directed is obliged to take. (SHALL has been replaced with MUST in this order to comply with Government plain language requirements.)
- c. **Should** -- Denotes an action that is desirable but not mandatory.
- d. **Safety Management System (SMS)** -- An integrated collection of processes, procedures, and programs that ensures a formalized and proactive approach to system safety through risk management.

6. **POLICY.** The following requirements apply to AVN's on-going programmatic flight inspection activities within the scope of this Order.

- a. Flight inspection activities must meet the requirements of Paragraph 7, General Organizational Requirements.
- b. Flight inspection personnel must meet the requirements of Paragraph 8, Flight Inspection Personnel Requirements.
- c. Flight inspection aircraft must meet the requirements of Paragraph 9, Flight Inspection Aircraft Requirements.

- d. Flight inspection measurements must be made using a Flight Inspection System (FIS) meeting the requirements of Paragraph 10, Flight Inspection System (FIS) Requirements.
- e. Flight inspections must meet the requirements of Order 8200.1 (including its active interim changes and guidance documents), and active Site- and System-specific Orders (see current list in Appendix 1).

NOTE: Individual flight inspection efforts conducted on behalf of the FAA under unusual circumstances may be handled on a case-by-case basis outside of the above policy statements, but will be subject to AVN review and acceptance. An example of an unusual circumstance is an FAA request to a foreign flight inspection organization to meet a time-critical AVN contractual obligation overseas, on a one-time basis, when the dispatched AVN aircraft suffers a mechanical breakdown.

7. GENERAL ORGANIZATIONAL REQUIREMENTS. This section presents general requirements for AVN to conduct flight inspections.

- a. **Flight Operations.** AVN must conduct its flight operations to equivalent standards of 14 CFR Part 135. (FAA's flight inspection operations are conducted in accordance with Order 4040.9, FAA Aircraft Management Program.)
- b. **Flight Rules Relief.** Depending on the flight inspection procedures to be conducted, exemptions, deviations, and/or waivers to applicable flight rules will be necessary.
 - (1) Some examples of flight inspection flight rules requiring relief include
 - (a) 91.119 (b) and (c), Minimum Safe Altitudes
 - (b) 91.159, VFR Cruising Altitude or Flight Level
 - (c) 91.175 (a) (b), Takeoff And Landing Under IFR
 - (d) 91.179 (b), IFR Cruising Altitude or Flight Level
 - (e) 91.515 (a), Flight Altitude Rules
 - (2) AVN must request from the FAA Flight Standards Service or the appropriate Flight Standards District Office all needed flight rule exemptions, deviations, and/or waivers, and possess appropriate approval prior to conducting any flight inspection procedures that require them.
- c. **Safety Management System.** AVN must establish and maintain an SMS that complies with Orders 1100.161 and JO 1000.37, Air Traffic Organization Safety Management System. Order 1100.161 describes the application of the system's safety approach and implements the procedures used to conduct oversight of the flight inspection function. Order JO 1000.37 defines the policy and application of an SMS for identifying and analyzing safety risk to appropriately mitigate and manage it.

- d. Organizational Quality.** AVN must maintain a Quality Management System (QMS) registered by an entity accredited by the ANSI-ASQ American National Accreditation Board. The purpose of the QMS is to maintain and improve the level of flight inspection product/ service quality, and assure safe operation of aircraft and the aeronautical navigation aids and procedures being flight inspected /evaluated.
- (1) The QMS must use the current edition of the ISO 9001 quality management system model.
 - (2) Documentation for the QMS must define its scope including justified exclusions, a description of the interaction of the QMS processes, written procedures required by ISO 9001, and any other documentation necessary to ensure the effective planning, operation, and control of flight inspection processes.
 - (3) The minimum features of this model include the following:
 - (a) The organization's business environment must embrace sound management practices that treat compliance with stakeholders' safety and quality requirements, including statutory and regulatory requirements as an imperative for the quality management system.
 - (b) Management of organizational features that can cause a risk to quality and safety must be conducted systematically. The focus of quality management must be prevention of factors that could be causative to accidents and product nonconformity.
 - (c) Accountability, responsibility, and competence must be documented, traceable, and verifiable from the point of action through to the appropriate manager.
 - (d) The system for management review must ensure that senior management is fully cognizant of the systems and features that affect the quality and safety of the operation and the flight inspection services provided.
 - (e) A company ISO quality manual must be maintained documenting clearly the organizational structure, processes, personnel, accountabilities, responsibilities, resources, facilities, capabilities, policies, and purposes of the Organization.
 - (f) Records must be accurate, legible, and capable of independent analysis. The retention period for all records must be defined to permit trend analysis of ground and airborne flight inspection equipment, to identify fault conditions or substandard performance before safety hazards develop. All procedures must be approved and controlled so that the correct and current version of any procedure is easily identified and used.

- (g) Relevant process performance and product conformity data must be monitored, measured, and analyzed on a regular basis, resulting in continual verifiable improvement in flight inspection services.
- (h) Outsourced processes must be identified and controlled within the QMS.
- (i) An internal ISO 9001 quality auditing process must be established, documented, and performed by competent personnel on a regular basis. Management must review documentation of audit results, and corrective actions must be taken that improve effectiveness and efficiency of the QMS.

e. Flight Inspection Documentation:

- (1) Documentation of flight inspection results must comply with Order 8240.36, Flight Inspection Report Processing System (FIRPS).
- (2) Records and graphs of flight measurements must meet the following requirements:
 - (a) System parameters must be retrievable. Clear and concise system parameters must be recorded on all records and graphs and be easily retrievable. Scaling of parameters must be appropriate to the required uncertainty requirements. The data comprising these recordings and graphs must be stored with sufficient accuracy that expanded scale plots can be provided on demand.
 - (b) When parameters are evaluated by comparison of the received signal and the output of a tracking device, only the final result need be presented for a normal inspection. However, position data and raw signal data must be recorded or stored and provided on demand, for cases where further analysis is required.
 - (c) Each record and graph must be identified with the aircraft tail number, the date and flight description, and the facility being inspected.
- (3) Flight inspection documentation, including reports, records, graphs, and any other relevant data, must be retained in accordance with Order 8200.1.

8. FLIGHT INSPECTION PERSONNEL REQUIREMENTS. This section presents qualification requirements for AVN personnel conducting flight inspections.

- a. Minimum Piloting Requirements.** Pilots operating aircraft for flight inspection purposes must be qualified in accordance with 14 CFR Part 135.
- b. Flight Inspection Crew Member Qualifications.** Crewmembers on an aircraft engaged in flight inspection activities must be qualified through appropriate training. Pilot crewmembers must be qualified and current in their duty positions and complete the flight inspection training curriculum defined in TI 4040.57,

Flight Inspection Training Manual. Mission specialist crewmembers must complete and maintain currency on relevant portions of the 135 new-hire training curriculum (e.g., emergency egress, crew resource management) and flight inspection mission training.

- c. Credentialing and Oversight of Flight Inspection Personnel.** AVN must provide initial and on-going credentialing and oversight of all personnel conducting flight inspections.
- (1) Credentialing of flight inspection personnel must be accomplished by application of Order VN 8240.3, Certification of Flight Inspection Personnel.
 - (2) Oversight of flight inspection personnel must be accomplished by application of Order VN 200 4040.3, Flight Inspection Proficiency and Standardization Evaluation Program.

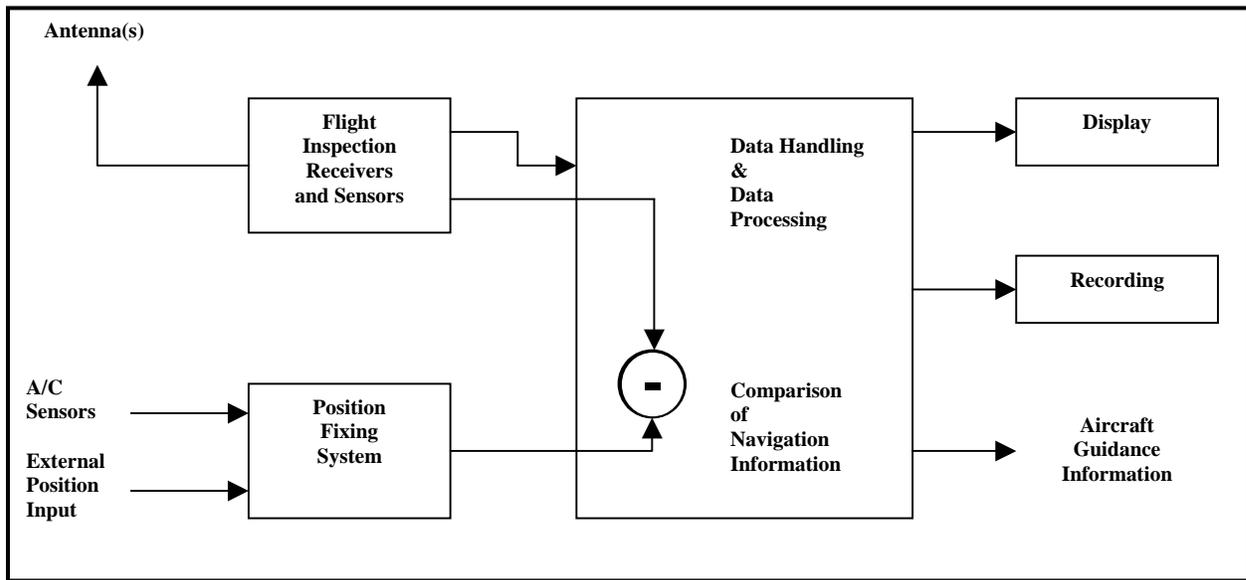
9. FLIGHT INSPECTION AIRCRAFT REQUIREMENTS. This section presents requirements for aircraft used for conducting flight inspections.

- a. Airframe.** The aircraft must meet U.S. certification requirements and possess the appropriate airworthiness certificate for the type of operations required. A variety of aircraft may be used, according to the type of aeronautical facilities to be flight inspected.
- (1) The aircraft must be a turbine-powered, multi-engine, all-weather type capable of safe flight with one engine inoperative.
 - (2) The aircraft must be operated by two flying crewmembers.
 - (3) The aircraft must provide accommodations for an observer and for a mission specialist if one is required for the type of inspections to be performed.
 - (4) The aircraft must have a stable electrical system with sufficient capacity to operate the additional electronic and recording equipment required by the type of inspections being performed.
 - (5) If a propeller-driven aircraft is used, the propeller modulation effects on measurement parameters must be reduced to an acceptably low level.
- b. Equipage.** The aircraft must be fully equipped and instrumented for night and instrument flight.
- (1) The aircraft must be equipped with Terrain Awareness and Warning System (TAWS), Traffic Alert and Collision Avoidance System (TCAS), and Ground Proximity Warning System (GPWS).
 - (2) Additional avionics, and data processing and recording equipment for measurement purposes must be included, dependent on the specific aeronautical facilities to be flight inspected.

- (3) An autopilot is required for Instrument Landing System (ILS) and Area Navigation (RNAV) flight inspections.
- (4) A Flight Management System (FMS) is required for Area Navigation (RNAV) based flight inspections. The FMS must meet the requirements contained in Appendix 15.

10. FLIGHT INSPECTION SYSTEM (FIS) REQUIREMENTS. This section presents requirements for the flight inspection system.

- a. **General.** Suitable antenna, avionics, and position reference information for all types of flight inspections are required for the determination of the accuracy of the navigation signal. Depending on the aeronautical facility being inspected, the position information may be obtained by visual observations (e.g., ground reference points), optical tracking (e.g., theodolite), or on-board autonomous systems (e.g., fully Automated Flight Inspection System, AFIS).
 - (1) Modern flight inspection measurement systems combine multiple sensor inputs to establish position fixing. A state-of-the-art solution that provides position sensing for all phases of flight inspection is the combination of different sensors, such as inertial navigation systems (INS), barometric altimeters, scanning DME receivers, and global navigation satellite system (GNSS) receivers. A high degree of automation can be achieved for the flight inspection equipment since continuous position reference information is available. In addition to position fixing capability, modern flight inspection systems also provide data processing, display, and recording functions, and may provide guidance to the crew for accurately positioning the aircraft for measurements. A typical block diagram of such a system is shown in the figure below.
 - (2) The position fixing system generates position reference information using the same coordinate system as the navigation system under test; e.g., a reference distance for a DME, a reference localizer deviation, or a reference glidepath signal. It must be independent of the facility being inspected and provide sufficient accuracy for the task.



- (3) The position fixing system and the flight inspection antennas and receivers contribute to the overall error budget according to the following equations:

$$NSE = FacilityError + MeasurementError$$

NSE: Navigation System Error (aboard aircraft)
Facility Error: Signal error of facility being inspected

$$MeasurementError = \sqrt{AvionicsError^2 + PositioningSystemError^2}$$

b. Requirements:

- (1) General. The purpose of flight inspection of aeronautical facilities is to verify that all parameters of the navigational aid meet the requirements specified in Annex 10 to the International Convention on Civil Aviation and in FAA Order 8200.1. The equipment installed in the aircraft must be capable of measuring all these parameters.
- (a) Flight inspection measuring equipment must not interfere with the operation or accuracy of the aircraft's normal navigation and general avionics equipment.
 - (b) The measurement equipment must be adequately protected against the electromagnetic environment both internal and external to the aircraft.

- (2) Flight Inspection Antennas. Careful consideration must be given to the selection and placement of aircraft antennas to optimize the performance of the airborne receiving system used for the flight inspection role. To the extent feasible, the flight inspection equipment and its associated antennas must be totally independent from the aircraft's operational avionics.
- (a) The antennas must not be obscured from the signal during any normal inspection flight profiles. This may require more than one measuring antenna for a particular function.
 - (b) Multiple measuring receivers may use a common antenna.
 - (c) Tracked structure measurements must account for the location of the avionics antennas with respect to the tracking reference on the aircraft. This error, if not corrected by using aircraft attitude information, must be included in measurement uncertainty calculations. Alternatively, the errors may be corrected using information from the aircraft's attitude sensors
 - (d) Calibration of the antenna system gain is required for antennas used to measure field strength. Antenna system gain characteristics (including all feed cables, switches and power splitters) must be determined in order to measure relative and absolute field strength within the specified uncertainties.
 - 1 The characteristics must be measured over the range of frequencies and at the aircraft orientations experienced during the measurement procedures to be used. These antenna gain characteristics must then be applied either in real-time as data is input and displayed, or post-processed to generate the final report data.
 - 2 Some flight inspection applications correct for gain errors, placing additional constraints on the achieved airborne antenna patterns. An example is course structure measurements for localizer, glidepath, and VOR, for which the contributing multipath errors may arrive at the aircraft from a widely different azimuth than the desired direct signal. In this case, variations in gain vs. azimuth will affect the measured amplitude of the course structure, with or without aircraft attitude variations, and flight measurements by differing aircraft types will vary. For these applications, and particularly for Category II and III ILS measurements, a smooth antenna pattern with 6 dB front-to-back and 6 dB front-to-side ratios is considered optimum.
 - 3 The achieved antenna patterns for structure measurements must be measured and documented.

- (3) Measurement Accuracy/ Uncertainty. Appendices 2 through 17 of this order contain tables that define currently used measurements tolerances and the allowed uncertainty for flight inspection measurements of aeronautical facilities. In general, the tolerances are used both in Order 8200.1 and the international community. The uncertainties are taken from standards defined in the international flight testing community; where these do not exist, the uncertainties are based on engineering judgment and knowledge of the current measurement methodology. The uncertainties of non-measurement requirements, such as human observations and subjective judgments, are not defined.
- (a) AVN must document the accuracies achieved by its measurements, showing that the uncertainties in the Appendices are not exceeded. Compliance with the requirements in the Appendices may be accomplished by analysis or demonstration. The method of calculation and any assumptions made must be clearly shown. The documentation must be approved and maintained by the Director of Operations, Flight Inspection Operations, AJW-330.
 - (b) Many measurements are a combination of receiver output and aircraft position, and in these cases the figure required is the sum of all the errors involved in the measurement, including aircraft position. Where several measurements are combined to produce a single result, the errors must be computed using the root-sum-squared (RSS) method to give the overall expected measurement uncertainty. For measurements that can only be derived from recordings, the accuracy and resolution of the recording equipment must be included in calculating the expected measurement uncertainty.
 - (c) Once initial documentation of measurement uncertainty has been accomplished, any subsequent change to measurement conditions (e.g., software algorithm change, avionics replacement, etc.) must be shown to continue to meet the requirements in the Appendices.
- (4) Temperature Stability. The uncertainties stated above must be maintained under the specified environmental conditions for a flight inspection measurement.
- (a) Allowable environmental conditions (e.g., temperature range, humidity range) must be defined and subsequently maintained during measurements.
 - (b) Documentation of measurement uncertainty with respect to temperature must be available for all the measuring equipment. This may be in the form of test results made by the organization or manufacturer's specifications. If manufacturer's specifications are used, the manufacturer's test results must be available as evidence.

- (5) Calibration. All measuring equipment used for flight inspection must be calibrated to defined standards.
 - (a) Regular calibration of the flight inspection receivers and position fixing system, as well as ground equipment used to maintain and calibrate them, must be performed traceable to the National Institute of Standards and Technology. The calibration may be performed either onboard the flight inspection aircraft or in a laboratory. Calibration intervals must be included in the calibration records and be made available for inspection.
 - (b) Clearly defined calibration procedures must be maintained and used for all equipment involved in flight inspection measurements.
 - (c) When any equipment used is advertised as self-calibrating, the internal processes involved must be clearly defined. This involves showing how the equipment's internal standard is applied to each of the parameters that it can measure or generate. The internal standard must have traceability to national standards.
- (6) Build State and Modification Control. The Build State of all equipment, including test equipment, must be recorded and the records updated whenever modifications or changes are made. All modifications must be accurately documented and cross-referenced to modification labels or numbers on the equipment. After making any modification, tests and analysis must ensure that the modification fulfills its intended purpose and that it has no undesired side effects.
- (7) Flight Inspection Software. All software (i.e., procedures, formulas, algorithms, etc.) used in flight inspection measurements and in trajectory control of the aircraft during flight inspection maneuvers must meet high safety and quality assurance standards. (It is assumed that all avionics used for these purposes have been certified to airworthiness standards.)
 - (a) Industry-standard procedures, such as the use of S.A.E. Aerospace Recommended Practice (ARP) 4761, Guidelines and Methods for Conducting the Safety Assessment Process on Civil Airborne Systems and Equipment, and S.A.E. 4754, Guidance for Development, Validation, and Verification of Aircraft Systems, or equivalent, must be used to assess the flight inspection hardware (avionics) and software architecture, to determine the safety risk arising from failures of flight inspection software.
 - (b) Given the resulting safety risk, industry standard software quality assurance standards, such as RTCA DO-178B, Software Considerations in Airborne Systems and Equipment Certification or equivalent, must be used to assign an assurance level to each module of software.

- (c) Each software module must be produced using procedures and methodology appropriate to its assigned assurance level.
 - (d) Documentation substantiating the safety risk analyses, the software assurance levels, and the procedures and methodology used to produce the software must be available.
- c. **Recording Equipment.** The flight inspection system must include equipment that electronically records the measured parameters of the aeronautical aid being inspected. Recorded data must be marked to correlate with the aircraft's position at the time of the measurement.

11. LIST OF APPENDICES

Appendix 1	Flight Inspection Related Publications
Appendix 2	Very High Frequency (VHF) Omnidirectional Range (VOR) Flight Inspection Requirements
Appendix 3	Distance Measuring Equipment (DME) Flight Inspection Requirements (may be combined with VOR/ TACAN)
Appendix 4	Instrument Landing System (ILS) Flight Inspection Requirements
Appendix 5	Non-Directional Beacon (NDB) Flight Inspection Requirements
Appendix 6	En route VHF Marker Beacons (75 MHz) Flight Inspection Requirements
Appendix 7	Precision Approach Radar (PAR) Flight Inspection Requirements
Appendix 8	Tactical Air Navigation (TACAN) Flight Inspection Requirements (may be combined with VOR/ DME)
Appendix 9	Instrument Flight Procedures Flight Inspection Requirements
Appendix 10	Aircraft-Based Augmentation System (ABAS) NPA Flight Inspection Requirements
Appendix 11	Space-Based Augmentation System (SBAS) Flight Inspection Requirements
Appendix 12	Ground-Based Augmentation System (GBAS) Flight Inspection Requirements
Appendix 13	Lighting System Flight Inspection Requirements
Appendix 14	Communications System Flight Inspection Requirements (including Direction Finder (DF) Systems)
Appendix 15	RNAV Flight Inspection Requirements
Appendix 16	Microwave Landing System Flight Inspection Requirements
Appendix 17	RFI Detection and Location Requirements

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Thomas C. Accardi
 Director of Aviation System Standards

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APPENDIX 1**FLIGHT INSPECTION AND RELATED PUBLICATIONS**

1. PURPOSE. This appendix lists FAA publications containing additional materials on flight inspection.

2. FAA REFERENCES. Consult the latest edition of the following FAA publications. Portions of these referenced documents are incorporated into this order, either directly or through the allowance of an approved equivalent.

a. General References

- (1) Order 4040.9, FAA Aircraft Management Program
- (2) Order 1100.161, Air Traffic Safety Oversight
- (3) Order JO 1000.37, Air Traffic Organization Safety Management System
- (4) Order 8200.1, United States Standard Flight Inspection Manual
- (5) Order 8240.36, Flight Inspection Report Processing System (FIRPS)
- (6) TI 4040.57, Flight Inspection Training Manual
- (7) Order VN 8240.3, Certification of Flight Inspection Personnel
- (8) Order VN 200 4040.3, Flight Inspection Proficiency and Standardization Evaluation Program

b. Notices containing interim changes to and guidance for flight inspection orders may be found at the Aviation System Standards website:
<http://www.avn.faa.gov/index.asp?xml=fioo/notices>

c. Site and System-Specific References

- (1) Order 8200.32, Flight Inspection Criteria for Aspen, Colorado, Localizer Directional Aid (LDA)
- (2) Order 8200.39, Flight Inspection of Precision Runway Monitors/Final Monitor Aid
- (3) Order 8200.40, Flight Inspection of the Transponder Landing System (TLS)
- (4) Order 8200.41, Flight Inspection Evaluation of Differential Global Navigation Satellite Positioning System (DGNSS) Special Category (SCAT-1) Instrument Approaches Using Private Ground Facilities
- (5) Order 8200.43, Flight Inspection of the Microwave Scanning Beam Landing System
- (6) Order 8240.47, Determination of Instrument Landing System (ILS) Glidepath Angle, Reference Datum Heights (RDH), and Ground Point of Intercept (GPI)

3. NON-FAA REFERENCES. Consult the latest edition of the following publications. Portions of these referenced documents are incorporated into this order, either directly or through the allowance of an approved equivalent.

- a. Society of Automotive Engineers (S.A.E.) Aerospace Recommended Practice (ARP) 4761, Guidelines and Methods for Conducting the Safety Assessment Process on Civil Airborne Systems and Equipment
- b. S.A.E. 4754, Guidance for Development, Validation, and Verification of Aircraft Systems
- c. RTCA DO-178B, Software Considerations in Airborne Systems and Equipment Certification
- d. ISO 9001:2000, Quality Management Systems -- Requirements

APPENDIX 2

Very High Frequency (VHF) Omnirange Range (VOR)
Flight Inspection Requirements

1. **PURPOSE.** This appendix lists the minimum measurement requirements for VOR facilities.
2. **MEASUREMENTS.** VOR parameters must be measurable to the accuracy shown in the table below.

Parameter	Measurand	Tolerance	Maximum Uncertainty
Azimuth Accuracy Alignment Bends Roughness & Scalping	Deviation	$\pm 2.5^\circ$ $\pm 3.5^\circ$ $\pm 3.0^\circ$	0.6° 0.6° 0.3°
Coverage	Field Strength	90 $\mu\text{V/m}$	3 dB absolute ¹ 1 dB repeatability
Modulation	Modulation Depth	25 to 35%	1%
Bearing Monitor	Deviation	$\pm 1.0^\circ$	0.3°

Note 1: Approaches state-of-the-art

3. **GUIDANCE.** The power level into the receiver is used as the normal reference parameter for the determination of field strength. The power level into the receiver can be converted to absolute field strength if the antenna factor and cable losses are known.

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APPENDIX 3
DISTANCE MEASURING EQUIPMENT (DME)
FLIGHT INSPECTION REQUIREMENTS

1. **PURPOSE.** This appendix lists the minimum measurement requirements for DME facilities.
2. **MEASUREMENTS.** DME parameters must be measurable to the accuracy shown in the table below.

Parameter	Measurand	Tolerance	Maximum Uncertainty
Range Accuracy	Distance	<150 m <75m if DME associated with landing aids	20 m
Coverage	Field Density	-89 dBw/m ²	3 dB absolute ¹ 1 dB repeatability

Note 1: Approaches state-of-the-art

3. **GUIDANCE:**

a. **The following equipment is needed for DME:**

- (1) **A DME interrogator** or, if possible, two. Having a second interrogator in the aircraft provides standby equipment and makes it possible to compare the information given by the two interrogators in case of difficulties. The interrogators should have outputs making it possible to:
 - (a) Measure and record digital output with distance, and AGC voltage, from which the signal strength at the receiver input may be deduced. (Signal level errors of the order of 3 dB may be expected from the interrogator receiver and this should be taken into account when evaluating data from this source)
 - (b) Make observations on an oscilloscope of the video signal before and after decoding; the suppression pulses, indicating that the transmitter is operating; and the coding signals of the interrogator, a particularly useful observation in case of anomalies during flight inspection.
 - (c) Observe reply pulses synchronized with interrogation pulses to detect the possibility of false lock-on by lesser quality receivers.

- (2) **The corresponding antenna**, the characteristics of which should be known, particularly its radiation pattern. Accurate calibration of the antenna radiation pattern may be challenging, and determination of the antenna gain with accuracy better than 3 dB may be difficult to achieve.
 - (3) **An oscilloscope** with good performance for time measurement. Digital oscilloscopes have the capability to store waveforms and built-in functions for calculating the pulse shape parameters. Parameters and graphs should be recorded and documented.
 - (4) **Spectrum Analyser.** To measure the pulse spectrum with the flight inspection aircraft, an UHF spectrum analyser should be carried onboard.
- b. The following calibration guidance** applies to DME flight inspection equipment:
- (1) **Interrogator Pulse Repetition Rate.** The pulse transmission should be repeated at a rate of 30 pair per second, 5% of the time spent in the SEARCH mode and 95% in the TRACK mode. The variation in time between successive pairs should be sufficient to prevent false lock-on.
 - (2) **Frequency Stability.** The center frequency of the radiated signal should not vary more than ± 100 kHz from the assigned frequency.
 - (3) **Peak Power Output.** The peak power output measured at the interrogator should be at least 100 watts. The constituent pulses of a pulse pair should have the same amplitude within 1 dB. Special care should be taken when using GPS reference systems with phase measurements and in particular when using the GPS L₂ frequency. This frequency is close to the DME band, and the maximum output power of the interrogator and the separation of the antennas should be kept in mind.
 - (4) **Spurious Radiation.** Spurious radiation between pulses on any DME interrogation or reply frequency measured in a receiver having the same characteristics of a DME transponder receiver should be more than 50 dB below the peak radiated power of the desired pulses. The spurious CW power radiated from the interrogator on any DME interrogation or reply frequency should not exceed 20 microwatts (- 47 dBW).
 - (5) **Sensitivity.** The signal level required at the input terminals to effect a successful end-of-search nine out of ten cycles should not exceed -82 dBm when the input signal is a DME test signal having 70% reply efficiency. The required signal level should not exceed -79 dBm when the test signal contains 6000 random pulses 10 dB above the test signal level. The minimum signal levels are -85 and -82 dBm respectively to maintain tracking under the above conditions.

- (6) **Selectivity.** The level of the input signal required to produce a successful end-of-search nine out of ten cycles should not vary in excess of 6 dB over the band 120 kHz above and below the assigned reply frequency. This includes receiver frequency stability requirements. The level of the input signal required to produce an average of not more than one successful end-of-search out of ten cycles (and that one to track for not more than five seconds) should be at least 30 dB greater than the on-frequency signal described above, and nine out of ten successful end-of-search cycles when the off-frequency signal is displaced by 940 kHz either side of the assigned channel frequency. Over the frequency range of 960 MHz to 1,215 MHz, excluding frequencies within 1 MHz of the desired channel, the equipment should not respond to nor be adversely affected by an undesired frequency DME signal having a level 50 dB above the level of the signal on the desired channel.

NOTE 1: In operational use, an adjacent channel transponder would provide at least 80 dB rejection of adjacent channel interrogations. Since the transponder effectively prevents replies to adjacent channel interrogations, no lock-on can occur.

NOTE 2: Spurious Responses. Over the frequency range of 90 kHz to 10,000 MHz, excluding frequencies within 3 MHz of the desired channel, a CW signal having a level of -30 dBm should not adversely affect the receiver sensitivity.

- (7) **Decoder Selectivity.** The equipment should be calibrated to indicate distance satisfactorily when the spacing of the received pulses is varied from 11.5 to 12.5 microseconds for X-channel or from 29.5 to 30.5 microseconds for Y-channel, over the input signal level range from -48 dBm to the minimum tracking level. If the spacing between pulses is less than 10 microseconds or more than 14 microseconds for X-channel, or less than 28 microseconds or more than 32 microseconds for Y-channel, and the signal level is below -48 dBm, that signal should not be decoded.
- (8) **Search Speed.** Search speed should be at least 10 NM per second.
- (9) **Memory.** To enable the detection of unlocks, the memory time of the equipment should be approximately 5 seconds upon the loss of signal. The information displayed during this period should be that information which was being displayed at the time of the loss of the signal ± 1 mile.
- (10) **Calibration.** The indication "Distance = 0 NM" should correspond to a time delay in responding to an interrogation of $50\mu\text{s} \pm 1\mu\text{s}$.
- (11) **Airborne Antenna.** The radiation pattern should be as omnidirectional as possible in the horizontal plane. It should be sited in such a way as to be free from masking effects of the aircraft structure. The use of two antennas may be a good solution. The characteristics of the antenna and associated feeder line should be taken into account when interpreting the results of measurements.

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APPENDIX 4
INSTRUMENT LANDING SYSTEM (ILS)
FLIGHT INSPECTION REQUIREMENTS

1. PURPOSE. This appendix lists the minimum measurement requirements for ILS facilities.

2. MEASUREMENTS. ILS parameters, including those from systems intended to be electrically equivalent to ILS (e.g., Transponder Landing System) must be measurable to the accuracy shown in the tables below.

LOCALIZER SUBSYSTEM

Parameter	Measurand	Tolerance	Maximum Uncertainty
Alignment	DDM	CAT I: 10.5m CAT II: 7.5m CAT III: 3.0m	2 m 1 m ² 0.7 m ²
Displacement Sensitivity	DDM	CAT I: Within 17% CAT II: Within 17% CAT III: Within 10%	3 μA 3 μA 2 μA
Off Course Clearance	DDM	Between 10 and 35°, 150 uA	5 μA with 150 μA input
Course Structure	DDM	CAT I: 15 uA CAT II: 5 uA CAT III: 5 uA	1 uA 1 uA 1 uA
Coverage	Field Density	-114 dBW/ m ¹	3 dB absolute ¹ 1 dB repeatability
Modulation Balance Depth	DDM Modulation Depth	0.002 DDM 18-22%	0.01 DDM 0.5% ²
Monitor Alignment Displacement Sensitivity Off Course Clearance	DDM DDM DDM	CAT I: 10.5m CAT II: 7.5m CAT III: 6.0m CAT I: Within 17% CAT II: Within 17% CAT III: Within 10% 150 μA	2 m 1 m 0.7 m 3 μA 3 μA 2 μA 5 μA with 150 μA input
Power	Field Strength	3 dB reduction	1 dB relative

NOTE 1: Approaches state-of-the-art

NOTE 2: Exceeds current industry capability

GLIDE SLOPE SUBSYSTEM

Parameter	Measurand	Tolerance	Maximum Uncertainty
Alignment	DDM, Angle	CAT I: within 7.5% CAT II: within 7.5% CAT III: within 4%	0.75% ¹ 0.75% ¹ 0.3% ²
Displacement Sensitivity	DDM, Angle	.0875 DDM at: CAT I: $\pm(0.07-0.14) \theta$ CAT II: $\pm 0.12 \theta$ CAT III: $\pm 0.12 \theta$	0.02 θ 0.02 θ 0.02 θ
Off Course Clearance	DDM, Angle	190 μ A at 0.3 θ	6 μ A with 190 μ A input
Course Structure	DDM	CAT I: 30 μ A CAT II: 20 μ A CAT III: 20 μ A	3 μ A 2 μ A 2 μ A
Coverage	Field Density	-95 dBW/ m ²	3 dB absolute ¹ 1 dB repeatability
Modulation Balance Depth	DDM Modulation Depth	0.002 DDM 37.5-42.5 %	0.001 DDM 0.5 % ¹
Monitor Alignment Displacement Sensitivity Power	DDM, Angle DDM Field Strength	7.5% CAT I: 0.037 θ CAT II: 25 % CAT III: 25 % 3 dB reduction	4 uA 4 μ A 4 μ A 4 μ A 1 dB relative

NOTE 1: Approaches state-of-the-art

NOTE 2: Exceeds current industry capability

ILS MARKER BEACON SUBSYSTEM

Parameter	Measurand	Tolerance	Maximum Uncertainty
Coverage	Distance	OM: ± 600 m MM: ± 300 m IM: ± 150 m	OM: 40m ¹ MM: 20m ² IM: 10m ²
Monitor Power	Field Strength	3 dB reduction	1 dB relative

NOTE 1: Approaches state-of-the-art

NOTE 2: Exceeds current industry capability

3. GUIDANCE. The following paragraphs define minimal performances of the equipment constituting the radio signals in flight measurement subsystem and recommends calibration procedures to reach them.

a. General:

- (1) A flight testing system may use equipment other than ILS receivers normally used for aircraft navigation (e.g., bench test equipment or portable ground maintenance receivers). Care should be used to ensure that this equipment performs the same as conventional, high-quality aircraft equipment.
- (2) For convenience reasons, the assessment of the accuracy of the reception and processing equipment of the radio subsystem will be made in units suitable to parameters to be measured -- in microamperes. To ensure a simple equivalence between the different units in which tolerances are expressed, the following relations are used: $1\mu\text{A} = 0.01^\circ$ for a distance of 4,000 m (13,000 feet) between localizer antenna and the threshold, and $1\mu\text{A} = 0.005^\circ$ for a glide path angle of 3° .
- (3) The evaluation of parameters such as course alignment and displacement sensitivity is performed by the radio electrical and positioning subsystems. These measurements are polluted by the specific errors of these two subsystems. By nature these errors are independent, and it is allowable to consider that the global statistical error on the parameter to be measured is equal to the root square of the sum of the squares of the equally weighted errors of the two parts of the system.

b. Equipment:

- (1) To minimize the errors due to implementation, antennas should be installed according to recommendations listed in Chapter 1. As an example of this importance, note that when the aircraft is over the runway threshold, a vertical displacement of 6 cm (2.5 inches) is equal to approximately 0.01° in elevation angle, observed from the glide path tracking site.
- (2) The receivers used should measure at a minimum the DDM, SDM, signal input level, and modulations depths. For integrity and technical comfort, the simultaneous use of two receivers is strongly recommended. This redundancy offers a protection against errors that might occur during the flight inspection because of unexpected short-term changes in a receiver's performance. A divergence of their output signals can therefore be noted immediately.

- (3) Equipment constituting the acquisition and processing subsystem should have such performance that it does not degrade the acquired parameters. It is necessary that signal acquisition occurs synchronously with the positioning determination of the plane, to compare measurements that correspond in time. It will be possible to convert, by the use of calibration tables, the radio electrical signals into usual physical units with a convenient resolution, and to take into account the actual functioning of the receiver in its operational environment. The graphic display and record should be such that they will allow the flight Inspector to evaluate fluctuations of signals against the required tolerances.

c. Calibration:

- (1) In the case where receivers deliver electrical voltages characterizing signals to be measured, calibration tables are first necessary to provide changes of units. Some equipment delivers the flight inspection parameters directly in the desired units, and calibration tables converting the different voltages into suitable units are not required in this case. Nevertheless, it is necessary to correct some errors of the subsystem (receiver centering error for instance), and limited calibration procedures will be accordingly defined. It is necessary to establish enough calibration tables that those established for a given frequency may be transposable to nearby ILS frequencies without significant error.

- (2) In most cases, the tables to be developed are described below:

Localizer: For a given VHF frequency:

- (a) $V_{agc} = f(\text{input level})$, input level varying from: -104 dBm to -18 dBm
 $I_{dev} = f(\text{input level})$, input level varying from: -90 dBm to -18 dBm
and for: DDM = 0
 DDM = 0.155 in the 90 Hz
 DDM = 0.155 in the 150 Hz
- (b) $I_{flag} = f(\text{input level})$, input level varying from: -90 dBm to -18 dBm and for modulation depths varying from: 17% to 23%
- (c) $V_{90\text{Hz}}$ and $V_{150\text{Hz}} = f(\text{modulation depth})$, for different values of the modulation depths, their sum remaining constant, and at different values of input level.

Glidepath: For a given UHF frequency:

(a) $V_{\text{agc}} = f(\text{input level})$, input level varying from: -104 dBm to -18 dBm

$I_{\text{dev}} = f(\text{input level})$, input level varying from: -90 dBm to -18 dBm

and for: DDM = 0
DDM = 0.088 in the 90 Hz
DDM = 0.088 in the 150 Hz

(b) $I_{\text{flag}} = f(\text{input level})$, input level varying from: -90 dBm to -18 dBm and for modulation depths varying from: 34% to 46%

(c) $V_{90\text{Hz}}$ and $V_{150\text{Hz}} = f(\text{modulation depth})$, for different values of the modulation depths, their sum remaining constant, and at different values of injection.

d. Positioning System. The evaluation of some parameters includes a combination of errors coming from the radio electrical outputs and from the positioning subsystem. By nature these errors are independent, and it is acceptable to consider that the global statistical error on the parameter to be measured is equal to the square root of the sum of the squares of the equally weighted errors of the two parts of the system.

e. Accuracies. The required accuracies are calculated by converting tolerances on the different ILS parameters into degrees, using the following formulas:

(1) Loc alignment tolerance = $\pm (\text{tolerance in } \mu\text{A} \times \text{nominal sector width} / 150)$ degrees

(2) GP alignment tolerance = $\theta \pm (\text{tolerance in } \mu\text{A} \times \text{nominal sector width} / 150)$ degrees

(3) Loc or GP sector tolerance = nominal sector $\times [150 / (150 \pm \text{tolerance in } \mu\text{A})]$ degrees

f. Error Budget. The different components of the error budget relative to the positioning measurement of the plane are listed below:

(1) The uncertainty on the database describing geometrically the field and the facility to be inspected (definition of every characteristic point in the runway reference coordinates system)

(2) The uncertainty on the platform coordinates (x, y, z) on which the positioning system is set up.

(3) The lack of care in setting up the positioning system on the ground.

- (4) The instrumentation error within its operating limits defined by the manufacturer.
- (5) Atmospheric refraction if optical or infrared tracker is used.
- (6) Parallax error due to the fact that the positioning system and the phase center of the facility to be measured are not co-located.
- (7) Error due to the fact that the reference aircraft positioning point and the localizer or glide path antenna are not co-located.
- (8) Conical effect of the radiated pattern of the glide path in the final part of the approach

To reduce the three last components above, it is necessary to use high accuracy devices providing distance (to a few meters), heading and attitude (to about 0.1° each) information. If distance, heading, and attitude parameters are not available, a crosswind limit should be set which allows measurement accuracies to be within the limits required.

APPENDIX 5
NON-DIRECTIONAL BEACON (NDB)
FLIGHT INSPECTION REQUIREMENTS

1. **PURPOSE.** This appendix lists the minimum measurement requirements for NDB facilities.
2. **MEASUREMENTS.** NDB parameters must be measurable to the accuracy shown in the tables below.

Parameter	Measurand	Tolerance	Maximum Uncertainty
Coverage	Signal Strength	Minimum required for geographical area	3 dB absolute ¹ 1 dB repeatability
	or Bearing	Oscillations < 10° en route < 5° approach	2°

NOTE 1: Approaches state-of-the-art

3. GUIDANCE:

- a. The basic airborne equipment used for flight testing NDB facilities is a standard aircraft automatic direction finding (ADF) receiver calibrated to read field strength and bearing to the NDB. A voltage proportional to the received signal strength usually can be obtained from the receiver, or field strength readings may be taken from a separate field strength measuring equipment carried in the aircraft.
- b. Since the ADF indicates the angle between the aircraft and the ground beacon, any yawing motion of the aircraft will produce a swing in the ADF needle indication. Care should therefore be taken during a flight check to keep the aircraft heading as steady as possible. In this way, the yawing motion of the aircraft is removed from the record. A typical formula used for this purpose is:

$$\text{ADF Error} = \text{ADF Bearing} - (\text{Azimuth to NDB} - \text{Aircraft Heading} \pm 180^\circ)$$

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APPENDIX 6

EN ROUTE VHF MARKER BEACONS (75 MHZ)
FLIGHT INSPECTION REQUIREMENTS

1. **PURPOSE.** This appendix lists the minimum measurement requirements for enroute MB facilities.
2. **MEASUREMENTS.** Enroute MB parameters must be measurable to the accuracy shown in the table below.

Parameter	Measurand	Tolerance	Maximum Uncertainty
Coverage	Time	Indication centered over beacon	1 s
	Field Strength	25 %	10 μ V

3. **GUIDANCE:**

- a. The airborne equipment used for flight inspection of marker beacons is usually a standard aircraft marker receiver and antenna, with the receiver modified so that field strength can be continuously recorded. Alternatively, a suitable general-purpose field strength meter covering the 75 MHz band could be used. The signal level used for calibration of the airborne marker receiver or field strength meter depends on the type of aircraft antenna used.
- b. The standard open wire antenna is a half-wave dipole mounted 15 cm below the approximate centerline of the metallic fuselage with its axis parallel to the longitudinal axis of the aircraft and cleared from any other antennas or projections by at least one meter. The lead-in consists of a wire connecting the antenna 13 cm off center to a 70 ohm concentric transmission line. The lead-in connects to the transmission line within 5 cm of the fuselage skin inside the aircraft.
- c. When the marker beacon receiver is used with the standard open wire antenna, the receiver sensitivity is adjusted so that the lamp is illuminated for an input signal level of 1,000 microvolts, 3,000 Hz modulated at 95 percent. The lamp should be extinguished (50 percent of lamp voltage or less) when the input signal is reduced to 800 microvolts. These signal levels are the open circuit voltages from a generator with a source impedance of 50 ohms. To ensure repeatable results, it is important that the input impedance of the marker receiver be resistive and between 50 and 100 ohms. If an antenna other than the above standard is used, a figure should be obtained from the manufacturer which relates its gain to that of the standard open wire antenna. This same factor is then applied to the receiver sensitivity adjustment. For example, if the antenna gain is -3 dB relative to the standard open wire, then the receiver should be adjusted so that the lamp is illuminated for an input of 700 microvolts and extinguished for an input of 570 microvolts. The antenna should be adjusted in accordance with the manufacturer's instructions to match the transmission line.

- d. When the coverage is determined by measuring the signal level from the aircraft antenna, the coverage limits are defined by the 1000 microvolt contour if the standard open wire antenna is employed. If another type of aircraft antenna is used, the equivalent signal level for coverage measurement is determined in the same manner described above for the receiver and lamp calibration.
- e. The tolerance for the coverage performance of a marker beacon is ± 5 sec compared to a 20 sec nominal value, or 25% relative. When applied to the allowable variation of the signal, this tolerance corresponds to:

Because the test equipment tolerances should be at least **five** times better than the parameter to be measured, the uncertainty on measuring the input signal level is 10 μ Volts.

APPENDIX 7
PRECISION APPROACH RADAR (PAR)
FLIGHT INSPECTION REQUIREMENTS

- 1. PURPOSE.** This appendix lists the minimum measurement requirements for PAR facilities.
- 2. MEASUREMENTS.** PAR parameters must be measurable to the accuracy shown in the table below.

Parameter	Measurand	Tolerance	Maximum Uncertainty
Coverage	Distance Azimuth Elevation	≥ 9 nm 20° 7°	0.1 nm 1° 0.1°
Accuracy Azimuth Elevation Distance	Azimuth Elevation Distance	Greater of 0.6% of distance to PAR antenna + 10% of deviation from on-course line, or 9m Greater of 0.4% of distance to PAR antenna + 10% of actual linear displacement from the chosen descent path, or 6m $30\text{m} + 3\%$ of distance to touchdown	3 m^1 3 m 3 m^1

NOTE 1: May approach state-of-the-art

3. GUIDANCE:

- a. Although it is not necessary to use a special aircraft for the flight testing of PAR, it is highly desirable that the aircraft used be specially designated for this work. It must be piloted by a qualified flight inspection pilot because the qualitative assessment of the PAR will form an important part of the validation for the facility.
- b. If a special aircraft is not used, a theodolite suitably modified to read accurately the displacement in azimuth and elevation of the flight test aircraft from the desired approach path may be required. This can be provided by vertical and horizontal vernier readouts on the theodolite to allow angular displacement to be determined to the nearest 0.01° .
- c. Radio communications are required between the controller at the console and the aircraft pilot and between the pilot and theodolite operator if a theodolite is used. The theodolite operator should also be capable of monitoring the controller's communications with the pilot.

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APPENDIX 8
TACTICAL AIR NAVIGATION (TACAN)
FLIGHT INSPECTION REQUIREMENTS

- 1. PURPOSE.** This appendix lists the minimum measurement requirements for TACAN facilities.
- 2. MEASUREMENTS.** TACAN parameters must be measurable to the accuracy shown in the table below.

Parameter	Measurand	Tolerance	Maximum Uncertainty
Azimuth Accuracy Alignment Bends Roughness & Scalping	Deviation	$\pm 2.0^\circ$ $\pm 3.5^\circ$ $\pm 3.0^\circ$	0.6° 0.6° 0.3°
Distance Accuracy	Distance; Range	± 0.2 nm	0.05 nm
Coverage	Signal Strength	-80 dBm	3 dB absolute ¹ 1 dB repeatability
Modulation	Modulation Depth, 15 and 135 Hz	10 to 30 %	2 %
Bearing Monitor	Deviation	$\pm 1.0^\circ$	0.3°
Reference Group Size Main Ref Group Aux Ref Group	Pulse Pair Count	± 1 pair ± 1 pair	Individual pulse detection

NOTE 1: Approaches state-of-the-art

3. GUIDANCE:

- a. An oscilloscope, TACAN test set, or equivalent computational and display ability is required to observe individual pulse characteristics such as pair spacing and **rise/ fall times, and to count TACAN pulses and pulse pairs.**
- b. The timing resolution of the oscilloscope, test set, or equivalent capability should be at least 0.1 microseconds.

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APPENDIX 9
INSTRUMENT FLIGHT PROCEDURES
FLIGHT INSPECTION REQUIREMENTS

1. **PURPOSE.** This appendix lists the minimum measurement requirements for instrument flight procedures.
2. **MEASUREMENTS.** None -- Inspection requirements consist entirely of observations and subjective judgments.
3. **GUIDANCE:**
 - a. **General:**
 - (1) Instrument flight procedures depict standard routings, maneuvering areas, flight altitudes, and approach minimums for instrument flight rules (IFR) flight activities. These procedures include airways, off-airway routes, jet routes, instrument approach procedures (IAP(s)), instrument departure procedures, terminal arrival routes, procedures predicated upon the use of flight management systems (FMS) and Global Navigation Satellite System (GNSS) operations.
 - (2) The flight inspection of an instrument flight procedure and verification of the obstacle data may be conducted during the associated navigation aid's inspection if visual meteorological conditions (VMC) prevail throughout each segment.
 - b. **Objective.** The objective of the flight inspection evaluation of instrument flight procedures is to assure that the navigation source supports the procedure, ensure obstacle clearance, and check the flyability of the design. The following activities should be accomplished:
 - (1) Verify the obstacle that serves as the basis for computing the minimum altitude in each segment of the IAP.
 - (2) Evaluate aircraft maneuvering areas for safe operations for each category of aircraft for which the procedure is intended.
 - (3) Review the instrument procedure for complexity of design, and evaluate the intensity of cockpit workload to determine if any unique requirements adversely impact safe operating practices. Check for correctness of information, propriety, and ease of interpretation.
 - (4) If appropriate, verify that all required runway markings, lighting, and communications are in-place and operative.

c. Verification of Obstacle Clearance

- (1) Original Flight Procedures. A ground or in-flight obstacle verification should be conducted for each route segment during the development of original flight procedures.
- (2) Identification of New Obstacles. When new obstacles are discovered during flight inspection activities, the flight inspector should identify the location and height of the new obstruction(s), and provide the information to the procedure specialist. Procedure commissioning should be denied until the procedure specialist's analysis has been completed and the flight procedure adjusted as appropriate.
- (3) Determination of Obstacle Heights. If in-flight height determination of obstacles or terrain is required, accurate altimeter settings and altitude references are necessary to obtain the most accurate results possible. The method of obstacle height determination should be documented on the flight inspection report.

APPENDIX 10**AIRCRAFT-BASED AUGMENTATION SYSTEM (ABAS)
NON-PRECISION APPROACH (NPA)
FLIGHT INSPECTION REQUIREMENTS**

- 1. PURPOSE.** This appendix lists the minimum measurement requirements for ABAS procedures. These include GNSS + Receiver Autonomous Integrity Monitoring (RAIM) and GNSS + RAIM + barometric altimetry, excluding computed vertical guidance.
- 2. MEASUREMENTS.** None – Inspection requirements consist entirely of observations and subjective judgments.
- 3. GUIDANCE:**
 - a. General.** The aircraft used for these procedural and interference tests may be of any type, if it is equipped with an appropriate receiver and external antenna installed and approved for that aircraft type.
 - b. Pre-departure checks:**
 - (1) GNSS instrument flight procedures consist of sequenced paths and terminators between waypoints. The entire sequence of procedure leg segments must be entered into the GNSS receiver for commissioning flight tests and selected from the GNSS receiver database for routine tests.
 - (2) Procedure segment and design correlation. The procedures should be evaluated before flight testing by entering the design data in the avionics and verifying the avionics display of range and bearing compares with the procedure design information. Care should be used to ensure that all tracks/ courses are in the same unit of measurement (e.g., true or magnetic as appropriate).
 - (3) RAIM prediction. Before flight testing begins, RAIM predictions should confirm that the GNSS signals will support the flight testing without RAIM alerts due to GNSS characteristics. Any value of Dilution of Precision (DOP) that also meets RAIM requirements is satisfactory for the flight testing.
 - c. Maneuvering**
 - (1) The entire procedure should be flown, including Initial, Intermediate, Final Approach, and Missed Approach segments. Alternate or additional segments should be checked on commissioning to the point where the routing intersects a portion of the procedure already checked. The intent is that each segment of the procedure should be flown at least once; common segments do not need to be repeated.

- (2) Verification of missed approach waypoint. The position of the MAWP must be confirmed with respect to the physical environment. This verification may be achieved either visually or electronically, and descent below the published minima may be necessary. A truth system may be used when visual verification is not practical, such as for over-water or some non-threshold MAWP(s).
- d. **Interference.** For NPA approaches, the presence of a RAIM alert and/or the loss of guidance have proven to be good indicators of probable GNSS interference, affecting availability rather than accuracy or integrity. Although relying on these indicators does not actually confirm that the spectrum environment meets the published “Resistance to Interference” standards, it is considered sufficient for the procedures covered by this Chapter. Therefore, the presence of interfering signals for these approaches may not require a procedural restriction unless GNSS receiver performance is affected. If interference is suspected, further investigation should be conducted. The suspected area should be probed to define its geographical extent, GNSS parameters such as signal/noise ratios and DOP should be documented, the approach procedure should be removed from operational status, and appropriate authorities should be notified.
 - e. **Evaluation.** Confirm the continuous presence of guidance information, the absence of RAIM alerts, and the location of the GNSS-indicated MAWP (see Table II-2-3). Visually confirm that the final approach course and distance to the MAWP coincide with the intended final approach course and satisfactorily deliver the aircraft to the desired point established for landing. Confirm the approach is flyable by taking into account the types of aircraft that will be using the procedure and such factors as the descent gradient, segment lengths, alignment on final, pilot workload and runway environment.

APPENDIX 11
SPACE-BASED AUGMENTATION SYSTEM (SBAS)
FLIGHT INSPECTION REQUIREMENTS

1. **PURPOSE.** This appendix lists the minimum measurement requirements for SBAS facilities.
2. **MEASUREMENTS.** SBAS parameters must be measurable to the accuracy shown in the table below.

Parameter	Measurand	Tolerance	Maximum Uncertainty
Waypoint and Procedure design correlation (all segments)			
Course/track to next WP	Degrees	0.5 °	N/A
Distance to next WP	Meters (nm)	185m (0.1 nm)	106m
WP Data	Coordinates	Entered to 0.01 minute ¹	N/A N/A
Final Approach Segment (FAS) Data	FAS Path	Consistent with FAS Design ²	
Interference	Various alerts and guidance indications	No alerts; continuous guidance	N/A
Guidance Indications	Nav indicator	Continuous	None

NOTE 1: Order 8200.1 requires entry precision to 0.001 minute

NOTE 2: The FAS design defines the course, glide path, and threshold crossing height, each of which must meet the relevant (e.g., CAT 1) requirements.

3. GUIDANCE:

a. General:

- (1) Flight inspection of the GNSS and SBAS signals-in-space is not required. Flight test is concerned with validation of instrument flight procedures, adequate SBAS support for the specific flight operations being evaluated, and as-required testing for interference.
- (2) Inspection of SBAS procedures does not require a position fixing system. GNSS Receivers should meet applicable standards for the phase of flight and type of flight procedure being tested. A stand-alone SBAS receiver or FMS must have manual entry capability. The receiver should have the capability of outputting and recording parameters required in the table above.
- (3) It is helpful to be able to observe and optionally record during flight-testing additional parameters beyond those listed in the above table, such as Horizontal Protection Level/ Vertical Protection Level (HPL)/ VPL, satellites tracked, geostationary satellite Signal-to-Noise Ratio (SNR), and SBAS sensor status. These parameters may provide an indication of marginal performance and are a baseline for further analysis of any observed anomalies.

b. Pre-Departure Checks:

- (1) SBAS instrument flight procedures consist of sequenced paths and terminators between waypoints leading to the FAS. Commissioning of new procedures may require manual entry of the procedure data, as they are not part of the current navigation database. The entire sequence of leg segments must be entered into the SBAS receiver or Flight Management System (FMS) for commissioning flight tests and selected from the SBAS receiver or FMS database for subsequent tests. The FAS block must be entered as binary or hexadecimal data.
- (2) New procedures should be evaluated before flight-testing by entering the design data in the avionics and verifying the avionics display of range, bearing, and vertical profile compares with the procedure design information. Subsequent inspections are accomplished utilizing the procedure data in the current navigation database. The FAS data should be checked for consistency against the original procedure design.
- (3) Before flight-testing begins, an analysis of GNSS and SBAS system predictions should be accomplished to confirm that the GNSS and SBAS signals will support the flight-testing without alerts.

- c. Maneuvering.** The entire procedure should be flown, including Initial, Intermediate, Final Approach, and Missed Approach segments. Alternate or additional segments should be checked on commissioning to the point where the routing intersects a portion of the procedure already checked. The intent is that each segment of the procedure should be flown at least once. Common segments do not need to be repeated. Maneuvering for obstacle evaluation may require flying various paths offset from the intended procedure, depending on the obstruction environment.
- d. Procedure Validation.** The instrument flight procedure should be evaluated for conformance with the following criteria:
- (1) Initial and Intermediate Approach Segments. Evaluation should confirm procedure design and GNSS/ SBAS signal reception throughout these segments. Reception of SBAS signals may be interrupted during aircraft banking or masked by terrain if the elevation of the geostationary satellite is low. When this is encountered, the instrument flight procedure may require modification. In some locations, modification may not mitigate this situation, and the instrument flight procedure should be denied.
 - (2) Final Approach Segment. Evaluation should confirm that the procedure design, FAS path, and GNSS signal reception deliver the aircraft to a position suitable for landing. Procedures that support azimuth-only approaches should be evaluated through the MAWP. Procedures with vertical guidance should be evaluated to the DA.
 - (3) Missed Approach Segment. Evaluation should confirm procedural design and GNSS/ SBAS signal reception if used.
 - (4) Aircraft maneuvering is consistent with safe operating practices for the category of aircraft intending to use the procedure.
 - (5) Cockpit workload is acceptable.
 - (6) Navigation charts properly portray the procedure and are easily interpreted.
 - (7) Obstacles that control the minimum altitude for each segment are verified visually by in-flight or ground observation.
- e. Interference.** SBAS receiver standards require that receivers must not provide hazardously misleading information in the presence of radio frequency interference. Excessive interference will therefore affect continuity and availability, rather than integrity. The loss of SBAS correction signals and/or the loss of guidance have proven to be good indicators of probable GNSS and/or SBAS interference. If interference is suspected, further investigation should be conducted. The suspected area should be probed and spectrum analysis accomplished to define its geographical extent. GNSS and SBAS parameters such as signal/noise ratio, horizontal and vertical protection levels, and DOP should be documented. If interference is confirmed, the approach procedure should be removed from operational status, pending corrective action, and appropriate authorities should be notified.

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APPENDIX 12
GROUND-BASED AUGMENTATION SYSTEM (GBAS)
FLIGHT INSPECTION REQUIREMENTS

- 1. PURPOSE.** This appendix lists the minimum measurement requirements for GBAS facilities.
- 2. MEASUREMENTS.** GBAS parameters must be measurable to the accuracy shown in the table below.

Parameter	Measurand	Tolerance	Maximum Uncertainty
Waypoint and Procedure design correlation (all segments)			
Course/track to next WP	Degrees	0.5°	N/A
Distance to next WP	Meters (nm)	185m (0.1 nm)	106m
WP Data	Coordinates	Entered to 0.01 minute ¹	N/A
FAS Data	FAS Path	Consistent with FAS Design ²	N/A
Resistance to Interference (ranging signal)	Interference signal level	< Interference mask definitions	3 dB absolute ³
VDB Coverage	Field Strength		3 dB absolute ³
GBAS/H field strength		>-99 dBW/m ² to -35 dBW/m ²	
GBAS/E field strength		>-99 dBW/m ² to -35 dBW/m ²	
Horizontal		-103 dBW/m ² to -39 dBW/m ²	
Vertical			
Position Domain Accuracy	Position	4m vertical 16m lateral	1m

NOTE 1: Order 8200.1 requires entry precision to 0.001 minute

NOTE 2: The FAS design defines the course, glide path, and threshold crossing height, each of which must meet the relevant (e.g., CAT 1) requirements.

NOTE 3: May approach state-of-the-art

3. GUIDANCE:

a. General:

- (1) Flight tests are used to confirm GBAS procedure design, related Terminal Area Paths (TAP(s)), final segment alignment, GNSS signal reception, and data link reception within the coverage volume.

The airborne GBAS equipment used for the flight test should meet the applicable standards required for the procedure being tested. There are situations that may require modifications to the flight test receiver that could invalidate the certification. An example is the need to override the broadcast “test” mode and maximum range (D_{max}) value of the GBAS facility. This may require special consideration or certification for instrument flight conditions use. In some cases, it may be desirable to acknowledge and suppress GBAS alerts, warnings, and flags for the purposes of completing required checks.

- (2) The receiver/ FIS should have the capability of outputting and recording parameters required in the table above. It is helpful to be able to observe and optionally record during flight-testing additional parameters beyond those listed in the above table, such as Horizontal Protection Level/Vertical Protection Level (HPL)/VPL, satellites tracked, geostationary satellite Signal-to-Noise Ratio (SNR), and GBAS sensor status. These parameters may provide an indication of marginal performance and are a baseline for further analysis of any observed anomalies.
- (3) GBAS procedures may be designed using ground-based facilities (e.g., VOR) for guidance to the final approach segment and missed approach segment. Traditional flight inspection of a ground facility supporting a GBAS procedure may also be required. GBAS procedures do not necessarily require RNAV equipage.

b. Pre-Departure Checks:

- (1) Commissioning of new TAP and GBAS procedures may require manual entry of the procedure data in an FMS, as they are not part of the current navigation database. The entire sequence of paths and terminators between waypoints must be entered into the Flight Management System (FMS) for commissioning flight tests, and selected from the FMS database for subsequent tests. The Final Approach Segment (FAS) block must be entered as binary or hexadecimal data.
- (2) New procedures should be evaluated before flight-testing by entering the design data in the avionics, and verifying the avionics display of range, bearing, and vertical profile between waypoints compares with the procedure design information. Subsequent inspections are accomplished utilizing the procedure data in the current navigation database. The FAS data should be checked for consistency against the original procedure design.

- (3) Before flight-testing begins, an analysis of GNSS predictions should be accomplished to confirm that the GNSS signals will support the flight-testing without alerts.
- c. Maneuvering.** Each procedure should be flown once completely in sequence. Alternate or additional segments should be checked on commissioning to the point where the routing intersects a portion of the procedure already checked. The intent is that each segment of the procedure need be flown only once.
- d. Procedure Validation.** The instrument flight procedure should be evaluated for conformance with the following criteria:
- (1) Initial and Intermediate Approach Segments. Evaluation should confirm procedure design, GNSS/ GBAS signal reception, and timely data link acquisition throughout these segments.
 - (2) Final Approach Segment. Evaluation should confirm that the procedure design, FAS path, GNSS signal reception, and data link reception deliver the aircraft to a position suitable for landing. Additionally, evaluation should confirm horizontal alignment and glidepath angle. Procedures with vertical guidance should be evaluated to the DA. Procedures supporting azimuth only approaches should be evaluated through the MAWP.
 - (3) Missed Approach Segment. Evaluation should confirm procedural design, GNSS signal reception if required, data link reception if required, and transition from the missed approach.
 - (4) Aircraft maneuvering is consistent with safe operating practices for the category of aircraft intending to use the procedure.
 - (5) Cockpit workload is acceptable.
 - (6) Procedure waypoint evaluation. The procedures should be evaluated to verify the geodetic coordinates [waypoints] are correct.
 - (7) Navigation charts properly portray the procedure and are easily interpreted.
 - (8) Obstacles that control the minimum altitude for each segment are verified visually by in-flight or ground observation.
- e. Interference.** Interference may occur on either the ranging (GNSS) or uplink/ VDB (VHF data broadcast) frequencies. GBAS receiver standards require that receivers must not provide hazardously misleading information in the presence of GNSS radio frequency interference. Excessive ranging signal interference will therefore affect continuity and availability, rather than integrity. The loss of GBAS correction signals and/or the loss of guidance have proven to be good indicators of probable GNSS and/or GBAS interference. If interference is suspected, further investigation should be conducted. The suspected area should be probed and spectrum analysis accomplished to define its geographical extent. GNSS and GBAS parameters such as signal/ noise ratio, horizontal and vertical protection levels, and DOP should be documented. If interference is confirmed, the approach procedure should be removed from operational status, pending corrective action, and appropriate authorities should be notified.

f. Coverage:

- (1) The broadcast power of an installed VDB is constrained by many factors, only one of which is the desired field strength in the defined coverage region. Other constraints include adjacent and co-channel interference to neighboring systems and the VDB receiver sensitivity. Within the minimum required GBAS coverage volume of each final approach segment served, the minimum and maximum VDB field strength requirements must be met. Where an operational requirement exists to use GBAS to altitudes and/or distances beyond the normal coverage volume, the field strength requirement should be inspected to the expanded altitudes and/or distances.
- (2) The field strength should be measured as an average over the period of the synchronization & ambiguity resolution bits in the training sequence portion of the message. As a recommended method, an onboard calibrated VDB receiver may be used to confirm adequate field strength within the coverage volume. This receiver should provide accurate power measurement within the full dynamic range necessary to confirm the minimum and maximum field strength on each received burst. Using this method allows checking the coverage in parallel with other checks (e.g. flyability, message content).
- (3) As an alternate method during commissioning, the VDB transmitter can be placed in CW mode and a spectrum analyser or power meter used. The power transmitted in CW mode should be the same as that measured as an average over the period of the synchronization & ambiguity resolution bits in the training sequence portion of the message.
- (4) Arcs. Arcs should be flown to assess the lower limit of the GBAS coverage within the required lateral region. Fly an arc $\pm 10^\circ$ across the extended Final Approach Segment course at 20 nm from the RDP. Fly an arc $\pm 35^\circ$ across the extended Final Approach Segment at 15 nm. The arc can be flown in either direction. A $\pm 35^\circ$ arc at 20 nm may be flown in lieu of the $\pm 10^\circ$ 20 nm and $\pm 35^\circ$ 15 nm arcs. Arcs for parallel or multiple runways may be combined to minimize flight inspection time. Confirm minimum field strength requirements are met at the lowest vertical coverage limit (0.9° or $0.3/0.45 \cdot \text{GPA}$). If the field strength is unsatisfactory, altitudes may be raised incrementally to an altitude that coincides with the lower limit of the coverage volume.

- (5) Flight at Constant Height. The minimum field strength level may be found not only at the edge of coverage, but within the coverage area because of fading effects. Adequate flight checks should be performed to verify that the required minimum field strength is met within the whole coverage volume. An acceptable means to assess the fading effects is to fly at a constant height along the extended runway centerline. Fly at the upper height of the required coverage volume (e.g. 7° minimum, 10,000 ft HAT) from the outer limit of coverage to less than 13 miles (for 7°), and at an altitude of 2,000' beginning at 21 miles (corresponding to the lowest vertical coverage limit of 0.9°) to within 2.5 miles for each runway end served. Confirm minimum field strength requirements are met on both level runs.
- (6) Final Approach Path. The minimum and maximum field strength requirements should be confirmed along all final approach segments (FAS) served by the ground subsystem. Proceed inbound along the final approach course following the procedure. Intercept the glidepath and fly to an altitude of 100 feet. When the coverage is required to be extended down to 3.7 m (12 ft) above runway surface, the maximum and minimum field strengths should be confirmed to the touchdown point. If the signal level is unsatisfactory prior to glidepath interception, altitudes may be raised incrementally to coincide with the lower limit of the coverage volume.

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APPENDIX 13
LIGHTING SYSTEM
FLIGHT INSPECTION REQUIREMENTS

1. **PURPOSE.** This appendix lists the minimum measurement requirements for lighting systems.
2. **MEASUREMENTS.** Lighting system parameters must be measurable to the accuracy shown in the table below.

Parameter	Measurand	Tolerance	Maximum Uncertainty
Visual glidepath angle	Elevation degrees	$\pm 0.2^\circ$	0.05° ¹
Coverage	Azimuth, degrees from approach angle	$> \pm 10^\circ$	0.5°

NOTE 1: May exceed current industry capability

3. **GUIDANCE:**
 - a. Although it is not necessary to use a special aircraft for the flight testing of lighting systems, it is highly desirable that the aircraft used be specially designated for this work.
 - b. If a special aircraft is not used, a theodolite suitably modified to read accurately the displacement in azimuth and elevation of the flight test aircraft from the desired approach path may be required.

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APPENDIX 14

COMMUNICATIONS SYSTEM FLIGHT INSPECTION REQUIREMENTS
(INCLUDING DIRECTION FINDER (DF) SYSTEMS)

1. **PURPOSE.** This appendix lists the minimum measurement requirements for communications systems.
2. **MEASUREMENTS.** There are no measurement requirements for air-ground voice communications facilities -- inspection requirements consist entirely of observations and subjective judgments. Direction Finder (DF) system parameters must be measurable to the accuracy shown in the table below.

Parameter	Measurand	Tolerance	Maximum Uncertainty
Bearing Accuracy	Azimuth	$\pm 6^\circ$	0.5°
Coverage	Distance	≥ 30 or 40 nm	1 nm
Station Passage	Distance	± 1.5 nm	0.2 nm

3. **GUIDANCE:**
 - a. Aircraft without on-board position-fixing systems may perform DF checks if accurately plotted ground checkpoints are selected over which the aircraft can safely maneuver, or if a theodolite is used.
 - b. Air-Ground communications with the DF operator are required during the measurements and observations.
 - c. For voice communications facilities, it is highly desirable to have the ability to measure frequency and received VHF/ UHF signal strength, and to record received audio on tape or other suitable media for subsequent engineering analysis.

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APPENDIX 15
RNAV
FLIGHT INSPECTION REQUIREMENTS

- 1. PURPOSE.** This appendix lists the minimum measurement requirements for RNAV flight inspections.
- 2. MEASUREMENTS.** None – Inspection requirements consist entirely of observations and subjective judgments. If positioning or measurement accuracies are needed, and because RNAV procedures can be based on a variety of navigation aids, the table(s) corresponding to the aids contributing to the RNAV-based guidance should be used.
- 3. GUIDANCE and FMS REQUIREMENTS:**
 - a. General:**
 - (1) RNAV procedures comprise a variety of applications, including instrument departures, enroute applications, and terminal arrival routes using multiple navigation aids (e.g., DME-DME, GPS-INS).
 - (2) The purpose of RNAV flight inspections is to evaluate the ground track and vertical path (if included) provided by the avionics. To detect coding errors in the electronic version of the procedure, the inspection must be evaluated against the original procedure design documents.
 - b. Required FMS Capabilities.** The FMS used for flight inspection of RNAV procedures must have the following characteristics:
 - (1) Capability to handle and display all ARINC 424 path and terminations.
 - (2) Capacity for navigation database resolution to 0.01 second of latitude and longitude.
 - (3) Waypoint entry resolution to 0.001 minute of latitude and longitude.
 - (4) Vertical navigation capability for BARO-aided and GNSS operations.
 - (5) RNP capability (display of RNP or equivalent level of performance).
 - (6) Capability to enter ground track route for flight inspections.
 - (7) Capability to display true track versus magnetic track.
 - (8) Display of navigation sensor status.

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APPENDIX 16
MICROWAVE LANDING SYSTEM
FLIGHT INSPECTION REQUIREMENTS

1. PURPOSE. This appendix lists the minimum measurement requirements for Microwave Landing Systems (MLS).

2. MEASUREMENTS

Azimuth Subsystem

Parameter	Measurand	Tolerance	Maximum Uncertainty
Alignment	Angle	0.02°	0.01° ¹
PFE	Distance and Angle	20' and <0.25°	3' 0.01°
PFN	Distance and Angle	11.5' and <0.15°	3' 0.01°
CMN	Distance and Angle	10.5' and <0.10°	3' 0.01°
Coverage Angle Signals, 1° BW Angle Signals, 2° BW Angle Signals, 3° BW	Power Density	-85.7 dBW/ m ² -79.7 dBW/ m ² -76.2 dBW/ m ²	3 dB absolute ² 1 dB repeatability

NOTE 1: Exceeds current industry capability **NOTE 2:** Approaches state-of-the-art

ELEVATION SUBSYSTEM

Parameter	Measurand	Tolerance	Maximum Uncertainty
Alignment	Angle	0.02°	0.01° ¹
PFE	Distance and Angle	2' and <0.2°	0.5' 0.01°
PFN	Distance and Angle	1.3' and <0.2°	0.5' 0.01°
CMN	Distance and Angle	1' and <0.1°	0.5' 0.01°
Coverage Angle Signals, 1° BW Angle Signals, 2° BW Angle Signals, 3° BW	Power Density	-85.7 dBW/ m ² -79.7 dBW/ m ² -76.2 dBW/ m ²	3 dB absolute ² 1 dB repeatability

NOTE 1: Exceeds current industry capability **NOTE 2:** Approaches state-of-the-art

3. GUIDANCE:

- a. The Tables in Paragraph 2 present requirements for runway-aligned subsystems. Although tolerances for subsystems not aligned with the runway, and for portable and military systems are less demanding, the measurement capability must be the **same**.
- b. The flight inspection evaluation of angle and distance accuracies requires the determination of PFE, PFN, and CMN.
 - (1) These error components have a close relationship to each other. Depending on the velocity and the flight track of an aircraft, PFE can turn into CMN, or vice versa. This allows the prediction of probable areas of high PFE where increases in measured CMN are observed. An increase in the CMN may also be used as an indication of a possible false guidance signal area.
 - (2) The angular and distance output data is referenced to the position information, to obtain the raw error data. To determine the PFE, PFN, CMN of this raw data, some processing is necessary. This may be accomplished by visually inspecting recordings of raw error data. To process PFE, PFN and CMN as defined in the guidance material of Annex 10, the raw error data has to be filtered. The easiest way to perform this filtering is to use digital filters.
- c. **The minimum MLS flight inspection equipment requirements are:**
 - (1) MLS test receiver with PFE and CMN filters.
 - (2) Selectable forward looking and side looking antennas.
 - (3) Recording and display equipment (preferably digital) with the following outputs: raw angle, PFE, CMN, and aircraft position in azimuth angle, elevation angle, and distance.
 - (4) A means of decoding and displaying the contents of all basic and auxiliary data words.
 - (5) An oscilloscope for monitoring log video signals.
- d. In addition to meeting the requirements of internationally recognized receiver minimum performance standards (e.g. EUROCAE or RTCA), a MLS test receiver should, as a minimum, include the following features:
 - (1) A log video signal output.
 - (2) Oscilloscope trigger pulse outputs for all angle functions, and for basic and auxiliary data words.
 - (3) Independent operation of azimuth and elevation angle and flag outputs.
 - (4) The ability to operate with the transmitter basic data word #2 performance bit set to "on test".
 - (5) The ability to be calibrated to an angular accuracy of 0.005 degrees for azimuth, elevation, and back azimuth.

- e. Modifications to a commercial MLS receiver** may also be convenient. These include:
- (1) The availability of information regarding each angle guidance function transmission (frame flags) and of angle guidance signal component level difference
 - (2) Data output of the measured relative signal levels (scanning beam, clearance, multipath, OCI and preamble)
 - (3) Data output identifying the number of angle frames which the receiver rejected ("flagged"), and the reasons for the rejection
 - (4) Raw angle output (i.e., without the specified 10 radians/ second receiver output filter). This is particularly useful when high speed angle guidance data sampling systems are used.
- f. Data processing and analysis requires angle and distance error filter.**
- (1) MLS system errors are expressed in terms of PFE, PFN, and CMN. This terminology is chosen to reflect the influence of errors on the behavior of an aircraft guided by an MLS signal.
 - (2) To separate the total error into PFE, PFN, and CMN components, a set of signal filters is defined. As most ground and flight inspection systems will use a digital implementation of the standard signal filters, the effects of sample rate and velocity on the measured error are of special interest.
 - (3) The minimum recommended data sampling rate for PFE and CMN measurements is 10 Hz. The output filter corner frequency of the receiver is 10 rad/s.
 - (4) PFE is comprised of those frequency components of the guidance signal error at the output of the airborne receiver that lie below 0.5 rad/s for azimuth guidance information or below 1.5 rad/s for elevation guidance information.
 - (5) CMN is comprised of those frequency components of the guidance signal error at the output of the airborne receiver that lie above 0.3 rad/s for azimuth guidance or above 0.5 rad/s for elevation guidance information.

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APPENDIX 17

RFI DETECTION AND LOCATION REQUIREMENTS

1. **PURPOSE.** This appendix lists the minimum measurement requirements for Radio Frequency Interference (RFI) detection and location.

2. **MEASUREMENTS**

Parameter	Measurand	Tolerance	Maximum Uncertainty
Frequency of source	Frequency	None	1 kHz
Azimuth to source (within 108-137 MHz and 225-400 MHz bands, and within 100 MHz of GPS frequencies)	Angle	None	5°

3. **GUIDANCE.** Airborne observations and location of interfering signals are necessary when the signals initially cannot be received or localized using ground-based techniques.

- a. Aircraft without on-board position-fixing systems may perform interference location missions if other means for defining the aircraft location at the time of interference observations are provided.
- b. Direction finding capability may require specialized antenna arrays on the aircraft for the frequency ranges required. For GPS frequencies, both top-mounted and bottom mounted antennas should be provided.
- c. An on-board spectrum analyzer should be provided, with capability to observe signals as low as -110 dBm at its input. Its input should be configurable to any of the antennas within the required frequency ranges. It should have either a zero-span (oscilloscope) function, or a separate oscilloscope for observation of pulse shapes, waveforms, etc., may be provided.
- d. A real-time audio recording capability should be provided for demodulated Nav/Comm receiver and spectrum analyzer outputs. The media may be magnetic tape, computer-based files such as MP3, or other suitable formats readily available for use by spectrum management personnel.
- e. Order 8200.1 provides several recommended procedures for locating interfering sources with an aircraft.

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