DEPARTMENT OF THE ARMY TECHNICAL MANUAL	**TM 95-225**
DEPARTMENT OF THE NAVY MANUAL	**NAVAIR 16-1-520**
DEPARTMENT OF THE AIR FORCE MANUAL	**AFMAN 11-225**
FEDERAL AVIATION ADMINISTRATION ORDER	**8200.1D**

UNITED STATES STANDARD FLIGHT INSPECTION MANUAL

April 2015

DEPARTMENTS OF THE ARMY, THE NAVY, AND THE AIR FORCE
AND
THE FEDERAL AVIATION ADMINISTRATION

DISTRIBUTION: **Electronic** **Initiated By:** **AJW-331**

RECORD OF CHANGES

DIRECTIVE NO. **8200.1D**

CHANGE TO BASIC	SUPPLEMENTS			OPTIONAL	CHANGE TO BASIC	SUPPLEMENTS			OPTIONAL

The material contained herein was formerly issued as the United States Standard Flight Inspection Manual, dated December 1956.

The second edition incorporated the technical material contained in the United States Standard Flight Inspection Manual and revisions thereto and was issued as the United States Standard Facilities Flight Check Manual, dated December 1960.

The third edition superseded the second edition of the United States Standard Facilities Flight Check Manual; Department of Army Technical Manual TM-11-2557-25; Department of Navy Manual NAVWEP 16-1-520; Department of the Air Force Manual AFM 55-6; United States Coast Guard Manual CG-317.

FAA Order 8200.1A was a revision of the third edition of the United States Standard Flight Inspection Manual, FAA OA P 8200.1; Department of the Army Technical Manual TM 95-225; Department of the Navy Manual NAVAIR 16-1-520; Department of the Air Force Manual AFMAN 11-225; United States Coast Guard Manual CG-317.

FAA Order 8200.1B, dated January 2, 2003, was a revision of FAA Order 8200.1A.

FAA Order 8200.1C, dated October 1, 2005, was a revision of FAA Order 8200.1B.
The current FAA Order 8200.1D is effective April 15, 2015.

CHANGE

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

Change 1 to 8200.1D

11/06/16

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 8200.1D; 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 April 15, 2015.

2. Audience. Air Traffic Organization Technical Operations Eastern, Central, and Western Service Areas; Flight Inspection Field Offices and crewmembers in Flight Inspection Team (AJW-333); 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. Flight Inspection Support Subteam (AJW-3331) has made numerous revisions to FAA Order 8200.1D, United States Standard Flight Inspection Manual, Chapter 14 "Surveillance." Impending limitations to the aircraft transponder systems used during flight inspection drove the need to revise this chapter. Therefore, Flight Inspection Support Subteam coordinated with the NAS Engineering Group, Radar Systems Team (AJW-147) to discuss the limitations, resulting in updates to the Surveillance Radar/ATCRBS inspection checklists.

Additionally, Flight Inspection Support Subteam took the opportunity to edit the entire chapter. The plain-language editorial revisions improve readability and clarify flight inspection guidance. The PAR tolerance table and associated inspection processes were revised, providing clearer guidance to inspection crews.

a. Technical Revisions: The following revisions include flight inspection guidance updates as well as checklist and tolerance revisions.

(1) **Paragraph 14.3.d.(3).** Guidance was added to ensure each published ASR approach procedure is inspected when changes to the primary or secondary radar power or tilt have been made.

(2) **Paragraph 14.4.** Revised the Surveillance checklist to accommodate the transponder limitations. All FI Transponder Settings were changed to either "OFF/OFF" or "ON/ON," and the "OFF/ON" combination has been removed. Revisions are evidenced with a gray background.

- **Orientation:** FI Transponder Setting changed from OFF/ON to OFF/OFF
- **Tilt:** Added Note 4 reference. Changed FI Transponder Setting from OFF/ON to ON/ON.
- **Primary Radar Optimization:** Added Note 3 & 4 references.
- **ATCRBS Power Optimization:** Added Note 3 & 4 references. Removed Note 1 reference from Commissioning inspection and Diff Type Antenna. Changed FI Transponder Setting from OFF/ON to ON/ON.

- **SLS/ISLS:** Added Note 4 reference. Changed FI Transponder Setting from OFF/ON to OFF/OFF.
- **Modes/Codes:** Changed FI Transponder Setting from OFF/ON to OFF/OFF.
- **GTC/STC:** Added Note 4 reference.
- **Vertical Coverage:** Deleted "Above 15,000 ft MSL" FI Transponder Setting variance. All altitudes will be inspected with the FI Transponder Setting ON/ON.
- **Horiz Screening:** Changed FI Transponder Setting from OFF/ON to ON/ON.
- **Airways/Route Coverage:** Note 1 now applies to all items in this row, instead of just the commissioning requirement. Changed FI Transponder Setting from OFF/ON to ON/ON.
- **Fix/Map Acc:** Added Note 4 reference. Changed FI Transponder Setting from OFF/ON to OFF/OFF.
- **Fixed Target Ident:** Added Note 4 reference. Changed FI Transponder Setting from OFF/ON to OFF/OFF.
- **ASR Approach:** Changed name from "Surveillance Apch" to "ASR Approach." Added Note 1 and 3 references. Changed FI Transponder Setting from OFF/ON to OFF/OFF.
- **Note 2:** Reworded for clarity
- **Note 3: A**dded requirement to inspect ASR approaches using a flight inspection aircraft following power or tilt adjustments.
- **Note 4:** Added note. Targets-of-opportunity may be used to accomplish various inspection items.

(3) **Paragraph 14.5.e.(2).** Added/changed the guidance: "If the tilt angle changes during the radar inspection, each previously-inspected item must be re-inspected using the new tilt angle. Additionally, with an increase in antenna tilt, perform an ATCRBS power optimization check. Engineering personnel may use targets-of-opportunity to optimize a previously-commissioned radar system following a tilt change, but may request a flight inspection aircraft. Changes to the primary or secondary radar tilt or power require the inspection of each published ASR approach procedure using a flight inspection aircraft."

(4) **Paragraph 14.5.f.(2).** Added guidance, "Changes to the primary or secondary radar power or tilt require the inspection of each published ASR approach procedure using a flight inspection aircraft."

(5) **Paragraph 14.5.g.(3).** Deleted references to Magnetron/Amplitron Systems; ARSR-1, -2, and -3; the Note below the table.

(6) **Paragraph 14.5.g.(4).** Added guidance, "Vertical coverage, whether verified by a flight inspection aircraft or using targets-of-opportunity, must be checked using the power level established by the ATCRBS Power Optimization procedure. The beacon must be commissioned at this power level, plus 1 dB."

(7) **Paragraph 14.5.k.** Renamed paragraph from "Surveillance Approaches" to "ASR Approach Procedures." Added a reference to Chapter 6, as well as primary or secondary radar tilt or power change guidance.

(8) **Paragraph 14.5.o.(2).** Added guidance, "ATCRBS power optimization is required with an increase in antenna tilt, and may be accomplished using targets-of-opportunity. Changes to the primary or secondary radar tilt or power require the inspection of each published ASR approach procedure using a flight inspection aircraft."

(9) **Paragraph 14.7.** Revised the WAM checklist Fix/Map Accuracy transponder setting from "OFF/ON" to "OFF/OFF." Notes 2, 3, and 4 were edited for readability.

(10) **Paragraph 14.17.a.(1), (2), and (3).** Revised the course alignment measurement methods. Added the following: "Azimuth alignment measurements between decision height and runway threshold are limited to the Visual Method."

(11) **Paragraph 14.17.b.** Reworded the paragraph for clarification and added guidance limiting alignment measurements to the Visual Method between 0.8 nm and runway threshold.

(12) **Paragraph 14.19.** Revised the Azimuth Course Alignment (Along-Track) tolerance from "The greater of 30 ft or 0.6% of the aircraft to PAR antenna distance, referenced to runway centerline" to "Greater of 30 ft or 0.34° from runway centerline; use the runway point of intercept as the azimuth point of origin." Deleted Note (1), and renumbered the Notes.

b. Editorial Revisions: The following editorial revisions use plain language to improve readability and clarity. These items do not change flight inspection guidance and do not affect NAS Safety.

(1) **Chapter Title. C**hanged from "Surveillance and Reports" to "Surveillance." The term "and Reports" does not apply to this Order, since FAA Order 8240.36N governs flight inspection reports.

(2) **Paragraph 14.1.** Reworded for clarity.

(3) **Paragraph 14.1.a.** Changed paragraph name from "Surveillance (Primary) Radar" to "Primary Radar"; reworded paragraph for clarity.

(4) **Paragraph 14.1.b.** Changed paragraph name from "ATCRBS (Secondary) Radar" to "Secondary Radar"; reworded paragraph for clarity.

(5) **Paragraph 14.1.d.** Added Mode-S information; reworded paragraph for clarity.

(6) **Paragraph 14.2.** Changed paragraph name from "Preflight Requirements/Inspection Plan" to "Flight Inspection Planning"; reworded paragraph for clarity. Corrected JO 6300.13 reference.

(7) **Paragraph 14.2.a.** Reworded paragraph and sub-paragraphs for clarity. Changed sub-paragraph (1), (2), (3) and (7) names, eliminating prepositions.

(8) **Paragraph 14.2.b.(4).** Replaced "ATCRBS" with "secondary". Reworded for clarity. Note (1) added to table.

(9) **Paragraph 14.2.c.** Deleted paragraph. Moved contents and consolidated into paragraph 5.t.

(10) **Paragraph 14.3.** Changed paragraph name from "Flight Inspection Procedures" to "Surveillance Radar Flight Inspections."

(11) **Paragraph 14.3.a.** Reworded for readability and clarity. Added "losing two-way radio communication" section to the end of this paragraph.

(12) **Paragraph 14.3.c.** Reworded for readability and clarity. Added reference to Chapter 4, Table 4-1.

(13) **Paragraph 14.3.d.(1).** Reworded for clarity; used active voice.

(14) **Paragraph 14.4.** Changed paragraph and checklist names from "Surveillance Radar/ATCRBS Checklist" to "Surveillance Radar Checklist."

(15) **Paragraph 14.5.** Changed paragraph name from "Detailed Procedures" to "Surveillance Radar Detailed Procedures."

(16) **Paragraph 14.5.a.** Reworded for clarity.

(17) **Paragraph 14.5.d.(1) and (3).** Reworded for clarity.

(18) **Paragraph 14.5.g.(1).** Reworded for clarity.

(19) **Paragraph 14.5.g.(4).** Reworded paragraph and Note for clarity.

(20) **Paragraph 14.5.g.(4).(d) and (e).** Reworded for clarity.

(21) **Paragraph 14.5.h.(2).** Reworded for clarity.

(22) **Paragraph 14.5.i.(1).** Reworded for clarity.

(23) **Paragraph 14.5.j.(1).** Reworded for clarity.

(24) **Paragraph 14.5.k.** Changed name from "Surveillance Approaches" to "ASR Approach Procedures."

(25) **Paragraph 14.5.k.** Reworded entire paragraph for clarity.

(26) **Paragraph 14.5.m.(2).** Reworded for clarity.

(27) **Paragraph 14.5.n.** Removed "ATCRBS" from paragraph name. Updated paragraph for clarity. Moved "Do not use codes 7500, 7600, and 7700…" to paragraph 5.n.(2).

(28) **Paragraph 14.5.o.** Reworded paragraph and NOTE for clarity.

(29) **Paragraph 14.5.p.** Removed "ATCRBS" from paragraph title, and reworded entire paragraph for clarity and readability.

(30) **Paragraph 14.5.s.** Reworded for clarity.

(31) **Paragraph 14.5.t.** Changed name to MSAW. Acronym was already defined in paragraph 1.c. Entire paragraph reworded to incorporate information deleted in paragraph 2.c. Flight inspection guidance remains unchanged.

(32) **Paragraph 14.6.** Changed name to "WAM Flight Inspection Procedures" since WAM has already been defined in the Section 1 title.

(33) **Paragraph 14.7.** Changed name from "Wide Area Multilateration Checklist" to "WAM Checklist." Reworded paragraph for clarity. Corrected transponder sensitivity in NOTE 6 from -66 dB to -69 dBm, which is the correct value based on Engineering Services analysis of the US WAM systems.

(34) **Paragraph 14.8.b.** Updated paragraph for readability and clarity.

(35) **Paragraph 14.8.d.(2).** Corrected transponder sensitivity from -66 dB to -69 dBm, which is the correct value based on Engineering Services analysis of the US WAM systems.

(36) **Paragraph 14.8.e.(2)(a).** Corrected transponder sensitivity from -66 dB to -69 dBm, which is the correct value based on Engineering Services analysis of the US WAM systems.

(37) **Paragraph 14.8.h.** Moved "Do not use codes 7500, 7600, and 7700…" from (1) to the end of paragraph (2) and reworded for clarity.

(38) **Paragraph 14.8.k.** Added verbiage for readability and clarity. Flight inspection guidance has not changed.

(39) **Paragraph 14.8.m.(2)(a).** Corrected transponder sensitivity from -66 dB to -69 dBm, which is the correct value based on Engineering Services analysis of the US WAM systems.

(40) **Paragraph 14.10.** Change the reference abeam "Communications" to 14.5.q and 14.8.i., instead of "Chapter 8". Change the Tolerance Limit to "See Chapter 8, Paragraph 8.5."

(41) **Paragraph 14.13.** Introduction reworded for clarity and readability.

(42) **Paragraph 14.15.** Changed name from "Flight Inspection Specifications" to "PAR Flight Inspections." Title fits the convention used throughout this Order. Updated sub-paragraphs to fit with the Order convention, specifically "General, Commissioning Inspections, Periodic Inspections, and Special Inspections." General information is provided for readability and clarity. Flight inspection guidance was not changed.

(43) **Paragraph 14.15.d.** Edited sub-paragraph wording for clarity.

(44) **Paragraph 14.16.** Reworded paragraph for clarity. Checklist Legend updated for readability. Added "A" Cursor, AZ, Channel, CP, EL, GP, LP, and MTI/MTD with definitions for clarity.

(45) **Paragraph 14.16.d.** Changed name of checklist to "MPN-25/ GCA(PAR)-2000/FPN-68, TPN-31 (31/A), FPN-67". FPN-68 is the same system as the GCA(PAR)-2000. Reworded paragraph for readability and clarity. Checklist Note 6 changed to 8, and added new notes 6 and 7. New notes are informational, and do not change the flight inspection guidance.

(46) **Paragraph 14.17.** Reworded for clarity.

(47) **Paragraph 14.17.a.** Changed name from "Course Alignment and Coverage (Azimuth)" to "Azimuth Course Alignment." Coverage guidance is located in paragraphs 17.e. and 17.f.

(48) **Paragraph 14.17.c.** Reworded for clarity.

(49) **Paragraph 14.17.d.** Reworded for clarity. Added reference to Chapter 24 and replaced “See Paragraph 14.17.e, Note” with the actual note contained in that paragraph.

(50) **Paragraph 14.17.e.** Changed name from “Usable Distance” to “Distance Coverage.” Reworded paragraph for clarity.

(51) **Paragraph 14.17.f.** Reworded for clarity.

(52) **Paragraph 14.17.g.(1).** Reworded for clarity.

(53) **Paragraph 14.17.g.** Changed name from “Glidepath Alignment” to “Glidepath Angle & Alignment.” Reworded for clarity.

(54) **Paragraph 14.17.h.** Reworded for clarity.

(55) **Paragraph 14.17.h.(1) and (2).** Reworded for clarity.

(56) **Paragraph 14.17.i.** Reworded for clarity.

(57) **Paragraph 14.17.j.** Reworded for clarity. Added GBAS GLS and WAAS LPV approach types (both precision) to the list of requiring PAR coincidence.

(58) **Paragraph 14.17.k.** Reworded for clarity.

PAGE CONTROL CHART

REMOVE PAGES	DATED	INSERT PAGES	DATED
Page 14-i thru 14-46	04/15/2015	Page 14-i thru 14-48	11/06/2016

David H. Boulter
Director, Flight Program Operations, AJW-3
Flight Program Executive

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

ORDER 8200.1D

Effective Date: 04/15/15

SUBJ: United States Standard Flight Inspection Manual (USSFIM)

This order prescribes standardized procedures for flight inspection of air navigation services. It is not intended as authorization for an agency to assume flight inspection authority over any group of services which are not now under its jurisdiction. Similarly, it carries no designation of responsibility within any agency unless such has been so designated in its usual procedural manner, such as general orders, regulations, etc.

This order is directive upon all personnel charged with the responsibility for execution of the flight inspection mission, when such personnel or organization is so designated by its agency. Compliance with this order, however, is not a substitute for common sense and sound judgment. Nothing in this order will be construed to relieve flight inspection crews or supervisory personnel of the responsibility of exercising initiative in the execution of the mission, or from taking such emergency action as the situation warrants.

The Federal Aviation Administration will coordinate and provide approved changes to this order by means of a page revision method. Revised pages will be transmitted by a Federal Aviation Administration Change or Notice. Recommendations concerning changes or additions to the subject material are welcomed and should be forwarded to one of the following addresses:

US Army:
Commander, US Army Aeronautical Services Agency
9325 Gunston Rd, Suite N319
Ft Belvoir, VA 22060-5582

US Navy:
Director, Naval Airspace and Air Traffic Control Standards and Evaluation Agency
(OPNAV N980A)
2000 Navy Pentagon (5D453)
Washington DC 20350-2000

US Air Force:
HQ USAF/A3OJ
Bases, Ranges & Airspace Division
1480 Air Force Pentagon
Suite 5D756
Washington, DC 20330-1480

FAA:
Director
Flight Inspection Services
PO Box 20582
Oklahoma City OK 73125

This order of Flight Inspection Procedures has been officially approved by:

US Army: Headquarters, Department of the Army, Deputy Chief of Staff, G-3/5/7

US Navy: Headquarters, US Navy, Deputy Chief of Naval Operations, N3/N5

US Air Force: HQ, Department of the Air Force, Deputy Chief of Staff for Operations, A3

FAA: Director, Flight Inspection Services

Edward W. Lucke, Jr.
Director, Flight Inspection Services
Federal Aviation Administration

TABLE OF CONTENTS

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Chapter 1. General Information

1. Purpose of This Order. This order contains the policy, procedures, and criteria for flight inspection and certification of air navigation services, instrument flight procedures, and FAA VFR Aeronautical Charts. The order applies to the flight inspection of all National Airspace System (NAS) and Department of Defense air navigation services and instrument flight procedures.

2. Audience. All FAA and DOD Flight Inspectors.

3. Where Can I Find This Order. You can find this order on the Directives Management Information System (DMIS) website: https://employees.faa.gov/tools_resources/orders_notices/.

4. What This Order Cancels. 8200.1C, United States Flight Inspection Manual, and all accompanying changes.

5. Explanation of Policy Changes. This order has been completely reformatted. Paragraph and item references in checklists and tolerance tables changed to reflect new numbering structure. The content of Chapters 6, 7, 15, and 22 have been changed as follows:

a. Chapter 6:

(1) Paragraph 4c(13). Updated description of VDA and added direction to fly on path below 200 feet above threshold elevation.

b. Chapter 7:

(1) Paragraph 1. Introduction. Clarification of VGSI definition, and the corresponding area it covers. No change in policy.

(2) Paragraph 1c. Added details about PVASI obstacle clearance surface and nomenclature.

(3) Paragraph 1f. Added details about Tri-Color VASI obstacle clearance surface.

(4) Paragraph 2c. Added Paragraph, "Installation Considerations." It describes various options when obstacles penetrations are an issue.

(5) Paragraph 3a. Checklist. No changes to the actual checklist. Updated list of events that drives the requirement to flight inspect a VGSI. Explicitly describes what is already established practice; harmonized with JO 6850.5, *Maintenance of Lighted Navigational Aids*, and Flight Standards requirements regarding use to mitigate 20:1 penetrations at night.

(6) Paragraph 3b(2)(a). General. Added additional guidance for checking the glidepath angle.

(7) Paragraph 3b(2)(c). Evaluation. New recommendation, consistent with common practice and good procedures, to not use the level-run method when checking the glidepath angle of VASI-type facilities. Also adds requirement to measure and report angles for all four light boxes in a 4-box PAPI system. This is necessary in order to assure the proper symmetry exists between all four boxes.

(8) Paragraph 3b(3). Angular Coverage. Added clarification about what constitutes a restriction with regard to angular coverage. No change in policy.

(9) Paragraph 3b(4). Obstruction Clearance. Requirements and procedures rewritten to include new guidance from Flight Standards Operational Safety Assessment Report on AFS-400 Policy Revision Regarding Visual Glide Slope Indicator (VGSI), dated April 15, 2013; and, AFS-400 Memorandum, Policy for Commissioning Visual Glide Slope Indicator (VGSI) Systems with Obstacle Clearance Surface (OCS) Penetrations, dated March 28, 2013. Defines VGSI "Commissioned Operational Service Volume," and the area that must be clear of obstacle penetrations. Describes when and how to restrict the usable distance of a VGSI. Requires flight inspection to verify obstacle clearance out to 8 nm, 4 nm for 2-box PAPIs. Defines the flight inspection obstacle clearance area to be within the lateral limits of the visible light beam, including any area where it is visible outside the standard +/- 10 degrees centered on the runway.

(10) Paragraph 3b(7). Rewritten to clarify how to determine VGSI coincidence with instrument approaches with vertical guidance. No change in existing policy.

(11) Paragraph 5d. Obstacle Clearance, under Tolerances. Added guidance to match changes made in previous section describing where and how to verify obstacle clearance. States requirement to issue a NOTAM and update the Airport/ Facility Directory when a facility is restricted due to an obstacle penetration.

c. Chapter 15 and 22:

(1) Paragraph 3a(3). Relieves crews of the requirement to check normal width on backcourses subordinate to front courses prior to the monitor check.

(2) Paragraph 3h(1) Single Frequency and (2) Dual Frequency Checklists. Clarified that localizer only minima check is required on one transmitter only.

(3) Paragraph 3h(4) Sideband Reference Glideslope Checklist. Changed verbiage in footnote 5 to eliminate final angle check if the low angle was checked by attenuating the upper antenna.

(4) Paragraph 3h(6). Removed Waveguide Glideslope checklist as that type no longer exists.

(5) Paragraph 3h(6) Endfire Glide Slope Checklist. Added reference to footnote 10 in the PM field of Course Normal/ Clearance Normal Configuration Transverse Structure check to allow for checking on one transmitter only.

(6) Paragraph 4g(3) Note 1. Added sentence directing readers to Chapter 22 to read ESV requirements. In Chapter 22 new sentence was added to allow checking of ESVs on one transmitter only. Previously it was by default that ESVs were required on both transmitters.

(7) Paragraph 5n, Note 1. Added sentence directing readers to Chapter 22 to read ESV requirements. In Chapter 22 new sentence was added to allow checking of ESVs on one transmitter only. Previously it was by default that ESVs were required on both transmitters.

(8) Paragraph 10a, Tolerances.

(a) Alignment. Added Commissioning tolerance for alignment for offset localizers, offset SDFs, LDAs and independently monitored backcourses to match what is in ILS maintenance handbook, JO 6750.49. It had previously been in the section of initial tolerances for alignment, but that was not correct. Initial tolerance for the aforementioned facility types will not have an initial tolerance applied on a monitor inspection. The wording was changed for initial tolerance applied during PM's for straight-in localizer facilities to say that the 3µa value is based on the reference transmitter.

(b) Clearances. Added the text of what the exception is in sectors 2 and 3 instead of just the NOTE which made readers look up the text in the document.

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Chapter 2. Flight Inspection Crew Authority and Responsibilities

1. Authority. The flight inspection crew is authorized to:

a. Perform flight inspections of air navigation systems to determine that such systems meet applicable tolerances contained in this manual, and that the facility will support the associated instrument flight procedures;

b. Perform surveillance of aeronautical services;

c. Issue NOTAMs subject to the limitations contained in Chapter 5, Section 1;

d. Certify the signal-in-space of a facility based on the result of the flight inspection;

e. Report hazards encountered during a flight inspection of any type;

f. Take appropriate procedural actions; and

g. Review, Verify, and Edit topographic, cultural, and obstruction data depicted on FAA VFR Aeronautical Charts for accuracy and navigational usefulness.

2. Responsibility. The flight inspection crew is responsible for:

a. Conducting flight inspections in accordance with the procedures established by this manual;

b. Determining the adequacy of the system to meet its required functions;

c. Analyzing and evaluating the flight inspection data to enable a status classification to be assigned;

d. Certifying the signal-in-space of a NAVAID in accordance with the tolerances prescribed in this manual;

e. Coordinating with engineering, maintenance, and/or Air Traffic Operations personnel;

f. Reporting the flight inspection results and status of the system to the appropriate authority;

g. Providing the technical details for NOTAMs based on the flight inspection data;

h. Making recommendations to military installation commanders regarding NOTAMs for military services;

i. Verifying the accuracy of NOTAMs and published information;

j. Flight inspecting instrument flight procedures prior to their publication;

k. Optimizing facility performance during flight inspections requiring adjustments;

l. Determining that RNAV procedural leg types meet the intent of the instrument procedure; and

m. Conducting flight inspection of non-public procedures IAW this manual and proponent's approved criteria. Documenting findings for Flight Standards Service (AFS) use in approving or denying the procedure.

Chapter 3. Special Requirements

1. Introduction. This chapter describes the special requirements of the aircraft flight crewmembers, and airborne and ground support equipment used for flight inspection.

2. Aircraft. Flight inspection organizations (Technical Operations Flight Inspection Services (AJW-3), regions, and the U.S. Military) must identify specific requirements based on their operational needs. Appropriately equipped aircraft and helicopters, from service proponent or other sources, may be used when required to complete flight inspection requirements. The general characteristics of a flight inspection aircraft should be as follows:

a. Equipped for night and instrument flight.

b. Sufficient capacity for a flight inspection crew, observers, ground maintenance and/or installation personnel, and required electronic equipment with spares.

c. Sufficient range and endurance for a normal mission without reservicing.

d. Aerodynamically stable throughout the speed range.

e. Low noise and vibration level.

f. Adequate and stable electrical system capable of operating required electronic and recording equipment and other aircraft equipment.

g. Wide speed and altitude range to allow the conduct of flight inspections under normal conditions as encountered by the users.

h. Appropriate for modifications for flight inspection of new and improved navigation services.

3. Flight Inspection Crewmembers. Flight inspection organizations certifying air navigation services must develop a program to formally certify flight inspection personnel. The objectives of this program are to:

a. Grant authority to the flight inspection crewmembers who carry out the administration's responsibility of ensuring the satisfactory operation of air navigation services, instrument flight procedures, and VFR Aeronautical Chart verification.

b. Provide a uniform method for examining employee competence.

c. Issue credentials which authenticate certification authority for the crewmember.

4. Airborne and Ground Support Equipment. Aircraft and ground support flight inspection equipment must be calibrated to a standard traceable to the National Institute of Standard and Technology.

a. An Automated Flight Inspection System (AFIS), when applicable, is the primary method for conducting flight inspections.

b. Other Flight Inspection Services Approved Systems (Portable/Utility Class) and Methods (Theodolite, RTT, or Manual) may be used unless prohibited by other guidance for flight inspection. These systems/ methods must not be used solely to bypass the need for facility data of sufficient accuracy to support AFIS. Portable/Utility class equipment, installed in aircraft for the purpose of conducting flight inspections, must be installed in accordance with AJW-3 approved procedures.

Chapter 4. Flight Inspection Types, Priorities, Intervals, Procedures

Chapter 4. Flight Inspection Types, Priorities, Intervals, Procedures

Section 1. Types and Priorities of Flight Inspections

1. Introduction. Official flight inspections are of five basic types: site evaluation, commissioning, periodic, special, and surveillance.

2. Site Evaluation. A flight inspection to determine the suitability of a proposed site for the permanent installation of a facility. It may include checks normally made during a commissioning inspection and any additional tests which may be required.

3. Commissioning. A comprehensive flight inspection designed to obtain complete information as to system performance and to establish that the system will support its operational requirements.

Commissioning of Facilities or Services on Incomplete Runways. Occasionally, a commissioning inspection is performed prior to the completion of runway construction activities, including but not limited to, painting and lighting. When this occurs, a Special Flight Inspection should be performed after completion of the runway work and before the facility is placed into service. The flight inspector performing the commissioning check must request the Special inspection, specifying the items needing inspection. If, in the flight inspector's judgment, the remaining runway work is negligible and no Special inspection is required before facility use, the condition must be documented on the Daily Flight Log

4. Periodic. A regularly scheduled flight inspection to determine that the system meets standards and supports the operational requirements.

5. Special Flight Inspections. These are inspections performed outside the normal periodic interval. They may be used to define/evaluate performance characteristics of systems, subsystems, or individual facilities. Facilities maintenance personnel must be responsible for coordinating with flight inspection which checks are to be accomplished, based on their requirements and type of maintenance performed on the equipment. Special inspections are also performed when radio frequency interference (RFI) degrades intended facility services.

a. USAF Air Traffic Control and Landing System (ATCALS) evaluation requirements. ATCALS evaluation inspections require a minimum of a periodic-with-monitors type profile for ILS and periodic-type profile for all other.

b. USAF Deployable (Mobile) ATCALS (DATCALS). Flight inspections of DATCALS deployed to support an exercise or operational readiness inspection (ORI), and not intended for actual use, are considered special inspections. Inspected these facilities to the extent necessary to assess the mobile unit’s deployment capability. The procedures and checklists contained in Chapter 24 will normally be accomplished. The ORI/exercise team chief will be responsible, after consulting with the flight inspector, for assessing the facility and determining if the unit could operate during an actual deployment. The facility classification will be “unusable” due to the limited nature of the check.

c. Unapproved Facilities. Inspections of facilities not approved for use (equipment under test, facilities without monitors, etc.) will be special inspections. Since these facilities cannot be commissioned for IFR use, the status will be unusable. Items inspected will be largely dependent on the customer's request.

d. Facility Removal and Replacement. When the equipment replaced is the same type and configuration as the former and located on the same physical site, including antenna location, a special check is required. Required items for an antenna change in each chapter must be accomplished as a minimum. Additional requirements of such a check will be jointly determined by the flight inspector and facilities maintenance.

e. New or Modified Equipment Testing. Coordinate all testing of new or modified types of equipment that require flight inspection support with the Flight Inspection Policy Team. Flight Inspection Policy will determine if personnel from that office will participate in the testing to both ensure the adequacy of the testing and scope of any flight inspection procedural changes required to support the equipment. This encompasses Operational Testing and Evaluation (OT&E), First Article Testing, Developmental Test and Evaluation (DT&E), and similar formal testing; it does not include normal flight inspection of subsequent installations. If any doubt exists about the need for coordination, contact Flight Inspection Policy.

f. Radio Frequency Interference (RFI). Qualified flight inspection personnel perform all inspection to confirm or locate natural or manmade interference to Communication, Navigation, or Surveillance (CNS) systems using flight inspection aircraft must be performed by qualified flight inspection personnel; spectrum management specialists may assist in the mission as necessary. A flight inspection report on the affected system must be completed.

g. After Accident. This inspection is performed at the request of the accident coordinator/investigator to verify that system performance is satisfactory and continues to support instrument flight procedure(s).

(1) Response. This inspection has a priority of 1a and should be accomplished as soon as possible.

(2) Preflight Requirements. The flight inspector must obtain the following information:

(a) Equipment configuration at the time of the accident, i.e., the receiver(s), transmitter(s), or radar channel(s) in operation.

(b) Instrument flight procedure(s) used.

(c) Any additional information that may aid in the inspection analysis.

(3) Inspection Procedure(s)

(a) Coordinate with maintenance to configure the system as indicated in Paragraph 5.g(2)(a).

(b) Complete periodic checklist requirements. Only the equipment and instrument flight procedures used by the accident aircraft need to be checked. A VOR or TACAN alignment orbit is not required. Do not make any facility adjustments during the after accident inspection. Any adjustments must require a separate special inspection.

(c) If a system or procedure has no periodic inspection requirements, evaluate performance in the area in which the accident occurred.

(d) Complete any additional items requested by maintenance, air traffic control personnel, the accident coordinator, or the commander at a military facility.

(e) Where an accident involves contact with the terrain or a manmade obstruction, confirm the procedural controlling obstruction by map study or flight evaluation.

(4) Dissemination of After Accident Information. All flight inspection findings or other pertinent accident investigation information must be restricted to the cognizant accident coordinator/ investigator, maintenance, and air traffic personnel. Results of the flight inspection must be given to the FAA Inspector-in-Charge (IIC) as soon as possible. A flight inspection report must be filed in accordance with current directives.

h. Reconfiguration. A special flight inspection requested by maintenance when modifications or the relocation of a facility affect the radiation pattern of the facility. Classify antenna changes to different type antennas as a reconfiguration inspection. Perform all commissioning checks following a facility reconfiguration, except those not required as determined jointly by flight inspection and facilities maintenance personnel. Apply commissioning tolerances.

i. Inspections of Shipboard TACAN(s) are considered complete at the termination of the inspection. Any subsequent inspection must be a new "special" inspection.

6. Surveillance. An ongoing observation of individual components of commissioned systems, procedures, or services. This inspection encompasses spot checks of individual components observed during normal flight operations. No reporting is required unless a discrepancy is found. An out-of-tolerance or unsatisfactory condition found on a surveillance inspection requires a Daily Flight Log entry, report, and, if necessary, NOTAM action.

Surveillance of Aeronautical Services. During the course of routine flight operations, flight inspection personnel must be alert for items which are unusual, substandard, or possibly hazardous.

a. Inspections. Inspections may include, but are not limited to, the following:

(1) Condition of runways, taxiways, and ramp areas.

(2) Runway, taxiway paint markings, and position signs missing or deteriorated to the extent that visual guidance is obscured or missing.

(3) Conditions which may lead to runway incursion by aircraft, vehicles, or pedestrians.

(4) Construction activity at airports which is a hazardous condition or might affect NAVAID performance.

(5) New obstructions in the instrument approach area which might become the controlling obstruction or constitute a hazardous condition.

(6) Brush or tree growth obstructing the view of approach lights.

(7) Obscured or broken runway or obstruction lights.

(8) Other hazardous situations (e.g., bird hazards).

(9) Air traffic services (e.g., clearances, flight plans, communications).

(10) Other services (e.g., weather bureau services or other airport support services).

b. Reports. See FAA Order 8240.36, Flight Inspection Report Processing System (latest edition)

7. Priorities of Flight Inspections. Use the priorities listed below to determine which mission will be supported first when two or more requirements are competing for limited flight inspection resources. Schedule all inspections to make the most effective use of aircraft and aircrew. Schedulers should consider weather; maintenance team availability; other facilities enroute; impact on both the airport and NAS; and Technical Operations Facilities, Service, and Equipment Profile (FSEP) Response Codes when scheduling missions.

Priority	Type of Service
1a	Accident Investigation, RFI impacting NAS services, any facility which has exceeded its inspection interval, inspection of facilities in support of military contingencies, or other nationally directed military deployments.
1b	Restoration of a commissioned facility after an unscheduled outage, restoration of CAT II/ III ILS approach minimums, or inspection of NAVAID(s) in support of military operational readiness and JCS directed exercises.
1c	Flight inspection of reported malfunctions.
1d	Restoration of a commissioned facility following a scheduled shutdown or inspections supporting DOD NAVAID evaluations (USAF TRACALS).
2a	Site evaluation.
2b	Commissioning inspection of a new facility or new instrument flight procedures.
3a	Periodic inspections.

Priority	Type of Service
3b	Restoration of standby equipment (except CAT II/ III ILS, see priority lb).
3c	Navigational Aids Signal Evaluator (NASE) evaluations
3d	Restoration of VFR training facilities following a scheduled or unscheduled outage.

Section 2. Frequency of Periodic Flight Inspection

8. Introduction. This section prescribes the minimum frequency of periodic flight inspections. Make more frequent inspections when deemed necessary or as requested by the owner or organization responsible for the operation of the facility.

a. Intervals. Table 4-1 specifies the intervals between scheduled periodic flight inspections. Use this schedule to determine dates for periodic inspections. Military, foreign, and MOA systems, facilities, and procedures may have unique requirements and non-standard inspection intervals. All records and reports will reflect the actual date(s) of the inspection and will specifically denote the date of completion. The next periodic inspection will be predicated on the actual date of completion.

(1) Due date window for facilities with a 90-day periodicity is from 15 days before to 15 days after the due date.

(2) Due date window for all other facilities, systems, and procedures is from 60 days before to 60 days after the due date.

(3) Due date window for VFR Aeronautical Charts is from 120 days before to 120 days after the due date.

NOTE: The VFR Flight Inspection Program will implement VFR Chart periodicity over a period of years.

For the contiguous United States, the chart periodicity is being implemented over the next several years. The periodic due date for each individual Sectional Aeronautical Chart and its associated Terminal Area and Flyway Chart is being established as the chart is inspected. Inspection and periodicity for the Aeronautical Charts outside the contiguous United States will be implemented in the future. Helicopter and Special VFR Charts have no periodicity and are updated as determined by NACO.

b. Scheduling.

(1) NAVAID(s) such as VORTAC, VOR/ DME, ILS, MLS, etc., must be flight inspected as a service with the same due date and inspection interval for all component facilities.

(2) The inspection priority must be raised to 1a when the system, facility, or procedure has exceeded the end of the due date window.

(3) Periodic inspections are considered complete when all scheduled checks are accomplished except as noted below. When flight inspection of all Standard Instrument Approach Procedures (SIAP(s)) cannot be completed within the periodic window and extension, the periodic inspection will be documented as complete, as directed by the Flight Inspection Central Operations (FICO) Manager.

Special inspections must be established to ensure the remaining SIAP(s) are completed. In the event the SIAP(s) are not checked by the end of the periodic window/ extension, the FICO must initiate NOTAM action to remove them from service. The SIAP(s) must be restored by a special flight inspection.

(4) Progressive Inspections. The requirements for periodic inspections are specified in a checklist in each chapter of this order. Partial or progressive inspections may be conducted, provided all of the individual periodic checklist items are satisfied within the due date window.

9. Extension of Services Overdue Periodic Inspection. When the inspection of a commissioned NAVAID or SIAP is not completed within the due date window, the window may be extended. The flight inspection priority of a NAVAID or SIAP in an extension is the same as an overdue NAVAID or procedure.

The periodic flight inspection window for a ground NAVAID may be extended an additional seven (7) calendar days if the FICO and regional facility maintenance engineering agree that no conditions exist which could adversely affect the safety of flight.

The periodic flight inspection window for all SIAP(s) may be extended an additional thirty (30) calendar days providing:

(1) A review of the SIAP is accomplished by a Flight Inspector and;

(2) Flight Inspection Central Operations (FICO), by coordination with regional or local airport personnel can determine that no known environmental (i.e., construction or natural growth) changes have occurred which could adversely affect the procedure and;

(3) The National Flight Procedures Office agrees that an extension of the window will not adversely affect the safety of flight.

10. NAVAIDS Temporarily Out-of-Service.

a. Use the priority listed in Section 1 of this chapter when a restoration inspection is required. The next periodic inspection must be predicated on the completion date of an inspection which satisfies all periodic checklist requirements.

b. When a portion of a NAVAID is restored to service, establish the periodic due dates in accordance with Paragraphs 8.a and 11 in Chapter 4.

c. Standby Equipment or Associated NAVAID. When flight inspection of standby equipment or an associated NAVAID is required but cannot be accomplished, the periodic inspection will be considered complete if the standby equipment or associated NAVAID is out-of-service (awaiting parts, etc.), or removed from service (due to an uncorrectable discrepancy, etc.)

Restore the standby equipment or associated NAVAID to service by the successful completion of a flight inspection which satisfies all periodic requirements (including monitors, where applicable).

11. Rho-Theta Receiver Checkpoints. When periodic or special flight inspections of ground or airborne receiver checkpoints cannot be completed, consider the inspection complete. The following actions will be taken:

a. The flight crew will document the required inspection as complete on both the Daily Flight Log (DFL) and the flight inspection report. Enter in Remarks those checkpoints that were not checked.

b. The FICO will:

(1) Schedule a special inspection to complete the checkpoints within the established facility periodicity.

(2) Take appropriate NOTAM action to remove the receiver checkpoints from service if the special inspection is not completed within the established facility periodicity. Notify the airport manager that the ground receiver checkpoints must be removed or covered.

12. Periodic Flight Inspection Intervals. The schedule for periodic flight inspections will be in accordance with Table 4-1. Basic Schedule for Periodic Flight Inspection.

a. Establishing the Interval.

(1) Commissioning. Inspect newly commissioned precision facilities initially at a 90, 180, and 270-day interval and then maintain the schedule established in Table 4-1. Basic Schedule for Periodic Flight Inspection. For PAR, each runway served and alternate angle or touchdown point used must be inspected on the 90 and 180-day checks. For ILS, a Periodic with Monitor check is required for the initial 90, 180, and 270-day checks. This requirement also applies to the glide slope, but not the localizer when a glide slope is added to a localizer-only or LDA/ SDF facility.

(2) Specials other than reconfigurations. Facilities may be restored to the existing periodicity without further checks once the special is complete and deemed satisfactory by Air Traffic Technical Operations engineering or maintenance personnel. The periodic due date may be updated if all system periodic requirements for the next scheduled periodic inspection are completed during any special inspection.

Newly commissioned GBAS facilities must be inspected initially on a 360-day interval. After two concurrent 360-day periodic cycles with no GBAS out-of-tolerance condition, the periodic interval may be increased to 540 days. During a 540-day periodic interval, any facility out-of-tolerance condition is cause to reset the GBAS back to the initial periodic interval requirement of 360 days until there are two out-of-tolerance condition free cycles.

(3) Reconfiguration of Precision Approach Services. Check reconfigured precision approach services at 90 days. For ILS, a full periodic with monitor reference check on both localizer and glide slope facilities must be scheduled as part of this special, and the periodic with monitors must be updated on the Daily Flight Log (DFL). The next periodic due date will be at the 270-day interval. For PAR, each runway served and alternate angle or touchdown point used must be inspected on this check.

13. ILS Monitor (or Reference) Intervals. ILS monitor inspection must be conducted every periodic for ILS and LDA/SDF with GS. Monitor inspections must be conducted every other periodic for LDA/SDF/LOC only facilities.

Table 4-1. Basic Schedule for Periodic Flight Inspection
(all intervals are in days)

Approach Obstacle Assessment	540
SIAP	540 (5)

Facility	Interval
ILS/ LDA/ SDF w/GS	540
Localizer Clearances at LSA	1,080
MLS	270
MMLS	180 (3)
GBAS	540 (6)
PAR	270
ASR or WAM system	540
DF	540
LDA/ SDF/ LOC only	540 (2)
NDB (UHF, LF/ MF)	540
VOR, VORTAC, TAC	540 (1)
VOR, VORTAC, TAC	1,080 (4)
VOT	540
DME, NDB facilities associated with an Instrument Approach Procedure, Marker Beacons, Communications, VGSI, and Approach Lighting Systems	Inspect these facilities at the same interval as the system or procedure they support.

NOTES:

(1) 540 days for facilities (VOR or TACAN of a VORTAC) which support a SIAP or receiver checkpoint. An alignment orbit is required every 1,080 days for all facilities.

(2) Monitors required every other inspection. See Paragraph 13 in Chapter 4.

(3) SIAP check required every 360 days.

(4) 1,080 days for facilities that do not support a SIAP or receiver checkpoint

(5) For all periodic SIAP inspections, the periodic obstacle assessment may be conducted independent of the SIAP inspection. Periodic inspections of RNAV or GBAS SIAP(s) do not require flying the actual procedure; however, an obstacle assessment must be conducted through the final and missed approach segments.

(6) See Paragraph 12 in Chapter 4

Section 3. General Flight Inspection Procedures

14. Introduction. Sequence of events encountered by the flight inspector in the performance of the flight inspection mission is generally as follows:

a. Request for flight inspection

b. Scheduling of flight inspection

c. Preflight preparation

d. Actual flight inspection

e. Analysis and evaluation

f. Post flight review and reporting

15. Request for Flight Inspection. Authorized personnel must request site, commissioning, and some special flight inspections. Requests are not required for periodic flight inspections.

a. Status of Equipment. Initiate the flight inspection request when the inspection requirement is known and finalize the schedule when the facility is ready for flight inspection.

b. Notification. Flight Inspection Central Operations (FICO) will notify the appropriate facility maintenance personnel of the estimated time of arrival (ETA) of the flight inspection aircraft. Provide as much advance notification as possible for a site evaluation, commissioning inspection, periodic with monitors, or inspections requiring maintenance support.

An ILS periodic inspection without monitors does not require pre-coordination with maintenance personnel. Conduct this inspection on the transmitter in operation. If an out-of-tolerance condition is found, notify maintenance of the discrepancy(ies) found and inspect the standby equipment. Issue NOTAM(s) if discrepancies are not corrected.

16. Preflight Inspection Preparation. A thorough and complete understanding between Facilities Maintenance and the flight inspection crew is essential for a successful flight inspection. The flight inspector and the person-in-charge of the facility are jointly responsible for the required coordination before, during, and after the flight inspection. The flight inspector will brief the Facilities Maintenance personnel of intended actions prior to commissioning flight inspections and for special circumstances.

Prior to each VFR Aeronautical Chart flight inspection mission, the inspector(s) will meet with the NACO VFIP coordinator and cartographers to discuss any issues pertinent to the inspection.

a. Facilities Maintenance Personnel. Efficient and expeditious flight inspections require preflight preparations and actions of facilities maintenance personnel. These preparations include the following actions:

(1) Ensure Air Traffic is notified when a facility will be unusable during a flight inspection and an appropriate NOTAM or ATIS information alerts users that flight inspection is in progress.

(2) Provide adequate two-way radio communications equipment and power source at facility sites.

(3) Ensure that all facility equipment is calibrated in accordance with technical orders.

(4) Ensure personnel will be available to make corrections and adjustments.

(5) Provide transportation to move flight inspection equipment and personnel.

(6) Provide accurate facility data for new or relocated facilities.

b. Flight Personnel. Accomplished the following actions prior to the flight inspection:

(1) Ensure that all flight inspection equipment is calibrated and operational.

(2) Brief Facilities Maintenance personnel.

(3) Conduct crew briefing.

(4) Obtain maps, charts, equipment, data sheets, etc.

(5) Review the status, limitations, and characteristics of the facility. Ensure that all publications and records agree with the results of the latest flight inspection, and all applicable restrictions are accurate.

(6) Brief the air traffic control (ATC) personnel about the areas and altitudes to be flown during the flight inspection maneuvers and of possible transmitter changes.

17. Flight Inspection. Perform the flight inspection in accordance with the procedures in Chapter 6 of this order.

a. Operator Proficiency. During flight inspections, qualified personnel will be assigned so operator deviations will not be confused with equipment performance.

b. Standby Equipment. It is necessary to know which system or transmitter is operating so the performance of each can be determined.

(1) When one unit of a dual equipped facility is found out-of-tolerance, it must be identified and removed from service. Identify the unit as transmitter number 1 or 2, channel A or B, serial number, etc.

(2) Some inspections may only require the checking of one equipment. The appropriate facility checklists include the details for each type of facility.

c. Standby Power.

(1) The flight inspector must check the facility on standby power during a commissioning flight inspection if standby power is installed. If a standby power system is installed after the commissioning flight inspection, the flight inspector must check the facility on standby power during the next regularly scheduled periodic inspection. The flight inspector must make comparative measurements to ensure that facility performance is not derogated on the standby power system and that all tolerance parameters for the specific inspection are met. Standby power checks are not required on facilities powered by batteries that are constantly charged by another power source.

(2) It is not necessary to recheck a facility when the standby power source is changed.

d. On-Station Philosophy. Flight inspectors will assist in resolving facility deficiencies and restoring the facility to service prior to departure.

e. Restrictions. When a facility parameter does not meet established tolerances or standards, the flight inspector must perform sufficient checks to determine the usable area of the facility. This data will be the basis of restrictions, NOTAM(s), and procedural redesign.

f. Spectrum Engineering Services Restrictions. Facilities assigned a spectrum management restriction will be classified as "Restricted" and identified on the Facility Data Sheet. This restriction remains in effect even when the facility performance indicates no interference exists. Do not remove published spectrum management restrictions based on flight inspection results.

g. Adjustments. Requests for adjustment must be specific. The flight inspection crew will furnish sufficient information to enable maintenance personnel to make adjustments. Adjustments which affect facility performance must be rechecked by flight inspection. Flight inspection certification must be based on facility performance after all adjustments are completed.

h. Incomplete Inspections. When an inspection on a commissioned facility is halted with the equipment in an abnormal condition due to aircraft malfunction, weather, etc., maintenance personnel and the flight crew will discuss the facility condition and the remaining checks. If the facility maintenance handbooks allow adjustments of the facility parameter without flight check, and adequate references provide the ability to return to a previously certified setting, the equipment may be returned to service. Classify the inspection as incomplete until the remainder of the checks is completed. When a prescribed inspection checklist item cannot be adjusted within tolerance, the inspection will be terminated, facility status changed to unusable, and the inspection classified as incomplete until the remainder of the checks are completed.

i. Hazardous and Misleading Information (HMI). During some flight inspections, ground equipment is configured in abnormal conditions radiating false information may be misleading to the pilot. Some of these conditions do not produce a “flag” indication. For ILS facilities, studies have shown the most effective warnings to the pilot are those that produce a flag. IAW FAA Order 6750.49, FAA localizers are required to be turned OFF when glide slopes are transmitting HMI, and glide slopes must be OFF when the localizer is producing HMI. This practice does not apply to routine monitor checks (PM). These actions are backed up by NOTAM action verified by other than the NOTAM originator. Checks requiring these configurations are identified in this order with the following placard:

WARNING
HAZARDOUSLY MISLEADING INFORMATION
Misleading information is produced by this configuration.
Ensure NOTAM is active.
Monitor ATC communications for improper approach clearance to other aircraft.
WARNING

Flight inspection crews must check for applicable NOTAM(s) remind Maintenance of required shutdowns as needed, and monitor ATC communications to other aircraft. If ATC clears an aircraft to use the NAVAID, immediately notify them of the facility’s unusable status.

18. Analysis and Evaluation.

a. Flight inspection data must be analyzed and evaluated by flight inspection using the tolerances specified in this manual. Recordings made during the flight inspections are the permanent records of facility performance.

b. Copies of flight inspection recordings for engineering analysis may be obtained from the Flight Inspection Records Team. This is a limited capability and should not be used routinely.

c. VFR Aeronautical Chart inspectors must record their notes on a NACO-annotated VFR chart field sheet. Field sheets are considered source data and must be retained and archived by NACO.

d. Alignment Convention. The alignment error of omni-directional type facilities (VOR, TACAN, DF, NDB, ASR, etc.) will be computed through algebraic addition. The azimuth reference (AFIS, theodolite, map) will be assigned a Positive (+) value, and the azimuth determined by the ground facility will be assigned a Negative (-) value. Thus, with a received VOR radial value of 090.5 and an AFIS/map position of 090.0, the facility error would be –0.5°. Alignment errors may also be referred to as clockwise (positive) and counterclockwise (negative).

e. System Evaluations. Flight inspectors must make maximum use of the capability of the flight inspection system. When a special inspection encompasses only one part of a system, i.e., VTAC/ V, ILS/ G, or MLS/ A, the other parts of the system, i.e., VTAC/ T, ILS/ L, Markers, MLS/ E, and DME must be recorded and analyzed on a surveillance basis during appropriate maneuvers. Recorder traces that are set by default to the ON position should not be turned OFF unless they obscure other traces. No additional checks are needed to inspect the additional components, unless an out-of-tolerance condition is found.

f. Publications Review. As part of a periodic inspection, the flight inspector must review the Airport/ Facility Directory (A/ FD), DOD IFR Supplement, U.S. Government-produced Approach Charts, and En Route Charts applicable to the facility/ procedure. The information available to users must be compared with Facility Data Sheets and chart legends to ensure accuracy of presentation. Report facility data discrepancies to the Aeronautical Data Services Team and charting errors to the National Flight Procedures Office for correction.

19. Post Flight Inspection Actions. Upon completion of the flight inspection, the flight inspection crew must perform the following actions:

a. Brief Facilities Maintenance personnel concerning results of the flight inspection. Flight inspection must report all facility outages to appropriate personnel.

b. Determine facility status. Flight inspection must assign a status for the facility (see Chapter 5). Flight inspection must also notify the appropriate personnel of the facility status.

c. Prescribe the issuance and/or cancellation of NOTAM(s) based on the flight inspection (See Chapter 5).

d. Prepare flight inspection reports that are accurate and describe facility performance and characteristics. Reports must be completed in accordance with FAA Order 8240.36, Flight Inspection Report Processing System, latest revision.

e. Ensure flight information is published. The flight inspector must provide information for publication to the Aeronautical Data Services Team or the National Flight Procedures Office. They will notify the National Flight Data Center.

f. Flight Information.

(1) Receiver Checkpoints**.** Provide the following information for receiver checkpoints:

(a) Airport name

(b) Bearing in degrees magnetic from the VOR/ TACAN

(c) Location and description

(d) Distance and altitude

Note: Examples
1. Ground Checkpoint. Central City, Utah, (Municipal): 130^{o}, 4.5nm, runup pad Rwy 14.
2. Airborne Checkpoint. Mudville, Ohio, (Jones): 148^{o}, 5.7nm, over int Rwys 20 and 13; 3,300.

(2) VOR Test Facilities (VOT). The following information must be provided for a VOT:

(a) Facility name (and airport name)

(b) VOT frequency

(c) Type facility (area or airport)

(d) Information describing usable area

g. VFR Aeronautical Charts.

(1) Consolidate and transfer all field notes to a clean chart, provided by NACO, for use by NACO cartographers.

(2) Provide the consolidated notes to NACO cartographers. Resolve any issues arising from the inspection with the NACO VFIP managers and cartographers.

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Chapter 5. Facility Status Classification, Notices to Airmen (NOTAM), Records, and Reports.

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Chapter 5. Facility Status Classification, Notices to Airmen (NOTAM), Records, and Reports.

Section 1. Facility Status Classification and Notices to Airmen (NOTAM)

1. Introduction. Air navigational and traffic control facilities are expected to be usable within specific limits of distances and altitudes (service volume). Facility status classification and NOTAM(s) will indicate restriction(s) to the expected use of these facilities. The facility status classification indicates the general performance of the facility as determined from each flight inspection. This classification is directed only to the maintenance and/or operating agency. The NOTAM advises the user of any restriction to facility usage.

2. Facility Status Classification. Based on the performance of the facility, flight inspection will assign one of the following status classifications:

- Unrestricted: The status of a facility which meets established tolerances.

- Restricted: The status of a facility which does not meet established tolerances throughout the flight inspection standard service volume (areas must be clearly defined as unusable in a NOTAM).

- Unusable: The status of a facility which is unsafe or unreliable for navigation (a NOTAM must be issued for the facility defining it as unusable).

a. International Facilities. The FAA performs flight inspection of international facilities on a contract or agreement basis and for NAVAIDS supporting U.S.-controlled instrument procedures. International facilities are maintained using the manufacturer's instructions manual and may have no procedures for accomplishing some checks required by this order. Checks performed under these conditions, while meeting the owning nation's procedural and maintenance certification requirements, do not encompass all checklist items required of U.S. facilities. Special procedures apply for checks performed under these conditions.

(1) For facilities for which the FAA has flight inspection responsibility, and all checklist items appropriate for the inspection have been completed, the flight inspector must assign a facility status.

(2) For facilities for which the FAA has flight inspection responsibility, and all checklist items appropriate for the inspection have not been completed, the flight inspector must discuss the uncompleted items with the facility manager and annotate the report with a statement that the assigned status applies only to the ICAO Annex 10 signal requirements in the as-left configuration. The assigned facility status must be as applied to usability.

(3) If the check does not meet the requirements of this order or ensure the standards of ICAO Annex 10, the host nation will assign the facility status.

(4) For facilities inspected only to the extent that they support U.S. instrument procedures, no status must be assigned and the report must be annotated as to the limited inspection.

(5) List any uncompleted checklist items on the report.

b. Facility Coverage in Limited Areas. When facility coverage throughout the flight inspection standard service volume cannot be checked due to inability to penetrate national borders or restricted airspace, the facility will be classified as RESTRICTED, with the report annotated as to the limited coverage flown. NOTAM and publications action will show the facility as UNUSABLE in the areas not checked.

3. NOTAM(s).

a. General. When a flight inspection necessitates NOTAM action, the flight inspector is responsible for initiating the NOTAM(s). The flight inspector must verify within 24 hours that the appropriate NOTAM(s) were issued and are correct. Find further NOTAM guidance in FAA Order 7930.2, Notices to Airman (NOTAM) Handbook (latest edition).

b. Facility NOTAM(s). The flight inspector must immediately initiate NOTAM action whenever a facility restriction is found or revised. The inspector must verify that NOTAM(s) are published in the appropriate agency publication.

c. Instrument Flight Procedures. Issue Flight Data Center (FDC) NOTAM(s) if a restriction affects instrument flight procedures, approach minimums, or category (CAT) II or III authorizations. NAVAID NOTAM(s) which impact instrument flight procedures should be coordinated with Aeronautical Information Services (AIS), as restrictions to NAVAID(s) may affect published instrument flight procedures.

d. Facilities not requiring NOTAM(s). Do not issue a NOTAM to reflect restrictions found during the flight check of radar or direction finding facilities; however, review the instrument flight procedures to ensure that those requiring ground radar are amended or suspended. Coordinate this action with the procedure designer.

When restricting GBAS facilities, do not issue flight procedure NOTAM(s) unless the restricted area affects procedural use. Document restrictions on the data sheet.

e. Expanded Service Volume (ESV) Facilities. When a facility no longer supports an ESV, the facility is not restricted, but issue a NOTAM for the instrument flight procedures predicated on that ESV.

f. Out-of-Tolerance Standby Equipment. Where one of two transmitters of a facility is restricted due to out-of-tolerance parameters and the other is satisfactory, the satisfactory transmitter may be operated without a NOTAM. However, NOTAM data describing the restriction must be provided to Facilities Maintenance personnel. In the event the restricted transmitter is used, the operating agency must issue the NOTAM.

g. NOTAM(s) on Military Facilities (including ships).

(1) The military installation commander has the final authority and responsibility for NOTAM issuance and for facility operations of all military facilities which are not part of the National Airspace System (NAS). The commander may elect to use "For Military Use Only" facilities found unsatisfactory.

(2) Recommend NOTAM (s) involving military facilities or procedures to the appropriate military authority for the airfield, facility, or instrument procedure in question. Initiate NOTAM(s) for U.S. Army instrument procedures within the United States through the NFPG. Any NOTAM action involving U.S. military instrument procedures or facilities overseas should be initiated through the appropriate military authority at the location involved. Military units will issue NOTAM(s) according to existing military regulations and letters of agreement with the appropriate host nation International NOTAM Office.

(3) Do not issue NOTAM(s) on shipboard facilities.

h. Preparation of NOTAM(s).

(1) NOTAM(s) must include facility name, type, component, and the unusable area/altitude. The absence of a specific altitude or distance will denote all altitudes and distances. It is important to include specific information to avoid confusion. The reason for the restriction, (e.g., lack of signal, frequency interference, course structure, alignment, unlocks) serves no useful purpose and must not be included in the text of the NOTAM.

(2) Restrictions to TACAN azimuth are not included in agency publications, but are referred to the military for dissemination as they consider necessary. A copy of each NOTAM issued or recommended for TACAN azimuth restrictions must be retained in the facility file for reference during subsequent flight inspections. The NOTAM preparation for the TACAN azimuth component of a VORTAC is identical to the VOR.

i. Facility Restrictions. Apply the following rules for restricted facility use:

(1) Describe the radials or bearings that are unusable.

(2) Describe the altitude and mileages that are unusable.

(3) VOR/ TACAN/ VOT/ DME/ DF/ NDB/ ASR. Describe radial/bearing from the station in a clockwise (CW) direction, altitude in terms of above or below an MSL altitude, and distance in terms of beyond or within a nautical mile distance.

(4) Localizer/ LDA/ SDF/ TLS Azimuth. Describe laterally in terms of degrees left or right of inbound course and in nautical miles from threshold if the restriction affects the limit of usable signal closest to the threshold. Use distance in nautical miles from the antenna to describe restrictions affecting the usable distance of the facility. Describe altitude in terms of above or below an MSL altitude. Additional reference to DME distances may be used if the DME is part of the SIAP.

(5) Glide Slope/ TLS Elevation. Describe in terms of degrees left or right of inbound course and nautical miles from threshold; restrictions pertaining to altitude must be in terms of above or below an MSL altitude. Ensure the restriction correctly reflects the service volume origin (see Chapter 15). Additional reference to DME distances may be used if the DME is part of the SIAP.

(6) MLS. Describe in azimuth terms of inbound magnetic courses, using clockwise (CW) references, starting at the restricted portion closest to the inbound right-hand edge of the service volume. Describe elevation terms in degrees when restricting an entire azimuth sector and in terms of feet MSL when restricting a sector beyond a distance. Define elevation restriction affecting decision height in feet MSL. Define distances in DME.

(7) VGSI. For VGSI, describe in terms of nautical miles from threshold and/ or degrees left and right of runway centerline any areas of coverage where the facility is unusable.

(8) GBAS. Document restrictions in flight inspection records as follows: For VDB coverage restrictions reference the VDB antenna, describe bearing in a clockwise (CW) direction, altitude in terms of above or below and MSL altitude, and distance in terms of beyond or within a nautical mile distance. For GBAS procedural restrictions describe laterally in terms of degrees left or right of inbound course and in nautical miles from threshold. Describe altitude in terms of above or below an MSL altitude.

(9) Published NOTAM(s) will usually omit, but may include, the “CW” reference. This does not constitute an erroneous NOTAM. The flight inspector must review the published NOTAM(s) and restrictions to ensure they convey the correct meaning.

j. NOTAM Examples. The following are examples of conditions and prescribed NOTAM(s):

NOTE: Published NOTAM verbiage may vary from the example given. FSS or NFDC may abbreviate as applicable.

(1) Condition 1. All components of a VORTAC are unusable in a specific sector due to out-of-tolerance VOR and TACAN course structure and unusable DME. NOTAM Chicago VORTAC: VOR, DME, and TACAN azimuth unusable, 025 cw 075° beyond 25 nm below 3,500 feet.

(2) Condition 2. A VOR does not provide adequate signal to 40 miles at the required altitudes in various areas. NOTAM Altoona VOR: VOR unusable, 080° cw 100° beyond 18 nm below 3,500 feet; 101° cw 200° beyond 30 nm below 3,500 feet; 201° cw 300° beyond 30 nm below 4,500 feet; 301° cw 350° beyond 15 nm; 351° cw 010° beyond 30 nm below 4,000 feet.

(3) Condition 3. VOR is unusable in various areas below one altitude. Also, the DME is unusable in one sector. NOTAM Yardley VORTAC: VOR unusable below 1,700 feet in the following areas: 250 cw 265° beyond 17 nm; 266 cw 280° beyond 10 nm; and 281cw 290° beyond 17 nm. DME unusable 225 cw 275° in the following areas: Beyond 15 nm below 2,400 feet and beyond 30 nm below 5,000 feet.

(4) Condition 4. A Nondirectional radio beacon is not usable in the Southeast quadrant. NOTAM Bradford NDB: unusable 090 cw 180° beyond 15 nm.

(5) Condition 5. Glide slope tolerances are exceeded at a specific point on the glidepath. NOTAM Ashville Regional, NC: Rwy 16 ILS glide slope unusable below 2,310 feet MSL.

(6) Condition 6. An ILS localizer exceeds tolerances at 1/2 mile from the runway threshold. NOTAM Hartsville Muni, SC, Rwy 16 ILS unusable from 1/2 nm inbound.

(7) Condition 7. Cat II ILS ceases to meet CAT II criteria. FDC, FI/ (P or T), NOTAM William B. Hartsfield, Atlanta Int'l, GA: ILS Rwy 9R, CAT II NA.

NOTE: FI/ P means permanent and FI/T means temporary flight information.

(8) Condition 8. CAT III ILS localizer exceeds CAT III tolerances in Zone 4. FDC, FI/P NOTAM Charleston AFB/Int'l SC: Rwy 15 ILS, CAT III NA.

(9) Condition 9. CAT II ILS localizer exceeds tolerances in Zone 4. NOTAM New Orleans Int'l, LA: Rwy 28 ILS LOC unusable inside runway threshold.

NOTE: The localizer is unrestricted.

(10) Condition 10. CAT III ILS localizer exceeds tolerances in Zone 5. NOTAM New Orleans Int'l, LA: Rwy 28 ILS LOC unusable for rollout guidance.

(11) Condition 11. Glide slope does not meet change/ reversal tolerances below a point on the glidepath. NOTAM Ashville Regional, NC: Rwy 16, autopilot coupled approaches NA below 2,000 feet MSL.

(12) Condition 12. Localizer does not meet tolerances in the vertical plane. NOTAM Wellsville Municipal Arpt., Tarantine Field Arpt., Wellsville, NY: ELZ LOC Rwy 28, LOC unusable beyond OM above 3,500, at threshold above 500.

(13) Condition 13. Beyond 5° left of LOC course, there are no glide slope clearances above path, and a glidepath is not provided. NOTAM Charlotte/ Douglas Int'l, NC: Rwy 36R ILS glide slope unusable beyond 5° left of LOC course.

(14) Condition 14.

(a) MLS Azimuth Unusable. Because an unusable approach azimuth renders the elevation unusable, refer to any unusable azimuth segment as "MLS unusable". Describe the limits using inbound courses; e.g.:

(i) UMP MLS unusable 196 cw 206°.

(ii) UMP MLS unusable 196 cw 206° below 4°.

(iii)UMP MLS unusable 196 cw 206° beyond 15 DME below 4,000 feet MSL.

(b) Elevation. Refer to any unusable segment as "MLS elevation unusable"; e.g.,

(i) UMP MLS elevation unusable 151 cw 156° below 3.5°.

(ii) UMP MLS elevation unusable 151 cw 156° beyond 15 DME below 7,000 feet MSL.

(c) MLS DME unusable. Refer to any area of unusable DME as "UMP MLS DME unusable".

(15) Condition 15. PAPI lights are baffled and unusable beyond 5° right of centerline due to obstructions: NOTAM Heber City-Russ McDonald Fld, UT, RWY 21 PAPI unusable beyond 5° right of runway centerline.

k. Required Advisories for Local NOTAM(s). The flight inspector must notify Air Traffic (AT) personnel when the facility is not authorized for use because of flight inspection actions.

Section 2. Records and Reports.

4. Introduction. This section provides policy for flight inspection reports and records. The flight inspection report provides permanent, historical interpretation of a system's performance. The report must accurately reflect the operational status of the system, the quality of the signal in space, the instrument flight procedure, and revised obstacle, topographical, and cultural data.

5. Records. Flight inspection files are Federal record material. The standards for their retention and destruction are contained in FAA Order 1350.15, Records Organization, Transfer, and Destruction Standards. A facility Reconfiguration (Special/ RF) inspection that meets all the commissioning requirements is considered a Commissioning type inspection for record keeping purposes. Flight inspection reports and source material for reports on all electronically radiated facilities inspected constitute report files that must be archived. Such material must contain, but is not limited to, recorder charts showing facility data used, system status, and self-test results, receiver outputs, and crew inputs affecting measurements. Data logger files must be archived for all inspections utilizing AFIS conducted with a functioning data logger. A functioning data logger should be available prior to the inspection. When logger files are not available for archive, either due to none being recorded or data corruption post flight, state such in the Remarks block of the report. Other material may include data items which are necessary for flight inspection purposes, such as horizon profiles, site drawings, topographic charts, instrument approach/ departure procedure charts, photographs, electronic media, and data sheets, aircraft logbooks, VFR Chart field sheets, and obstacle records. PAR, VGSI, and NDB source material is not required to be retained once the report has been archived.

a. General Information. Ensure any information included in the facility file is annotated with the following information:

(1) Facility identification/type of facility

(2) Date(s) of inspection

(3) Type of inspection (e.g., periodic)

(4) Aircraft tail number

(5) Crew initials and numbers

(6) Recorder calibration

(7) Equipment-required flight inspection self-test

(8) Airborne flight inspection system calibrations (i.e., TVPS, and system setup)

b. Facility Data Sheets. The flight inspector must ensure that the facility data reflects the most current information and is sufficient to complete the flight check requirements.

6. Reports. The flight inspection report serves as the primary means of documentation and dissemination of the results of each flight inspection. Requirements for the use, completion, and distribution of standard FAA and suitable military flight inspection forms are contained in FAA Order 8240.36, Flight Inspection Report Processing System (latest revision).

a. Military Facilities.

(1) Changing a Facility Classification to Restricted or Unusable or Altering a Restriction. When the results of the flight inspection indicate that the facility classification is to be changed to "restricted" or "unusable" or that facility restrictions have changed, land the aircraft, if practical, and discuss the reasons and recommended action with appropriate representatives of the base commander. If it is impractical to land, give a status report to the control tower (on ground or tower frequency) indicating the exact status of the facility (unrestricted, restricted, or unusable) and all discrepancies found. Provide them with suggested wording for any required NOTAM(s). Request acknowledgement of the information.

(2) Where there has been no change in facility performance, inform the control tower (on ground or tower frequency) of the exact facility classification. Again, request acknowledgement.

(3) If a military installation does not have a control tower, attempt to pass the information over any other available air-to-ground frequency that would ensure dissemination of the flight check results. If no appropriate air-to-ground frequency is available and it is impractical to land, telephone the appropriate personnel as soon as possible.

(4) In any of the above cases, inform the appropriate military maintenance personnel of any discrepancies discovered, and the resulting facility classification.

b. Reports Submitted by Military Flight Inspectors.

(1) Flight inspection reports of facilities inspected by military flight inspection crews, who have been delegated the authority for execution of the flight inspection mission, must be accepted by the FAA as official flight inspection reports.

(2) Military flight inspectors must assign a classification or status to those facilities for which they have flight inspection responsibility.

> NOTE: Coordination may be in the form of a letter of agreement or may be handled on a case-by-case basis. Coordination with AJW-3 constitutes full flight inspection authority for the respective facility.

c. VFR Aeronautical Chart field sheet notes and obstacle evaluations are a record of having performed the flight inspection and will be archived at NACO.

Chapter 6. Flight Inspection and Flight Validation of Instrument Flight Procedures.

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Chapter 6. Flight Inspection and Flight Validation of Instrument Flight Procedures

1. 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. Focus particular attention 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. Resolve concerns 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.

2. 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. Archive all recorded electronic data and the final report.

3. 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. Use data documented on FAA 8260-XX forms 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. Return procedure packages with inadequate informationto 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. Reflect those areas 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.

4. 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	6.4	X	X, 2
Final Approach Segment	6.4	X	X, 2
Missed Approach Segment	6.4	X	X, 2
Circling Segment	6.4	X	1
En route and Terminal Segments (i.e., SID, ODP, STAR)	6.4	X	1
Holding Pattern	6.4	X	1
Air/ Ground Communications	6.4	X	1
Runway Markings, Lighting, and Supporting Infrastructure	6.4	X, 3	X, 3
RADAR	6.4	X	1
Charted Visual	6.4	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 Evaluation. 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/mn.

(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 of a non-precision approach. A VDA may be implemented without considering obstacles in the visual segment. Consequently, an aircraft that follows the path defined by the VDA may come too close to, or impact obstacles or terrain. Published guidance warns pilots to delay descent from the MDA until it is safe to do so. However, it is not appropriate to chart VDA and TCH information when there is a significant risk that the aircraft will need to destabilize the approach in the visual segment to avoid collision with obstacles.

(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, no VDP published, or indications of a 34:1 penetration like the absence of 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. Don't continue the below-path check below 200 feet above threshold elevation, be on path below 200 feet. 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. Fly route segments 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 Patters. 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 consistent with the guidance in this order. Forward misalignment or inaccurate data indications 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 inspection, 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 B.

(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, apprise the procedure developer 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. Charted visual procedures require a commissioning inspection. 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 Information Services (AJV-5), 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. Notify the appropriate military authorities 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.

5. 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. Evaluate the following factors:

(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. 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.

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Chapter 7. Lighting Systems

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Chapter 7. Lighting Systems

Section 1. Visual Glide Slope Indicator (VGSI)

1. Introduction. Visual Glide Slope Indicators (VGSI) are ground devices that use lights to define a vertical approach path during the final approach to a runway. The visual signal must consist of not less than two and not more than four colors. Allowable colors are red, amber, green, or white. Color sectors must be distinct and identifiable throughout the horizontal beam width at all intensity settings. Only red is used to indicate the lowest below-path sector of the system.

VGSI(s) are aligned to provide a glidepath not less than 1.0° above obstacles. VGSI(s) provide visual coverage 10° either side of the runway centerline extended to a distance specified for the system, usually 4 statute miles(sm) in daylight conditions. Lateral guidance is obtained by reference to either visual cues or electronic aids.

Threshold crossing height (TCH) is the height of the lowest on-path signal at the threshold. The minimum TCH is determined by the most critical aircraft that normally operates on the runway. The TCH of VGSI(s) will normally be 25 to 75 ft. Specific TCH criteria for each type system is located in Order JO 6850.2, Visual Guidance Lighting Systems.

Box Identification**.** The U.S. practice, as found in Order JO 6850.5, Maintenance of Lighted Navigational Aids, is that individual VASI or PAPI light boxes are numbered starting at (1), with the box nearest the runway on each side and working outboard. ICAO Annex 14 and Aerodrome Design Manual reverse this, and number or letter the boxes starting with (1) or (A) at the outermost box and working toward the runway.

There are several different types of VGSI(s). The primary systems covered in this chapter are visual approach slope indicators (VASI), precision approach path indicators (PAPI), pulsating visual approach slope indicators (PVASI), T-VASI, three-color VASI, and helicopter approach path indicator (HAPI). Each of these systems presents a different type of visual indication to the pilot and requires different in-flight interpretation.

a. Visual Approach Slope Indicator System (VASI).

(1) The VASI consists of either two or three light bars placed perpendicular to the runway. The light bars consist of one, two, or three boxes aligned on the left or both sides of the runway. Each box contains three high intensity lamps behind a horizontally divided filter with red colored and clear portions.

(2) In using the systems, a pilot should fly through the light bar nearest the runway threshold (number 1 bar) until it appears WHITE, and undershoot the light bar beyond the touchdown point (number 2 bar) until it appears RED. The aircraft will be on the visual glide slope when the number 2 light bar appears RED and the number 1 light bar appears WHITE. When the aircraft deviates from visual glidepath, the pilot will see a change in color of one of the light bars.

Deviation above the established glidepath will cause the number 2 light bar to fade from RED, through PINK, to WHITE, with the total change occurring within 1/4° to 1/2°. Deviation below the glidepath will cause the number 1 light bar to change from WHITE, through PINK, to RED, within 1/4° to 1/2°. A pilot sees two WHITE bars above glidepath and two RED bars below glidepath. (See Figures 7-D and G.)

(3) The basic configurations of VASI are described below:

(a) Left Side of Runway.

(i) VASI-2 consists of two light boxes as shown in Figure 7-1. This system provides descent information under daytime conditions to a distance of 3 sm.

(ii) Simplified Abbreviated Visual Approach Slope Indicator System (SAVASI-2) consists of two light boxes with a single lamp in each box as shown in Figure 7-1. This system is designed for nonjet, utility runways, and provides descent information under daytime conditions to a distance of 1.5 sm.

(iii) VASI-4 consists of four light boxes installed as shown in Figure 7-2. This system provides descent information under daytime conditions to a distance of 4 sm.

(iv) Walker 3-Bar VASI-6 is a 3-bar system installed as shown in Figure 7-5. Each bar consists of two light boxes aligned on the left side of the runway. The system provides descent information under daytime conditions to a distance of 3 sm.

(b) Both Sides of Runway.

(i) VASI-12 consists of 12 light boxes installed as shown in Figure 7-3. This system provides descent information under daytime conditions to a distance of 5 sm.

(ii) VASI-8 consists of eight light boxes installed as shown in Figure 7-3. This system is basically the 12-box system with the outer four boxes removed and provides descent information under daytime conditions to a distance of 5 sm.

(iii) Walker 3-Bar VASI-16 consists of 16 light boxes installed as shown in Figure 7-6. The system is basically a VASI-12 with the addition of an upwind 2-box light bar on each side of the runway. This provides an additional visual glidepath above and almost parallel to the normal path. The upper path is designed for high cockpit aircraft, ensuring a safe minimum wheel clearance over the runway threshold. This system provides descent information under daytime conditions to a distance of 5 sm.

b. Precision Approach Path Indicator System (PAPI)

(1) The PAPI uses a two-color light projector system that produces a visual glidepath as shown in Figure 7-8. Each light box consists of at least two optical projectors that produce a single beam of light, the upper part of the beam is WHITE and the lower part RED. When passing through the beams, the transition from one color to the other is almost instantaneous.

(2) There are two basic configurations of PAPI(s) that are described below:

(a) Four-Box System. The glidepath angle of a 4-box system is the midpoint of the angular setting of the center pair of light boxes. The on-path width is the difference between the angles of light boxes 2 and 3. Normal installation requires 0.33° between light box settings 1 and 2, 2 and 3, and 3 and 4. Systems that support large aircraft require 0.50° between light boxes 2 and 3. The on-glidepath indication is two RED and two WHITE lights on the light bar. When the aircraft goes below the glidepath, the pilot sees a progressively increasing number of RED lights, and if the aircraft goes above the glide slope, the number of WHITE lights increases as shown in Figure 7-9. This system provides descent information under daytime conditions to a distance of 4 sm.

(b) Two-Box System. This system is designed for utility type runways. The glidepath angle is the midpoint between the angular setting of the two light boxes. The on-path width of this system is normally 0.50°, but may be reduced to provide obstacle clearance. The on-glidepath indication is one RED and one WHITE light. When the aircraft goes below the glidepath, the pilot sees two RED lights and two WHITE lights above glidepath. This system provides descent information under daytime conditions to a distance of 2 sm.

(c) Installation Convention. The system is normally installed on the left side of the runway but may be on the right or on both sides as shown in Figure 7-9.

c. Pulsating Visual Approach Slope Indicator System (PVASI). PVASI(s) normally consist of a single light unit projecting a two-color visual approach path as shown in Figure 7-10. The below glidepath indication may be pulsating or steady RED, and the above glidepath indication is normally pulsating WHITE. The above and below path pulsating lights appear to pulse faster the farther off path the pilot flies. The on-glide-path indication for one system is a steady WHITE light, and for another system the on-glide-path indication is an alternating RED and WHITE light. The on-path width of the steady WHITE light is approximately 0.35° wide. This system provides descent information under daytime conditions to a distance of 4 sm. The obstacle clearance surface extends out at an angle 1° below the transition from steady to pulsating red. PVASI installations may be referenced in FAA publications as PSIL or PRIL. These abbreviations indicate a pulsating/steady burning visual approach slope indicator (PVASI) installed on the left side (PSIL) or right side (PSIR) of the runway.

d. T-VASI. The T-VASI presents a T-shaped light configuration as shown in Figure 7-11. The standard version has 10 lights on each side of the runway; the abbreviated AT-VASI is installed on only one side. If the aircraft is above the path, the vertical 'stem' of the T appears inverted above the horizontal path. The length of the stem is relative to the amount the aircraft is above the angle. As the aircraft nears the glide angle, the stem length decreases until it is not visible at the glide angle. As the aircraft goes below the glide angle, the stem of the T appears below the horizontal lights. When the aircraft reaches 1.9°, the lights turn RED, indicating well below glidepath. When above the path, the fly-up lights should not be visible, and when below the path, the fly-down lights should not be visible.

e. Helicopter Approach Path Indicator (HAPI). The HAPI system, as shown in Figure 7-12, provides angular indications by changing light color between red and green and by pulsing the light. The on-path indication is a steady green light and, as the angle increases, the light flashes at a rate of at least 2 Hz. The slightly below path indication is a steady red indication, which turns to a flashing red indication at well below path. The width of the on-path should be 0.75°, and the width of the slightly below indication should be 0.25°.

f. Tri-Color VASI. The tri-color VASI (TRCV) is a single steady light that appears to change color in relation to the observer's angle. The on-path indication is a steady GREEN light, and the above path indication is AMBER. As the aircraft goes below path, a RED indication, sometimes preceded by a DARK AMBER, is seen. The obstacle clearance surface extends out at an angle 1° below the transition to red.

2. Preflight Requirements.

a. Ground. In addition to preparations specified in Chapter 4, Section 3, the Facilities Maintenance personnel must:

(1) Ensure that all lamps are operating.

(2) Check the lamps for blackening and the lenses for cleanliness.

(3) Check the setting of each box to determine proper angular adjustment.

(4) Inform the flight inspection personnel of any unique siting conditions such as visual screening, waivers, or local restrictions.

b. Air. The flight inspector will comply with the preparations specified in Chapter 4, Section 3.

c. Installation Considerations. When an obstacle penetrates the obstacle clearance surface (OCS) and the obstacle cannot be removed, one of the following actions may be considered by the facility owner and airport management: suitably raise the path angle of the system; or, displace the system upwind further from the threshold. When neither step is practical, it may be possible to baffle the azimuth spread of the light system so that the object is outside the confines of the observable light beam. Consideration may also be given to rotating the entire system, especially when the instrument approach final course is offset from the runway. When a facility is baffled or rotated, flight inspection must confirm there is no VGSI guidance visible in the vicinity of the penetrating obstacle.

3. Flight Inspection Procedures. Initial settings are determined by ground adjustments and verified by flight inspection. Flight inspection checks the overall appearance and usability of the system as viewed by the pilot on the approach, checks for coincidence of the VGSI(s) with other NAVAID(s) serving the same runway, and confirms obstacle clearance. If the flight inspection effective glidepath angle is found out of tolerance IAW Paragraph 7.5.b, the VGSI vertical alignment angles may be adjusted beyond JO 6850.5, Maintenance of Lighted Navigational Aids, tolerances to satisfy flight inspection results. These reference settings will be the basis for all future VGSI vertical alignments. Some of the detailed procedures below are type specific; adaptation of these procedures may be required for new or modified equipment types.

a. Checklist. A commissioning inspection is required for all new VGSI(s) with an associated IFR procedure (to include circling approaches). Many existing VGSI(s) were placed into service without flight inspection; they remain in service without a commissioning-type inspection until reconfigured, a new published angle is established, the addition of electronic vertical guidance to that runway, or until such time it is deemed a flight inspection is appropriate. Any VGSI system required for night use of an instrument approach procedure must receive a commissioning flight inspection before that instrument approach is used at night. Approved VGSI facility data is required for any VGSI inspection except Surveillance. Do not attempt to conduct the inspection using data from other facilities on that runway, e.g., ILS data.

Type Check	**Reference Paragraph**	**C**
Light Intensity	7.3.b(1)	X
Glidepath Angle	7.3.b(2)	X
Angular Coverage	7.3.b(3)	X
Obstruction Clearance	7.3.b(4)	X
System Identification/ Contrast	7.3.b(5)	X
Radio Control	7.3.b(6)	X
Coincidence with electronic glidepath	7.3.b(7)	X

NOTE: There is no periodic inspection requirement for VGSI facilities. However, surveillance of safe operation will be accomplished in conjunction with other flight inspections involving the associated runway.

b. Detailed Procedures

(1) Light Intensity

(a) General. Depending on the type of VGSI(s) and system design, the light intensity can be either manually or automatically controlled for daylight or darkness operations Some systems have three settings which allow for daylight, twilight, and dark operations. Maintenance can select one or two options for night operations to accommodate local site conditions for some systems.

(b) Positioning. For facilities that are manually controlled, fly inbound while the controller changes the intensity settings to all operating ranges. Systems that use the automatic intensity settings should be checked the same as the manually controlled systems, if a method of changing the intensity is available. Intensity should be observed throughout the flight inspection.

(c) Evaluation. Ensure all lamps are operating and are at the same relative intensity for each setting. If possible, the flight inspection should not be made during bright sunlight as it will reduce the effectiveness of the VGSI(s). The normal intensity setting for daylight operation is 100 percent, for twilight periods 30 percent, and for hours of darkness 10 percent.

(2) Glidepath Angle

(a) General. VGSI(s) provide vertical guidance for a VFR approach or for the visual portion of an instrument approach. The angle established by the VGSI(s) is referred to as the visual glidepath angle. The signal formats used to establish the visual glidepath angle can vary from a single light source, two or three light sources in a longitudinal array, and four or more light sources in a lateral and/or longitudinal array. While evaluating the vertical guidance, check for: proper angle alignment; flyability versus width of the effective visual glidepath; and, normal sequence of light box color changes. When VGSI systems are installed on both sides of a runway, alignment and symmetry should match so as not to confuse pilots. Setting the required visual angle is a function of ground installation personnel. (See Figures 7-4, 7 and 10.) Measure and report angles for all four light boxes in a 4-box PAPI system. Make adjustments as necessary when the symmetry is unacceptable.

(b) Positioning

(i) Level Run Method. Position the aircraft inbound on the runway centerline in the below path sector at an altitude that will intercept the light pattern within a distance at which it can be clearly seen. Proceed inbound in level flight at the slowest practical speed.

(ii) On-Path Method. Position the aircraft inbound on the runway centerline in the below path sector at the procedural intercept altitude or 1,000 ft AGL, whichever is higher. Upon reaching the glidepath indications, begin a descent and keep the aircraft in the center of the on-glidepath indication.

(iii) Theodolite Positioning. Position the theodolite beside the runway so the imaginary glidepath, originating from a point abeam the runway reference point (RRP), will pass through the theodolite eyepiece. The RRP is the point on the runway where the visual glidepath intercepts the surface.

(c) Evaluation

(i) The Level Run Method is best suited for PAPI-type systems and should not be used for VASI-type facilities. Average the results of at least two runs for commissioning-type inspections. Keeping a constant altitude and airspeed, the flight inspector marks the appropriate indications for the VGSI type. These are typically transition points and/or on-path indications. If a theodolite is used, the operator tracks the aircraft during the level run. The pilot calls when passing the desired indications, and the theodolite operator notes the angles. The center of the on-path indications is used as the glidepath angle. For PAPI, the effective on-path angle is the average of the individual angles measured for two light boxes, boxes 2 and 3 on 4-box systems. The angle for an individual PAPI light box is measured at the narrow transition point from RED to WHITE.

(ii) On-Path Method. The on-path method, using AFIS or theodolite, may be used to determine the path angle of all VGSI types. If theodolite is used, the operator tracks the pilot's window and notes the angles when the pilot reports the desired indication. Unlike the level run method, the inspection aircraft flies down the appropriate glidepath indication for the VGSI type. For PAPI systems, fly the transition angle of a single-light box. VASI, PVASI, T-VASI, TRCV, and HAPI should be measured at the center of the on-path indication as defined in Paragraphs 7.1.a, 7.1.c, 7.1.d, and 7.1.f. Reference Figure 7-4. Aiming and Obstruction Clearance Diagram for 2-Bar VASI. and Figure 7-7. Aiming and Obstruction Clearance Diagram Walker 3-Bar VASI. for VASI.

(iii) PAPI Evaluation using the On-Path Method. Determine the angle of individual light boxes by measuring the angle the light box changes color from WHITE to RED and from RED to WHITE. Fly the color changes of a single box and measure the angle at which it changes colors. The light box angle is the average of not less than three light color changes in each direction. The PAPI angle is the average between the angle of light boxes 2 and 3 of a 4-box system or light boxes 1 and 2 of a 2-box system as shown in Figure 7-8. For an accurate angle, you must average equal WHITE/ RED and RED/ WHITE calls; otherwise, the average is skewed in the direction of the larger number of calls.

(3) Angular Coverage

(a) General. Unrestricted VGSI(s) will provide coverage/ obstacle clearance 10° either side of the runway centerline extended. Fly a perpendicular crossing to determine the horizontal angular coverage of the VGSI(s) during commissioning inspections. In addition, this check is used to verify a restriction in coverage if a blanking device is used to limit coverage of a system due to obstructions or other hazardous situations. Facility status is restricted whenever the lateral coverage is less than 10 degrees either side of runway centerline, including as a result of rotated alignment.

(b) Positioning. Check the angular coverage by crossing the extended runway centerline at a 90° angle at a sufficient distance to enable the flight inspector to observe any shielding effect on the system. Conduct the maneuver at an altitude that allows the lights to be easily seen while remaining safely above obstacles.

(c) Evaluation. Observe the point where the VGSI system becomes usable or unusable. The usable area is the angular coverage. For a system installed on only one side to be considered usable, all lights must be visible. For dual side installations, coverage from either side is required.

(4) Obstruction Clearance

(a) General. The visual glidepath should be at least 1° above all obstacles. The VGSI(s) must provide clearance above all obstacles within the commissioned operational service volume. The "commissioned operational service volume" is the area over which the VGSI light signal can be safely used. This area will be determined by flight inspection. Figures 7-4, 7, 8, and 10 diagrams the aiming of light boxes and installation obstruction clearance requirements for the different type VGSI systems. Flight inspection verifies VGSI below path indications clear all obstacles within the commissioned operational service volume. The below-path approach is conducted during commissioning inspections and anytime there is a questionable obstruction to determine satisfactory guidance and obstruction clearances. When necessary, lateral coverage may be reduced for obstacles by the use of blanking devices or baffles.

(b) Positioning. Position the aircraft below the visual glidepath beyond the distance needed to conduct the evaluation. . While proceeding inbound, a definite below path indication must be visible on the VGSI(s) while maintaining clearance above all obstacles in the approach path.

(c) Evaluation.

(i) The flight inspector will evaluate obstacle penetrations to 8 nm from threshold. The distance checked may be reduced to 4 nm for 2-box PAPIs, and other low intensity or non-standard systems with limited visibility. Use map study to assist in determining where the OCS area is clear of penetrations. The map study is not intended to ensure the applicable VGSI below path reference clears all obstacles by one degree, only that there is no obvious penetration of the OCS. In relatively flat areas, very little airborne observation should be necessary beyond where the VGSI guidance is visible during daylight hours. Do not evaluate obstacle clearance at night.

(ii) If necessary, the usable distance of the VGSI may be restricted. The restriction may be based on a penetration of the OCS. It may also be based on the maximum distance at which the flight inspector is able to verify obstacle clearance based on map study, direct observation, below-path approach run, or other applicable means. A restriction is not required when the OCS is clear to 8 nm (4 nm for 2-box PAPIs on utility runways).

(iii) When the usable distance must be restricted, the restricted distance must provide a safety buffer of at least one-half nautical mile inside the obstacle penetration location. For example, if the OCS is penetrated at 2.7 nm from the threshold, the restricted usable distance can be no greater than 2.2 nm. The restricted usable distance may be as small as 1.3 nm from threshold. Ensure the appropriate remarks are entered in the A/FD or similar publication. The format of the remarks <u>must</u> clearly communicate that the restriction is due to a lack of obstacle clearance. For example, "PAPI Rwy 12 does not provide obstruction clearance beyond 2.2 nm from threshold."

(iv) When an obstacle/penetration is limited to one side of centerline, it may be practical to physically baffle the light signal so it is not visible in the vicinity of the penetration. This could be a way to avoid a restriction on usable distance. When a VGSI light signal is physically restricted in azimuth with baffling to remove coverage in the area of a penetration, ensure the VGSI signal is not visible in the vicinity of the obstacle(s). Normally, any such baffling should not eliminate VGSI coverage on the runway centerline extended. Some VGSI facilities may be rotated to align with offset approach paths.

(v) Evaluate obstacle clearance within the lateral limits of the visible light beam, even if it means going <u>outside</u> the standard 10° to 10° obstacle protection area centered on the runway. If an obstacle outside the standard 10° azimuth poses a risk to aircraft maneuvering to land, the azimuth spread of the light beam shall be suitably restricted so that the object remains outside the confines of the light beam.

(vi) Although VGSI installation criteria establishes that the lowest on-path indication clears all obstacles by at least one degree, it is not practical nor required for flight inspection aircraft to measure this clearance. If there is any doubt about the clearance from a particular obstacle, document and forward the pertinent information for further analysis. Questionable obstacles should be evaluated by survey or other appropriate means prior to completing a satisfactory inspection. Ask that the VGSI be removed from service until the issue is resolved.

(d) Other Considerations. Make approaches on runway centerline extended and along each side of the approach area from a distance where terrain or obstacles may first be a factor. If the lateral coverage extremities can be checked for obstacle clearance while flying the runway centerline track, a single inbound run may be used. A definite climb indication must be evidenced by the system while maintaining clearance above all obstacles. If necessary, use a theodolite to verify a critical obstacle. The following climb indications must be visible while maintaining clearance above all obstacles:

(i) VASI. A definite RED/ RED light must be visible on both upwind and downwind bars while maintaining clearance above all obstacles.

(ii) PAPI. A definite RED must be visible on all light boxes while maintaining clearance above all obstacles.

(iii) PVASI/ HAPI. A definite flashing RED must be visible on the light unit while maintaining clearance above all obstacles.

(iv) T-VASI. A definite RED must be observed on all 4 horizontal and all 3 vertical lights while maintaining clearance above all obstacles.

(5) System Identification/ Contrast

(a) General. VGSI(s) must provide a glidepath which is easily identifiable and readily distinguishable from other visual aids and aeronautical lights within the runway threshold and touchdown zone area.

(b) Positioning. This evaluation is conducted during the other flight inspection maneuvers.

(c) Evaluation. During the flight inspection maneuvers, observe if any surrounding lights or aircraft on taxiways interfere with the identification or use of the installed system. If there is any question of misidentification or interference, this inspection parameter should be checked at night. If a specific problem can be identified during the day, there is no requirement to confirm it at night.

(6) Radio Control

(a) General. Commissioning flight inspection of the radio control system for VGSI(s) is only necessary when the VGSI(s) require a commissioning flight inspection in accordance with Paragraph 7.3.a. When a commissioning flight inspection is not required, a check should be accomplished to verify system operation until a surveillance flight inspection can be performed.

Prior to a commissioning/ surveillance inspection, the flight inspector should consult with the appropriate personnel to determine operational procedures and correct transmitter keying sequences.

(b) Positioning. The aircraft should be positioned 4 - 5 miles from the airport at minimum line-of-sight altitude.

(c) Evaluation. The sensitivity of the VGSI's ground radio control should be adjusted to allow facility activation when a proper radio signal is transmitted. Check for standardization of radio controlled lighting operations, as depicted in the Airmen's Information Manual. If Pilot-Controlled Lighting is inoperative, initiate NOTAM action and attempt to contact airport authority to have the lights manually activated for night or IFR use.

(7) Coincidence (ILS/ MLS/ PAR/ GBAS GLS/ WAAS LPV).

(a) General. When VGSI(s) and electronic glidepath information serve the same runway, the visual approach path will coincide with the one produced electronically. VGSI installations are engineered to provide close RRP coincidence with the RPI (ILS, MLS, PAR) or the GPI (GBAS GLS, WAAS LPV), using the same commissioned angle for both systems. Siting conditions affecting the electronic aid's achieved RPI may result in achieved RPI/ RRP coincidence values beyond installation specifications, but satisfactory for use. Non-coincidence of angles and/or intercept points may be allowed, providing they are published as such. Approved waivers to electronic glide slopes must apply to VGSI systems. Instrument approach procedure design criteria for VGSI coincidence requires the angle be within 0.2 degrees of the published SIAP glidepath/ vertical descent angle, and the VGSI TCH must be within 3 feet of the published SIAP TCH. When design criteria for coincidence are met, a visual evaluation by flight inspection should be made to confirm the VGSI is coincident. The visual glidepath must coincide in the area between 6,000 feet and 1,000 feet prior to the threshold such that there are no conflicting indications that may result in pilot confusion.

(i) Height Group 4. Some PAPI and PVASI are installed to serve aircraft in Height Group 4 (JO 6850.2, Visual Guidance Lighting Systems). The RRP of these systems is engineered to be 300 – 350 ft down the runway from the electronic RPI. PAPI or PVASI sited to support height group 4 must be identified in Airport/ Facility Directories or similar publications.

(ii) Barometric Vertical Navigation (VNAV). Do not fly a Baro-VNAV based glidepath to check coincidence with a VGSI. Instead, mathematically check the measured effective visual glidepath for the VGSI against the published path angle for the approach procedure. This is because the actual aircraft in-flight path using Baro-VNAV will vary with temperature. RNAV approach procedures with FAS data blocks like LPV and GLS define a fixed path angle that does not vary in space, and therefore can be flown to evaluate VGSI coincidence.

(b) Positioning. For systems installed to support aircraft in Height Groups 1, 2, and 3, fly the electronic glide slope from approximately 2 nm to threshold. For PAPI/ PVASI installed for Height Group 4, independently fly both the electronic and visual glide slopes. While flying the visual glide slope, monitor or record the ILS/ MLS/ GLS/ LPV glide slope for expected ILS/ MLS/ GLS/ LPV displacement at the 6,000 ft and 1,000 ft points.

(c) Evaluation. Compare the electronic and visual glide slopes in the area between 6,000 ft and 1,000 ft prior to threshold for coincidence of runway point-of-intercept. To be considered coincident, the VGSI system's effective visual glidepath angle as measured by flight inspection must be within 0.2 degrees of the instrument approach procedure's design path angle. For commissioning, both angles should be optimized if possible. For PAPI/ PVASI sited for Height Group 4 aircraft, compare the achieved runway intersection points of both systems.

4. Analysis. Many factors, such as snow, dust, precipitation, color of background, terrain, etc., affect the pilot's color interpretation of the VGSI. Some deterioration of system guidance may occur as the pilot approaches the runway threshold due to the spread of light sources and narrowing of individual colors.

5. Tolerances. Classification of the system based on flight inspection results is the responsibility of the flight inspector. All systems must meet these tolerances for an unrestricted classification. USAF/ USN may commission facilities that do not meet the criteria for visual glidepath angle, glidepath coincidence, or RRP. VGSI system angle and the runway served are included in the routine FSS/ commissioning message for appropriate publication.

a. Light Intensity. All lights must operate at the same relative intensity at each setting.

b. Visual Glidepath Angle.

(1) The visual glidepath is normally 3.0°, unless a different angle is necessary for obstacle clearance or special operations. The angle must be published in the Airport/ Facility Directory or similar publication.

(2) The effective glidepath angle must be within 0.20° of the established or desired angle.

(3) The visual and electronic glide slopes must coincide in the area between 6,000 ft and 1,000 ft prior to threshold such that there are no conflicting indications that may result in pilot confusion. For PAPI/ PVASI sited to support aircraft in Height Group 4, coincidence must be considered satisfactory if the visual glide slope intersects the runway 300 to 350 ft past the point where the electronic glide slope intersects the runway.

c. Angular Coverage. The VGSI(s) must provide guidance relative to the approach angle over a horizontal angle of not less than 10° either side of the runway centerline extended. Coverage may have been restricted using blanking devices or baffles to position an obstacle penetration outside the lateral limits of the observable light beam. When coverage is less than 10° either side of runway centerline, including as a result of rotated alignment, restrict the facility, issue a NOTAM, and ensure publication in the Airport/ Facility Directory.

d. Obstacle Clearance. A definite fly-up indication must be visible while maintaining the required clearance above all obstacles within the commissioned operational service volume. When the usable distance is limited due to terrain or obstructions, a suitable NOTAM will be issued and the reduced coverage area and obstacle clearance warning will be published in the Airport/ Facility Directory.

e. System Identification/ Contrast. The system must provide a glidepath signal which is easily identifiable and readily distinguishable from other visual aids and aeronautical lights within the installed environment. Misidentifying or failure to readily acquire the VGSI system will require an unusable status designation.

6. Adjustments. See Chapter 4, Section 3.

Figure 7-1. VASI-2 System Layout.

Figure 7-2. VASI-4 System Layout.

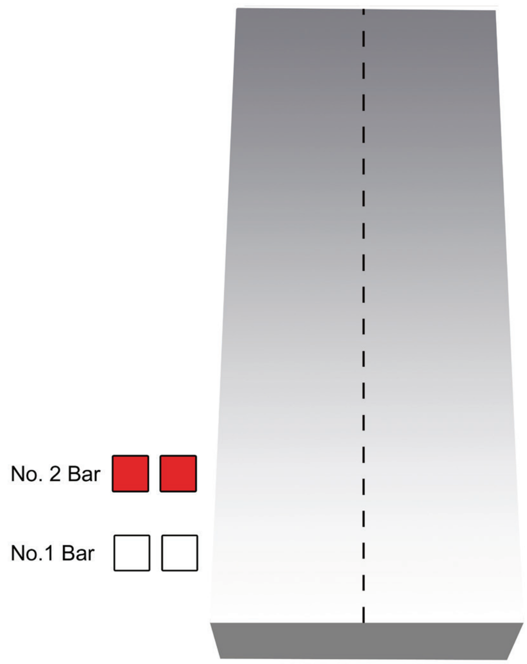


Figure 7-3. VASI-12 System Layout.

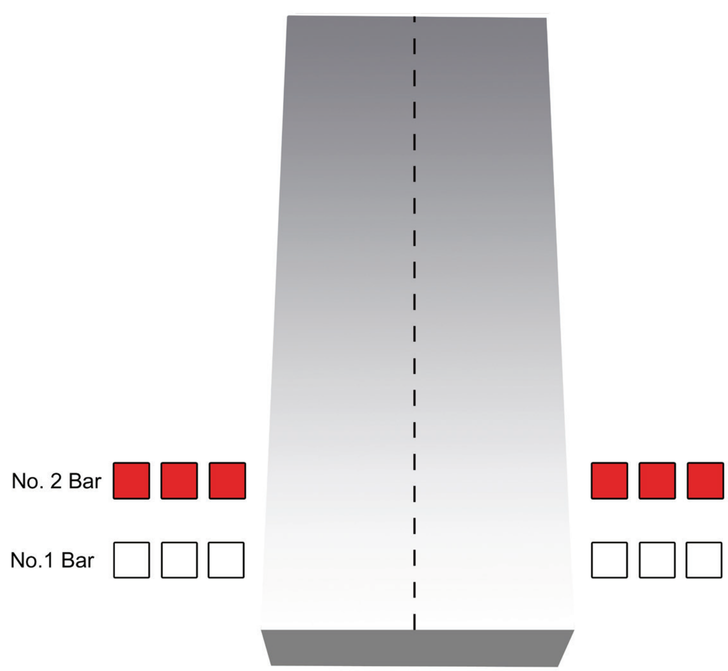


Figure 7-4. Aiming and Obstruction Clearance Diagram for 2-Bar VASI.

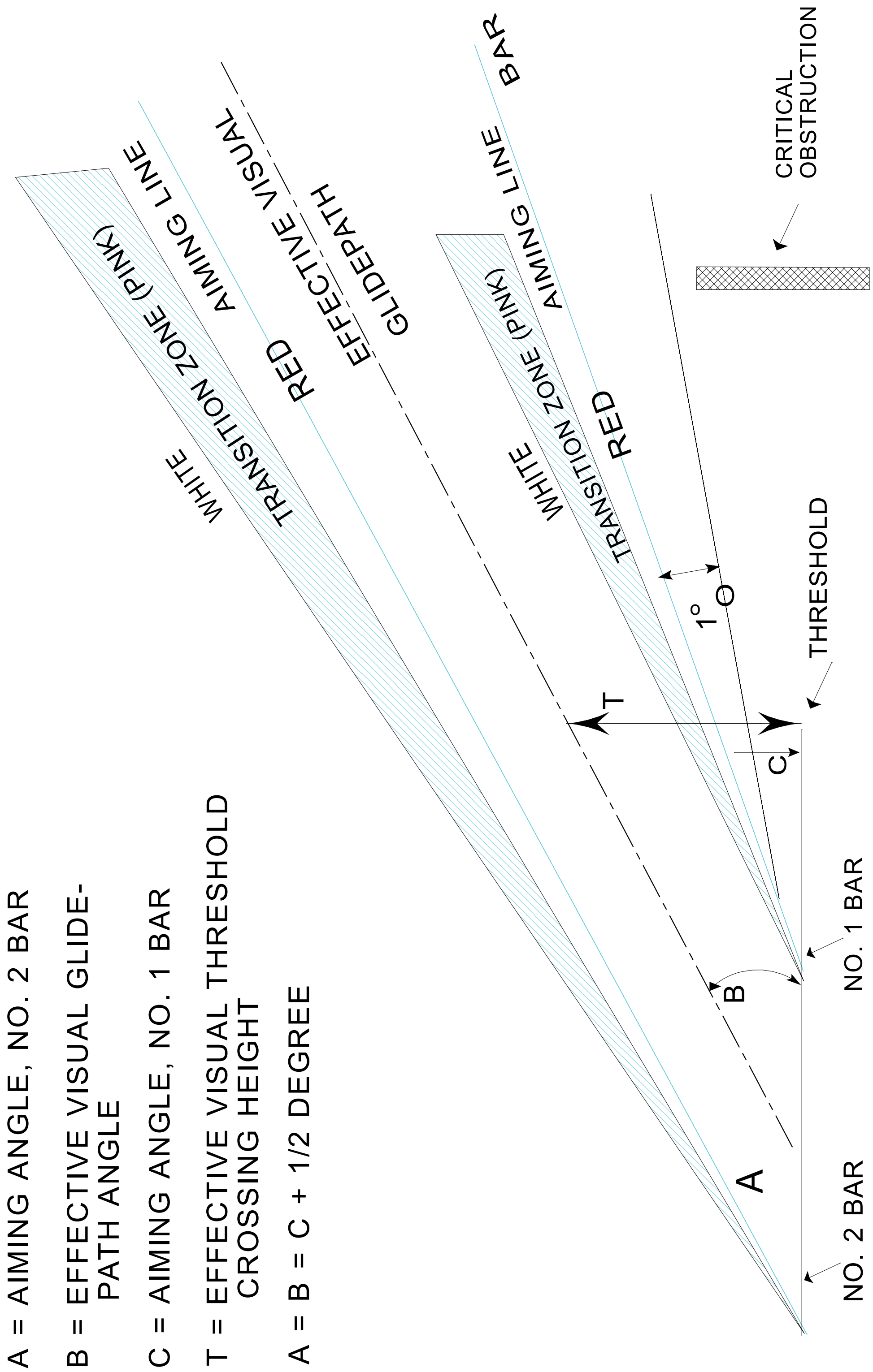


Figure 7-5. Walker 3-Bar VASI System Layout (VASI-6).

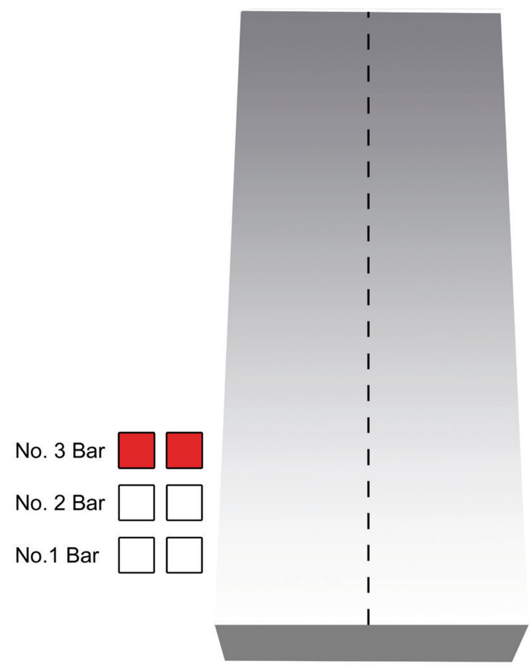


Figure 7-6. Walker 3-Bar VASI System Layout.

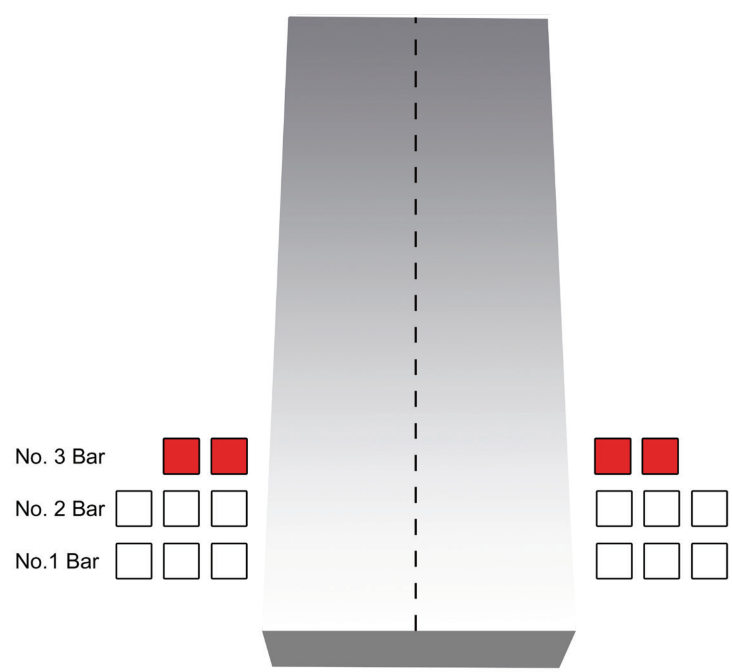


Figure 7-7. Aiming and Obstruction Clearance Diagram Walker 3-Bar VASI.

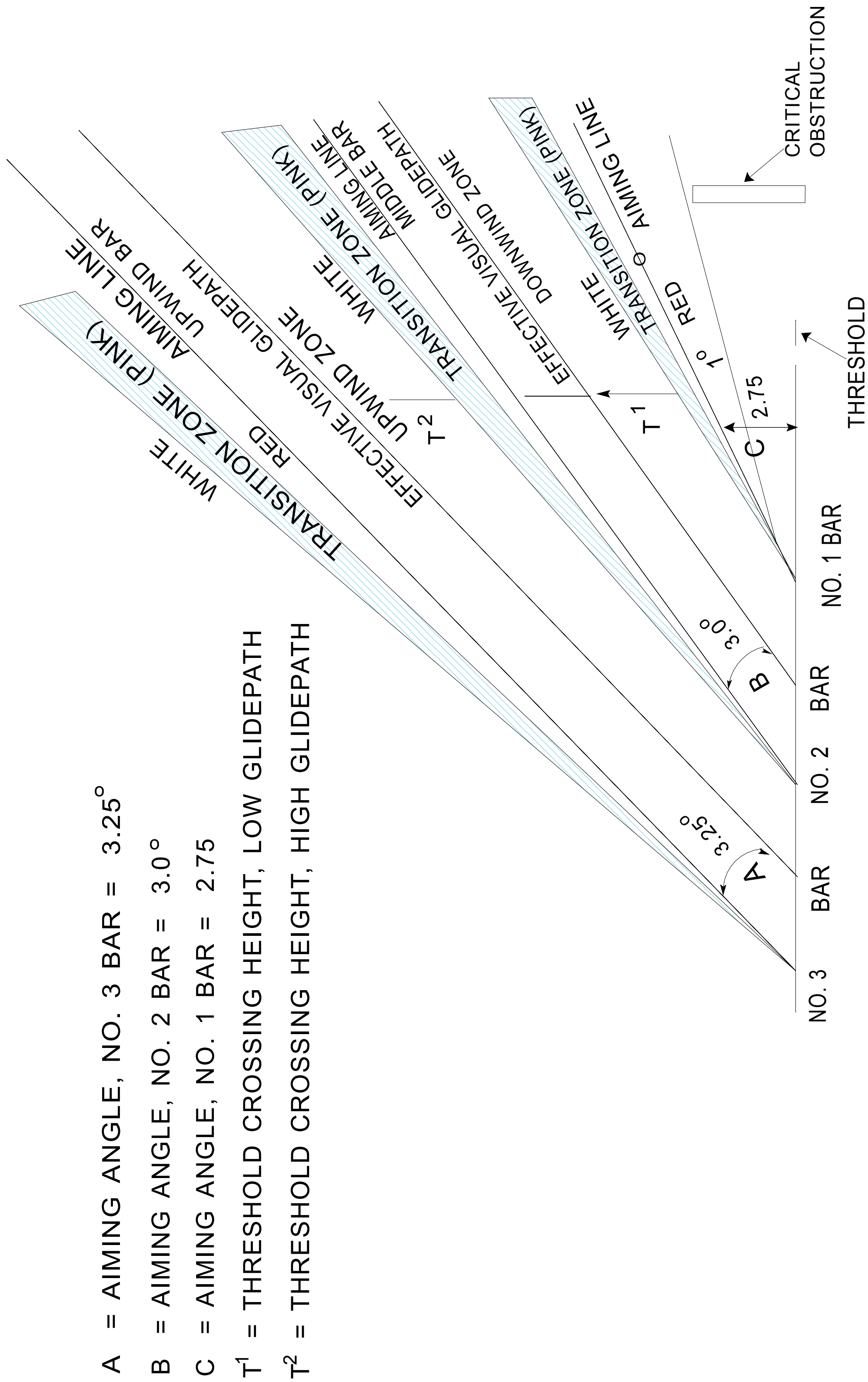


Figure 7-8. PAPI Approach Path (Side View).

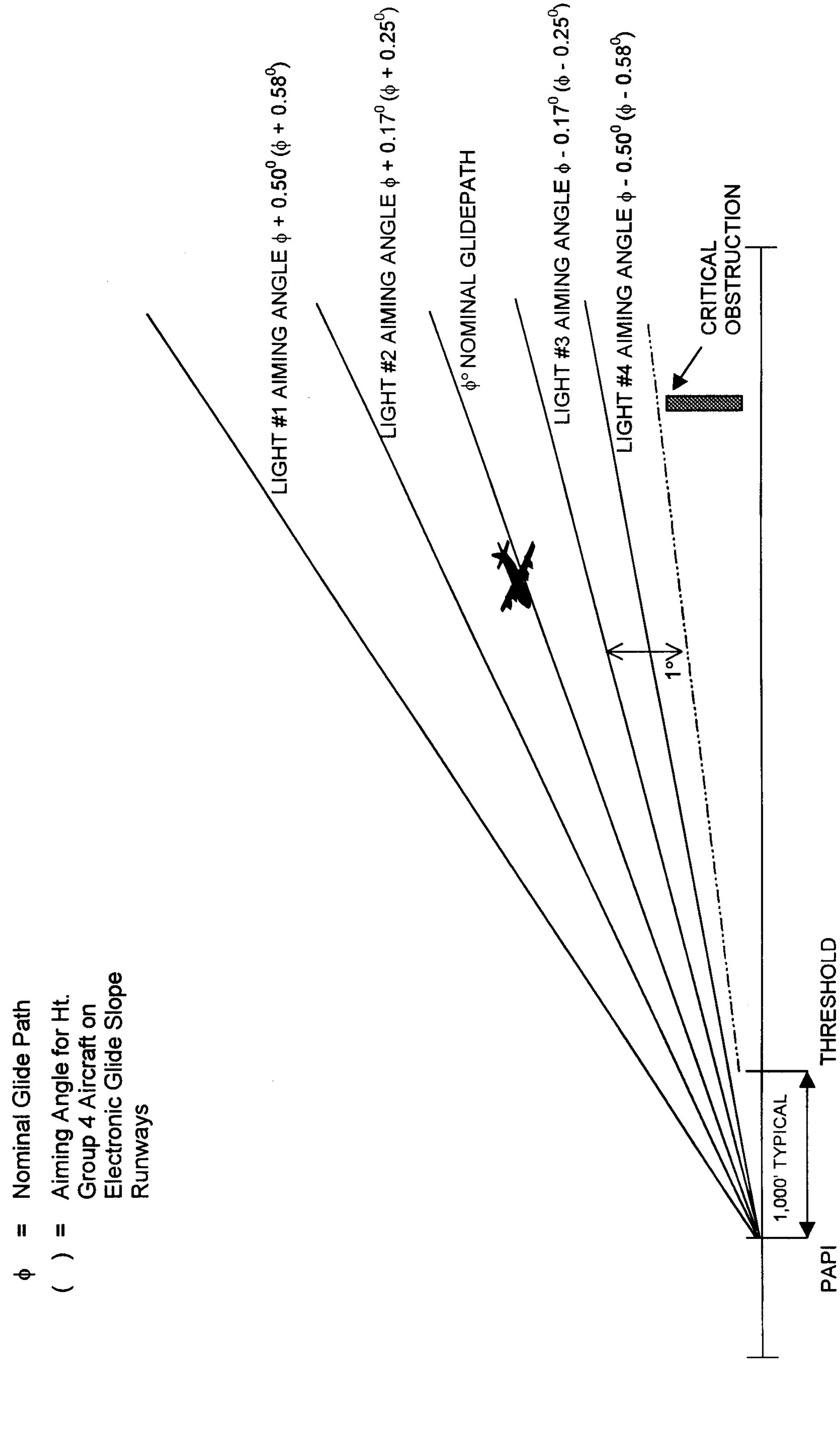
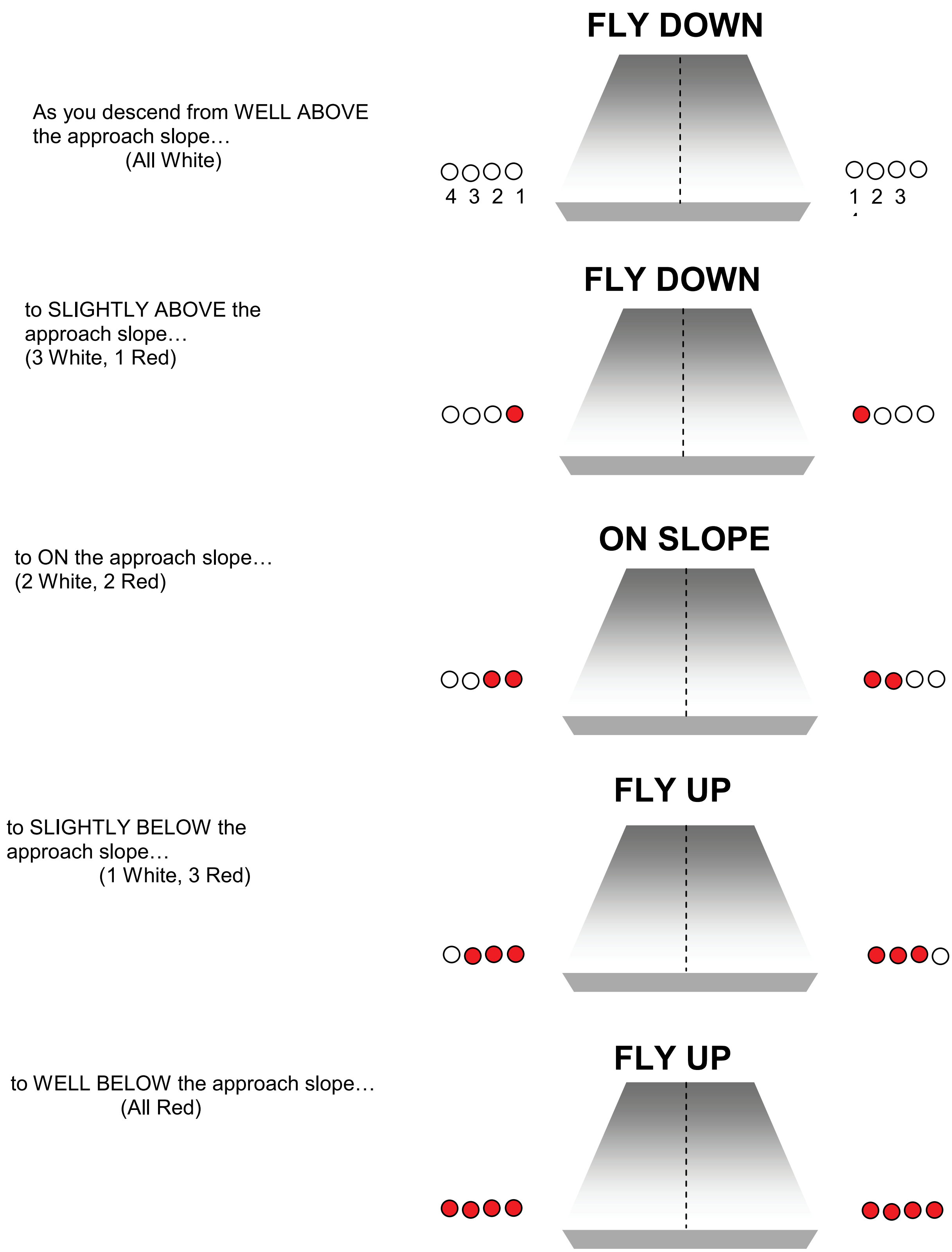


Figure 7-9. PAPI.



…there is a progressive change from all white to all red lights.

Note: Normal installation is left side only, but may be both sides or right side only.

Figure 7-10. PVASI Approach Path (Side View).

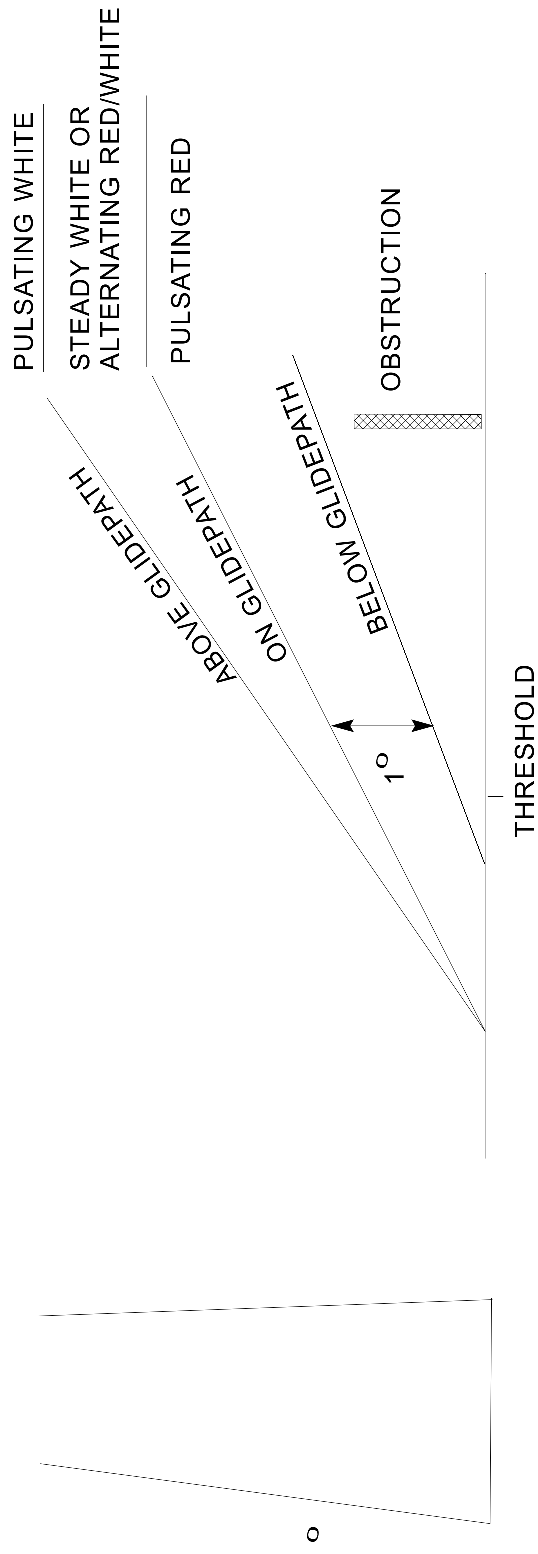
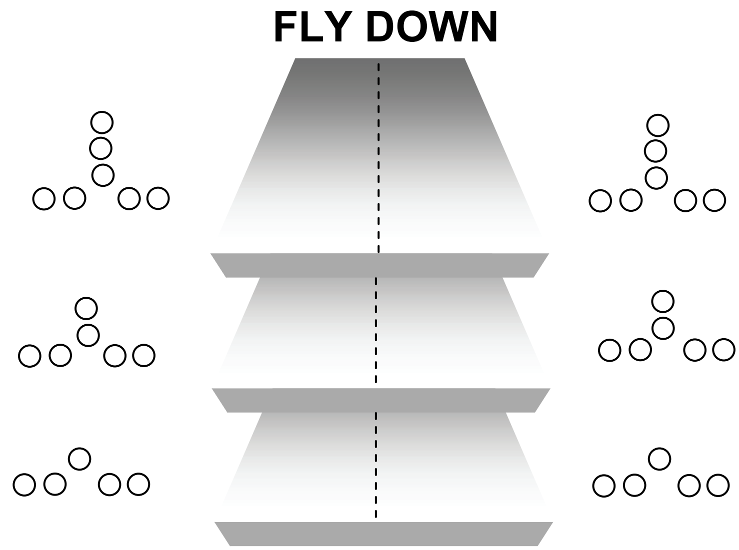
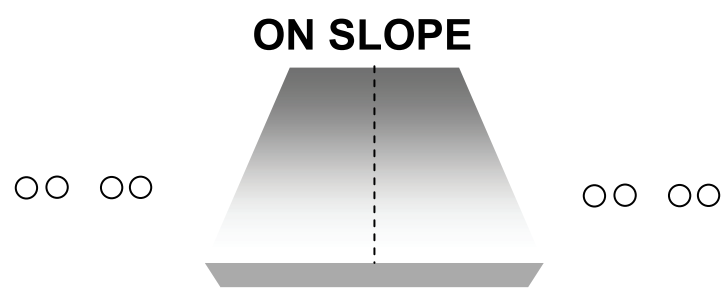


Figure 7-11. T-VASI.

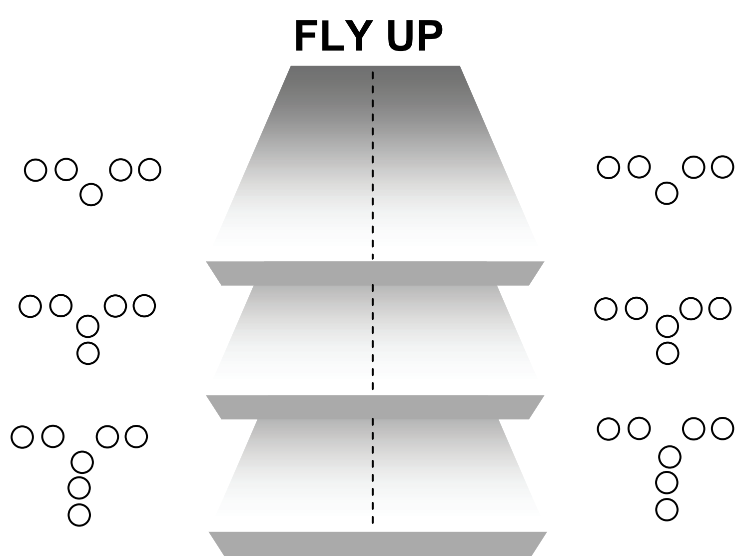
As you descend from WELL ABOVE the approach slope, the lights in the upper stem of the “ “ will progressively disappear until…
⊥



you are ON the approach slope….



Then if you descend BELOW the approach slope, the lights in the lower stem of the “T” will progressively appear.



If all the lights of the “T” turn RED, you could be in serious trouble!

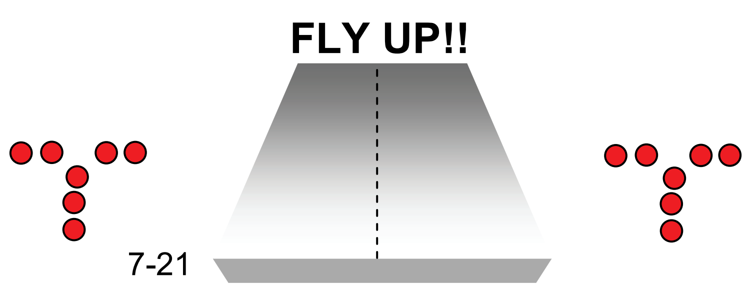


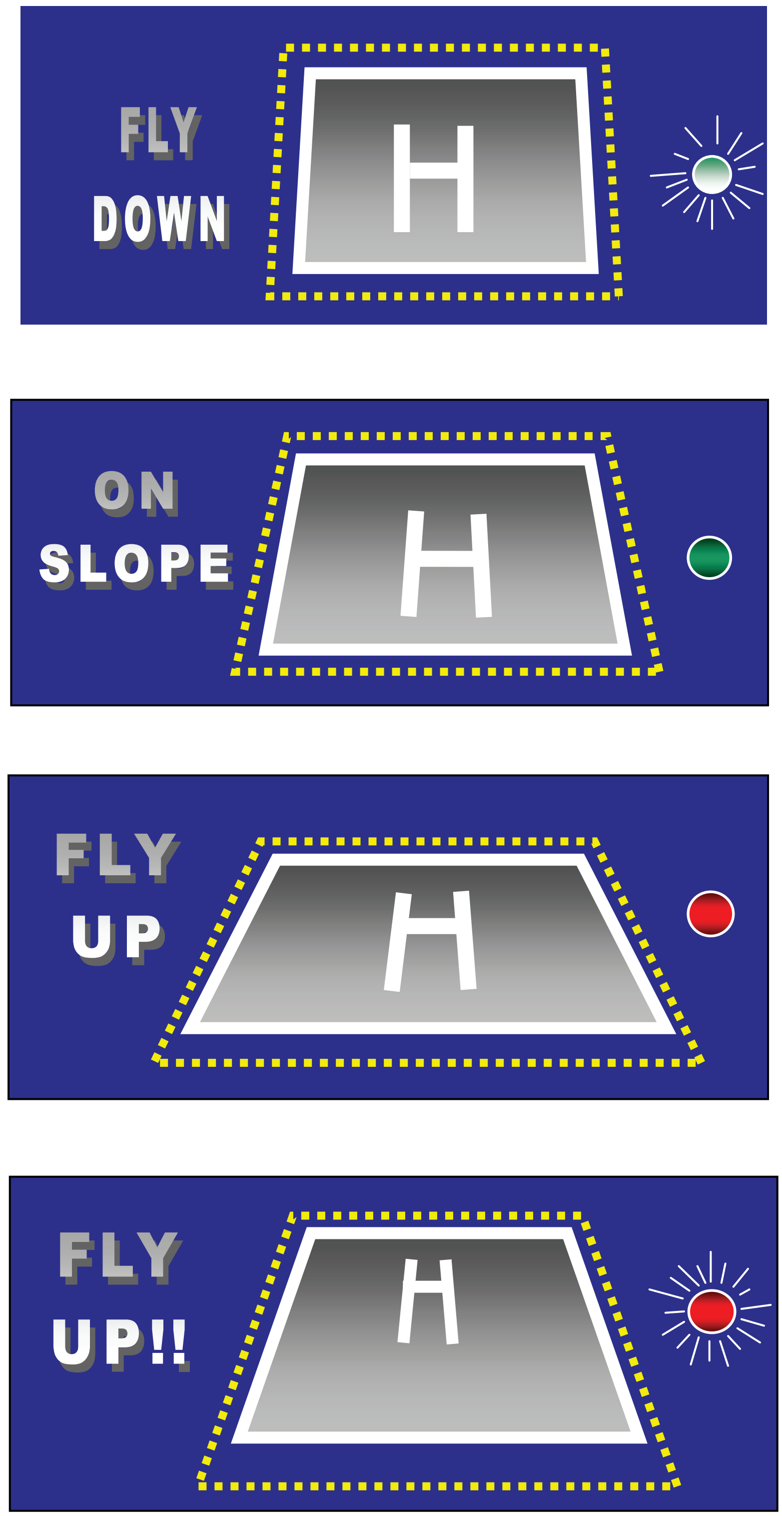
Figure 7-12. HAPI.

ABOVE
The approach slope…
(flashing green)

ON the approach slope…
(green)

SLIGHTLY BELOW
the approach slope…
(red)

TOO LOW!!
(flashing red)



Section 2. Approach and Runway Lights.

7. Introduction. An approach lighting system is a configuration of signal lights disposed symmetrically about the runway centerline extended, starting at the runway threshold and extending outward into the approach zone. This system provides visual information on runway alignment, height perception, roll guidance and horizontal references. Approach lighting systems are designed to improve operational capability and safety of aircraft during approach and landing operations, particularly during the hours of darkness and/or reduced visibility. Although these facilities are considered visual navigational facilities, they are used with electronic landing aids, and generally will support reduced visibility minimums. In order to meet the objective of improved safety, the approach lighting system configurations and equipment must be consistent and suited to operational requirements.

a. Category I Approach Lighting System, Sequenced Flashers, (ALSF-1), (Figure 7-15. Lighting System Configurations.). This is a Category I approach lighting system with sequenced flasher lights. It consists of a light bar containing five lamps at each 100-foot interval starting 300 ft from the runway threshold and continuing out to 3,000 ft (total of 28 centerline bars). Light bars are installed perpendicular to the runway centerline extended, and all lights are aimed away from the runway threshold. The centerline light bar at 1,000 ft from the threshold is supplemented with eight additional lights on either side, forming a light bar 100 ft long and containing 21 lights. This bar is called the 1000-foot bar. All of the aforementioned lights are white in color. The terminating bar, installed 200 ft from the threshold, is 50 ft long and contains 11 red lights. Wing bars or pre-threshold bars, each containing 5 red lights, are located 100 ft from the threshold, one on either side of the runway. The innermost light (nearest runway centerline) of each wing is located in-line with the runway edge lights. The threshold bar is a row of green lights spaced 5 to 10 ft apart which are located near the threshold and extended across the runway threshold to approximately 45 ft from the runway edge on either side of the runway. The ALSF-1 operates on five intensity settings of 100%; 20%; 4%; 0.8%; and 0.16%. This system may be authorized for approval of Category II minima by appropriate authority.

b. Category II Approach Lighting System, Sequenced Flashers, (ALSF-2), (Figure 7-15. Lighting System Configurations.). The ALSF-2 is the standard Category II approach lighting system and differs from the ALSF-1 system only in the inner 1,000 ft (nearest the runway threshold) with the outer 2,000 ft being identical for both. The terminating bar and wing bars of the ALSF-1 configuration are replaced with centerline bars of 5 white lights each. In addition, there are side row bars containing 3 red lights each on either side of the centerline bars at each light station in the inner 1,000 ft. Also, this system has an additional light bar (4 white lights each) on either side of the centerline bar 500 ft from the threshold. These lights form a crossbar referred to as the 500-foot bar. The ALSF-2 operates on five intensity settings of 100%; 20%; 4%; 0.8%; and 0.16%.

c. Sequenced Flashers for ALSF-1 and ALSF-2. In addition to the steady burning lights, both configurations are augmented with a system of sequenced flashing lights. One such light is installed at each centerline bar starting 1,000 ft from the threshold, out to the end of the system 3,000 ft from the threshold. Sequenced flasher lights on U.S. Air Force installations will commence 200 ft from the runway threshold. These lights sequence toward the threshold at a rate of twice per second. They appear as a ball of light traveling in the direction of the landing runway threshold at a very rapid speed.

d. Simplified Short Approach Lighting System (SSALS), (Figure 7-15. Lighting System Configurations.). This is a 1,400-foot system, uses the standard ALS centerline light bar hardware, and is capable of being upgraded to a standard 3,000-ft system. It consists of seven light bars of five white lamps each, spaced 200 ft apart, beginning 200 ft from the threshold. Two additional light bars, containing five white lamps each, are located on either side of the centerline bar at 1,000 ft from the runway threshold, forming a crossbar 70 ft long. All lights in this system operate on three intensity settings of approximately 100%; 20%; and 4%.

e. Simplified Short Approach Lighting System with Sequenced Flashers (SSALF), (Figure 7-15. Lighting System Configurations.). This system is identical to the SSALS system, except for the addition of three sequenced flashers located on the runway centerline at the outer three light bar stations. These flashers assist pilots in making early identification of the system in areas of extensive ambient background light. The sequenced flashers have an "on-off" switch and will operate on all intensity settings of the steady burning lights.

f. Simplified Short Approach Light System with Runway Alignment Indicator Lights (SSALR), (Figure 7-15. Lighting System Configurations.). This is a 3,000-foot system and is identical to the SSALS except that five sequenced flasher lights spaced 200 ft apart are added on the centerline, beginning 200 ft beyond the end of the SSALS system. The sequenced flashers have a separate on-off switch but do not have a separate intensity control; they operate with all intensity settings of the steady burning lights and runway edge lights. SSALR(s) may be incorporated as part of an ALSF-2 system for operational purposes. During IFR conditions, the full ALSF-2 system must be operating.

> NOTE: Some part-time control towers will leave just the SSALR(s) operational since Category II operations and subsequent use of ALSF-2 lights require a manned control tower.

g. Medium Intensity Approach Lighting System (MALS), (Figure 7-15. Lighting System Configurations.). This system is 1,400 ft in length, consisting of seven light bars of five lamps each, located on the runway centerline, extended and spaced 200 ft apart. Two additional light bars are located on either side of the centerline bar at 1,000 ft from the runway threshold. All lights in this system operate on two intensity settings, 100% and 10%, controlled through the runway edge lighting system.

h. Medium Intensity Approach Lighting System with Sequenced Flashers (MALSF), (Figure 7-15. Lighting System Configurations.). This system is identical to the MALS, except that three sequenced flasher lights are located at the outer three light bar stations. These sequenced flashers do not have an intensity control; they operate on both intensity settings of the steady burning lights.

i. Medium Intensity Approach Lighting System with Runway Alignment Indicator Lights (MALSR), (Figure 7-15. Lighting System Configurations.). This system is the same as a MALS configuration, except that five sequenced flashers are added on the extended runway centerline, beginning 200 ft beyond the outer end of the MALS system and extending out at 200-foot intervals to 3,000 ft. The MALSR and SSALR may have an overall length of 2,400 ft at locations where the glide slope is greater than 2.75°. The MALSR may be used with precision navigation aids, i.e., PAR, ILS.

j. Omnidirectional Approach Lighting System (ODALS) consists of seven omnidirectional flashing lights. Five lights are located on the runway centerline extended, with the first light located 300 ft from the threshold and extending at equal intervals up to 1,500 ft from the threshold. The other two lights are located, one on each side of the runway threshold. They must flash in sequence toward the runway threshold at a rate of once per second, with the two lights located on each side of the runway flashing simultaneously.

k. Runway End Identifier Lights (REIL). REIL provide rapid and positive identification of the approach end of a particular runway. REIL do not provide course alignment, descent, or altitude information. The system consists of a pair of synchronized flashing lights located laterally on each side of the runway threshold. REIL systems may be either omni-directional or unidirectional facing the approach area.

(1) Unidirectional REIL (Figure 7-P). Unidirectional REIL are installed where environmental conditions require that the area affected by the flash from the REIL will be greatly limited. Unidirectional REIL systems have a flash rate of 120 flashes per minute (± 10%), and a beam pattern of 10° vertical and 30° horizontal. Installation instructions call for the beam axis of an unbaffled unit to be aligned 15° outward from a line parallel to the runway and inclined at an angle 10° above the horizontal. If this standard setting is operationally objectionable, optical baffles are provided and the beam axis of the unit is oriented 10° outward from a line parallel to the runway centerline and inclined at an angle of 3°above horizontal.

(2) The Omni-directional REIL, (OD REIL) system provides good circling guidance and is the preferred system. OD REIL systems have a flash rate of 60 flashes per minute (± 10%), and a beam pattern from 2 to 10° above horizontal.

l. Sequence Flashing Lights (SFL)/ Runway Alignment Indicator Lights (RAIL) are the same kind of lights but are used differently with various approach lighting systems and affect visibility minimums. SFL(s) are used with precision approaches and ALSF-1/ 2 systems. Inoperative SFL(s) have no affect on Category I or III service, but deny Category II service. Runway alignment indicator lights are part of SSAL and MALS systems when used for precision approaches. Inoperative RAIL(s) result in raised Category I minimums, deny Category II service, and have no affect on Category III service.

8. Pre-Flight Requirements.

a. Facilities Maintenance. In addition to preparations contained in Chapter 4, Section 3, Facilities Maintenance personnel should ensure that all light units are operating, aimed at the proper angle, and in a clean condition.

b. Air. The flight inspector should consult with appropriate personnel to determine local operational procedures and the correct transmitter keying sequence for Radio Controlled Lights. Also see Chapter 4, Section 3.

9. Flight Inspection Procedures. These lighting system configurations are identified as the United States Standard. While there are other approach lighting system configurations in existence, no attempt has been made to describe all systems in this chapter due to the fact that they are considered as non-standard lighting systems and will not be found in quantity. Where it is necessary to make an in-flight evaluation of non-standard systems, the flight inspector must determine that they fulfill the operational requirements for which they are installed and do not create signals which might be misleading or hazardous. For airports with no prior IFR service or airports that have constructed a new IFR runway, a night flight inspection must be conducted to determine the adequacy of the light systems to support the procedure. Night IFR operations must not be allowed until the night evaluation is complete. A subsequent night evaluation may be required when lighting systems have been modified, replaced, or reconfigured, depending on the type of lighting and the extent of the modifications. Approach lights, except semi-flush lights, are aimed vertically to a point on the ILS or PAR glidepath 1,600 ft in advance of the light; therefore, it is necessary that the aircraft be positioned on the glidepath for proper evaluation. For non-precision type navigational facilities, a 3° glidepath angle is simulated for aiming purposes.

a. Checklist. The following checks will be performed on flight inspections of approach lighting systems and runway end identifier lights.

(1) Light Intensity

(2) Lamp Alignment

(3) Inoperative Lights

(4) Radio Controlled Lights

b. Detailed Procedures. A commissioning flight inspection is required for all airport lighting systems, including approach lights, REILS, runway lights, and radio control of lights, that support a public-use or military instrument approach procedure. Recurring inspections will be conducted concurrently with the periodic inspection of the primary navigational facility which the lighting system supports. The periodic inspection of the primary navigational facility will be considered complete if circumstances prohibit inspection of the lighting system, provided all other checklist items have been accomplished satisfactorily.

c. Approach Light Systems.

(1) Light Intensity. The flight inspector will have the approach lighting system sequenced through the normal intensity settings to determine that the relative brightness of each intensity setting is uniform. All light units should be operating with the proper filters in place, depending on the type system installed.

(2) Lamp Alignment. The electronic glide slope angle will determine the proper aiming points for an Approach Lighting System. It is necessary to position the aircraft on the prescribed glidepath to determine if each light and light bar is properly aimed in the system. For non-precision type instrument approaches, the lights and light bars are aimed along a theoretical glide slope angle of 3.0°. The flight inspector will identify the lights or light bars that are inoperative or misaligned; improper aiming, up or down, can be detected by positioning the aircraft above and below the normal approach path.

(3) Radio Controlled Lighting Systems. All radio controlled lighting systems associated with either a precision or non-precision Instrument Approach Procedure will be flight checked for satisfactory operation on commissioning and during subsequent periodic inspections. These light systems are activated and controlled by radio signals generated from an aircraft or a ground facility. If Pilot-Controlled Lighting is inoperative, initiate NOTAM action and attempt to contact airport authority to have the lights manually activated for night or IFR use. Some lighting systems have a photocell that prevents operation during daylight hours. Flight inspectors will verify this with airport authorities before initiating NOTAM action. This information will be added to airport data sheets.

Figure 7-13. Runway with Approach Lights.

Lighting System	No. of Int. Steps	Status During Nonuse Period	Intensity Step Selected Per No. of Mike Clicks		
			3 Clicks	5 Clicks	7 Clicks
Approach Lights (Med. Int.)	2	Off	Low	Low	High
Approach Lights (Med. Int.)	3	Off	Low	Med	High
HIRL	5	Off or Low	†	†	†
MIRL	3	Off or Low	†	†	†
VASI	2	Off	◊	◊	◊

† Predetermined intensity step.

◊ Low intensity for night use. High intensity for day use as determined by photocell control.

Figure 7-14. Runway without Approach Lights

Lighting System	No. of Int. Steps	Status During Nonuse Period	Intensity Step Selected Per No. of Mike Clicks		
			3 Clicks	5 Clicks	7 Clicks
HIRL	5	Off or Low	Step 1 or 2	Step 3	Step 5
MIRL	3	Off or Low	Low	Med	High
LIRL	1	Off	On	On	On
VASI✮	2	Off	◊	◊	◊
REIL✮	1	Off	Off	On/Off	On
REIL✮	3	Off	Low	Med	High

◊ Low intensity for night use. High intensity for day use as determined by photocell control.
✮ The control of VASI and/or REIL may be independent of other lighting systems.

d. Runway End Identifier Lights. The REIL lights will be checked for synchronization of the two lights and approximate flashing rate of 120 flashes per minute for unidirectional REIL systems, or approximately 60 flashes per minute for omni-directional REIL systems.

The aiming of the REIL system will be evaluated during a visual approach, commencing from a distance of two miles from the runway threshold on the runway centerline extended. A descent will be made at a vertical angle not lower than 2.5° (530 ft @ 2 miles) to the runway threshold. The facility will be observed for blinding characteristics and overall effectiveness of the REIL system.

10. Flight Inspection Analysis.

a. The flight inspector will observe any malfunction or noticeable defects and report such discrepancies to the persons responsible for maintenance and control of the facility. It is not intended that discrepancies found during flight inspection will result in restrictions to use of the facility unless a hazard to safety exists. For example, several lamps might be inoperative, obscured or improperly aligned, yet this condition would not have an immediate effect on overall system use. High Intensity Runway Edge Lights, Touchdown Zone, and Runway Centerline lights are required for approval of day/ night Category II

b. Minima. When any of these systems are installed, they will be inspected in the same manner as the approach lighting system, i.e., if discrepancies are observed by the flight inspector, they should be described and reported in as much detail as possible to the operating or maintenance authority for corrective action at the earliest opportunity. The Air Traffic Control facility chief or other designated authority assigned such responsibility must make the final decision regarding use of the Approach Lights, Runway Edge Lights, Touchdown Zone, and Centerline Lights and issue appropriate Notice to Airmen.

11. Tolerances.

a. Approach Lighting Systems, Runway Edge Lights, Touchdown Zone, and Runway Centerline Lights will meet the following tolerances. It is not intended that these facilities be classified in accordance with Chapter 5, Section 1 unless a hazard to safety exists.

(1) Light Intensity. The system must be capable of operating on all light intensity settings; the relative intensity of all lights must be uniform on each individual setting. Light intensity should be checked by pilot control function and controller operation.

(2) Lamp Alignment. All lamps must be aimed in both vertical and horizontal axes to provide the proper guidance along an electronic glidepath of approximately 3.0°.

(3) Inoperative Lights. For a commissioning inspection, all lights of each system must be operative, and proper filters must be in place. During routine inspection if inoperative, obscured, or misaligned lights are detected, the number and location must be noted in as much detail as practicable and this information reported to the operating or maintenance authority for corrective action.

(4) Touchdown Zone and Centerline Lighting Systems. These systems are integral parts of the Category II ILS and will conform to specified criteria. When reduced minimums have been authorized on the basis of these systems being available and operative, compliance with the below criteria is required for the application of reduced minimums. Whenever the system fails to meet the following requirements, out-of-tolerance conditions exist and the system automatically reverts to application of Category I minima.

(a) No more than 10% of the lights of the Centerline Lighting System may be inoperative.

(b) No more than 10% of the lights on either side of the Touchdown Zone Lighting System may be inoperative.

(c) No more than four consecutive lights of the Centerline Lighting system may be inoperative.

(d) More than one bar (three-light fixture) of the touchdown zone system may be inoperative; however, two adjacent bars on the same side of the system may not be inoperative. A bar is considered inoperative when all of its lights are out.

b. Runway End Identifier Lights (REIL) will meet the following tolerances. It is not intended that the facility be classified in accordance with Chapter 5, Section 1 unless a hazard to safety exists.

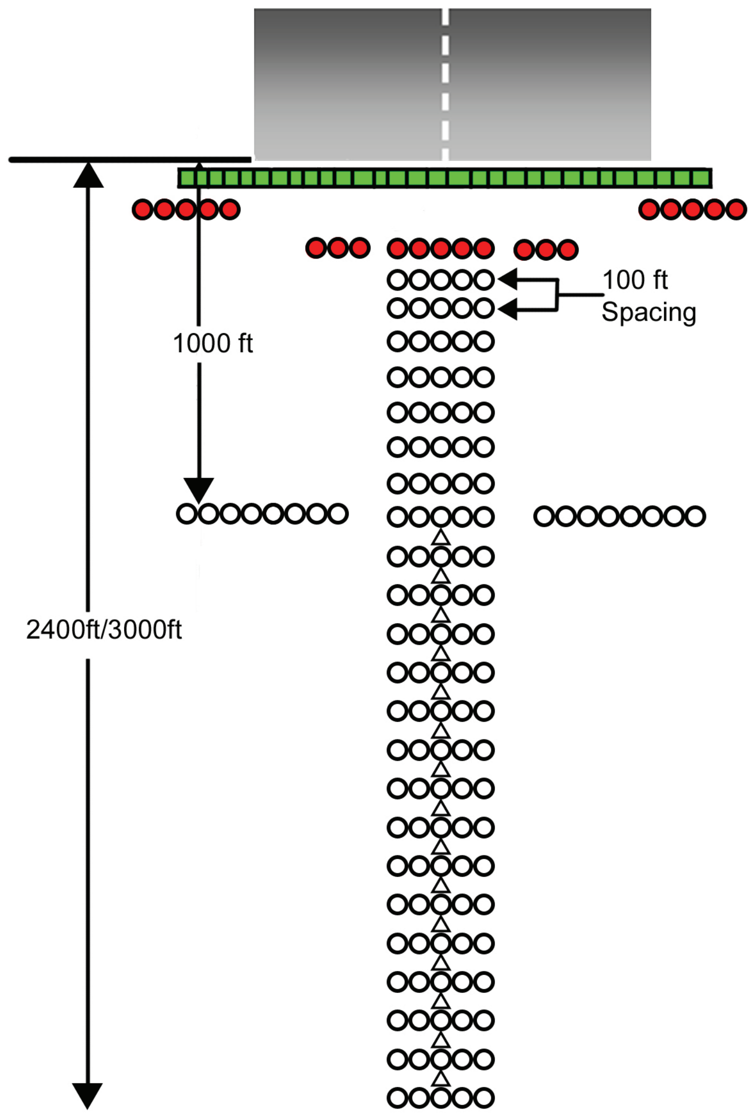
(1) Light Intensity. The lights must be oriented so that the light intensity is substantially uniform on the runway centerline extended. The character of appearance of the light must be aviation white or xenon ARC. No color is permitted, and both lights must be operative. The flashing rate can be measured best by observation from the ground; however, the flight inspector should observe this feature for grossly rapid or slow flashing rate.

(2) Lamp Alignment. The system must be aligned or shielded so as to be unobjectionable to a pilot on final approach within 1,500 ft of the runway threshold on an approach path of 2.5° or higher. If the REIL lights produce an unacceptable glare within 1,500 ft of the runway threshold, the flight inspector must request that the aiming of the lamps be adjusted.

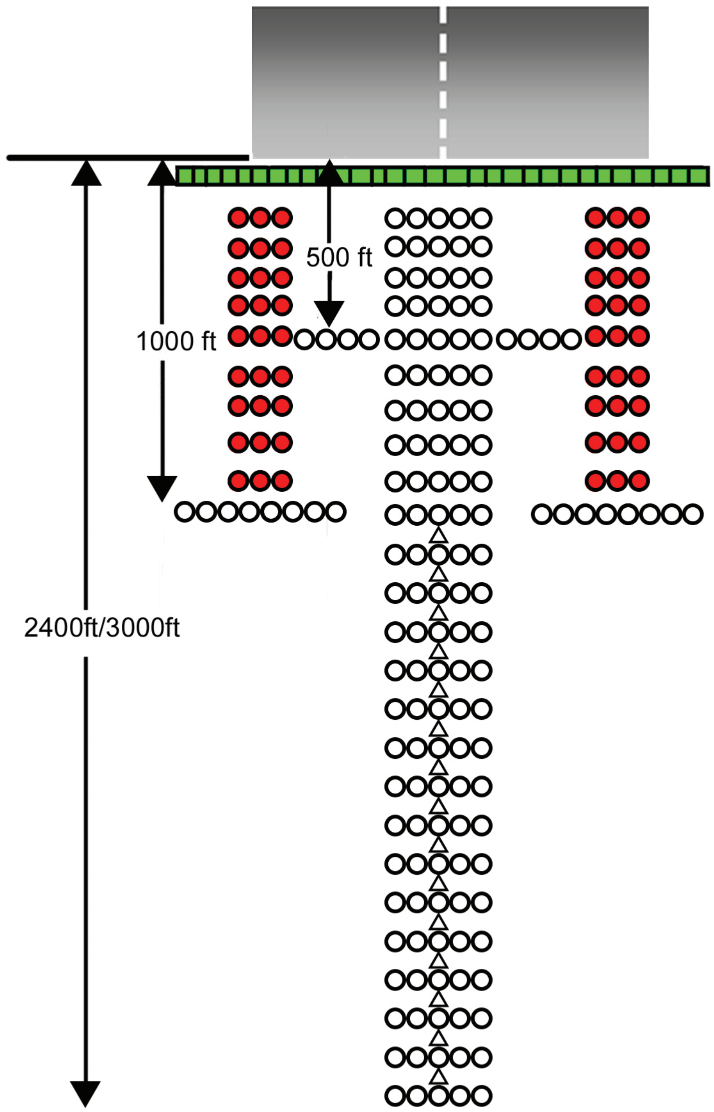
12. Adjustments. Maintenance personnel should make every effort to correct any discrepancies discovered on an approach lighting system or a REIL system during the conduct of the flight inspection of the primary navigational facility. Where a hazard to safety exists, correction of discrepancies will be made prior to further use of the system; otherwise, correction of minor deficiencies will be made as soon as possible (Ref: Paragraphs 7.10 and 4.11e).

Figure 7-15. Lighting System Configurations.

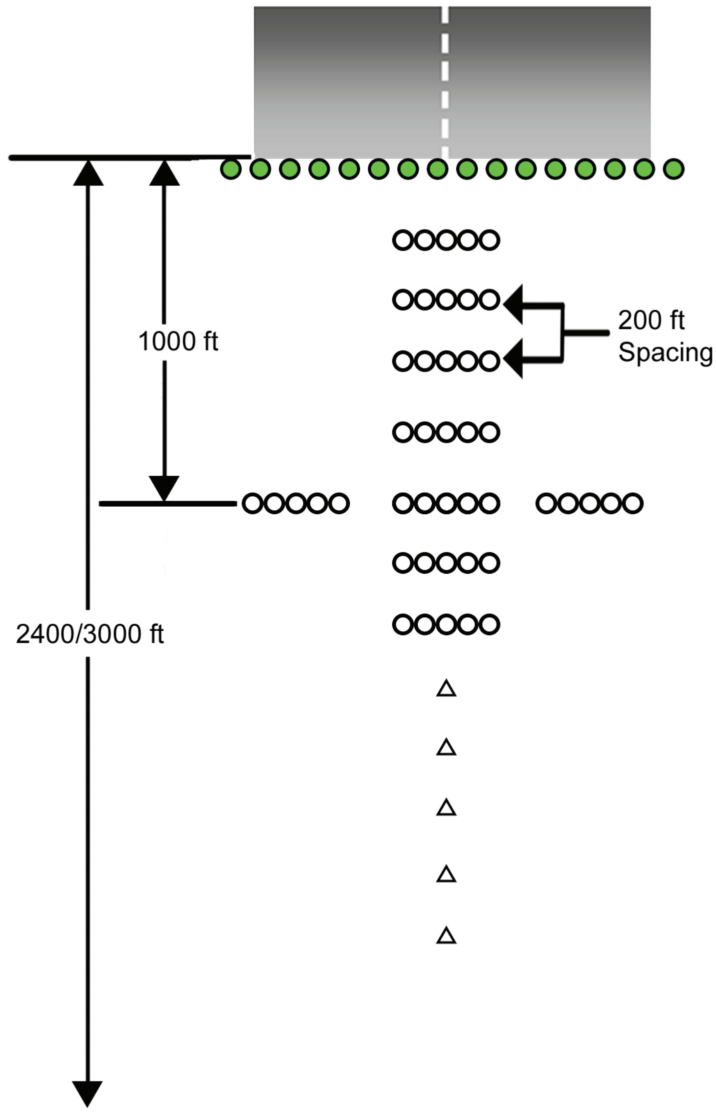
ALSF-1



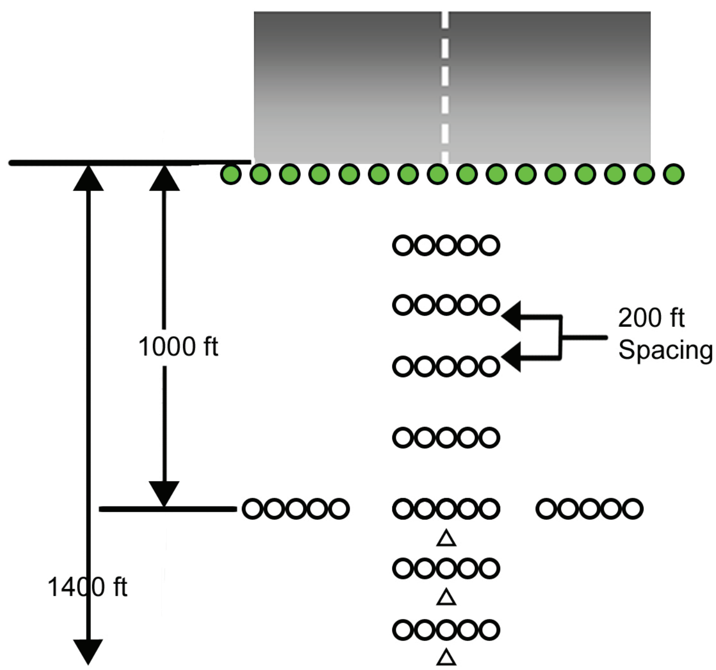
ALSF-2



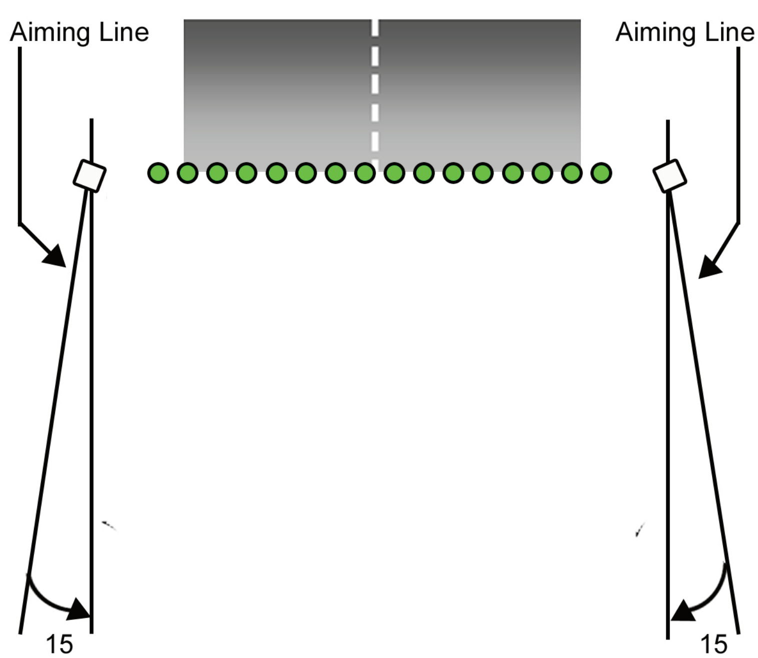
SSALR/MALSR



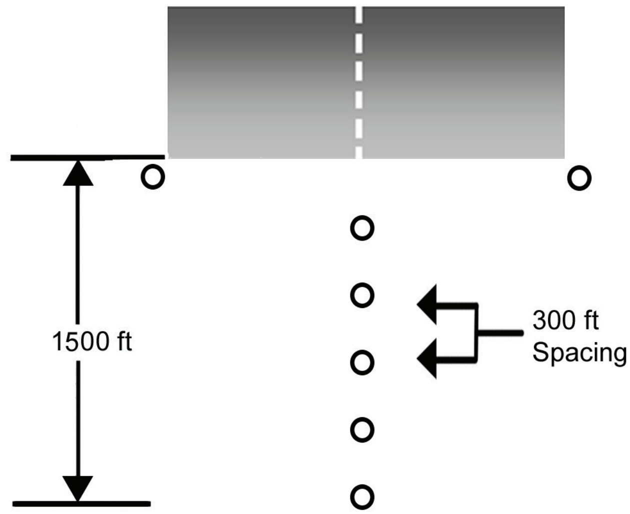
SSALS/MALS/MALSF



REILS



ODALS



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Chapter 8. Communications

Chapter 8. Communications.

Section 1. Ultra-High Frequency (UHF)/ Very High Frequency (VHF).

1. Introduction. Air/ ground communications services within the NAS are classified according to function. En route communications (ECOM) is the service provided between ARTCC controllers and pilots, and includes Remote Center Air/ Ground (RCAG) Communications and Backup Emergency Communications (BUEC) facilities. Terminal communications (TCOM) is the service provided between approach and departure controllers and pilots in terminal airspace, including RCF and ATCT facilities. FSS communications (FCOM) is the service provided between the FSS and the pilot and is advisory in nature, such as EFAS. Other advisory services include ATIS, AWOS, and ASOS, all of which may be transmitted on a NAVAID or a discrete communications frequency. Unrestricted: The status of a facility which meets established tolerances.

2. Preflight Requirements. The flight inspector must prepare for the flight inspection in accordance with the procedures outlined in Chapter 4, Section 3. Local Facilities Maintenance and Air Traffic personnel must provide coverage requirements, including tailored sector definitions.

3. Flight Inspection Procedures. The performance of communications facilities is accurately predicted by computer-aided modeling. Therefore, commissioning inspections are only required when requested by Facilities Maintenance Engineering. Periodic inspections must be conducted on a surveillance basis in conjunction with evaluation of associated navigation and air traffic control facilities.

a. Checklist

Type Check	Reference Paragraph	C	P
TCOM	8.3.c	1	2
ECOM	8.3.d	1	2
ATIS	8.3.e	1, 3	2, 3
AWOS/ ASOS	8.3.f	1, 3	2, 3
TWEB	8.3.g	1, 3	2, 3

Footnotes:
1. When requested.
2. Surveillance inspections conducted during other inspection evaluations.
3. If the NAVAID has no other voice services, verify that the voice broadcast effect on the navigation signal is within applicable tolerances.

b. Detailed Procedures

(1) Coverage. When coverage cannot be predicted by facility engineering, a flight inspection will be requested. Evaluate facilities where the minimum en route altitude (MEA) is determined by communications coverage.

(2) During requested commissioning inspections, coverage must be determined by the air traffic service requirements established locally.

(3) Flight profiles may vary according to the local requirements and could include an orbit or a detailed sector evaluation. Communications for fixes, hand-off positions, changeover points, or controlled airspace must be checked.

(4) Additional frequencies assigned to the same service requirement will not require a complete inspection, but should be evaluated on a surveillance basis.

(5) Light Gun Signals must be checked for adequate coverage on the ground and in flight.

(6) Standby equipment must be checked during any requested commissioning inspection.

c. Terminal Communications (TCOM) includes tower, ground control, clearance delivery, departure, arrival, and light gun communications. Commissioning inspections, when requested, must be conducted at the extremities of the airport to determine if there are blind spots and adequate coverage. Departure and arrival frequencies must be checked to verify service throughout the established sector volume.

d. En route Communications (ECOM) includes VHF and UHF air/ ground frequencies and BUEC channels. When requested, these frequencies must be evaluated throughout the established sector service volume.

e. Automatic Terminal Information Service (ATIS) broadcast on a NAVAID facility must be commissioned and reported with that NAVAID (see Chapter 11, Section 1). When commissioning is requested, ATIS broadcast on a discrete communications frequency must be checked in accordance with local requirements. Departure ATIS must be verified at the airport extremities.

f. Automated Weather Observing System (AWOS)/Automated Surface Aviation Observing System (ASOS). These systems provide local weather observations and may be broadcast on a NAVAID or a discrete VHF communications frequency. Transmission on a NAVAID must be verified in accordance with Chapter 11 or 12. Local altimeter settings from these systems can result in lower minimums for standard instrument approach procedures. Whenever this occurs, ensure that the associated procedure has been flight inspected to the new minimum prior to publication. When AWOS/ ASOS is used as the primary airport altimeter source, flight inspection must verify reception at or before the initial approach fix (IAF).

g. Transcribed Weather Broadcast (TWEB). This system broadcasts route-oriented data with specially prepared National Weather Service forecasts, inflight advisories, and winds aloft plus pre-selected current information, such as routine or special weather reports (METAR/ SPECI), NOTAM(s), and special notices. The data is broadcast continuously over selected L/ MF and H NDB(s) and/or VOR(s).

4. Analysis. Unsatisfactory conditions must be brought to the attention of the appropriate air traffic control and facilities maintenance personnel.

5. Tolerances

a. Maximum Recommended Coverage. Communications frequencies are engineered for distinct volumes of airspace, which are guaranteed to be free from a preset level of interference from an undesired source. Each specific function has its own frequency protected service volume. Some are cylinders, and others are odd multi-point geometric shapes. These odd shapes are normally required for en route ATC services. Following is a table of maximum altitude and radius dimensions recommended for each type of service. Under no circumstances will a service volume be approved at an altitude and distance greater than the radio line of sight (RLOS) distance (reference Figure A3-1).

	Maximum Dimensions	
Service	**Altitude**	**Distance**
ECOM		
Low Altitude	Surface to 23,000	60
Intermediate Altitude	11,000 to 25,000	60
High Altitude	24,000 to 35,000	150
Ultra-High Altitude	35,000 and above	150
TCOM		
Ground Control	100	5
Clearance Delivery	100	5
PAR (Military)	5,000	15
Helicopter	5,000	30
Local Control	25,000	30
Approach Control	25,000	60
Departure Control	25,000	60
ATIS		
Arrival	25,000	60
Departure	100	5
AWOS/ ASOS	10,000	25
NAVAID	Chapter 11 or 12	
Discrete Comm	At or before the IAF	
TWEB	Chapter 11 or 12	

b. Local Requirements. Communications service volume requirements are established by the controlling Air Traffic facility based on local operational requirements. When a flight inspection is requested, these local requirements must be validated and adjusted, if necessary, for satisfactory operation. Communications must be clear and readable.

c. Restrictions. USAF air traffic control facilities will not be restricted due to unusable radios unless the ability to provide required service is severely limited; the loss of 50% or more of published frequencies or loss of VHF/ UHF emergency capability is considered a severe limitation. Document inoperative or unusable radios and frequencies on the flight inspection report. The inoperative or unusable radio or frequency can be returned to service after a satisfactory operational check is conducted by local aircraft at a distance of maximum intended use and altitude of MVA/ MEA.

d. Light Gun Requirements

(1) Ground. Ensure adequate coverage for operational control of ground traffic.

(2) Air. Three miles in all quadrants at the lowest traffic pattern altitude.

6. Adjustments. All requests for facility adjustments must be specific. Flight inspection certification must be based on facility performance.

Section 2. Direction Finding Stations (DF).

7. Introduction. Direction finding stations use normal VHF or UHF communication transmissions from aircraft to determine bearing information from a ground station. Flight Service Station (FSS) personnel may then relay this information to an aircraft in flight to assist in determining the aircraft position. Doppler type VHF/ DF is the standard equipment within the FAA. Older equipment, such as U.S. Navy VHF and UHF/ DF facilities, may still be in use at certain locations. Operational performance and flight inspection procedures are the same for all DF equipment, with minor tolerance differences as noted in Paragraph 8.11. AFIS is the accuracy standard, but non-AFIS equipped aircraft with suitable communication equipment may perform DF inspections when operated in accordance with appropriate chapters in this manual. Direction Finding stations are normally located at or near airports and/or Flight Service Stations. Many DF facilities have the capability of providing an emergency instrument approach procedure where favorably sited with respect to an airport. Assuring the accuracy of these procedures is an integral part of the DF flight inspection.

8. Preflight Requirements.

a. Facilities Maintenance personnel must prepare for flight inspection in accordance with procedures specified in Chapter 4, Section 3. For commissioning inspections, Facilities Maintenance personnel should:

(1) Prepare a detailed outline of any special information or procedure(s) desired as an outcome of the flight inspection;

(2) Prepare the desired sequence for the inspection;

(3) Optimize the facilities equipment.

(4) Ascertain that fully qualified operators and maintenance technicians are available.

b. Flight Personnel must prepare for the DF flight inspection in accordance with procedures specified in Chapter 4, Section 3. Aircrews must:

(1) For commissioning inspections, prepare a chart with the DF facility accurately plotted and appropriate radials and a 360° orbit drawn. The scale of the chart should be 1:500,000 (Sectional) or larger, and the areas to be overflown evaluated per Chapter 6.

(2) Obtain information from Facilities Maintenance personnel pertinent to the planned inspection, including desired outcomes, expected performance, and sequence of events.

(3) For periodic inspections, obtain previous flight inspection data pertinent to the planned inspection.

9. Flight Inspection Procedures. The aircraft must be positioned precisely to determine bearing accuracy and service area. AFIS has the positioning capability to the accuracy standard required. Non-AFIS aircraft may perform the inspection if accurately plotted ground checkpoints are selected and the aircraft can be safely maneuvered over these checkpoints. Where neither AFIS nor ground checkpoint positioning is available, the theodolite must be used. The DF operator will be briefed to compute all bearings as from the DF facility, except for station passage and approach procedures.

a. Checklist. All of the checks listed below must be performed on the commissioning flight inspection. Special flight inspections may require any one or all of these checks, depending on the reason for the inspection. Periodic inspection of bearing accuracy will be conducted in conformance with this section.

Type of Check	Reference Paragraph	C	P
Preliminary Station Alignment	8.9	X	
Bearing Accuracy	8.9	X	X
Alignment Orbit	8.9	X	
Communication and Coverage	8.9	X	X
Station Passage	8.9	X	
Operator Performance	8.9	X	
Standby Power	8.9	X	
DF Approaches	8.9	X	

b. Detailed Procedures

(1) Preliminary Station Alignment

(a) Use AFIS and select an azimuth from the DF facility to establish an alignment reference. For non-AFIS aircraft, use the theodolite on a pre-determined azimuth or select a checkpoint which lies within the quadrant of the planned orbit containing the maximum number of checkpoints. At an altitude which will assure radio line of sight, obtain a DF bearing from the operator and compare this bearing with the actual bearing determined from AFIS, theodolite, or checkpoint.

(b) If the DF bearing error is less than $\pm 6^{o}$, continue an orbital flight for at least 90^{o} of azimuth. Non-AFIS aircraft will orbit in the direction of the maximum number of checkpoints; theodolite or AFIS orbit direction is at the discretion of the flight inspector and/or DF operator. If the remaining bearings in this primary quadrant are within $\pm 6^{o}$, proceed with the bearing accuracy check as required in Paragraph 8.9.b(2). If the reference or succeeding DF bearings in this primary quadrant exceed $\pm 6^{o}$ error, the equipment must be adjusted and the procedure repeated. From the preliminary check, data should be derived to balance the overall error curve.

(2) Bearing Accuracy

(a) DF coverage will not substantially exceed line-of-sight. Coverage is dependent on power output, antenna height, terrain, and the effects of signal reflection. The bearing accuracy check is conducted to determine the ability of the DF facility to furnish accurate bearings throughout the service area during commissioning, and forms the reference for other inspections. This is accomplished by comparing DF bearings from the facility with bearings measured from AFIS, theodolite, or ground checkpoints.

(b) If communications become unsatisfactory, or if bearing errors exceed tolerance, climb above the altitude being flown until adequate communications are established again and/or bearing errors are satisfactory.

(c) If communications and bearing accuracy remain satisfactory on the next measurement, descend to the appropriate selected altitude or to the minimum altitude which will provide satisfactory bearings and communications, whichever is higher, and continue to the next checkpoint. This procedure will provide the lowest altitudes throughout the coverage area of the DF facility at which acceptable bearing information and communication can be expected.

(3) AFIS Alignment and Orbit

(a) Proceed to the range appropriate to the facility and to the altitude previously determined. If HYBRID Mode is not available, use the minimum DME update altitude and plan to fly a second orbit for coverage if the minimum DME update altitude is higher than the intended use altitude. The AFIS will be programmed for the DF facility parameters (Identification, Latitude, Longitude, Magnetic Variation) inserted in the FI FAC series.

(b) For initial facility alignment (reference), the AFIS system will be programmed for an RNAV Radial flight path, Inbound or Outbound, beyond 10 nm from the DF antenna. DF bearing accuracy may be determined by comparing the operator DF bearing to the bearing displayed on the CDU. RNAV/ Autopilot coupled flight is recommended for radial or orbit maneuvers.

(c) After the initial alignment has been accomplished, an orbit CW or CCW will be programmed and flown. An event mark will be made on the recording at the position the transmitter is keyed for the DF steer; comparison can then be made to the 5^{o} bearing marks on the analog recording.

(4) Theodolite Orbit

(a) The theodolite must be aligned to read magnetic bearings from the DF station. It should be located adjacent to the DF site at a position where the aircraft will be visible throughout as much of the orbit as possible. This position should be less than 300 ft from the site. The flight inspector should brief the DF operator and the theodolite operator to avoid confusion during the actual flight inspection.

(b) The theodolite operator must track the aircraft throughout the orbit and actuate one event mark (1020 Hz tone) at each 10° of azimuth. The pilot must transmit for a DF bearing at frequent intervals and actuate the pilot event mark on the opposite side of the recording during each such transmission. The airborne technician must label each of these event marks. The leading edge of the theodolite event mark will represent the actual bearing of the aircraft from the station, and the pilot event marks will represent the DF bearing. The airborne technician will label the DF bearing as reported by the DF operator and determine the error with the use of proportional ("Ten Point") dividers.

(5) Checkpoint Orbit

(a) Position the aircraft over the predetermined checkpoints. Where possible, these checkpoints should be located at or near the limits of the DF and communication range capability to validate bearing accuracy and service area simultaneously. As the aircraft approaches the first ground checkpoint or measured bearing, the pilot must transmit a 10-second radio signal, timed so that the aircraft will be over the checkpoint in the middle of the transmission. Compare the bearing provided by the DF operator with the measured magnetic bearing. Note each DF bearing, magnetic bearing, error, radio frequency, altitude, and distance on he flight inspection report. Bearing errors must be computed in the same manner as VOR course alignment errors; i.e., when the aircraft bearing is less than the bearing reported by the DF operator, the error is negative.

(b) Proceed with the orbit of the facility at the appropriate range and altitudes, obtaining bearings as often as practical. After initial contact has been established, a 5 to 10 second radio signal is usually sufficient to obtain bearings. Because of the capability of almost instantaneous readout on the Doppler type DF, a five-second radio signal is usually sufficient to obtain bearings on this type facility.

(6) Analysis of Bearing Accuracy. After completing the bearing accuracy check, station adjustment may be necessary to balance station error and keep all bearings within tolerance. Whenever orbital bearing errors are beyond ± 6° on any type of flight inspection, verify the errors radially. If, due to the availability of ground checkpoints, the exact azimuth found suspect in the orbit cannot be verified, radially fly another inbound/ outbound radial in the same 90° quadrant. When an out-of-tolerance condition cannot be corrected, the controller must be advised of the area(s) not to be used. The condition(s) will be noted on the flight inspection report and the facility assigned a "restricted" classification. A NOTAM will not be issued.

(7) Periodic Inspections will include a bearing accuracy check at a minimum distance of 20 nm and at a minimum altitude of 1500 ft, an altitude which will provide obstacle clearance in the area, or radio line of sight, whichever is highest. A minimum of one bearing check must be accomplished on each published frequency and, if available, the VHF emergency frequency.

(8) Commissioning Inspection

(a) An orbit procedure, as outlined in this section, must be used to evaluate bearing accuracy for the commissioning flight inspection. Orbit radius must be the minimum of:

(i) 40 miles for Doppler DF facilities;

(ii) 30 miles for older equipment;

(iii)operational requirements

The altitude must be 1,500 ft above site elevation, the minimum altitude providing 1,000 ft of obstacle clearance (2,000 ft obstacle clearance in designated mountainous areas), or the minimum altitude which will provide radio line-of-sight, whichever is the higher.

(b) AFIS or theodolite bearings may be taken at frequent intervals as close together as 10°. A minimum of four bearings must be taken for each quadrant, regardless of which orbit method is used.

(9) Communications and Coverage. Voice communication is the means for getting DF information to a pilot. Quality of communications greatly affects the capability of the DF to provide quality service. Bearings must be obtained on as many of the published frequencies as practical during the checkpoint orbit. For a commissioning inspection, all frequencies proposed for use will be checked. This may be accomplished on the orbit or during radial flight at the extremes of coverage. For periodic inspections, voice communications will be checked on all frequencies if less than four are used for DF bearings. If more than four are available, at least four frequencies will be checked. The VHF emergency frequency, if available, must be evaluated during all flight inspections. Where coverage is required at greater distances for special purposes, it can be determined by either orbital or radial flight at the greater distance and altitude.

(10) Station Passage. Fly inbound to the DF antenna from a position at least 5 miles out and an altitude of 1,500 ft above the antenna. Obtain sufficient steers from the DF operator to overfly the antenna and note the distance from the aircraft to the DF antenna when the operator reports station passage. This check may be performed in conjunction with the DF approach procedure (Paragraph 8.9.b(13) at the discretion of the pilot and DF operator.

(11) Operator Performance. The flight inspector must determine that the overall system is safe and reliable. The operator should be able to direct the aircraft over the facility, report station passage, and provide pertinent information relative to the use of DF service. If an emergency approach procedure has been established (DF approaches are not SIAP(s)), the operator should be able to direct the aircraft to a position from which a safe landing can be made.

(12) Standby Power

(a) Standby power, if installed, must be checked on the commissioning inspection to ensure that no derogation of communication or bearing accuracy occurs when using the alternate power source. An orbit on each source will be performed and the bearing accuracy and overall station error compared. If standby power is installed at a later date, the facility will be inspected on standby power at the first periodic inspection scheduled after the installation of the standby power system. Inspections after a change in the standby power source are at the discretion of the Airway Facilities Engineering Division.

(b) Periodic inspections normally will not require the use of standby power systems. Airway Facilities personnel may request a check on standby power if they suspect that the alternate power source causes a deterioration in the performance of the DF facility.

(13) DF Approaches

(a) The emergency DF approach must be checked at the time of commissioning. Airway Facilities personnel or DF facility operators may request a check of the approach during any inspection if, in their opinion, verification of the procedure, obstructions, or equipment performance is desired.

(b) Conduct the approach in accordance with the DF operator's instructions and evaluate the obstacle clearance and flyability per Chapter 6. The flight inspector must note the position of the aircraft relative to the airport and determine whether it will permit a safe landing.

10. Standby Equipment. Where installed, standby equipment will meet the same operational tolerances during commissioning as the primary equipment. Periodic inspection of standby equipment is not required unless requested by Airway Facilities, Engineering, or the DF operator.

11. Tolerances. All DF stations must conform to these tolerances for an UNRESTRICTED classification. Classification of the facility is the responsibility of the flight inspector.

a. Bearing Accuracy.

VHF/ DF, UHF/ DF: Each DF bearing must be within 10^{o} of the actual bearing.

VHF/ DF (doppler): Each DF bearing must be within 6^{o} of the actual bearing

b. Coverage.

VHF/ DF UHF/ DF: 30 miles

VHF/ DF (doppler): 40 miles

c. Communications. Communications on all required frequencies must be clear and readable throughout the coverage area.

d. Station Passage. Station passage must be recognized within 1 1/2 miles at 1,500 ft AGL.

e. Controller Performance. Controllers must be capable of directing an aircraft to the station, reporting station passage, providing guidance for an emergency approach, and vectoring aircraft to avoid terrain and obstacles.

f. Standby Power. The DF facility will meet all tolerances in this chapter when operating on an alternate power source.

g. Emergency Approaches. Where a DF approach procedure is established, the system must provide the capability of directing the aircraft to a position from which a safe landing can be made.

12. Adjustments. Equipment adjustment must be made to balance the overall station error.

Chapters 9 and 10.

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Chapter 11. Rho and Theta Systems

Table of Figures

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Chapter 11. Rho and Theta Systems

Section 1. General

1. Introduction. Rho and Theta Systems include VOR, TACAN, DME, and VOR Test (VOT) facilities.

2. Preflight Requirements.

a. Facilities Maintenance Personnel. Prepare for flight inspection IAW Chapter 4.

b. Flight Personnel. In addition to the preparation outlined in Chapter 4, the flight inspection personnel must prepare charts, plot the position of the facility, and depict the orbit and radial checkpoints that will be used during the evaluations. VOT flight inspection preflight requirements are described in Section 3.

3. Checklist. The checklist prescribes the items to be inspected on each specific type of inspection. When evaluating airways or expanded service volumes (ESV(s)) of a VORTAC or VDME, both VOR and TACAN/ DME must be recorded. When inspecting a VORTAC that has published VOR SIAP(s) but no published TACAN SIAP(s), record both the VOR and TACAN component. Report the VOR component of the SIAP, and the TACAN and VOR component of the ARR and alignment orbit. Due to antenna nulling, the TACAN azimuth may not support an approach that is satisfactory for VOR use. This inability to support a TACAN approach should not incur a facility restriction. Victor airways connect VOR, VORTAC, and VOR/ DME stations and are predicated on VOR signals. When evaluating an airway of a VORTAC, do not deny the use of a Victor airway due to an out-of-tolerance value found on the TACAN azimuth or DME. If a TACAN parameter is found out of tolerance within the flight inspection standard service volume, a facility restriction and NOTAM must be required.

RHO and THETA Systems Flight Inspection Requirements

CHECK	REFERENCE PARAGRAPH	SITE EVALUATION	COMMISSIONING (12)	PERIODIC	ANTENNA CHANGE (9), (12)	FREQUENCY CHANGE (12)	FACILITY ROTATE (2), (11)
Reference Radial Check	11.4.a 11.10		X	X	X, (8)	X	X
Monitors	11.4.b		(3)		(3)	(3)	(3)
En Route Radials (10)	11.4.c 11.10		X				
Intersection Radials/ DME Fixes (10)	11.4.d 11.10		X	(5)	(5)	(5)	(5)
Terminal Radials	11.4.e	X, (14)	X,(14)	X, (6)	X, (6), (8), (14)	X, (14)	X, (6)
Orbits	11.4.f						
Coverage (10) (13)	11.4.f(2)	X	X		(3), (7)	X	
Alignment (1)	11.4.f(1)	X	X	(1)	X	X	X
Differential	11.4.f		X		X		X
Ground Receiver Checkpoints	11.4.h 11.4.h(1)		X	X	X, (8)	X	X
Airborne Receiver Checkpoint	11.4.h 11.4.h(2)		X	X	X, (8)	X	X
Standby Transmitters	11.4.i 4.17b		X	X	X, (8)	X	X
Standby Power (10)	11.4.j 4.17c		X				
Associated NAVAID(s)	11.4.k		X	X	X	X	X
Identification	11.5.a		X	X	X	X	X
Voice	11.5.b		X	X	X	X	X
Sensing and Rotation	11.5.c	X	X	X	X	X	X
Modulation Levels	11.5.d 11.5.h	X	X	X	X	X	X
Polarization (4) (10)	11.5.e	X	X	X	X	X	X
Frequency Interference	11.5.f	X	X	X	X	X	X
Course Structure	11.6	X	X	X	X	X	X
Signal Strength	11.7	X	X	X	X	X	X
DME	11.11 11.8	X	X	X	X	X	X

Notes:

(1) An alignment orbit (Paragraph 11.4.f) is required for all facilities every 1,080 days, including those facilities where VOR and TACAN components do not support a SIAP or receiver checkpoint.

(2) Required if facility rotation is more than 1° from maintenance reference alignment.

(3) Maintenance request.

(4) TACAN requirement – Check and report polarization on at least one radial.

(5) Fixes depicted on a SIAP in final approach segment must be evaluated concurrently with the SIAP.

(6) Check final approach segment of the SIAP(s). SID(s), STAR(s), and DP(s) are not required.

(7) First time replacement with a new type antenna, such as a Low Power TACAN Antenna (LPTA) or DOD OE-258 electronic antenna requires a coverage orbit and revalidation of all ESV(s) supporting a procedure.

(8) Evaluate on DME antenna change (same type antenna). Inspect the final approach segment on SIAP(s) that use DME.

(9) Also applies to a RANTEC TACAN Modulation Generator change.

(10) One transmitter only.

(11) For a Magnetic Variation Change, use the facility rotation checklist.

(12) VOR Polarization – Check at least one radial in each quadrant.

(13) ESV(s) must be revalidated any time a coverage orbit is required by this order.

(14) On site, commissioning, antenna change, frequency change type inspections, and applicable changes to the final approach segment, check VOR 5° offsets and TACAN nulls. For changes to FAF altitude of 300’ or greater on existing procedures, inspect TACAN nulls.

Section 2. VHF Omnirange (VOR and TACAN/DME Flight Inspection Specifications

4. Flight Inspection Specifications. An approved automated flight inspection system (AFIS) is the preferred method for conducting a facility flight inspection using procedures contained in appropriate agency directives. If a theodolite is used to evaluate facility performance, it must be positioned and operated by a properly trained operator. The theodolite azimuth bearings must be referenced to magnetic bearings "from" the facility. Prior to performing the checks listed below, sensing and rotation must be verified.

a. Reference Radial Check. A reference radial must be established when establishing an orbital reference and evaluated during subsequent checks. An approach radial is recommended as the reference. When course roughness and scalloping occur during an alignment evaluation, the graphic average of the deviations must be used. This reference will be used for subsequent checks of course alignment and airborne monitor reference evaluation. Determine DME accuracy as described in Paragraph 11.10.

(1) Following an antenna change, optimize the orbital alignment, then re-establish the reference.

(2) During a periodic evaluation, if the alignment is found more than 1° than previously established, perform an alignment orbit. If a change in mean course alignment of more than 1° is found, contact Facilities Maintenance. Facilities Maintenance will conduct an evaluation to determine if the change in the facility was caused by a maintenance problem or caused by an environmental change.

b. Monitor Reference Evaluation.

(1) The monitor reference evaluation determines the minimum amount of azimuth course shift required to activate the ground facility monitor alarm system.

(2) Monitor reference may be established either in the air or on the ground. Once established, the check must become the reference for all subsequent checks. The procedure for establishing a monitor reference is as follows:

(a) With the course in the normal operating condition.

(b) With the course shifted to the monitor reference point.

(c) With the course shifted to the monitor reference point in the opposite direction from Step (b) above.

(d) With the course returned to the normal operating condition.

Note: Step (d). There is no requirement that the course return to the measurement in Step (a). Monitor shifts of more than 1° will be brought to the attention of appropriate engineering personnel to determine if environmental or equipment related.

In each of these conditions, the course alignment will be compared by reference to recorded data to determine the amount of shift to the alarm point and to verify that it has returned to a normal condition.

(3) Facilities that have dual parallel monitors require a monitor evaluation on one transmitter only. Facilities that have two individual monitors require evaluations on each transmitter.

c. En Route Radials.

(1) FISSV. Radials flown to determine the facility's ability to support the FISSV must be flown at a minimum altitude of 1,000 ft (2,000 ft in designated mountainous terrain) above the site elevation, or the highest terrain or obstruction, to a distance of 40 miles for “L” and “H” class facilities, or 25 miles for "T" class facilities. The 40-mile or 25-mile distances are considered the standard flight inspection coverage distances.

(2) All radials supporting instrument flight procedures must be checked for signal quality and accuracy. Fly Airways, Off-Airway Routes, or route segments throughout the length of the intended use, at or below the minimum requested altitudes. If these radials have procedural requirements beyond the Flight Inspection Standard Service Volume (FISSV) distance, they must be inspected to the additional distances at the minimum requested altitudes.

(3) Changeover Points. The minimum en route altitude (MEA) for an airway change-over point (COP) must be the altitude where usable signals exist from the supporting stations. There is no requirement to check coverage beyond the COP.

(4) Evaluate azimuth alignment, modulations, polarization, roughness and scalloping, bends, identification, voice features, sensing, and signal strength while flying the desired azimuth.

d. Intersection Radials/ DME Fixes.

(1) Intersections are used to identify azimuth positions in space. These intersections can be used for navigational fixes, reporting points, DME fixes, COP(s), etc. Establish a minimum reception altitude (MRA) for each intersection that does not meet the minimum en route IFR altitude (MEA). The MRA is the lowest altitude where reliable signals can be received within the procedural design area.

(2) Fixes located within the FISSV. When fixes are located within the FISSV, coverage throughout the fix displacement area can be predicted (fix displacement evaluation is not required). Inspect these fixes for azimuth alignment, modulations, identification, roughness and scalloping, and signal strength along the radial track used to define the fix at the proposed procedural use altitude.

> Note: Flight inspection of ESV is described in Chapter 22 of this order.

e. Terminal Radials/ Fixes (Approach, Missed Approach).

(1) Evaluate all the radial segments that comprise the STAR, SID/ DP, or SIAP on commissioning and frequency change inspections. All final segments must be flown in the direction of intended use. Ensure the procedure is compatible with human factors (see Paragraph 6.6.c.) and the navigational guidance is satisfactory. On commissioning and frequency change inspections, the radials must be evaluated to include the holding patterns, procedure turns, approach and missed approach, or departure routings. During periodic, antenna change, and facility rotation inspections evaluate only the final approach segment of the SIAP(s). Evaluate other terminal radials on a surveillance basis.

(2) All evaluations must be conducted at the procedural altitudes except the final approach segment. This segment is evaluated from the FAF (or final descent point) descending to 100 ft below the lowest MDA to the MAP. During site, commissioning, reconfiguration, antenna change, frequency change, and applicable changes to the final approach segment, evaluate VOR radials 5° on each side of the final approach radial. Evaluate the offset VOR radials on one transmitter at the same altitudes as the final approach radial segment.

(3) When terminal fixes are located within the facility's FISSV or below the FISSV but within the standard service volume, coverage, throughout the fix displacement area, can be predicted (fix displacement evaluation is not required).

(4) During a periodic evaluation, verify that the crossing radial identifying the fix supports the procedure. Verification may be by recording trace or analysis of the cockpit instrumentation. There is no requirement to evaluate the fix displacement area.

(5) TACAN Azimuth Null Checks will be flown as follows:

(a) Approved Procedure

(i) On site, commissioning, reconfiguration, frequency change, antenna change, changes to the location of the FAF, and changes in FAF altitude of 300 ft or more on existing procedures, the following null checks are required:

- Approach radial
- 5° either side of the approach radial

The radials will be flown inbound or outbound on a level flight from 3 miles outside the final approach fix (FAF) to 3 miles inside the FAF at the lowest minimum altitude for FAF.

(b) Nulls, defined as any repeatable out-of-tolerance crosspointer action or condition of unlock usually accompanied by rapid changes in the automatic gain control (AGC) and oscilloscope indications of a loss or distortion of the 15 and 135 cycle modulation components, are not permitted in this area. If a null is found, measure the vertical angle by flight in the area described above at an altitude 500 ft above or below the minimum FAF altitude, and inform Maintenance so that the problem can be corrected if possible. If the null cannot be corrected by antenna change or height adjustment, a new procedure will be developed which will avoid the affected area. Null checks are required on only one transponder. Due to the effect of the station cone on azimuth performance, null checks are not required when the TACAN facility is located at the FAF.

(6) Commissioning Inspections. On commissioning inspections, missed approach, and SID/ DP radials for facilities located within the airfield, boundary must be evaluated from overhead the station outbound to the limits depicted for the procedure. If no termination point is depicted, the radial must be checked to where it joins the en route structure or the expected coverage limit of the facility category, i.e., 25 miles for a “T” class and 40 miles for “L” or “H” class facilities.

(7) Evaluate the radials for signal quality and accuracy. The final approach course must deliver the aircraft to the desired aiming point. Evaluate azimuth alignment, modulations, polarization (when within 5 to 20 nm of the station), roughness and scalloping, bends, identification, and signal strength when flying the radials. Evaluate the 5° offset radials for modulations, roughness and scalloping, spectrum analysis, identification, and signal strength.

(8) Facility Rotation for MAGVAR Change Inspection. Evaluate one TACAN null and VOR offset radial 5° beyond the final approach radial, IAW Paragraph 11.4.e(2), to ensure a minimum of 5° has been checked each side of the published final approach radial. For example, when the published approach radial is changed from R090 to R087, based on a MAGVAR change from 2° East to 5° East, fly R082 as the null/ offset radial. R095 will have been flown previously to support the R090 approach, and provides the 5° minimum requirement. Ensure the published facility restriction, receiver checkpoint, and ESV radials, changed per the facility rotation check, are reported on the flight inspection report.

f. Orbit Evaluations. Orbit evaluations are used to determine azimuth error distribution and signal quality. Orbit data are used as reference information. Establish reference alignment during commissioning, antenna change, frequency change, facility rotation, if no orbital reference exists, or if the ARR and alignment orbit dates on the AVNIS Data Sheet do not match. Evaluate for deviation from the reference during all subsequent orbital evaluations. When optimizing alignment, the mean orbital alignment should be within ± 0.5°, and the system differential between a collocated VOR and TACAN should not exceed 1°. For dual transmitter systems, use the primary transmitter as the reference. Inform maintenance when alignment references are established/ re-established. Notification may be accomplished through Flight Inspection Central Operations if maintenance is not on site and/or abnormal delays occur.

(1) Alignment Orbit

(a) The alignment orbit is used to determine the accuracy and optimum error distribution of the azimuth. The evaluation is conducted for 360° of azimuth. An orbit radius of 5 nm and beyond may be used when using GPS hybrid or equivalent for updating and 10 nm and beyond when using distance measuring equipment updating. When using theodolite, the orbit radius must be the maximum visual range for the theodolite operator.

The orbit may be flown clockwise (CW) or counterclockwise (CCW), but once established, it must be flown in the same direction, at the same distance and altitude, on each subsequent inspection. Compute a tapeline altitude to fly the orbit at a standard angle of 4 to 6° from the site. The objective of the check is to help Facilities Maintenance personnel determine environmental problems close in to the facility. The ratio between distance and altitude becomes critical when looking for low angle reflections or shadowing. Altitudes and distance may be modified when conditions prevent establishing them at the recommended 4 to 6° (air traffic requirements, engineering or maintenance support, and site conditions). Indicate deviations from the standard on the flight inspection report and Facility Data Sheet.

(b) If alignment cannot be determined orbitally, it may be measured by flying one radial in each quadrant. A partial orbit, augmented with radial alignment, is preferred over alignment determined solely by radial means. Notify the Flight Inspection Services Technical Services if the use of radial flight is accomplished in lieu of orbital alignment.

(c) One orbit may be flown on dual transmitter facilities during any inspection, except commissioning, by requesting transmitter changes. If sufficient transmitter changes cannot be accommodated (at least one in every 40^{o}), fly an orbit on each transmitter.

(d) During the orbit, evaluate azimuth alignment, modulations, sensing and rotation, roughness and scalloping, identification, and signal strength (a minimum of 1 evaluation every 20°). Out-of-tolerance conditions found during an orbital inspection must be confirmed by a radial evaluation before restricting a facility or issuing a NOTAM. The radial evaluations normally have priority.

(e) Course error distribution must be determined prior to rotation (if required) to achieve optimum station balance. It is not necessary to refly the orbit after this facility rotation, provided the direction and magnitude of the adjustment can be confirmed radially. Apply the confirmed azimuth shift to the alignment orbit for final error spread determination and plotting. Complete the remaining facility rotation checklist items after the rotation.

(f) Course Alignment. On periodics, if a change in mean course alignment of more than 1° is found, contact Facilities Maintenance. Facilities Maintenance will conduct an evaluation to determine if the change in the facility was caused by a maintenance problem or caused by an environmental change.

(2) Coverage

(a) This check is conducted to determine the facility's ability to support the Flight Inspection Standard Service Volume (FISSV). The FISSV must be established as follows: On "T" class facilities, the FISSV is 25 nm and 1,000 ft above facility antenna elevation, or the minimum altitude which will provide 1,000 ft (2,000 ft in designated mountainous areas) above intervening terrain or obstruction as determined by map study. On "L" and "H" class facilities, the distance extends to 40 nm, and the altitudes are the same as for the "T" class. Establish facility restrictions and performance status based on the FISSV. One complete orbit (one transmitter only) must be flown at either:

(i) The applicable FISSV

(ii) Altitudes high enough to receive in-tolerance signals. If these altitudes are higher than the altitudes in paragraph (1) above, facility restrictions and NOTAM action are required.

(b) During the orbit, evaluate azimuth alignment, modulations, sensing and rotation, roughness and scalloping, identification, and signal strength (a minimum of 1 evaluation every 20°).

(c) Out-of-tolerance conditions discovered during orbital inspections must be confirmed by a radial inspection before restricting a facility or issuing a NOTAM. An orbit segment used to establish a restriction may be defined laterally by orbital means. Radials flown through the most severe out-of-tolerance area may be used to define the distance and altitude limits of the entire segment. The radial inspection results normally have priority over orbital inspection data. In areas of multiple restricted segments, it may be appropriate to group those segments into larger, easier to understand restrictions. The advantages of this possible over-restriction in some areas must be weighed against user requirements. Fly an arc at the FISSV of the facility at the restricted altitude to encompass the restricted area to determine usable signal coverage.

(d) Procedures flown below or outside the FISSV, which are found unsatisfactory, must be denied, but a facility restriction is not required.

g. Expanded Service Volumes (ESV(s)) are required only when procedural use is predicated on a NAVAID's performance outside of the SSV, as illustrated in Appendix C, Figures A3-5A – F. Evaluate ESV(s) on one transmitter only. When required, an ESV may be revalidated by orbital flight at the ESV distance and lowest approved altitude. Lateral limits of the area should encompass allowable radial misalignment or applicable fix displacement area. There is no need to inspect the upper limits of an ESV unless interference is reported or suspected

In most applications, the VOR is the primary facility supporting procedural use (i.e., airways, fixes, intersections). When evaluating facilities supporting procedural uses, record all component signals. If any NAVAID component (i.e., VOR, TAC, or DME) does not meet flight inspection parameter tolerances, document the results as follows.

(1) Within the applicable 25 or 40 nm flight inspection service volume, complete the appropriate flight inspection report form(s) and restrict the NAVAID accordingly.

(2) Beyond the applicable flight inspection service volume but within the SSV, complete the appropriate flight inspection report form(s) and document flight inspection results on the procedures package forms. No facility restriction is required.

(3) Beyond the applicable SSV, complete the appropriate flight inspection form(s), ESV forms, noting the component(s) which will not support the ESV, and document the results on the procedures package forms. No facility restriction is required.

(4) For flight inspections beyond the applicable 25 or 40 nm distance, complete only the fields of the flight inspection report forms for the NAVAID components identified for procedural use.

h. Receiver Checkpoints are established to allow pilots to check the accuracy of their receivers. Inability of a facility to support receiver checkpoints must not result in facility restrictions.

(1) Ground Receiver Checkpoints will be established on the airport ramp or taxiways at points selected for easy access by aircraft, but where there will be no obstruction of other airport traffic. They normally will not be established at distances less than one-half mile from the facility, nor should they be established on non-paved areas. All azimuth bearings must be stable and within prescribed azimuth tolerance. Evaluate azimuth alignment, modulations, roughness and scalloping, identification, and signal strength. If a stable signal and alignment cannot be obtained at a location, select another site or establish an airborne receiver checkpoint. Ensure that surface markings and signage are correct. Observed slight variances in airport surface markings and signage should not affect their acceptability unless, in the judgment of the flight inspector, they could affect the usability of the checkpoint.

(2) Airborne Receiver Checkpoints must be designated over prominent ground checkpoints. It is preferred that such checkpoints be near an airport so they are easily accessible to users and must be at least 1,000 ft AGL. The checkpoint should not be established at a distance less than 5 miles or more than 30 miles from the facility. However, consideration should be given to selecting an area and altitude that will not interfere with normal traffic patterns. The electronic radial overlying the geographic checkpoint, rounded off to the nearest whole degree, will be the azimuth published as the receiver checkpoint.

i. Standby Transmitters. Both transmitters must be evaluated for each required checklist item, except the coverage orbit and ESV(s), which are required on one transmitter only. Alignment evaluations may be made by changing transmitters during an evaluation and comparing the azimuth course shift. Transmitter changes must not be made inside the final approach fix; however, transmitter changes made before the final approach fix are satisfactory for evaluation purposes. If comparison results are questionable, fly the approach segment on each transmitter.

j. Standby Power (reference Paragraph 4.17.c.)

(1) The following checklist items will be inspected while operating on standby power (one transmitter only need be checked):

(a) Course alignment (one radial)

(b) Course structure

(c) Identification

(d) Distance accuracy

(2) The inspections are to be performed when flying a portion of a radial with the station operating on normal power and then repeating the check over the same ground track with the station operating on standby power.

k. Associated Facilities.

(1) Inspect associated facilities concurrently with the inspection of the primary facility. These include marker beacons, lighting aids, communications, etc., which support the en route/ approach procedures and landing weather minimums of an associated approach procedure.

(2) Conduct inspections of these facilities in conformance with the detailed specifications and tolerances contained in the applicable section of this manual.

l. Crossing Radials. When a crossing radial is used to define a point in space (i.e., IAF, FAF, etc.), there is no requirement to fly it radially. The evaluation of the crossing radial is accomplished while the aircraft remains on the procedural track.

(1) For a commissioning or reconfiguration evaluation, or new procedure development, the crossing radial must be verified by recording trace analysis for azimuth alignment, modulation, identification, roughness and scalloping, and signal strength. (Alignment may be determined by manual crosspointer analysis of the crossing radial at the fix.) If the fix is not contained within the FISSV of either facility, an ESV must be established to support the procedure.

(2) For a periodic evaluation, verification may be accomplished by recording trace or analysis of the cockpit instrumentation.

5. Analysis.

a. Identification (ID). This check is made to ensure the identification is correct and is usable throughout the operational service volume.

(1) Specifications. Evaluate the identification during all checks. The facility must be restricted if the identification is not usable in all areas of required coverage.

(2) Identification Sequence

(a) VOR(s), VOR/ DME(s), and VORTAC(s) with VOR voice identification using dual voice code reproducers at dual location or single voice code reproducer at single VOR location uses the following sequence:

Identification on VOR in code.
Identification on VOR by voice.
Identification on VOR in code.
Identification on TACAN/ DME at the normal time for voice identification on the VOR.

(b) VOR(s), VOR/ DME(s), and VORTAC(s) with VOR voice identification using single voice code reproducer with dual VOR equipment: The identification sequence is the same as in Paragraph (a) above; however, synchronization will not exist between the TACAN and VOR identification. Voice identification may be heard with the keyed ident, and the flight inspector must determine from an operational standpoint if the identification is clear and that the course is not adversely affected.

(c) VOR(s), VOR/ DME(s), and VORTAC(s) without VOR voice identification uses the following sequence:

Identification on VOR in code.
Blank
Identification on VOR in code.
Identification on TACAN/ DME at the normal time for code identification on the VOR.

(3) Identification is a series of coded dots and dashes and/or voice identification transmissions that amplitude modulate the VOR RF carrier frequency. The ID enables a user to identify the VOR station.

(4) Evaluate the ID signals for correctness, clarity, and to ensure there is no adverse effect on the azimuth course structure. When it is difficult to determine what effect the ID has on the azimuth course structure because of roughness and scalloping, evaluate the same azimuth radial with the ID off and compare the results. When simultaneous voice and Morse coded ID are installed, the modulation levels are adjusted so both audio levels sound the same. These levels are approximately 30 and 8 percent, respectively.

When a voice broadcast feature is installed (ATIS, AWOS, etc.), the voice ID feature is suppressed during voice transmissions, but the Morse coded ID should still be heard. The Morse coded ID signals must be identifiable throughout the entire unrestricted VOR coverage area, including ESV(s). When the identification is unacceptable, take appropriate NOTAM action and notify Facilities Maintenance.

(5) For facilities with standby transmitters and separate standby ID equipment, use the Morse coded ID to identify each transmitter. The number one transmitter has equal spacing between all characters of the coded identification. The spacing between the second and third characters of the number two transmitter is increased by one dot.

b. Voice.

(1) The voice broadcast feature, when installed, allows a user to receive radio communications, weather and altimeter information, air traffic and airport advisories, etc., on the VOR frequency. Voice amplitude modulates the VOR carrier frequency by 30 percent.

(2) Inspect the voice for clarity to ensure there is no adverse effect on the azimuth course. Ensure that all published remote sites can respond on the VOR frequency when contacted. Maintain a periodic surveillance of the quality and coverage of the voice transmissions throughout the VOR coverage area.

(3) Advisory services that provide voice broadcast features include ATIS, AWOS, ASOS, TWEB, and HIWAS. Some services may not be continuously available. Inspect only the services available.

(4) When the voice transmissions are unsatisfactory, but the remainder of the VOR operation is satisfactory, NOTAM only the voice feature out of service. When the voice modulation adversely affects the VOR operations, the voice portion must be disabled and NOTAMed out of service, or the VOR must be NOTAMed out of service.

c. Sensing and Rotation.

(1) The sensing and the following rotation check are required at the beginning of the flight inspection. The position of the aircraft on a radial from the station must be known. Select the azimuth of the radial being flown. When the crosspointer is centered, the "TO – FROM" indicator will properly indicate "FROM" if sensing is correct. For AFIS-equipped aircraft, compare the computer-generated bearing. Sensing should be checked before rotation, as incorrect sensing may in itself cause the station rotation to appear reversed. See Appendix C.

(2) Rotation. Upon completion of the sensing check, conduct a partial orbit. The radial bearings must continually decrease for a counterclockwise orbit or continually increase for a clockwise orbit. This check may be satisfied by visually observing either cockpit or AFIS azimuth indications.

d. Modulation Levels.

(1) The three individual modulation levels associated with the VOR are: 30 Hz AM, the 30 Hz FM (or deviation ratio of the 9960 Hz subcarrier), and the 9960 Hz AM modulation of the VOR RF carrier.

(a) 30 Hz AM is optimized at 30% and is termed the "variable phase" on conventional VOR(s).

(b) 30 Hz FM (a deviation ratio of 16 is equivalent to 30% modulation value) is termed the "reference phase" on a conventional VOR. On Doppler VOR(s), it is termed the "variable phase".

(c) 9960 Hz AM is optimized at 30%. The 9960 Hz amplitude modulation of the VOR RF carrier may cause receiver flag warnings when out of tolerance.

(2) Analysis. Adjustments of modulation values may be made on any radial (within 10 to 25 miles of the facility). Modulation values must meet operational tolerances throughout the unrestricted service volume of a VOR. Determine the average modulation values or the graphical average of the recorded modulation values (when available) when fluctuations are encountered.

e. Polarization causes azimuth course variations whenever the aircraft is banked around its longitudinal axis. It is caused by the radiation of a vertically polarized signal from the VOR antennas (horizontal polarization on TACAN) or other reflective surfaces around the site. The indications are similar to course roughness and scalloping, but normally can be separated by relating the course deviations to the aircraft banking. When roughness and scalloping cannot be separated from polarization, select another radial. The evaluations should be conducted on another nearby radial in the same azimuth quadrant.

(1) Evaluation. Polarization should be evaluated any time a radial is checked and within 5 to 20 miles (inbound or outbound) from the facility. Only one radial is required for TACAN. The preferred method of evaluating for polarization is to bank the aircraft 30° around the longitudinal axis (starting on either side) returning to level flight momentarily, bank 30° in the opposite direction and returning to straight and level flight. During the aircraft banking, the tracking and heading changes must be kept to a minimum. The course deviations that occur during the 30°rolls may indicate polarization.

The indications of polarization may be influenced by course roughness and scalloping. A confirmation check is required if out-of-tolerance conditions are discovered using this method.

(2) Confirmation Procedure. Fly over a prominent ground checkpoint, located 5 – 20 miles from the facility. Execute a 30° bank and turn, holding this attitude through 360°. End this maneuver as close to the same ground checkpoint as possible. Mark the recording at the beginning and end and at each 90° change in azimuth heading. If polarization is not present, the course will indicate a smooth departure from and return to the "on-course" position, deviating only by the amount that the aircraft is displaced from the original azimuth.

f. Frequency Interference.

(1) The RF electromagnetic spectrum from 108 to 118 MHz is reserved for VOR and ILS localizer signals. Undesirable RF signals can be radiated in this frequency band that interfere with the VOR signals. Electromagnetic interference (EMI) signals can be produced by electrical manufacturing processes, power-generating facilities, etc., which may be sporadic. Radio frequency interference (RFI) may be caused by other VOR(s), harmonics of other frequencies, FM stations, etc., which are usually continuous.

(2) The VOR spectrum must be monitored for undesirable electromagnetic radiation when RF interference is suspected. When interfering radiation is observed, it is not justification for restricting the facility, unless other flight inspection tolerances are exceeded. Undesirable signals must be reported to Facilities Maintenance.

(3) Facility restrictions and NOTAM(s), established by Spectrum Management, must be identified on the Facility Data Sheet. These restrictions must not be removed by flight inspection alone.

g. TACAN Analysis. The oscilloscope, TACAN Test Set, or AFIS display/ plots) should be used for analysis of TACAN signals. The following are suggested analytical procedures, and no facility restrictions are to be applied if adjustment cannot be made or if maintenance personnel are not available for adjustment. The composite video, when displayed on the oscilloscope, will yield considerable data about the TACAN facility. The following video parameters may be measured:

(1) 15 Hz modulation

(2) 135 Hz modulation

(3) Identification train

(4) Reflections

(5) MRG size

(6) Auxiliary Reference Group (ARG) size

(7) ARG count

h. Modulation Percentage 135 and 15 Hz. Measure the modulation of each component and calculate the percentage Notify maintenance if modulation limits are exceeded.

(1) Modulation measurements are more easily and accurately made via the TACAN Test Set or AFIS. The oscilloscope should be used only when other options are not available.

(2) Identification Train. To measure the ident spacing group, adjust the oscilloscope so that the main burst is on the left edge of the graticule and the first auxiliary burst is on the right edge. When the ident is on, the reference bursts, the ident groups become very evenly spaced, and a group should appear on each division line.

(3) Reflections. Reflected signals may be detected by examining the composite video. Reflections, when present, may duplicate the normal pattern in an image pattern slightly displaced to the right. Reflections may be of sufficient amplitude to cause the pattern amplitude to oscillate or cause the modulation percentage to oscillate at a sine wave frequency dependent on velocity and position of the aircraft.

(4) Main Reference Group Size. Size refers to the number of pulse pairs in a group. For "X" channel, there should be 12 pulse pairs in the main reference group spaced 30 usec apart with spacing of each pulse in a pair of 12 usec. For "Y" channel, there are 13 single pulses in the MRG spaced 30 usec apart. If the TACAN test set indicates a discrepancy in the group size, use of the oscilloscope will identify the trouble. Advising maintenance of the condition found may ease their task of correcting the problem.

(5) Auxiliary Reference Group Size. Size refers to the number of pulse pairs in an auxiliary reference group. For "X" channel, there should be six pulse pairs spaced 24 usec apart with spacing of each pulse in a pair of 12 usec. For "Y" channel, there are 13 single pulses in a group spaced 15 usec apart. If the TACAN test set indicates a discrepancy in the group size, use of the oscilloscope will identify the trouble. Advising maintenance of the condition may ease their task of correcting the problem.

(6) Auxiliary Reference Group Count. Count refers to the number of auxiliary reference groups between North reference bursts or groups. There are eight auxiliary reference groups between North reference bursts. If the TACAN test set shows the loss of auxiliary reference groups, use of the oscilloscope will quickly identify the exact problem. Advising maintenance of the condition may ease their task of correcting the problem.

(7) Operational Limits. Measurements should fall within the following limits:

Parameters	Limit	Remarks
15 Hz Modulation	10 – 30%	Inform maintenance if graphical average exceeds limits
135 Hz Modulation	10 – 30%	Inform maintenance if graphical average exceeds limits
Identification pulse spacing	740 microseconds	Synchronized with burst.
Reflections	N/A	No derogation of facility performance.
MRG size	12 ± 1 pulse pair	
ARG size	6 ± 1 pulse pair	
ARG count	8 ± 0 burst	

6. Course Structure.

a. Roughness, scalloping, and bends are displayed on the recorder charts as deviations of the crosspointer (course deviation indicator) recording trace. Roughness will show a series of ragged irregular deviations; scalloping as a series of smooth rhythmic deviations; and the frequency of each is such that it is not flyable and must be "averaged out" to obtain a course.

b. To measure the amplitude of roughness and scalloping, or the combination, draw two lines on the recording which are tangential to and along each positive and negative peak of the course deviation. The number of degrees or microamperes between these lines will be the total magnitude of course deviations; one-half of this magnitude will be the plus and minus deviations.

c. Draw a third line equidistant from these lines to obtain the average "on course" from which course alignment is measured. Thus, the instantaneous alignment error of the course may be computed from the course recordings at any point where an accurate checkpoint has been marked on the recording. Alignment error will be referred to in degrees to the nearest tenth. Misalignment in a clockwise direction is considered positive. Where the magnetic azimuth of the measured (ground) checkpoint is greater than the electronic radial, the error is positive. (See Figure 11-2.)

d. A bend is similar to scalloping except its frequency is such that an aircraft can be maneuvered throughout a bend to maintain a centered crosspointer. Accordingly, a bend might be described as a brief misalignment of the course. Bends are sometimes difficult to discern, especially in those areas where good ground checkpoints or other means of aircraft positioning are not available. It is, therefore, important to the analysis of a bend to consider aircraft heading and radial alignment deviations. A smooth deviation of the course over a distance of 2 miles would manifest itself as a bend for a flight inspection aircraft at a ground speed of 150 knots. An aircraft of greater speed would not detect such smooth deviations of the course as a bend unless it was over a greater distance. In the analysis of bends, further consideration should be given to the flight levels and speeds of potential users. Since speed, altitude, system response, and other factors are important in the analysis of course structure, the flight inspector should carefully evaluate the flyability factor before assigning a final facility classification.

e. Application of Tolerances.

(1) The alignment of a radial is the long-term average of the data points derived by eliminating the short-term variations of roughness and scalloping and bends. Bends and the length of the measurement distance influence the measured alignment. A short measurement segment may sample only an area that is really a bend when compared to a longer measurement segment. Flight inspectors must consider the procedural needs of the radial and measure enough of the radial to define alignment in the procedural use area. Thus, a short radial segment used for an approach may be unsatisfactory due to a bend being correctly analyzed as alignment when an identical bend would be correctly analyzed as a bend from the overall alignment of a longer airway radial segment.

(2) The displacement of the course by a bend must not exceed 3.5° from either the correct magnetic azimuth or the average "on course" provided by the facility. The following two examples are offered for clarification:

(a) A radial having zero alignment error. The maximum bend tolerance of 3.5° is allowable both sides of the "on course", whether the bends occur singly or in a series.

(b) A radial having an alignment error of +2.0°. Further displacement of the course by a bend of +1.5° is allowable: this results in a +3.5° displacement from the correct magnetic azimuth. Displacement of the course of –3.5° from the average "on course" is allowable; this results in a –1.5° displacement from the correct magnetic azimuth.

(3) In the event of roughness or scalloping, or combination, superimposed on the bend, the average "on course" must be determined by averaging the total amplitude of such aberrations. This can result in a momentary displacement of the course of 6.5° where ± 3.0° of roughness is superimposed on a bend of 3.5°.

(4) The criteria for roughness and scalloping must not be applied strictly as a plus and a minus factor from the average course. Where it is apparent that a rapid deviation occurs only on one side of the course rather than in a series, the criteria must be applied as a plus or minus factor.

7. Signal Strength. During all flight inspection evaluations, the received signal must be equal to or greater than the specified tolerance.

8. DME Coverage must be recorded or annotated and evaluated to the same coverage requirements as the service (ILS/ VOR/ NDB, etc.) it supports.

Figure 11-1. Bends.
(Example – not drawn to scale)

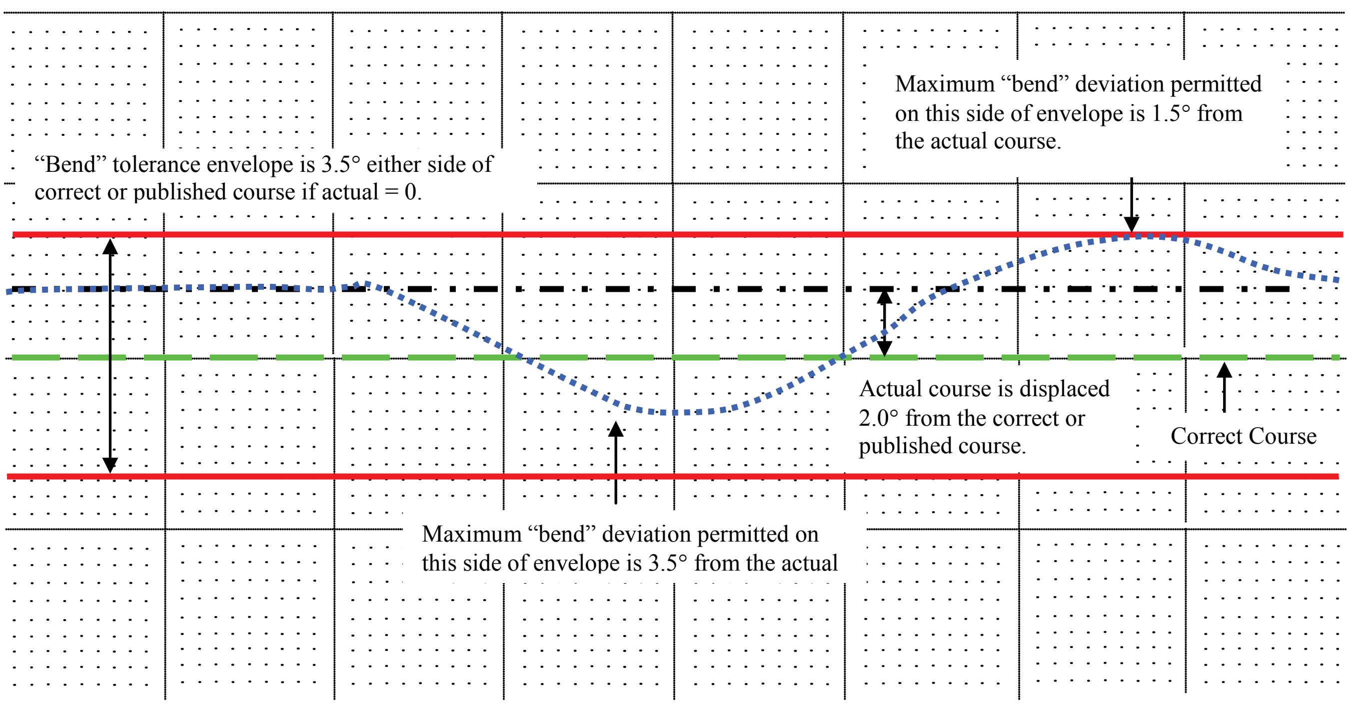
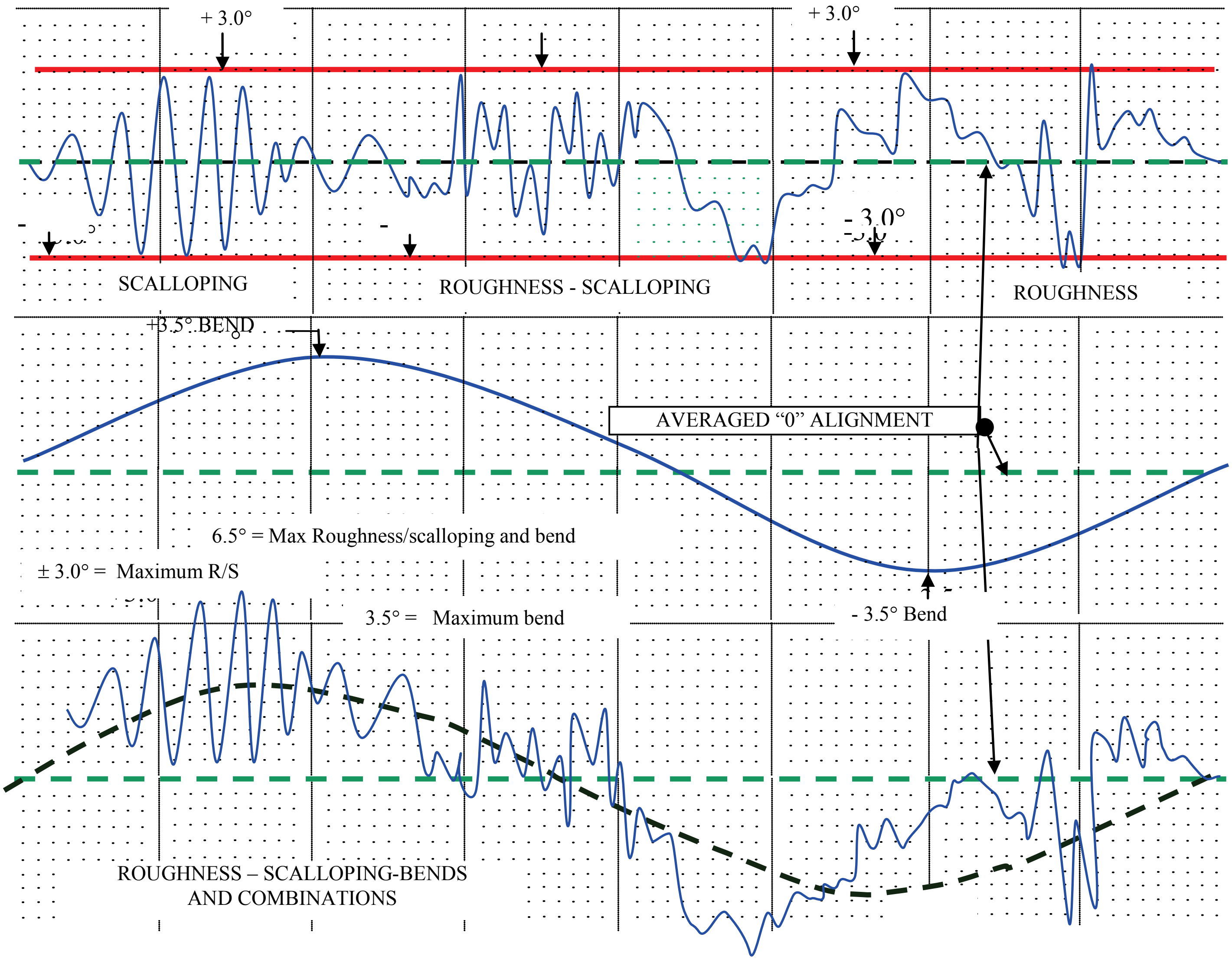


Figure 11-2. Structure.
(Example – not drawn to scale)



Section 3. Distance Measuring Equipment (DME)

9. Introduction. This section provides instructions and performance criteria for certifying standard distance measuring equipment (DME).

The flight inspection of DME can be performed separately but is normally checked in conjunction with the more detailed check of the associated ILS, MLS, VOR, or TACAN facility. When conducting a flight inspection of DME, independent of an associated facility, check the following:

- Accuracy
- Identification
- Coverage

10. Distance Accuracy. Check the accuracy of the DME distance information during inspection of radials, orbits, approach procedures, and DME fixes. The exact mileage indication displayed on the distance indicators must be noted on the recordings. Comparison of the scaled distance on the chart (converted to slant range) to the distance indicated by the DME distance indicator at the various points may be made for accuracy determination.

a. It is not necessary to compute the slant range for distances measured at altitudes below a vertical angle of 5° because the relative difference between slant and chart range is negligible (less than ½ to 1 percent).

b. For ease of computation, a 5° angle is equivalent to approximately 1,000 ft above the antenna at 2 miles and 5,000' above the antenna at 10 miles. Above a 5° angle, a DME slant range mileage must be converted to chart distance.

c. If the ground facility is emitting false reply pulses, erroneous distance information may be present. This condition usually occurs within 25 miles of the antenna. Whenever actual false lock-ons are experienced, the offending facility must be removed from service until this condition is remedied.

11. Identification. The identification must be checked for correctness and clarity, with the aircraft either in orbital or radial flight. A DME associated with an associated facility will be checked for correct synchronization of the two identification signals.

12. Coverage. DME coverage must be recorded or annotated and evaluated to the same coverage requirements as the service (ILS/ VOR/ NDB, etc.) it supports. Stand-alone DME's will be inspected to the service volume described in paragraph 11.4.f(2)(a). DME fixes located outside the FISSV must be evaluated for coverage ± 4 nm or 4.5° (whichever is greater) at 5 nm greater than the fix distance. Coverage is validated on one transponder only.

Section 4. Shipboard TACAN.

13. Introduction. Flight inspection of shipboard TACAN must be performed when requested by the U.S. Navy. Due to the deployment of ships, these inspections must be considered a one-time inspection and must include all checklist items in Paragraph 11.15.

14. Flight Inspection Specifications.

a. The flight inspection must be scheduled upon receipt of the following information:

(1) Date and time of requested inspection.

(2) Name and hull number of the ship.

(3) TACAN channel.

(4) UHF primary and secondary communication frequency.

(5) Location of ships (latitude and longitude).

(6) Name and phone number of area coordinator.

b. The inspection must be conducted with the ship underway and at a distance from shore that is sufficient to preclude interference or shielding of the signal by landmass during radial and orbital inspections.

c. The ship's radar must be used as a basis to determine alignment. Fire control radar is considered the most accurate and will be used when available. Search (CIC) radar may be used if fire control radar is not available. Fire control information is given as TRUE bearings, and search radar is MAGNETIC.

d. Due to various antenna mount positions on ships and possible shielding by other antennas, masts, etc., nulls and/or unusable sectors may occur. Suspected out-of-tolerance conditions must be confirmed by a second evaluation of the area in question. Any sector of the TACAN that does not provide azimuth or distance information must be reported immediately to the ship and documented in the flight inspection report.

15. Checklist. The following must be inspected during shipboard inspections.

a. Identification

b. Sensing and rotation

c. Polarization

d. Radial alignment (minimum of one)

e. Coverage

f. Distance accuracy

g. Frequency interference

h. Alignment orbit

i. Approach radial

j. Standby equipment

k. Stabilization

l. Checks will be completed in accordance with appropriate paragraphs of this chapter, unless modified or changed by the following:

(1) Those items normally inspected during radial flight may be accomplished on a radial to or from the ship or during inspection of the approach radial.

(2) Identification. Shipboard TACAN identification consists of two Morse code letters transmitted every 30 or 37 ½ seconds.

(3) Coverage. Check a minimum of one radial for coverage to 40 nm during inbound or outbound flight at 700 MSL. Advise the ship if coverage is less than 40 nm.

(4) Frequency Interference. All of the ship's electronic equipment that is normally operating should be activated during the inspection.

(5) Alignment Orbit. The orbit must be flown beyond 7 nm from the ships and no lower than 700 ft MSL. On those ships using search radar (CIC) for alignment, the orbit must be flown below 2,000 ft MSL.

(6) Approach Radial. The ship's approach radial is the radial that will guide the aircraft to the stern of the ship and will vary depending on the heading of the ship. Fly the radial from a minimum of 7 nm and 700 ft MSL to pass over the ship at 300 ft MSL. Determine and report radial alignment and structure.

(7) Standby Equipment. CV, LPH, LHA, and LPD ships have dual TACAN equipment. Spot-check the standby equipment during radial flight by requesting a change from primary to standby equipment.

(8) Equipment Stability. Stability of the TACAN equipment may be affected during a turn of the ship. Stability will be checked during radial inspections by requesting the ship to turn left 15° and then right 15°. Advise the ship's personnel of any change to azimuth or alignment during the turns.

16. Tolerance. The tolerance contained in this chapter applies as appropriate to the shipboard TACAN.

Section 5. VOR Test Facility (VOT).

17. Introduction. This section describes the procedure and tolerances used to inspect and certify a VOT. A VOT is a facility, which transmits a test signal that is used to determine the operational status of a VOR receiver. A "Standard VOT" is a facility intended for use on the ground. It should be checked on the ground in the area of intended use. An "Area VOT" is 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. Certification of an area VOT must be based on checks of facility performance in all areas of intended use.

18. Checklist. Perform the checks as noted below. Periodic requirements may be performed either on the ground or in the air within the areas approved for use.

Parameter	Reference Paragraph	Inspection	
		C	P
Frequency Interference	11.20.a	X	X
Identification	11.20.b	X	X
Sensing	11.20.c	X	X
Modulation Level	11.20.d	X	X
VOT Reference Point	11.20.e	X	
Alignment (Course Indication)	11.20.f	X	X
Coverage	11.20.g	X	X
Monitor	11.20.h	(1)	
Standby Power	11.20.i 4.17.c	X	

Note:
(1) Maintenance request.

19. Preflight Requirements. At this time, VOT(s) do not have a specified service volume. VOT service is identified and controlled by the FAA Service Area having jurisdiction of the airport where VOT service can be provided. Area VOT(s) are strategically installed to serve certain specific airports on the ground. Additional airports may be identified by the appropriate Service Area to receive airborne VOT service. The inspector must inspect those airports identified to receive ground and/or airborne service. If, as a result of the inspection, adequate VOT coverage is found at additional airports, the FAA Service Area must be notified. If they concur that the additional airports should receive VOT service, the inspector must publish the additional airports.

20. Flight Inspection Specifications. Recordings must be made on all flight inspections to provide graphic data for analysis of signal intensity and station performance. Record crosspointer, flag alarm current, identification, and AGC on all checks.

a. Frequency Interference (Spectrum Analysis). Evaluate the electromagnetic spectrum using a spectrum analyzer if interference is suspected. Record the measured frequency and detailed information on observed interference.

b. Identification. The purpose of this check is to assure that the correct tone and identification are transmitted.

(1) Two means of identification are used with these facilities—either a continuous series of dots, or a series of dots that cannot be interpreted as Morse code. Facilities Maintenance personnel should be consulted for the proper identification. For both standard and area VOT(s), check the identification for correctness, clarity, and possible effects on the course indications throughout the areas of intended use (both in the air and on the ground). Record the commissioned identification on the Facility Data Sheet.

(2) Approved Procedure. For both standard and area VOT(s), check the identification for correctness, clarity, and possible effects on the course indications throughout the areas of intended use (both in the air and on the ground).

c. Sensing. This check determines and/or establishes the correct ambiguity of the transmitted signal.

While on the ground or in the air, check that the ambiguity indicates TO with 180° set in the omnibearing selector (OBS) and FROM with 360° set in the OBS, throughout the areas of intended use.

d. Modulation Level. Since minor variations of the 30 Hz AM, 30 Hz FM (Deviation Ratio), and 9960 will effect flight data, check the modulation levels throughout the areas of intended use. Measure and record modulation levels during all inspections.

(1) Specifications:

(a) Ground. Establish nominal values at the VOT reference point. Ensure that modulations remain within tolerance throughout all use areas.

(b) Airborne. Ensure that modulations remain in tolerance throughout all areas while conducting coverage maneuvers.

e. VOT Reference Point. This check provides a designated area to begin an inspection or verify facility performance. The reference point must be documented on the Facility Data Sheet.

(1) Standard VOT. This check should be performed on the ground. It is recommended that the area chosen be the furthest distance from the facility maintaining line of sight.

(2) For ground-use standard VOT(s) at airports not accessible to flight inspection aircraft, the reference point may be evaluated utilizing a Portable ILS/ VOR Receiver (PIR). The Aviation System Standards Flight Inspection Policy Team must approve the use of these procedures on a case-by-case basis. This alternative is subject to the following conditions:

(a) Wilcox Model 7010 PIR or equivalent, capable of displaying VOR bearing and modulations, must be used.

(b) Calibration of the PIR must be current.

(c) A certified flight inspector must accompany the maintenance technician to the VOT location. That person must record the detected course deviation, modulation levels, and signal strength from the PIR display.

(d) A certified VOT maintenance technician must operate the PIR and verify the detected PIR information from Step (c) above.

NOTE: The "30 Hz" PIR readout is a measurement of 30 Hz AM modulation. Apply the 25 – 35% VOT modulation tolerance to the 30 Hz and 9960 PIR readouts. The PIR's "FM" output is an FM deviation ratio subject to a 14.8 – 17.2 modulation tolerance.

(e) NOTAM procedures IAW Chapter 5, Section 1 of Order 8200.1 apply. The Pilot in Command (PIC) must initiate the NOTAM process, if required, and sign the flight inspection report. In the event a Mission Specialist is deployed without a PIC, the Flight Inspection Office Manager, or a designated PIC, must initiate any NOTAM process and sign the report.

(3) Area VOT. This check may be performed on the ground or in the air.

f. Alignment. This check is performed to establish and/or verify the accuracy of the transmitted VOT course throughout the coverage areas.

Approved Procedure. Establish the VOT course alignment at its optimum value (zero degree course error) at the VOT reference point.

(1) Commissioning. Use the procedure described in Paragraph 11.20.e.

(2) Periodic. Inspect the alignment of the VOT anywhere within the approved use areas. If the station alignment exceeds the tolerances specified in Paragraph 11.21, recheck and reestablish the alignment (and monitors if necessary).

g. Coverage. The purpose of this check is to ensure that adequate signal is received in all areas of intended use.

(1) Specification:

(a) Standard VOT. Coverage is evaluated during a commissioning inspection, concurrent with establishing the standard VOT Reference Point. For periodic inspections, evaluate coverage anywhere within the approved use area.

(b) Area VOT. Identify all the airports that the area VOT is to serve. Evaluate VOT performance at these airports in the air and/or ground, depending on air or ground use.

(i) Ground coverage is evaluated during a commissioning inspection, concurrent with establishing the area VOT Reference Point. For periodic inspections, evaluate coverage anywhere within the approved area at each airport served.

(ii) Airborne Coverage is evaluated during the commissioning inspection, concurrent with establishing the approved use area. Since there is no standard service volume, the area is predicated on the need for VOT service, facility performance, and frequency protection. Establishing an approved use area that is a fixed radius around the VOT site, normally 10 to 15 miles, can provide the most beneficial service. An alternative to this method would be to fly a separate 3-mile orbit around each airport where VOT service will be provided.

(iii)Inspections. During the commissioning inspection, fly the orbits at the minimum and maximum altitudes at which VOT use will be authorized, normally between 1,000 and 5,000 ft. On periodic inspections, evaluate facility performance anywhere within the approved use area.

(2) Restrictions to Coverage. Notify appropriate airport personnel of any areas within line-of-sight of the VOT in which sufficient signal is not available

h. Monitor. This check assures that a valid course is transmitted within specified values. For flight inspection purposes, the remote alarm unit must be considered a part of the monitor.

Approved Procedure. Conduct this check at the VOT reference point or at any point on the airport where a valid signal is received.

(1) Have Facilities Maintenance personnel shift the course to the alignment monitor reference. Record and measure the course.

(2) Have Facilities Maintenance personnel shift the course in the opposite direction to the alignment monitor reference. Record and measure the course.

(3) Have Facilities Maintenance personnel return the course to normal. Record and measure the course.

i. Standby Power. See Paragraph 4.17.c.

Section 6. Flight Inspection Tolerances.

21. Tolerances. Facilities that meet tolerances throughout the flight inspection SSV are classified as UNRESTRICTED. Facilities that do not meet tolerances in the flight inspection SSV are classified as RESTRICTED. Appropriate NOTAM action must be taken to notify the user of the unusable areas (see Paragraph 5.3). Do not restrict a facility when it fails to meet tolerances outside the flight inspection SSV.

a. VOR Tolerances.

Parameter	Reference Paragraph	Inspection C	Inspection P	Tolerance/Limit
Identification	11.5.a	X	X	Morse code and voice identification must be correct, clear and identifiable. The audio levels of code and voice must sound similar. The course structure must not be affected by the identification.
Voice	11.5.b	X	X	Voice transmissions must be clear and understandable. Simultaneous voice transmissions and code identification must sound similar. The voice identification must be suppressed during voice transmissions. Voice transmissions must not cause more than ± 0.5° of course deviations.
Sensing and Rotation	11.5.c	X	X	The "To/From" sensing must be "From" when positioned on a selected radial, and the bearings must decrease in a counterclockwise direction around the station.

Parameter	Reference Paragraph	Inspection C	Inspection P	Tolerance/Limit
Modulation	11.5.d	X	X	
30 Hz AM				25 – 35% (optimum 30%)
30 Hz FM				Deviation Ratio 14.8 – 17.2 (optimum 16.0) Doppler VOR deviation ratio 11.0 – 17.2 when measured above 5° angle from the facility.
9960 Hz				20 to 35% on transmitters with voice modulation 20 to 55% on transmitters without voice modulation **NOTE:** Modulation exceeding these limits is acceptable, using the following criteria: .05 nm in any 1.0 nm segment from FAF to the MAP. 0.25 nm in any 5 nm segment from sea level up to 10,000 ft MSL. 0.5 nm in any 10 nm segment from 10,001 to 20,000 ft MSL. 1.0 nm in any 20 nm segment above 20,000 ft MSL.
Polarization	11.5.e	X	X	Less than or equal to 2.0°

Parameter	Reference Paragraph	Inspection C	Inspection P	Tolerance/Limit
Radials	11.4.a	X	X	
Alignment				Alignment of all electronic radials must not exceed ± 2.5° of correct magnetic azimuth except: Deviations of the course due to bends must not exceed 3.5° from the correct magnetic azimuth and must not exceed 3.5° from the average electronic radial alignment. Roughness/ Scalloping/ Course Aberrations: Deviations from the course, greater than 3.0° are acceptable, provided the aggregate does not exceed the following:
Structure	11.6			.05 nm in any 1.0 nm segment from FAF to the MAP. 0.25 nm in any 5 nm segment from sea level up to 10,000 ft MSL. 0.5 nm in any 10 nm segment from 10,001 to 20,000 ft MSL. 1.0 nm in any 20 nm segment above 20,000 ft MSL. Flyability: The effects of any one, or combination of any alignment and/or structure criteria, even though individually in tolerance, must not render the radial unusable or unsafe.
Signal Strength	11.7	X	X	Received RF signal strength must equal or exceed 5 μv or –93 dbm.

Parameter	Reference Paragraph	Inspection C	Inspection P	Tolerance/Limit
Receiver Checkpoints	11.4.h	X	X	Airborne Receiver Checkpoints. All parameters must meet tolerances, and the alignment must be within ± 1.5° of the published azimuth. Ground receiver checkpoints must equal or exceed 15 µv or –83 dbm. Ground Receiver Checkpoints. All parameters must meet tolerances, and the alignment must be within ± 2.0° of the published azimuth. Inability of the facility to provide a ground or airborne receiver checkpoint according to the tolerances specified above must not cause a restriction to be placed on the facility.
Monitor	11.4.b			The transmitter azimuth monitor reference must not exceed ± 1.0°.
Standby Equipment	11.4.i 4.17	X	X	The standby transmitter must meet all tolerances and the difference in azimuth alignment between transmitters must not exceed 2.0°.
Standby Power	11.4.j 4.17	X		Operation on standby power must not cause any parameters to exceed tolerances.
Orbital Alignment	11.4.f		X	Notify maintenance if found to exceed ± 1° from the reference.

b. TACAN Tolerances.

Parameter	Reference Paragraph	Inspection C	Inspection P	Tolerance/Limit
Identification	11.5.a 11.5.g	X	X	Code identification must be correct, clear, distinct, without background noise, and not affect course characteristics throughout the coverage limits of the facility. TACAN/ DME identification must be correctly sequenced with the VOR identification when collocated.
Sensing and Rotation	11.5.c	X	X	Sensing and rotation must be correct.
Distance Accuracy	11.9	X	X	0.20 nm.
Polarization	11.5.e	X	X	Maximum ± 2.0° course deviation caused by horizontal polarization

Parameter	Reference Paragraph	Inspection C	Inspection P	Tolerance/Limit
Radials	11.4.a	X	X	
Alignment				Alignment of all approach radials must not exceed ± 2.0° of the correct magnetic azimuth. Alignment of all electronic radials must not exceed ± 2.5° of correct magnetic azimuth except: Deviations of the course due to bends must not exceed 3.5° from the correct magnetic azimuth and must not exceed 3.5° from the average electronic radial alignment.
Structure	11.6			Roughness/ Scalloping/ Course Aberrations: Deviations from the course, greater than 3.0° are acceptable, provided the aggregate area does not exceed the following: 0.05 nm in any 1.0 nm segment from the FAF to the MAP. 0.25 nm in any 5 nm segment from sea level up to 10,000 ft MSL. 0.5 nm in any 10 nm segment from 10,001 to 20,000 ft MSL. 1.0 nm in any 20 nm segment above 20,000 ft MSL. Flyability: The effects of any one, or combination of any alignment and/or structure criteria, even though individually in tolerance, must not render the radial unusable or unsafe. Unlocks: Approach Radials: No condition of azimuth or distance unlock is permitted within the final segment. The only exception would be normal passage through the station cone. En route criteria should be applied to all other segments.

Parameter	Reference Paragraph	Inspection C	Inspection P	Tolerance/Limit
				En route Radials: No more than one condition of azimuth unlock not to exceed 1 nm in a 5 nm segment and/or condition of distance unlock not to exceed 0.5 nm in a 5 nm segment.
				Note: Where airspace procedures depict a 10 DME or greater arc from the station to a final approach radial, en route tolerances must be applied to both azimuth and range functions, except that no conditions of unlock are permitted 5.0° either side of any radial depicted or proposed for procedural use (i.e., initial approach fix, intermediate approach fix, final approach radial, lead radial, crossing radial, reference, point, etc.)
Signal Strength	11.7	X	X	The expected minimum signal strength is –80 dbm. However, a lesser signal must not be the sole determination for restricting or removing a facility from service if a solid stable DME or azimuth lock-on is present.
Receiver Checkpoints	11.4.h	X	X	Receiver Checkpoint alignment must not exceed ± 1.5° of the published azimuth. Distance must be within 0.2 nm of the measured distance.
Monitor	11.4.b			The transmitter azimuth monitor reference must not exceed ± 1.0°.
Standby Equipment	11.4.i 4.17	X	X	Operative standby and primary equipment will meet the same tolerances. The difference in the alignment of the course formed by each transmitter must not exceed ± 1.5°. Distance differential between transmitters must not exceed 0.2 nm.
Standby Power	11.4.j 4.17	X		Tolerances for a facility on standby power must be the same as those on primary power.

Parameter	Reference Paragraph	Inspection C	Inspection P	Tolerance/Limit
Orbital Alignment	11.4.f		X	Notify maintenance if found to exceed ± 1° from the reference.
Coverage	11.12	X	X	Solid stable DME lock-on is present throughout all areas of intended use.

c. DME Tolerances.

Parameter	Reference Paragraph	Inspection C	Inspection P	Tolerance/Limit
Identification	11.11	X	X	Morse code and voice identification must be correct, clear, and identifiable. The audio levels of code and voice must sound similar. The course structure must not be affected by the identification.
Signal Strength	11.7	X	X	The expected minimum signal strength is –80 dbm. However, a lesser signal must not be the sole determination for restricting or removing a facility from service if a solid stable DME lock-on is present.
Distance Accuracy	11.10	X	X	0.20 nm.
Receiver Checkpoints	11.4.h	X	X	Distance must be within 0.2 nm of the measured distance.
Coverage	11.8 11.12	X	X	Solid stable DME lock-on is present throughout all areas of intended use. Unlocks: Approach Radials: No condition of distance unlock is permitted within the final segment if required procedurally. The only exception would be normal passage through the station cone. En route criteria should be applied to all other segments. En route Radials: No more than one condition of distance unlock not to exceed 0.5 nm in a 5 nm segment.

d. VOT Tolerances.

Parameter	Reference Paragraph	Inspection C	Inspection P	Tolerance/Limit
Frequency Interference	11.20.a	X	X	Interference must not cause any out-of-tolerance condition.
Identification	11.20.b	X	X	Correct, clear, without background noise. Readable throughout area of coverage. Identification must not affect course characteristics.
Sensing	11.20.c	X	X	TO with OBS set at 180° FROM with OBS set at 360°
Modulation Level 30 Hz AM, 30 Hz FM (3) and 9960	11.20.d	X	X	25 – 35% (optimum 30%)
Alignment	11.20.f	X		0.0°
			X	1.0° or less
Coverage (1)	11.20.g			
Ground (Normal use areas)		X	X	15 µV minimum
VOT Reference Point	11.20.e	X	X	15 µV minimum
Air		X	X	15 µV minimum throughout those areas/ altitudes approved for use
Monitor	11.20.h	X	(2)	The course alignment monitor must alarm when the course shifts exceed 1.0°
Standby Power	11.20.i 4.17	X		Tolerances for a facility on standby power should be the same as those on primary power.

NOTES:

(1) If the aircraft receiver is capable of measuring exact flag alarm current, apply a tolerance of 240 µA flag to all “coverage” checks.

(2) Maintenance request

(3) When the 30 Hz signal is reported as a deviation ratio, the tolerance is 14.8 – 17.2

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Chapter 12. Low and Medium Frequency Nondirectional Beacons (NDB)

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Chapter 12. Low and Medium Frequency Nondirectional Beacons (NDB)

Section 1. General

1. Introduction. A Nondirectional Beacon (NDB) is a low or medium frequency radio beacon that operates in the frequency range 190 to 1,750 kilohertz (kHz). A radio beacon used in conjunction with an Instrument Landing System marker is called a Compass Locator.

a. Classification. NDB(s) are classified according to their intended use. NDB classifications are:

(1) Compass Locators, including a locator at the outer marker (LOM) and a locator at the middle marker (LMM), standard service volume of 15 nm. These facilities are installed at the marker beacon sites associated with ILS facilities. Output power is 25 watts or less.

> Note: M and H class beacons can also be used as compass locators, in which case the standard service volume would increase to that class level, i.e., MLOM standard service volume is 25 nm, and a HLOM standard service volume is 50 nm.

(2) MH Facility, standard service volume of 25 nm. These facilities are used for short-range navigational purposes. Authorized output power is 50 watts or less.

(3) H Facility, standard service volume of 50 nm. These facilities are used for medium-to long-range navigation and are located along the airways where needed to provide suitable coverage. Authorized output power is from 50 to 2,000 watts.

(4) HH Facility, standard service volume of 75 nm. These facilities are used for long-range and over-water navigation. Authorized output power is 2,000 watts or more.

b. Identifier. Radio beacons transmit a continuous Morse code identifier. Some facilities have a voice feature. A voice feature may be live from a remote location, transcribed weather, or AWOS/ ASOS. A live voice feature may interrupt the facility identification.

(1) The Morse code identification of all classes of NDB facilities, except compass locators, is repeated 5 to 15 times per minute depending on equipment type. Compass locators are identified in the same manner, except the repetition rate is 7 to 20 times per minute.

(2) A three-letter code is used to identify all classes of NDB facilities except compass locators. All radio beacons except the compass locators transmit a continuous three-letter identification code except during voice transmissions.

A two-letter code is used to identify compass locator facilities. The code letters are obtained from the code of the associated ILS. The first two letters of the ILS identification are used to identify the outer compass locator (LOM), and the last two letters of the ILS identification are used to identify the middle compass locator (LMM).

2. Flight Inspection Specifications:

a. Checklist.

Type Check	Reference Paragraph	C	P (5)	Antenna Change (3)	Frequency Change
Identification	12.2.b(1)	X	X	X	X
Voice	12.2.b(2)	X	X	X	X
Coverage Orbit	12.2.b(3)	X		X	X
Routes and Transitions	12.2.b(4)	X	(1)	(4)	(1)
SIAP	12.2.b(5)	X	(2)	(2)	(2)
Station Passage	12.2.b(6)	X	X	X	X
Standby Transmitter	12.2.b(7)	X			
Standby Power	12.2.b(8) 4.17c(1)	X			

Notes:
(1) Surveillance only incidental to other required checks.
(2) Final approach segment only.
(3) Required for change in antenna type, or when modifications are made to the antenna or to the ground plane, or a change in antenna current designed to change coverage area.
(4) Fly airways, routes, and transitions and reevaluate associated. ESV(s).
(5) During periodic inspections, evaluate coverage on a surveillance basis, including verification of the minimum

b. Detailed Specifications.

(1) Identification. Monitor the Identification during the evaluation for clarity and interference throughout the intended service volume.

(2) Voice. When installed, the voice feature enables the NDB to transmit messages such as weather reports and observations. For commissioning inspections, the flight inspector must ensure the facility complies with the tolerances in Paragraph 12.6. Spot check operation during periodic inspections.

(3) Coverage Orbit. Coverage must be evaluated by flying an orbit with the radius equal to the area of intended use as listed in Paragraph 12.6.c.

(4) Routes and Transitions. Coverage at distances greater than the orbit radius will be certified for specific routes or transitions and may be evaluated on one transmitter. For satisfactory performance, the facility must meet the tolerances in Paragraph 12.6.

(5) Standard Instrument Approach Procedure (SIAP). Follow the procedures for inspection of SIAP(s) contained in Chapter 6. Altitudes flown must be the minimum proposed or published for the segment evaluated, except that the final segment must be flown to 100 ft below the lowest published MDA.

(a) Commissioning Inspection of SIAP. Evaluate all segments of the proposed procedure, including any holding patterns. Check for excessive needle oscillation, erroneous reversals giving false impression of station passage, or any other unusual condition.

(b) Periodic Inspection of SIAP. The evaluation may be limited to the final approach segment only.

(6) Station Passage. Evaluate the area over the facility for correct indication of station passage. Needle reversal should occur when the aircraft passes directly over or in very near proximity to the station.

(7) Standby Equipment. At facilities where dual transmitters are installed, the flight inspector must check each for a commissioning inspection.

(8) Standby Power. Refer to Paragraph 4.17c(1). If Paragraph 4.17c indicates the standby power should be checked, all the flight inspection checks should be repeated with the NDB on standby power.

3. Maintenance Actions Requiring Flight Inspection. Activities requiring a confirming flight inspection:

a. Major changes in local obstructions, buildings, etc., which may affect the signal strength and coverage.

b. Replacing the antenna with a different type antenna. Modifications of the antenna or to the ground plane.

c. Change in the antenna current to increase or decrease the service area.

d. Frequency change.

4. Flight Inspection Procedures. The primary objectives of flight inspection are to determine the coverage and quality of the guidance provided by the NDB system and to check for interference from other stations. These assessments are to be made in all areas where coverage is required and with all operational procedures designed for the NDB, in order to determine the usability of the facility and to ensure that it meets the operational requirements for which it was installed.

a. Identification. The facility identification is evaluated throughout the area of intended use, including any route, airway or transition that may extend beyond the normal service volume. The evaluation should be accomplished during all required checks.

(1) Maneuvering. No specific maneuver instructions.

(2) Analysis**.** The voice feature is out of tolerance if it renders the facility identification not decipherable (except live voice). The voice transmission should be evaluated for quality, modulation and freedom from interference. Record the maximum usable voice range on commissioning for future reference. The voice feature should be clear and recognizable for a minimum of two-thirds the standard service volume range. Notify maintenance anytime the voice reception distance is less than the required range. Facility restrictions are not determined by the voice feature. The voice feature should be removed from service if it adversely affects the facility identification.

(3) Other Considerations. On aircraft so equipped, utilize the "Ident" feature on the ADF audio panel.

b. Voice. The voice feature (if installed) is evaluated within the standard service volume. The evaluation may be accomplished while other required checks are being performed.

(1) Maneuvering. No specific maneuver instructions.

(2) Analysis. The voice feature is out of tolerance if it renders the facility identification not decipherable (except live voice). The voice transmission should be evaluated for quality, modulation and freedom from interference. Record the maximum usable voice range on commissioning for future reference. The voice feature should be clear and recognizable for a minimum of two-thirds the standard service volume range. Notify maintenance anytime the voice reception distance is less than the required range. Facility restrictions are not determined by the voice feature. The voice feature should be removed from service if it adversely affects the facility identification.

(3) Other Considerations. On aircraft so equipped, utilize the "Voice" function on the ADF audio panel.

c. Coverage Orbit. Standard service volume coverage is evaluated by flying orbits at the lowest coverage altitude. Facility Maintenance determines the reduced power output of the facility during coverage checks. At facilities where dual transmitters are installed, facility coverage for maximum useable distance may be evaluated by alternating transmitters. Switch transmitters at least every 30 degrees.

(1) Maneuvering. Fly an orbit about the facility at the maximum distance specified by the facility classification. The orbit altitude must be 1,500 ft above facility site elevation, or the minimum altitude which will provide 1,000 (2,000 ft in designated mountainous areas) above intervening terrain or obstacles, whichever is higher as determined by map study. Coverage orbits are usually completed counterclockwise, as the ADF navigation needle parks to the right if the signal has an unlock (this is true for mechanical instruments; however, the needle may disappear on electronic displays). Sectors found out of tolerance must be evaluated using orbits at reduced distances or increased altitudes in an attempt to determine facility restrictions. Monitor the facility identification during coverage checks, as the loss of the identifier usually corresponds with the loss of the NDB signal.

(2) Analysis. Evaluate the signal for out of tolerance needle oscillations, weak or garbled identification, and interference throughout the coverage area. If the facility performance does not meet tolerances to the SSV, the facility will have the status of restricted or unusable, and NOTAM action is required. If there is a suspicion the beacon carrier frequency is out of tune (off frequency), have ground maintenance check the transmitted frequency, or evaluate with the onboard spectrum analyzer.

(3) Other Considerations. NDB restrictions must be sectored as bearings from the facility. See Chapter 5 for examples of NDB restrictions.

Recommendation: The number of sectors should be kept to a minimum, and preferably should not exceed two.

d. Instrument Flight Procedures

(1) Maneuvering:

(a) Commissioning or Evaluating Amended Procedures. Fly each new procedural segment that uses a facility bearing at the minimum procedural altitude. Fly final approach segments in the direction of intended use. After the procedure turn or FAF, descend to 100 feet below the minimum descent altitude for the segment. In addition, descend to 100 feet below all step-down fix altitudes inside the FAF. Evaluate holding patterns, airways, routes and transitions along the entire procedure at the minimum procedural altitude(s).

(b) Periodic Inspections. Required coverage evaluations during periodic inspections are limited to surveillance checks of any airways, routes or transitions to the extent the aircraft is maneuvered to position for other required checks, as well as all SIAP final approach segments. For SIAP(s) with a FAF, cross the FAF at the minimum published altitude and descend to at least 100 feet below the minimum descent altitude for that segment. For SIAP(s) without a FAF, fly the final segment from the procedure turn distance at the minimum published procedure turn completion altitude and descend to at least 100 feet below the minimum descent altitude for that segment. In addition, descend to 100 feet below all step-down fix altitudes inside the FAF.

(2) Analysis. Evaluate the signal for out of tolerance needle oscillations, weak or garbled identification, and interference.

> Recommendation: Where two locators are used as supplements to an ILS, the frequency separation between the carriers of the two should be not less than 15 kHz to ensure correct operation of the radio compass, and preferably not more than 25 kHz in order to permit a quick tuning shift in cases where an aircraft has only one radio compass.

e. ESV. For ESV(s), refer to Chapter 22. Coverage at greater than the orbital distance for specific fixes, airways, routes or transitions, may be evaluated on one transmitter. Establish at normal power.

f. Station Passage. Needle reversal should occur when the aircraft passes directly over, or in very close proximity to the facility.

(1) Maneuvering. Overfly the antenna at the minimum procedural altitude.

(2) Analysis. Station passage is out of tolerance if any indication of false station passage occurs, or if station passage does not occur over the station. Momentary needle hunting while near or over the station does not in itself constitute false station passage.

g. Standby Equipment. If dual transmitters are installed, evaluate all required parameters for each transmitter during a commissioning inspection. When practical, for periodic inspections of dual transmitter facilities, conduct the inspection using the transmitter not checked during the previous periodic inspection.

(1) Maneuvering. No specific maneuver instructions.

(2) Analysis**.** Evaluate the same as primary equipment.

(3) Other Considerations. See Chapter 5 for standby equipment NOTAM.

h. Standby Power. If standby power is installed and of such a type that Paragraph 4.17 requires it be checked, have the facility power source switched to the standby source and repeat all the flight inspection checks (one transmitter only).

(1) Maneuvering. No specific maneuver instructions.

(2) Analysis. Evaluate the signal for out of tolerance needle oscillations, weak or garbled identification, and interference within the coverage area.

(3) Other considerations. Standby power checks are not required for facilities powered by batteries that are constantly charged by another power source. The Facility Data Sheet should indicate the source of standby power

i. Special Inspections.

(1) Antenna Change. A special inspection will be conducted when an antenna is replaced with a new type, or modifications are made to the antenna or to the ground plane, or there is a change in antenna current designed to change the coverage area. Evaluate coverage by flying a coverage orbit and the final segments of any SIAP(s). Fly any airways, routes, or transitions and re-evaluate any associated ESV(s). There is no requirement to conduct any checks on standby power or to check the standby transmitter if it is a dual transmitter facility.

(2) Transmitter Change. A flight inspection is not required if the transmitter equipment is replaced, provided ground maintenance can match the established antenna current reference. If ground maintenance does request a flight inspection, follow the antenna change checklist requirements.

(3) Frequency Change. A special inspection will be conducted when a frequency change is made to the facility. Evaluate coverage by flying a coverage orbit and the final segments of any SIAP(s). A surveillance check of any airways, routes, or transitions should be made incidental to aircraft maneuvering to position for other required checks. There is no requirement to reevaluate ESV(s), or conduct any checks on standby power or to check the standby transmitter if it is a dual transmitter facility.

5. Reporting. Reference Order VN200 8240.4, Daily Flight Log (DFL), FAA Form 4040-5, and FAA Order 8240.36, Flight Inspection Report Processing System.

Section 2. Flight Inspection Tolerances.

6. Tolerances:

a. Morse Code Identification. All facilities must have a Morse code identifier that is correct, clear, and identifiable throughout the area of intended use, including any route, airway or transition that may extend beyond the normal service volume. If the Morse identifier is augmented with voice identification, the voice identification must adhere to the same tolerance as the associated Morse identifier.

b. Voice Transmission. Broadcast information should be clear and recognizable for a minimum of two-thirds of the NDB's usable distance.

c. Usable Distance:

(1) The minimum usable distance must be:

Class	Coverage
Compass Locator	15 nm
MH Facility	25 nm
H Facility	50 nm
HH Facility	75 nm

(2) Maximum bearing deviation: 20° (± 10°).

d. NDB Approach. Bearing indicator deviation in the final approach segment and holding pattern must not exceed: 10° (± 5°)

e. Bearing Tolerance Deviation. Short duration out-of-tolerance needle activity (including repetitive events) will be allowed when either:

(1) The duration does not exceed four seconds on an approach (flown at a nominal 130 knot ground speed), or

(2) The duration does not exceed eight seconds for en route and holding pattern use; but only if the out-of-tolerance activity cannot be construed as a station passage, and the activity is not generally one-sided when repetitive.

f. Station Passage. Station passage indications must be unambiguous. Momentary needle hunting while over the station will not be construed as false passage.

g. Standby Equipment. If installed, standby equipment must perform to all tolerances in this chapter.

Chapter 13. Area Navigation (RNAV).

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Chapter 13. Area Navigation (RNAV)

Section 1. Area Navigation (RNAV)

1. 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 within 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).

2. 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:

- Procedure Name, Runway
- Transition
- Fix/Waypoint Name
- Sequence Number
- Use (For Example: IAF, FACF, FAF)
- Leg Type (For Example: IF, TF, CF)
- Turn (R, L)
- Fly-Over (FO) /Fly-By (FB)
- Mag Course or True Course, RNAV Track
- Distance of leg
- Altitude
- Latitude
- Longitude
- Threshold Crossing Height
- Datum Check
- Vertical Angle
- FAS Data Block Check
- CRC Remainder Check
- 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 6.4c(1)(e).

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.

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.

3. 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)

Notes:
(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.

4. 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.

5. 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

6. Adjustments. Reserved.

7. 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.

8. 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.

9. 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.\

10. 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.

11. 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.

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.

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

12. 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.

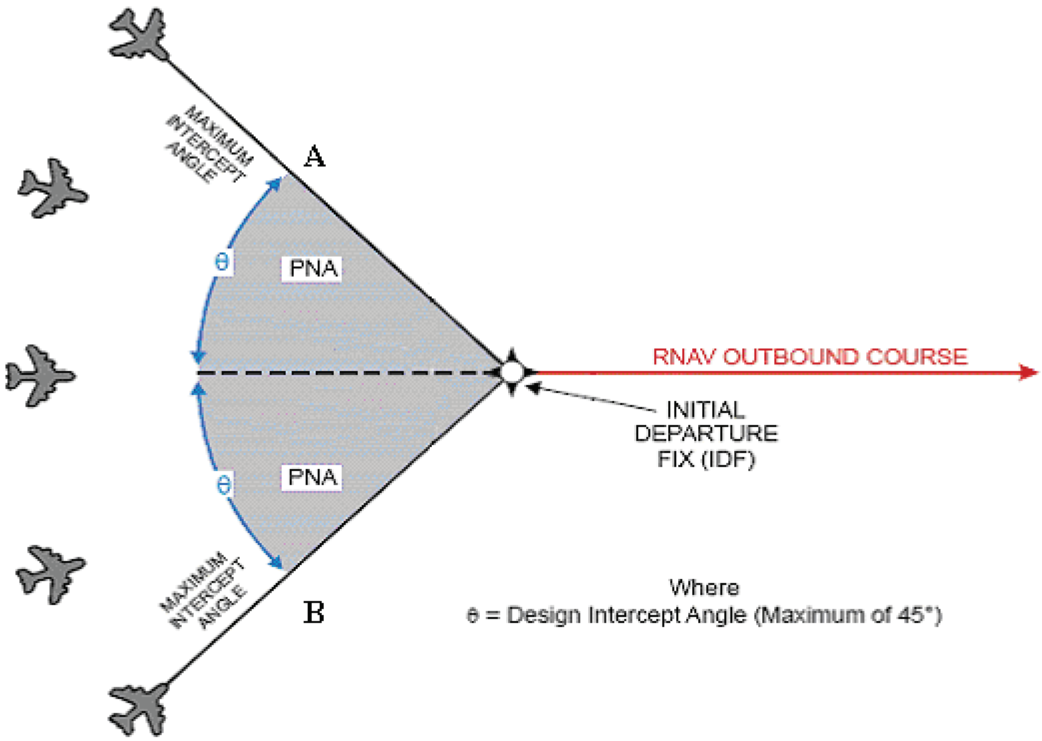
During the inspection, if a Critical, or expanded service volume (ESV) designated DME appears not to be transmitting, verify with Air Traffic or a local Flight Service Station that the facility is in service. If a DME designated Critical is off the air, the inspection must be terminated and resumed after 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. 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.

14. Tolerances

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

Note: [1]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.

15. 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.

16. 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.

17. 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 13.3a)

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 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.

18. 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.

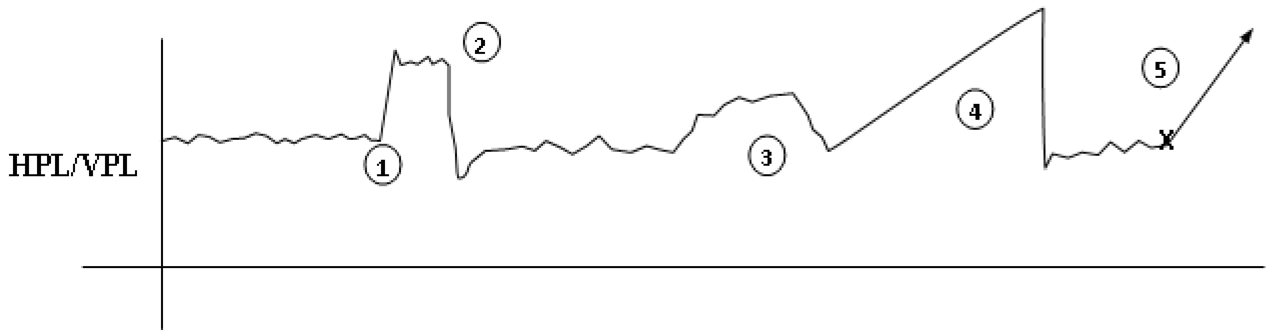
The parameters in Table 13-1 must be documented throughout the Intermediate and Final Approach Segments and whenever anomalies are found during any phase of the flight inspection.

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”

Notes:
(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/VLP: 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

19. 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:
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) WAAS Vertical Protection Level (VPL)	≤ 556 m ≤ 50m

Chapter 14. Surveillance

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Chapter 14. Surveillance

Section 1. Surveillance Radar & Wide Area Multilateration

1. Introduction. This section outlines Surveillance Radar and Wide Area Multilateration flight inspection procedures. Surveillance radar systems include the Airport Surveillance Radar (ASR), Air Route Surveillance Radar (ARSR), Air Traffic Control Radar Beacon System (ATCRBS), and Precision Runway Monitor/ Final Monitor Aid systems. Radar inspection procedures differ from traditional NAVAID inspections in that data collection and analysis is primarily accomplished by technical personnel at the ground radar site. Current digital techniques and statistical sampling permit the analysis of most radar parameters using aircraft targets-of-opportunity. Technical Operations (Tech Ops) Facility Maintenance personnel should use targets-of-opportunity, radar data analysis software (RDAS) tools, and other test equipment to the maximum extent allowable to complete checklist requirements. However, certain tests may require a specially-equipped flight inspection aircraft. The flight inspector's primary role is to maneuver a calibrated flight inspection "target" throughout the radar airspace in accordance with a coordinated flight inspection plan. Maintenance personnel evaluate and document facility performance parameters, except those specifically delegated to the flight inspector. Tech Ops engineers, in coordination with Air Traffic Control (ATC) personnel, are responsible to prepare radar inspection plans, and those special inspections requiring coordination outside the facility of concern. Joint-use facilities require coordination with military personnel.

a. Primary Radar. The ASR and ARSR are primary surveillance radars, and rely upon reflected radio energy to generate video targets on the controller's display. The radar targets vary in strength due to atmospheric conditions, target range, radar cross section, aircraft reflective surfaces, and other phenomena.

b. Secondary Radar. The ATCRBS is also known as secondary surveillance radar. Through enhanced, electronic target identification, secondary radar overcomes some of the inherent limitations of the primary radar system. Secondary radar interrogates transponder-equipped aircraft, and detects transponder-generated replies, or "squawks." A basic Mode-A transponder squawks a 4-digit assigned beacon code enabling primary target identification and verification. Additionally, Mode-C and Mode-S equipped transponders encode the aircraft's pressure altitude and identification, respectively. ATCRBS coverage is a function of many factors, including siting and antenna patterns, and is normally much broader than the primary radar coverage area. ATCRBS is normally inspected in conjunction with the primary radar system.

c. Minimum Safe Altitude Warning System (MSAW). MSAW is a software function of the Automated Radar Terminal System (ARTS), and consists of two detection components, the General Terrain Monitor and the Approach Path Monitor. The MSAW software is programmed to alert air traffic control when a Mode-C equipped aircraft is at, or predicted to be at an unsafe altitude. The system monitors aircraft separation from terrain and obstacles, generates a visible alert on the controller's radar display, and sounds an alarm when separation is compromised.

(1) General Terrain Monitor (GTM). GTM exists within a radius of approximately 60 nm of the associated radar site and normally consists of multiple, 2-mile square bins. Some locations may use half-mile square bins. When an aircraft is below, predicted to be below, or projected to be below the bin altitude, an alert is generated.

(2) Approach Path Monitor (APM). The APM bin is normally 1 nm wide, either side of the final approach course or runway heading. An APM bin begins at the final approach fix, or 5 nm from the runway approach end. The APM bin terminates at approximately 1 nm from the runway approach end. An altitude value is determined for obstruction clearance at the beginning and end of the APM. These two values provide MSAW protection as an aircraft descends along the approach course towards the runway. Parallel runways use the same APM system. For a circling-only approach, the APM zone begins at the final approach fix, or 5 nm from the nearest landing surface, and terminates 1 to 2 nm from the nearest landing surface.

d. Precision Runway Monitor/ Final Monitor Aid (PRM/ FMA). Accomplish PRM/ FMA flight inspections in accordance with FAA Order 8200.39, Flight Inspection of Precision Runway Monitors/ Final Monitor Aid. The PRM system is designed to permit simultaneous precision approaches to close parallel runways. The PRM uses a stand-alone high update secondary surveillance radar system to track aircraft, while the FMA uses existing ATCRBS and Mode-S data with specialized software to track aircraft. Both systems display targets on a high-resolution color monitor. The PRM system requires a commissioning flight inspection, whereas the FMA requires a commissioning inspection only upon request.

e. Wide Area Multilateration (WAM). The WAM surveillance system uses multiple sensors to detect, identify, display, and track targets. WAM uses a constellation of ground stations or Remote Units (RU) to provide surveillance coverage within a defined region. WAM calculates aircraft position using Mode-A, Mode-C, and Mode-S transponder interrogations. WAM also processes ADS-B Mode-S extended squitter signals. When an ADS-B message is received at three or more RUs, a multilateration report may be generated. WAM may be configured as a virtual radar, and feed live data to an automation system (e.g., MEARTS) for air traffic control system display.

2. Flight Inspection Planning. The Tech Ops facility engineer or military equivalent is responsible to prepare the Radar Operational Performance Inspection Plan in accordance with JO 6300.13, Radar Systems Optimization and Flight Inspection Handbook. A formal flight inspection plan is required for all commissioning, and some special inspections that require coordination outside the facility of concern. Simple special inspections not requiring system parameter changes or coordination outside Tech Ops Facility Maintenance and ATC may not require a formal inspection plan, but must be reported. Joint Surveillance Site (JSS) inspection plans require coordination with Air Combat Command (ACC) technical personnel.

a. Facility Maintenance Personnel. The appointee preparing the inspection plan must coordinate with personnel from the associated offices. For en route sites, the participants should include: Tech Ops Facility Maintenance representatives from the ARTCC and the remote site, AT representatives from the regional office and the ARTCC, and a Flight Inspection representative. The DoD user and appropriate ACC representatives should attend planning meetings to identify operational requirements and evaluation objectives for a JSS. For terminal radar inspections, the appointed coordinators must include ATC representatives from the region and local site, Facility Maintenance personnel, and a Flight Inspection representative. Military offices must provide the required coordination and a flight inspection plan for joint-use and military sites.

Representatives from each office of concern should assist the Facility Maintenance appointee with the inspection plan. In addition to the requirements outlined in Chapter 4, Facility Maintenance personnel must ensure the following items are addressed in the *Flight Inspection Plan*:

(1) Inspection Objectives. The inspection objectives, or goals, determine which organizations must be involved in the inspection plan development. Additionally, the objectives determine the radar system checks required and the methods used.

(2) Operational Requirements List. The operational requirements list outlines each planned inspection item and maneuver. The list should include the planned inspection details, such as routes, fixes, holding patterns, coverage patterns, and instrument procedures. The details must include planned altitudes, distances, and other pertinent information. The inspection items may be divided between flight inspection aircraft and targets-of-opportunity, depending on the check. Additionally, the flight inspection aircraft items may be sub-divided between calibrated transponder and standard transponder requirements. Normally, flight inspection aircraft will be used in low-traffic areas, where siting criteria predicts marginal, or no coverage, or where fix/ map accuracy must be determined. When assigned to inspect or evaluate a military or JSS facility, the ACC representative must perform all coordination and notification requirements, complete the flight phase planning, and publish required documents.

(3) Required Resources List. This list identifies essential personnel, aircraft, special tools and equipment, equipment calibration, computer time and software, charts, graphs, maps, etc. necessary for the inspection. The inspection plan must also include all data required to prepare, conduct, and document the inspection.

(4) Flight Scheduling. Recommend the best flight period for evaluating coverage. The flight period is usually a compromise between operational and engineering needs. Normally, ATC prefers to manage flight inspections during periods of low traffic activity; however, the Tech Ops engineers may need to accomplish coverage checks during peak traffic periods.

(5) Radar Equipment Performance. Ensure the radar equipment is tuned to facility operational specifications prior to the flight inspection. A joint inspection is required to measure and optimize JSS equipment parameters.

(6) Participating Personnel. Ensure participating maintenance and operations personnel (including military) are experienced, and are familiar with the inspection objectives and requirements.

(7) Sequence of Events. Ensure the inspection plan includes a sequence of events to optimize air traffic coordination and communication, and minimize required flight inspection time. The sequence of events will be used as a run-sheet during the actual inspection.

(8) Final Plan. Ensure the final plan is reviewed and signed by representatives from Tech Ops engineering, ATC, Flight Inspection, and military (when applicable).

(9) Consolidated Inspection Data. Consolidate and evaluate all inspection data obtained using targets-of-opportunity and advise the flight inspector of additional checks requiring the use of a flight inspection aircraft.

(10) Interrogator Calibration Values. Furnish the interrogator power values (in watts at the antenna) for inclusion in the flight inspection report.

b. Flight Personnel. Prepare for the flight inspection in accordance with Chapter 4. In addition:

(1) Flight Inspection Coordination. The Flight Inspector will establish contact with the personnel responsible for the radar inspection plan. This may be someone from Air Traffic Control, a Tech Ops Service Area engineer, or DoD personnel (for military facilities). Pre-inspection coordination should be accomplished in concert with the maintenance actions listed in Paragraph 14.2.a. Simple special inspections not requiring coordination outside the local Maintenance and ATC offices may not necessitate a formal inspection plan, but should always be documented.

(2) Inspection Plan. The flight inspector must have a current copy of the inspection plan. The flight inspection crew must be aware of the operational requirements, expected facility performance, and the performance evaluations determined using targets-of-opportunity. This information will be used to determine the scope of the flight inspection.

(3) Checklist Requirements. The flight inspector will work with Facility Maintenance to determine which checklist items have been completed, and which need to be inspected. The role of the flight inspector varies greatly depending on the radar facility type, sophistication, intended use, and location. For example, an ARSR may require the flight inspector to only accomplish a limited portion of the vertical coverage check, whereas a mobile ASR may require a dedicated aircraft for each checklist item.

(4) Aircraft Requirements. Flight inspection aircraft used for primary and secondary radar checks are equipped with a special transponder calibrated in accordance with avionics maintenance standards. The transponder has pilot-selectable power output and sensitivity. The following table depicts flight inspection transponder settings and parameters:

FLIGHT INSPECTION TRANSPONDER SWITCH SETTINGS		FLIGHT INSPECTION TRANSPONDER PARAMETERS	
Flt Insp Select	**Lo-Power Select**	**Rx Sensitivity**	**Tx Power**
OFF	OFF	Normal (-75 dBm)	Normal (350 watts)
ON (1) (barber pole lit)	OFF (1)	Low (-69 dBm)	Normal (350 watts)
ON (barber pole lit)	ON (barber pole lit)	Low (-69 dBm)	Low (88 watts)

(1) Flt Insp Select "ON" (Low sensitivity) with Lo-Power "OFF" (Normal Power) is no longer a standard flight inspection transponder capability.

3. Surveillance Radar Flight Inspections.

a. General. Radar flight inspection requirements may vary from a single, special inspection requirement, such as verifying coverage at a "fix," to a comprehensive commissioning inspection. The coordination, preparation, reporting, and personnel required for each inspection varies widely. An inspection normally consists of three distinct phases: Planning, Engineering & Testing, and Documentation. The planning phase involves coordination between radar engineers, ATC and the flight inspection crew to determine specific inspection requirements, and to develop a flight inspection plan with a sequence of events (i.e., run sheet). The engineering and testing phase involves radar system testing and adjustment, ensuring it performs in accordance with designed specifications. This phase is accomplished using targets-of-opportunity and flight inspection aircraft. Finally, the documentation phase is completed when system performance is formally reported and archived as a baseline reference.

Engineering and maintenance may use targets-of-opportunity, radar data analysis software (RDAS), and other equipment to perform various radar system tests. However, some tests require specially-equipped flight inspection aircraft flown by qualified aircrew. Unless constrained by a specific method, the radar engineering team decides which testing methods to employ. ATC requirements are outlined in the facility siting report and the inspection plan. Surveillance radar flight inspection procedures are detailed in Paragraph 14.5. For Wide Area Multilateration flight inspection guidance, reference Paragraphs 14.6 through 14.8.

The flight inspection crew should anticipate losing two-way radio communication with ground maintenance personnel during various portions of the radar inspection. Therefore, the flight crew should coordinate an alternate means of communication (e.g., ATC relay, satellite telephone, etc.).

b. Commissioning Inspections. The commissioning is the most thorough inspection and requires a detailed run-sheet and formal report. The objective of the commissioning inspection is to evaluate system performance, determine and document the site coverage, and provide a baseline for the detection of a deteriorating performance. Data obtained during this inspection will be used for daily comparison of facility performance, as well as future inspections.

c. Periodic Inspections. ASR approaches and MSAW GTM functions will be periodically flight inspected in accordance with Chapter 4, Table 4-1.

d. Special Inspections. Special inspections are conducted to fulfill a particular need and may be very limited in scope. The limited inspection may not require a formal written plan, and only a short inspection report. If equipment changes or modifications to commissioned facilities change the coverage pattern, document the changes in the inspection report. The new coverage pattern will become the baseline for subsequent inspection comparison. Coordination with appropriate military personnel is vital at joint-use sites. Special inspections include the following:

(1) Engineering Support. Engineering support is essential when developing a test and inspection plan and to help ATC determine if the radar meets certification and operational requirements. Facility Maintenance personnel will determine specific "engineering support" inspection requirements. This data may be used for commissioning purposes, provided no equipment modifications are made prior to the final commissioning inspection.

(2) Antenna Change. When a radar antenna of the same or different type replaces a previously commissioned radar, reference the Surveillance Radar Checklist in Paragraph 14.4 to determine the required inspection checks. If there is a question concerning the radar characteristics or type antenna installed, the engineer-in-charge will determine which antenna change checklist items apply. If the antenna pedestal or rotary joint is replaced, a flight inspection is not required, provided the ground measurements of the reflector position, feedhorn alignment, and antenna tilt are satisfactory. Reference Paragraphs 14.5.g(4)(d) and 14.5.g(4)(e) for primary and secondary radar antenna change procedures.

(3) Major Modifications (other than antenna change). The inspection plan, actual flight inspection, and the report should be limited to the parameters necessary to validate facility performance. The system engineer will determine the special flight inspection requirements and will coordinate with the flight crew to develop a flight inspection plan. Depending upon the modifications, inspection requirements may be satisfied using targets-of-opportunity and RDAS. Optimizing a previously-commissioned radar system, resulting in changes to the tilt and/ or power setting, does not necessitate a flight inspection, so long as the Facility Maintenance and Engineering personnel are satisfied with system performance. However, changes to the primary or secondary radar power or tilt will require a satisfactory flight inspection of each published ASR approach procedure using a flight inspection aircraft.

(4) Near-Midair-Collision Inspections. The ATC manager of the facility involved must request a near-midair-collision inspection. The inspection determines the radar coverage in the area where the incident occurred. The flight inspection must be conducted as soon as possible following the near-midair-collision, duplicating the maneuvers, altitude, and direction of flight of the incident aircraft. If feasible, the radar should be configured the same as it was when the incident occurred. Near-midair flight inspection reports will be handled the same as after-accident reports. Reference FAA Order 8240.36, Flight Inspection Report Processing System (FIRPS) for after-accident reporting instructions.

4. Surveillance Radar Checklist. The following checklist specifies the flight inspection requirements for primary and secondary radar systems, but does not necessarily indicate a sequential order. Radar inspections may be customized, depending on engineering requirements. Some checks require a suitably-equipped flight inspection aircraft. Consult the referenced paragraphs to ensure compliance with each inspection requirement. Checklist items identified by an "X" are mandatory. Facility Maintenance personnel will evaluate the data obtained using targets-of-opportunity to determine if further evaluation using a flight inspection aircraft is necessary. The flight inspector must consult with the radar engineer prior to departing the area to ensure all requirements have been met.

Surveillance Radar Checklist

Type Check	Reference Paragraph	Inspection		Antenna Change Primary		Antenna Change ATCRBS		Major Mods	FI Transponder Settings	
		C	P	Same Type	Diff Type	Same Type	Diff Type		Lo-Pwr Select	Flt Insp Select
Orientation	14.5.d	X		X	X	X	X	X	OFF	OFF
Tilt (3,4)	14.5.e	X			X		X		ON	ON
Primary Radar Optimization (3,4)	14.5.f									
ATCRBS Power Optimization (3,4)	14.5.o	X					X		ON	ON
SLS/ ISLS (4)	14.5.m	X					X		OFF	OFF
Modes/ Codes	14.5.n	X							OFF	OFF
GTC/ STC (4)	14.5.p	X					X		ON	ON
Vertical Coverage	14.5.g	X			X		X		ON	ON
Horiz Screening	14.5.h								ON	ON
Airway/ Route Coverage (1)	14.5.i	X							ON	ON
Fix/ Map Acc (4)	14.5.j	X							OFF	OFF
Fixed Target Ident (4)	14.5.l	X							OFF	OFF
ASR Approach (1,3)	14.5.k	X	X	X	X				OFF	OFF
Communications	14.5.q	X	X						As requested	
Standby Equipment	14.5.r	X							As requested	
Standby Power	14.5.s	X							As requested	
MSAW (2)	14.5.t	X	X						OFF	OFF

C = Commissioning P = Periodic X = Denotes mandatory check (all others at user request)

NOTES:

(1) Requires flight inspection aircraft for final evaluation. All other checks may be accomplished using targets-of-opportunity and RDAS.

(2) *Commissioning:* Check both GTM and APM; if either or both are unavailable during commissioning, a flight inspection is not required prior to use. *Periodic:* Check the GTM; Check the APM only when requested by Maintenance or ATC.

(3) Changes to the Primary or Secondary radar power or tilt require the inspection of each published ASR approach procedure using a flight inspection aircraft.

(4) Normally accomplished using targets-of-opportunity. However, maintenance may request using a flight inspection aircraft.

5. Surveillance Radar Detailed Procedures.

a. General. Tech Ops Facility Maintenance personnel must use operational displays for target grading and guidance information. Facility Maintenance personnel must configure the radar in its most-degraded, but still usable configuration. Be aware, the most-degraded configuration, with all enhancements turned on, may degrade modern "smart" systems to the point the radar is no longer "usable." Data from the operational displays and automation diagnostic and analysis programs will determine if the system supports operational requirements. When using targets-of-opportunity, multiple target returns are required to ensure accuracy. Verify questionable accuracy using a flight inspection aircraft.

b. Evaluation. ATCRBS and primary radar must be evaluated simultaneously throughout the inspection whenever possible. If the ATCRBS replies obscure the primary target, the operator should slightly offset the ATCRBS display to allow evaluation of both the ATCRBS and primary targets.

c. Inspection Sequence. The engineer must ensure the radar facility is operating according to designed specifications before any inspection tests begin. The inspection should start with orientation, tilt, and an initial ATCRBS power setting. During installation, the antenna is normally set to the tilt recommended in the siting report, and the azimuth is set to a prescribed reference. These settings should provide adequate accuracy for the initial tests. The initial ATCRBS power may be set to either a theoretical value or a setting that will interrogate aircraft at maximum radar range. After refining these preliminary settings and becoming confident in them, the engineer should use targets-of-opportunity to ensure the primary and secondary coverage is at least as good as the quality test. All tests which can be accomplished without a flight inspection aircraft should be completed prior to the arrival of the flight inspection aircraft. At joint-use sites, inspection sequence may vary, in order to satisfy the requirements of all agencies concerned.

> Note: Parameter changes occurring during the flight inspection aircraft evaluation may require a repetition of previously conducted tests.

d. Orientation.

(1) Purpose. The orientation check ensures the radar azimuth display is properly aligned with a known ground checkpoint or position. This check may be accomplished using a flight inspection aircraft or a known permanent echo (PE).

(2) Approved Procedures

(a) Fly radially, inbound or outbound, over a well-defined ground checkpoint or position the aircraft using AFIS. The altitude and distance of the checkpoint should be well within the radar coverage.

(b) A radar PE, maintenance beacon, or MTI reflector of known location may be used to determine alignment of the radar azimuth in lieu of a flight inspection aircraft.

(3) Evaluation. Compare the AFIS azimuth with the controller's observed radar azimuth. If the radar display is aligned to magnetic north, ensure the designated magnetic variation is applied to the AFIS measurements.

e. Tilt Verification.

(1) Purpose. The tilt verification check ensures the primary and secondary radar antenna tilt settings are optimum and the mechanical antenna tilt indicators are accurate.

(2) Approved Procedure. Facility Maintenance personnel must direct the aircraft through the heaviest ground clutter within operational areas so the predetermined angle can be evaluated and adjustments made, if required. If radar coverage is acceptable and the radar range is satisfactory, complete the remaining portions of the flight inspection. If parameters are not acceptable, maintenance may need to adjust the antenna tilt angle. If the tilt angle changes during the radar inspection, each previously-inspected item must be re-inspected using the new tilt angle. Additionally, with an increase in antenna tilt, perform an ATCRBS power optimization check. Engineering personnel may use targets-of-opportunity to optimize a previously-commissioned radar system following a tilt change, but may request a flight inspection aircraft. Changes to the primary or secondary radar tilt or power require the inspection of each published ASR approach procedure using a flight inspection aircraft.

(3) Evaluation. The tilt selection process considers the interaction of various radar parameters and the final radar system performance. The optimum tilt angle is a compromise between coverage (with/ without MTI) over clutter and range coverage.

f. Primary Radar Optimization.

(1) Purpose. Primary radar optimization maximizes the radar's ability to display aircraft targets while minimizing clutter. Adjustments in STC, beam gating, receiver sensitivity, pulse width, etc., may improve a radar's performance.

(2) Approved Procedure. Facility Maintenance personnel will provide a detailed flight profile. Changes to the primary or secondary radar power or tilt require the inspection of each published ASR approach procedure using a flight inspection aircraft.

(3) Evaluation. Facility Maintenance personnel will observe the target display and adjust the radar as necessary.

g. Vertical Coverage.

(1) Purpose. The vertical coverage check determines and documents the primary and secondary radar performance in the vertical plane. Evaluate both the inner and outer fringes of the primary and secondary radar antennas.

(2) Vertical Coverage Azimuth. Maintenance should choose an azimuth from the radar antenna or a VOR/ TACAN radial coincident with the radar azimuth which is free of clutter, dense traffic, heavily populated areas, and line-of-site obstructions. For comparison purposes, conduct the commissioning inspection and all subsequent facility performance inspections on the same azimuth. To inspect coverage at altitudes higher than the flight inspection aircraft service ceiling, Tech Ops engineering or ATC may use targets-of-opportunity and RDAS.

(3) Configuration: Facility Maintenance personnel must determine the lowest usable radar configuration. Suggested configurations are as follows:

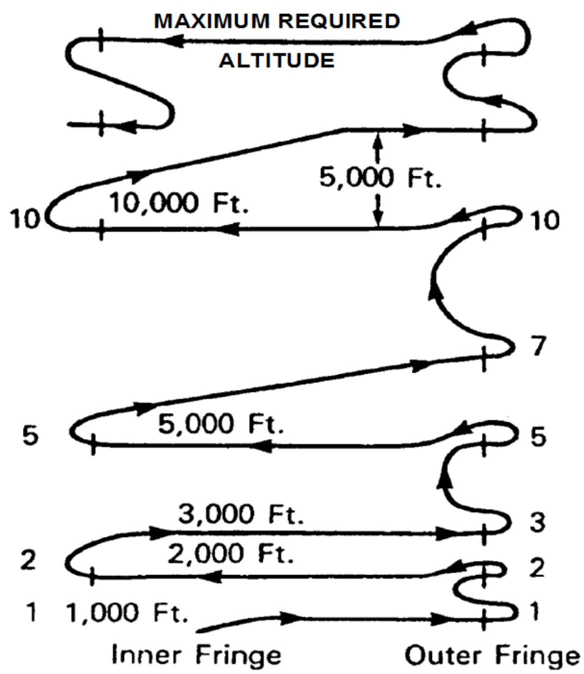
Antenna Polarization	Circular
Diplex Systems	Simplex mode
Integrators/ Enhancers	OFF
Video Processor (military mobile radar)	OFF
ASR-9 Display Video	Uncorrelated

(4) Approved Procedures. Targets-of-opportunity may be used to check the vertical coverage, provided sufficient targets are present to verify the coverage volume. When using targets-of-opportunity, multiple target returns are required to ensure accuracy. Verify questionable accuracy with a flight inspection aircraft. Aircraft reflective surfaces and transponder antenna radiation characteristics vary between inbound (nose-on) and outbound (tail-on) flight; therefore, expect coverage variations. Normally, determine the outer-fringe coverage using tail-on targets and the inner-fringe coverage using nose-on targets. If Facility Maintenance personnel request to evaluate the outer-fringe using nose-on targets, the flight inspection report should clearly differentiate between nose-on and tail-on results. The flight inspector must obtain the vertical coverage azimuth and maximum required altitude from the Facility Maintenance personnel. Use map checkpoints, a NAVAID radial, AFIS, or radar vectors to remain on the vertical coverage azimuth. All altitudes depicted in the figures 14-1 through 14-4 depict height above the radar antenna. Reference the appropriate sub-paragraph below, depending on the type radar antenna. Vertical coverage, whether verified by a flight inspection aircraft or targets-of-opportunity, must be evaluated using the power level established during the ATCRBS Power Optimization procedure. Commission the beacon at the optimized flight inspected power level, plus 1 dB.

Note: For mobile radar inspections where the outer fringe inspection is not required, or a comprehensive vertical coverage check is not requested, inspect the coverage to the planned operational range plus 10 percent, at a minimum. The final report will include a comment stating the vertical coverage was inspected to the required operational range plus 10 percent. The mobile radar facility will be restricted.

(a) Commissioning – ASR/ ATCRBS Vertical Coverage Profile. Refer to the Surveillance Checklist in Paragraph 14.4 and Figure 14-1 below.

Figure 14-1. Commissioning - ASR/ ATCRBS Vertical Coverage Profile.



(i) Determine the inner fringe at 1,000 ft. Then fly outbound at 1,000 ft and establish the outer fringe.

(ii) Climb to 2,000 ft and establish the outer fringe. Then proceed inbound at 2,000 ft and establish the inner fringe.

(iii) Climb to 3,000 ft and establish the outer fringe.

(iv) Climb to 5,000 ft and establish the outer fringe.

(v) Repeat the outer fringe check at 5,000 ft (or lower if necessary) to evaluate radar auxiliary functions such as linear polarization, pin diode, integrators, etc., on the primary and GTC/ STC on the secondary radar. Linear polarization normally increases the usable distance, so this check should be performed at an altitude where the change can be observed. Most auxiliary functions produce a decrease in receiver sensitivity, thereby decreasing the usable distance. Conduct these tests by establishing the outer fringe with the function on, and then off, and noting the difference in usable distance.

(vi) Return the equipment to its original inspection configuration and proceed inbound at 5,000 ft and establish the inner fringe.

(vii) Climb to 7,000 ft and establish the outer fringe.

(viii) Climb to 10,000 ft and establish the outer fringe. Then proceed inbound at 10,000 ft and establish the inner fringe.

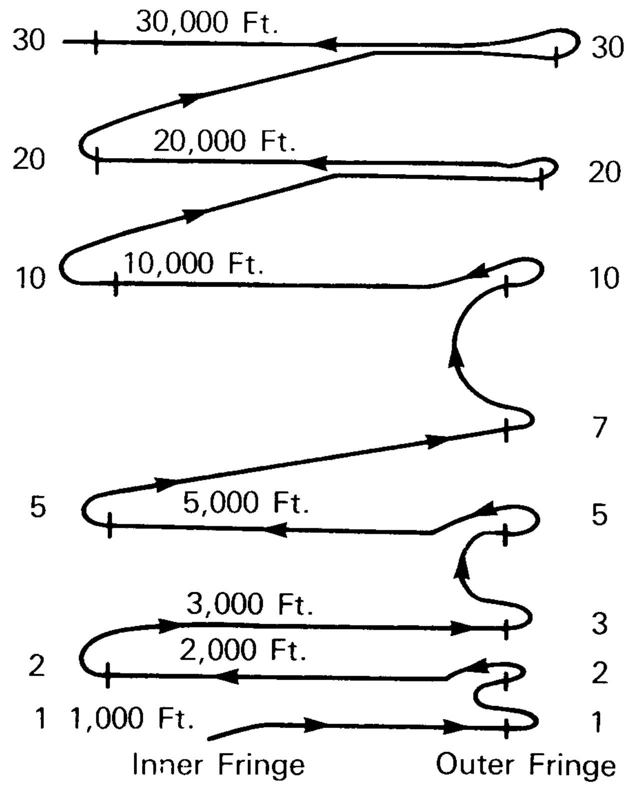
(ix) If the maximum required altitude is greater than 10,000 ft, check the outer fringe in 5,000 foot increments up to the maximum required altitude; e.g., if 17,000 ft, check the outer fringe at 15,000 and 17,000 ft, then proceed inbound at the maximum required altitude and establish the inner fringe. If satisfactory radar coverage is not maintained during this inbound run, conduct additional flights through the vertical coverage pattern and establish the maximum usable altitude.

(x) Check the inner fringe at the altitudes used to establish the outer fringe stepping down in altitude to the 10,000-foot level.

Note: If the maximum required altitude is 10,000 ft or lower, do not inspect vertical coverage above this altitude unless requested.

(b) Commissioning – ARSR/ ATCRBS Vertical Coverage Profile. Refer to the Surveillance Checklist in Paragraph 14.4 and Figure 14-2 below.

Figure 14-2. Commissioning - ARSR/ ATCRBS Vertical Coverage Profile.



(i) Complete steps (1) through (8) of the ASR commissioning requirements in Paragraph 14.5.g(4)(a).

(ii) Climb to 20,000 ft and establish the outer fringe. Then proceed inbound at 20,000 ft and establish the inner fringe.

(iii) Climb to 30,000 ft and establish the outer fringe.

(iv) Repeat the outer fringe, as required, to conduct auxiliary functions tests.

(v) Then proceed inbound at 30,000 ft and establish the inner fringe.

(vi) If operational or engineering requirements are greater than 30,000 ft, or 30,000 ft conflicts with air traffic, climb to a mutually agreeable altitude and establish the outer and inner fringes.

(c) Commissioning - Military BRITE/ DBRITE Display. If the sole function of the ASR is to provide a video source for a BRITE/ DBRITE display, inspect either to operational requirements, or 4,000 ft/ 10 miles, whichever is greater.

(i) Determine the inner and outer fringes at every 1,000-foot level up to 4,000 ft or the operational altitude.

(ii) No comparative equipment auxiliary function configuration checks are required.

(iii) Target definition will be from the BRITE display.

(iv) There are no periodic inspection requirements.

(d) Antenna Change – ASR or ARSR. When the primary ASR or ARSR is replaced with the same type antenna, any inspection requirements may be completed using targets-of-opportunity. When the ASR or ARSR is changed to a different type antenna, perform the required Checklist inspection items, including the vertical coverage profile depicted in either Figure 14-3 or 14-4, as applicable.

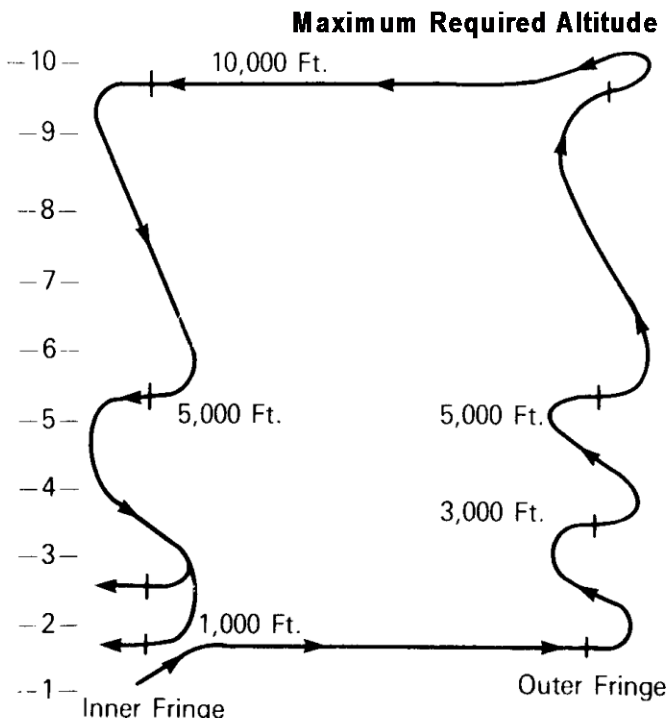
(i) After determining the outer fringe at 5,000 ft, repeat the outer fringe check, as required, to evaluate auxiliary functions as requested by Facility Maintenance personnel. Conduct the remainder of the coverage check in the original configuration.

(ii) Checks of additional facility equipment configurations and altitudes will be at the option of Facility Maintenance personnel.

(e) Antenna Change – ATCRBS. When the ATCRBS is replaced with the same type antenna, any inspection requirements may be completed using targets-of-opportunity. When the ATCRBS is changed to a different type antenna, perform the required Checklist inspection items.

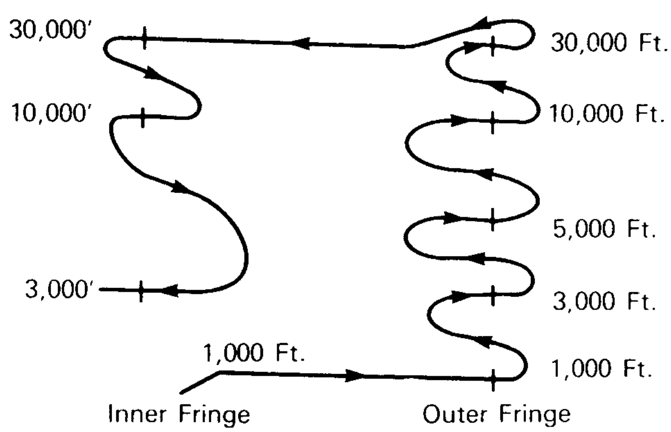
(i) Terminal Radar. The profile for a primary radar antenna change is depicted by Figure 14-3 below.

Figure 14-3. Antenna Change - ASR/ ATCRBS.



(ii) En Route Radar. The profile for a primary radar antenna change is indicated in Figure 14-4 below.

Figure 14-4. Antenna Change - ARSR/ ATCRBS.



(5) Evaluation. Facility Maintenance personnel must record target strength as defined in Paragraph 14.10 on each scan, aircraft position every five miles, and aircraft altitude for each fringe check and level run. Facility Maintenance personnel must document results of the vertical coverage check using analysis/ diagnostic programs (RDAS tools), when available, for inclusion in the facility report

h. Horizontal Screening.

(1) Purpose. Horizontal screening verifies the indicated coverage on the horizontal screening charts. This test is optional depending upon operational requirements and ground evaluation tools available. After reviewing the results of the vertical coverage check and other data, engineering personnel will determine if the horizontal coverage check is required.

(2) Approved Procedure. Fly an orbit at an altitude and distance corresponding to the lowest screening angle at which coverage is expected. Do not use an orbit radius of less than ten miles. Use AFIS, DME, or radar vectors to remain on the orbit. Except where ground clutter obscures targets unless MTI is used, the MTI should be gated to a range inside the orbit radius. However, if MTI is gated outside the orbit, continuously change the orbit radius to avoid target cancellation due to tangential blind speed. For example, vary the distance on a 12-mile orbit between 10 and 14 miles, flying oblique straight courses between the 10-mile and 14-mile orbits, so as to average a 12-mile orbital distance.

(3) Evaluation. Facility Maintenance personnel must record target strength, azimuth and distance on every scan. They must determine if the coverage supports operational requirements.

i. Airway/ Route Coverage.

(1) Purpose. Airway and route coverage verifies primary and secondary radar performance in the active airspace, and becomes a baseline for future reference. Facility Maintenance personnel, in coordination with ATC, will determine the extent of airway and route evaluations. Areas of intense clutter, poor target returns, or other potential problems identified in the inspection plan may be further evaluated to determine actual facility coverage. This check may be accomplished using targets-of-opportunity with the final commissioning check accomplished using a flight inspection aircraft.

(2) Approved Procedures.

(a) Flight Inspection Aircraft. Facility Maintenance personnel must configure the primary radar in "circular polarization". The altitudes at which satisfactory radar coverage exists will be determined by flying the minimum altitude (not lower than MOCA) on airway centerline. The terminal arrival and departure routes and other areas of interest identified in the inspection plan will be flown at MOCA. Maintain course guidance by reference to AFIS, ground checkpoints, NAVAID signals, or radar vectors. Coverage verification using linear polarization may be checked at the discretion of the test engineer or, if a joint use site, by the DoD agency.

(b) Targets-of-Opportunity. Targets may consist of one or an assortment of aircraft returns on a particular airway, route or terminal radial. Targets used must be Mode-C equipped so altitude information can be obtained. Scoring may be accomplished manually, or using software tools. Software analysis tools may be used to evaluate the track information of a selected (beacon code) target.

(3) Evaluation. Facility Maintenance personnel must determine if the facility coverage meets operational requirements.

j. Fix/ Map Accuracy.

(1) Purpose. The fix and map accuracy check verifies the airways, routes, fixes, and runway centerlines are accurately depicted on the video map display. Facility Maintenance personnel may use targets-of-opportunity in lieu of a flight inspection aircraft to verify fix and map accuracy, including replacement map overlays, video maps, or digitally-generated maps.

(2) Approved Procedure. The flight inspector must fly the minimum altitude where satisfactory radar coverage exists. Use NAVAID guidance, ground checkpoints, or AFIS to identify the airway, route, or fix. The inspection method is the same, whether using a flight inspection aircraft or targets-of-opportunity; Facility Maintenance personnel compare reported aircraft position relative to the airway, route, or fix with the video map presentation. Similarly, verify runway centerline to video map alignment by observing landing and departing aircraft.

(3) Evaluation. Compute the distance between the airway, route or fix, and the aircraft position, and apply the appropriate tolerance.

(4) Radar Overlays. A radar map overlay used as a video map backup need not be flight inspected, provided the overlay data is identical to the video map, and the video map has been previously verified accurate. Any overlay data which differs from the video map display must be verified accurate, using targets-of-opportunity or a flight inspection aircraft, before use. This applies to new or replacement map overlays.

k. ASR Approach Procedures.

(1) Purpose. In compliance with the surveillance checklist and the requirements of Chapter 6, each ASR approach procedure must be inspected for accuracy and coverage using a suitably-equipped flight inspection aircraft. Changes to the primary or secondary radar tilt or power require the inspection of each published ASR approach procedure using a flight inspection aircraft. ASR approaches must be inspected on a periodic basis.

(a) Approach to a Runway. The approach course must coincide with the runway centerline extended, and must meet accuracy and coverage tolerances.

(b) Approach to an Airport. The approach course must be aligned to the MAP as determined by procedures and Facility Maintenance personnel. Helicopter-only final approach courses may be established to a MAP no farther than 2,600 ft from the center of the landing area.

(2) Approved Procedure. Except for emergencies, ATC should not use the secondary radar to control aircraft on an ASR approach. Therefore, ATC must use only the primary ASR display during an ASR approach inspection, with the ATCRBS display offset. ATC must not use a PAR display during an ASR approach inspection. The controller must provide vectors to a 10-mile ASR final approach, at the MVA. The flight inspector will fly at the MVA until reaching the final approach segment. Prior to the final segment, verify the minimum descent altitude (MDA) provided by the controller matches with the published MDA. Fly the vectored headings during final approach, and descend to the MDA when directed. Verify the controller's recommended altitudes during descent.

(3) Evaluation. The flight inspector will evaluate the ASR approach procedure in accordance with Chapter 6 of this order. Additionally, determine the aircraft position relative to runway centerline extended/ airport at the MAP, and whether a safe landing can be made without excessive maneuvering. ASR approaches must meet flight inspection tolerances or be canceled by NOTAM action. Cancellation of an ASR approach does not constitute a radar restriction. When MTI is required for an ASR approach, information must be documented on the flight inspection report. The use of MTI does not constitute a facility restriction; however, an ASR approach which requires MTI must be considered “Not Authorized” while MTI is inoperative.

l. Fixed Target Identification.

(1) Purpose. To identify prominent, primary broadband targets used for range and azimuth accuracy checks when they cannot be identified by other means. This check may be accomplished using targets-of-opportunity or flight inspection aircraft.

(2) Approved Procedure. Facility Maintenance personnel will select identifiable features from a comparison of the ground clutter return and geographic maps (islands, mountain peaks, towers, etc.). They should direct the pilot to the PE return. If the pilot can identify and describe the ground target, and the target is a permanent feature, record the PE in the inspection report.

(3) Evaluation. The pilot will identify and describe in the formal inspection report each fixed target PE inspected.

m. Side-Lobe Suppression.

(1) Purpose. This check enables Facility Maintenance to set the transmitter power feeding the beacon SLS or ISLS antenna elements. The use of SLS/ ISLS improves beacon performance, and reduces or eliminates ring-around caused by antenna pattern side lobes. ISLS also reduces false targets, normally caused by close, vertical reflecting surfaces. This check may be accomplished using targets-of-opportunity or flight inspection aircraft.

(2) Approved Procedure. Normally, this inspection is accomplished using targets-of-opportunity. However, Facility Maintenance personnel may request a flight inspection aircraft fly designated azimuths in areas where there are side lobe problems. Fly the designated radials at 1,000 ft above the radar site elevation to the coverage limits (normally line-of-sight). Facility Maintenance personnel must adjust the SLS or ISLS power levels while observing beacon inner-range coverage. The power levels must be adjusted for minimum ring-around and false target returns. After making final adjustments, ensure inner range coverage is still satisfactory.

(3) Evaluation. Facility Maintenance personnel must evaluate SLS/ ISLS performance.

n. Modes and Codes.

(1) Purpose. The modes and codes check verifies the proper ATCRBS decoding of transponder reply pulses. Facility Maintenance personnel must ensure all modes and codes are verified by equipment test procedures before requesting flight inspection.

(2) Approved Procedure. Facility Maintenance personnel must monitor the flight inspection aircraft transponder replies or targets-of-opportunity throughout the vertical coverage, airway, route, and terminal checks to verify correct altitude readout. During these tests, Facility Maintenance personnel should request the flight inspection aircraft use different modes or codes to sample various modes and code trains. When targets-of-opportunity are used, ensure the sample contains all modes interrogated and a sufficiently large sample of codes to ensure correct decoding of beacon replies. Do not use codes 7500, 7600, and 7700, due to false emergency alarms.

(3) Evaluation. Facility Maintenance personnel must ensure the displayed transponder code matches the aircraft transponder setting and altitude.

o. ATCRBS Power Optimization.

(1) Purpose. The ATCRBS power optimization check reduces over-interrogation, over-suppression, fruit, and false targets caused by reflections. The optimum ATCRBS power is the minimum power necessary to meet operational requirements.

(2) Approved Procedure. Position the aircraft to fly an arc in the vicinity of the vertical coverage radial, or a mutually agreed reference radial, at maximum distance. Fly the maneuver at 10,000 ft AGL for an ASR or 30,000 ft AGL for an ARSR, or as close to these altitudes as operational conditions allow. The beacon transmitter power must be adjusted to the minimum value producing a usable beacon reply or target. During this check, ensure the aircraft transponder antenna is not shielded by the aircraft. ATCRBS power optimization is required with an increase in antenna tilt, and may be accomplished using targets-of-opportunity. Changes to the primary or secondary radar tilt or power require the inspection of each published ASR approach procedure using a flight inspection aircraft.

Vertical coverage, whether verified by a flight inspection aircraft or using targets-of-opportunity, must be evaluated using the power level established during the ATCRBS Power Optimization procedure. Commission the beacon at the optimized flight inspected power level, plus 1 dB.

(3) Evaluation. Facility Maintenance personnel must observe ATCRBS performance during the ATCRBS power optimization for a usable beacon reply.

> Note: Although power optimization may be accomplished during the vertical coverage check, a change in beacon power requires repeating each inspection item already performed up to the point of the power adjustment.

p. GTC/ STC Evaluation.

(1) Purpose. The ATCRBS Gain Time Control/ Sensitivity Time Control (GTC/ STC) decreases interrogator receiver gain as aircraft-to-station range decreases, thereby limiting ring-around and false targets. Facility Maintenance personnel must set the GTC/ STC prior to the flight inspection and confirm proper performance during the vertical and airway/ route coverage inspections.

(2) Approved Procedures.

(a) Targets-of-Opportunity. Facility Maintenance may establish the STC setting during ground checks, and validate using targets-of-opportunity and RDAS, or other software tools. If Facility Maintenance observes ring-around or false targets while monitoring targets-of-opportunity, the GTC/ STC is improperly adjusted. A special target scoring check solely to adjust GTC/ STC is required.

(b) Flight Inspection Aircraft. A target scoring check solely to adjust GTC/ STC requires a flight inspection aircraft, configured in accordance with the checklist in Paragraph 14.4. Position the aircraft on the vertical coverage radial, or a mutually agreed reference radial. The aircraft will fly inbound or outbound, at 10,000 ft AGL for an ASR or 30,000 ft AGL for an ARSR, or as close to these altitudes as operational conditions allow. Facility Maintenance personnel must examine the received beacon signal on the entire radial, fringe-to-fringe. A fairly constant signal level on the entire radial indicates a proper GTC/ STC setting.

(3) Evaluation. Facility Maintenance personnel must evaluate the display for minimum ATCRBS false targets and/ or ring-around.

q. Communications. The purpose of this check is to evaluate VHF/ UHF communications capability within the radar coverage area. When flight inspection aircraft are not equipped for UHF communications, the inspection may be completed using VHF only. UHF coverage may be confirmed by the appropriate air traffic facility using targets-of-opportunity. Concurrent with the radar inspection, the flight inspector must check communications in accordance with Chapter 8.

r. Standby Equipment. The purpose of this check is to evaluate and compare the performance of standby equipment in relation to the primary equipment. This check may be accomplished during pre-inspection testing using targets-of-opportunity. If standby equipment is available, but not working, the flight inspector must be notified (see Chapter 4, Paragraph 17.b). Some radar installations are engineered to meet reliability requirements by the use of redundant parallel units, instead of standby transmitters.

Conduct flight inspection of these facilities while the system is operating in parallel. A separate check of each channel is not required. Some replacement radar units are collocated in the building with the primary radar and share the same waveguide and antenna during installation and checkout. In this case, the standby transmitter cannot be placed in operation without an extended facility shutdown. The pre-inspection testing of these systems must thoroughly test all redundant and standby units to ensure they meet or exceed tolerances established on the flight inspected channel. A standby antenna (duplicate) may be installed at selected locations to provide continued radar service, in the event of antenna failure. The commissioning requirements for a standby antenna will be completed using the antenna change checklist.

s. Standby Power. The purpose of this check is to ensure system performance remains within flight inspection tolerances while operating on standby power (see Chapter 4, Paragraph 17.c). Maintenance simulates normal power failure by manually switching to standby power prior to the flight inspection. Results are satisfactory when the monitor equipment detects a power failure, starts the standby generator, and switches to standby power without manual intervention.

t. MSAW. The MSAW flight inspection is a test of the ARTS software and has no flight inspection tolerances. MSAW test results do not affect the associated ASR status. The flight crew will coordinate with ATC and Facility Maintenance to ensure the planned altitudes and alert points are clearly understood. Perform all MSAW tests under Day/ VFR conditions, using an “uninhibited” IFR beacon code with the transponder set to Normal/ Normal. After the test, verify with ATC the MSAW alerted properly. Notify Facility Maintenance or ATC of any alert discrepancies. Air Traffic and/ or Facility Maintenance will determine the final MSAW status.

(1) Approach Path Monitor (APM). Between the initial point 5 nm prior to AER or FAF, whichever is first, and the APM cut-off point, descend below the normal approach path into the APM area. Depending upon the rate of descent, an MSAW should alert at, or prior to the monitored area. The APM cut-off point will be 1 to 2 nm prior to AER. For a circling-only approach, the APM starts at 5 nm from the airfield, or FAF, and terminates 1 to 2 nm from the closest landing surface.

(2) General Terrain Monitor (GTM). A flight inspection aircraft must perform a GTM check during the periodic interval. Within 55 nm of the radar, descend below the MVA. Depending upon the rate of descent, an MSAW should alert at, or prior to the assigned bin altitude. Perform the GTM check beyond 10 nm from any airport with an APM.

6. WAM Flight Inspection Procedures.

a. General. WAM inspections are similar to surveillance radar inspections, and may vary from a solitary special inspection requirement, such as coverage over a “fix,” to a comprehensive commissioning inspection. In very general terms, planning activities and engineering support involvement is similar to the traditional ATCRBS inspection.

b. Commissioning Inspections. The objective of the commissioning inspection is to evaluate system performance, determine and document site coverage, and establish a system baseline. Facility Maintenance and Air Traffic will use the baseline data to identify performance deterioration, when compared to daily performance and future WAM inspections. The commissioning is the most thorough inspection and requires a correspondingly detailed plan and report.

c. Periodic Inspections. WAM systems require periodic flight inspections.

d. Special Inspections. Special inspections are conducted to fulfill a particular need and may be very limited in scope. The limited inspection may not require a formal written plan and only a short inspection report. If equipment changes or modifications to commissioned facilities change the coverage pattern, document the changes in the inspection report. The new coverage pattern then becomes the basis for comparison during subsequent inspections. Coordination with appropriate military personnel is vital at joint-use sites. Special inspections include the following:

(1) Engineering Support. An "Engineering Support" inspection helps Facility Maintenance and ATC personnel determine if the system meets equipment certification and operational requirements. This data may be used for commissioning purposes, provided no equipment modifications are made prior to the commissioning inspection.

(2) Major Modification. A "Major Modification" requires a detailed inspection plan and report, but should be confined to the parameters necessary to verify system performance. During preparation and coordination of the inspection plan, the system engineer will determine the extent of the special inspection. Depending on the modifications, an inspection using targets-of-opportunity and software tools may satisfy inspection requirements.

(3) Near Midair-Collision. The ATC manager of the facility involved must request a near midair-collision inspection. The inspection determines the coverage in the area where the incident occurred. The flight inspection must be conducted as soon as possible following the near-midair-collision, duplicating the maneuvers, altitude, and direction of flight of the incident aircraft. If feasible, the WAM system should be configured the same as it was when the incident occurred. Near-midair flight inspection reports will be handled the same as after-accident reports. Reference FAA Order 8240.36, Flight Inspection Report Processing System (FIRPS) for after-accident reporting instructions.

7. WAM Checklist. The following checklist specifies the WAM flight inspection requirements. Special inspections may be customized, depending on engineering requirements. Some checks require a suitably-equipped flight inspection aircraft, while others may be accomplished using targets-of-opportunity and software analysis. Consult the referenced paragraphs to ensure compliance with each inspection requirement. Checklist items identified by an "X" are mandatory. Facility Maintenance personnel will evaluate the data obtained using targets-of-opportunity to determine if further evaluation using a flight inspection aircraft is necessary. Prior to departing the area, the flight inspector must consult with the system engineer to ensure all requirements have been met. The following checklist items must be completed as indicated.

WAM Checklist

Type Check	Paragraph Reference	Inspection		FI Transponder Settings		
		C	P	Lo-Pwr Select	Flt Insp Select	Transponder Type (6)
Vertical Transition Handoff	14.8.b	X		As Requested		Either
Modes/ Codes	14.8.h	X		Not Applicable		Either
General Coverage	14.8.c	X		(3)	(3)	(3)
Perimeter Coverage	14.8.d	X(1)		(4)	(4)	(4)
Airways/ Route Coverage	14.8.e	X(1)		(3)	(3)	(3)
Fix / Map Accuracy	14.8.f	X		OFF	OFF	Either
Communications	14.8.i	X	X	Not Applicable		Either
Standby Equip	14.8.j	X		As Requested		Either
Standby Power	14.8.k	X		Not Applicable		Either
MSAW (2)	14.8.l	X	X	OFF	OFF	Either
Degraded System Configuration (5)	14.8.m	X (1)		(4)	(4)	(4)

C = Commissioning P = Periodic X = Denotes mandatory check (all others by request)

NOTES:

(1) Requires flight inspection aircraft for final evaluation. All other checks may be accomplished using targets-of-opportunity and RDAS.

(2) *Commissioning:* Check both GTM and APM; if either or both are unavailable during commissioning, a flight inspection is not required prior to use. *Periodic:* Check the GTM; Check the APM only when requested by Maintenance or ATC.

(3) Check with “Either” type transponder, using targets-of-opportunity; when using a flight inspection aircraft with an ATCRBS-only transponder, ensure it is set at low sensitivity and low power (i.e., ON/ ON), unless engineering directs otherwise.

(4) Flight inspection aircraft should use an ATCRBS-only transponder set at low sensitivity and low power (i.e., ON/ ON), unless engineering directs otherwise.

(5) WAM system configured per engineering instructions.

(6) The two basic types of aircraft transponders are Mode-S and ATCRBS-only. Some checks require a flight inspection aircraft equipped with an ATCRBS-only transponder (without Mode-S), capable of reduced receiver sensitivity to approximately -69 dBm. Checks with “Either” may use either a Mode-S or ATCRBS-only transponder.

8. WAM Detailed Procedures.

a. General. Facility Maintenance personnel must use operational displays for target grading and guidance information. Data from the operational displays and automation diagnostic and analysis programs will determine if the system supports operational requirements. When using targets-of-opportunity, multiple target returns are required to ensure accuracy. Verify questionable accuracy with a flight inspection aircraft. The system should be configured for use in the day-to-day standard operating configuration (Normal), except during the Degraded Configuration System checks. During these checks, Facility Maintenance personnel will configure the WAM system in its lowest usable configuration(s). WAM processes Mode-S and ATCRBS aircraft transponders differently; therefore, some checks are designed to evaluate performance using a specific type of transponder.

b. Vertical Transition Handoff.

(1) Purpose. This check is designed to verify when an aircraft target transitions vertically between the WAM and conventional secondary radar airspaces. The check also verifies the handoff occurs seamlessly, without a loss of coverage.

(2) Approved Procedures. Choose a ground track between one or more waypoints transiting through the WAM coverage area, where vertical transition testing will occur. Targets-of-opportunity may be used to check the vertical handoff between WAM and the conventional radar. Verify questionable results with flight inspection aircraft. The flight inspection aircraft should fly the planned ground track while climbing and descending through the transition boundary altitude multiple times. Penetrate the transition boundary altitude by at least 1,000 feet.

(3) Evaluation. When an aircraft target crosses through the transition boundary altitude, there should not be any coverage loss.

c. General Coverage.

(1) Purpose. This check verifies the WAM coverage limitations.

(2) Approved Procedures. Targets-of-opportunity should be the primary method to determine system coverage. Use flight inspection aircraft when there is insufficient data or problems are suspected. Fly the altitudes and distances requested by engineering personnel.

(3) Evaluation. Facility Maintenance personnel must determine if the actual coverage meets operational requirements.

d. Perimeter Coverage.

(1) Purpose. This check verifies WAM coverage and performance at maximum altitudes and distances.

(2) Approved Procedure. Unless otherwise directed by engineering, the flight inspection aircraft should use an ATCRBS-only transponder in low-sensitivity/ low-power mode (approximately -69 dBm and 90 watts). The lower-than-normal sensitivity approximates the operational limit for a reduction in transmission power from the WAM system ground stations. Engineering may request repeating portions of this check using a Mode-S transponder (FI Insp Select-ON; Lo-Pwr Select-ON at/ or below 15,000 ft MSL). Fly the perimeter of the WAM constellation, adjusting altitude to follow the highest adapted altitude. Fly 100 feet below the adapted altitude to prevent unnecessary coverage dropouts due to momentarily exceeding the top altitude. If the terrain elevation becomes a factor while flying the perimeter, adjust the ground track towards the inside of the coverage area while maintaining the desired MSL altitude. Repeat for each constellation, if applicable. Record time-stamped positioning data for engineering post-flight analysis.

(3) Evaluation. Facility Maintenance personnel must determine if the coverage supports operational requirements.

e. Airway/ Route Coverage.

(1) Purpose: To document coverage along routes and airways, required by ATC. Facility Maintenance personnel must determine the extent of these evaluations which determine the overall WAM facility coverage. Areas of poor target returns, or other potential problems identified in the inspection plan may be further evaluated to determine actual facility coverage. This check must be accomplished using targets-of-opportunity with a flight inspection aircraft performing the final commissioning check.

(2) Approved Procedures.

(a) Inspecting Routes and Airways. Unless otherwise directed by engineering, the flight inspection aircraft should use an ATCRBS-only transponder in low-sensitivity/low-power mode (approximately -69 dBm and 90 watts). The lower-than-normal sensitivity approximates the tolerance limit for a reduction in transmission power from the WAM system ground stations. Engineering may request repeating airway and route coverage with a Mode-S transponder (FI Insp Select-ON; Lo-Pwr Select-ON at/ below 15,000 ft MSL). The altitudes at which satisfactory coverage exists will be determined by flying the minimum altitude (not lower than MOCA) on airway centerline. Fly the terminal arrival, departure routes, and other areas of interest at MOCA. Use AFIS, ground checkpoints, NAVAID signals, or radar vectors to maintain course guidance. Record time-stamped positioning data for engineering post-flight analysis, if requested.

(b) Targets-of-Opportunity. Targets may consist of one or an assortment of aircraft returns on a particular airway, route or terminal radial. Targets must show altitude. Scoring may be accomplished manually, or using software tools. Software analysis tools may be used to evaluate the track information of a selected (beacon code) target.

(3) Evaluation. Facility Maintenance personnel must determine if the facility coverage meets operational requirements.

f. Fix/ Map Accuracy.

(1) Purpose. The WAM fix and map accuracy check verifies the airways, routes, fixes, and runway centerlines are accurately depicted on the video map display. If Facility Maintenance personnel used targets-of-opportunity to verify map accuracy, then replacement map overlays, video maps, or digitally-generated maps do not require a flight inspection.

(2) Approved Procedure. If requested, fly the minimum altitude where satisfactory coverage exists along the airway, route, or fix. The procedure is the same whether using a flight inspection aircraft or targets-of-opportunity; Facility Maintenance personnel compare reported aircraft position relative to the airway, route, or fix with the video map presentation. Similarly, verify runway centerline to video map alignment by observing landing and departing aircraft.

(3) Evaluation. Compute the distance between the airway, route or fix, and the aircraft position, and apply the appropriate tolerance.

(4) Radar Overlays. A radar map overlay used as a video map backup need not be flight inspected, provided the overlay data is identical to the video map, and the video map has been previously flight inspected. Any overlay data which differs from the video map display must be inspected before use. This applies to new or replacement map overlays.

g. WAM Approaches. WAM does not support surveillance approaches at this time.

h. Modes and Codes.

(1) Purpose. The modes and codes check verifies the proper ATCRBS decoding of transponder reply pulses. Facility Maintenance personnel must ensure all modes and codes are verified by equipment test procedures before requesting flight inspection.

(2) Approved Procedure. Facility Maintenance personnel must monitor the flight inspection aircraft transponder replies or targets-of-opportunity throughout the vertical coverage, airway, route, and terminal checks to verify correct altitude readout. During these tests, Facility Maintenance personnel should request the flight inspection aircraft use different modes or codes to sample various modes and code trains. When targets-of-opportunity are used, ensure the sample contains all modes interrogated and a sufficiently large sample of codes to ensure correct decoding of beacon replies. Do not use codes 7500, 7600, and 7700, due to false emergency alarms.

(3) Evaluation. Facility Maintenance personnel must ensure the displayed transponder code matches the aircraft transponder setting and altitude.

i. Communications. The purpose of this check is to evaluate VHF/ UHF communications capability within the coverage area. When flight inspection aircraft are not equipped for UHF communications, the inspection may be completed using VHF only. UHF coverage may be confirmed by the appropriate air traffic facility using targets-of-opportunity. Concurrent with the WAM inspection, the flight inspector must check communications in accordance with Chapter 8.

j. Standby Equipment. The purpose of this check is to evaluate and compare the performance of standby equipment. This check may be accomplished during pre-inspection testing using targets-of-opportunity. A WAM system normally has two Target Processors (TP1 and TP2). Attempt to document the performance of both during the commissioning flight inspection.

k. Standby Power. The purpose of this check is to ensure system performance remains within flight inspection tolerances while operating on standby power (see Chapter 4, Paragraph 17.c). Maintenance simulates normal power failure by manually switching to standby power prior to the flight inspection. Results are satisfactory when the monitor equipment detects a power failure, starts the standby generator, and switches to standby power without manual intervention.

l. MSAW. Follow the guidance in Paragraph 14.5.t.

m. Degraded System Configuration.

(1) Purpose: To verify the system performs in an acceptable manner, with adequate coverage and position accuracy, in the allowable degraded states..

(2) Approved Procedure.

(a) During each of these checks, the flight inspection aircraft will record time-stamped positioning data for post-flight analysis by engineering personnel. Unless otherwise requested by engineering, the flight inspection aircraft should utilize the ATCRBS-only flight inspection transponder, (i.e., without Mode-S), operating in the low sensitivity and low power mode (approximately -69 dBm and 90 watts).

(b) N-1 State Check. A WAM system is normally designed to operate in a "N-1" state, with one of the Receive Only (RO) or Receive/ Transmit (RT) Remote Units (RUs) out of service.

> Note: Some WAM systems may not be designed to operate in an N-1 configuration, and some may be designed to operate in an even more (e.g., N-2) degraded configuration. Adapt this check accordingly to the given situation.

Prior to the flight inspection, engineering personnel will determine, using software analysis tools, which RUs, when disabled result in possible marginal coverage, and/ or marginal performance (positional accuracy). In addition, a specific routing (ground track and altitudes) will be identified in the inspection plan to be flown with each marginal "N-1" state. Also fly an instrument procedure final segment and missed approach segment (if available) to any runways within the area identified as an area of possible marginal coverage/ performance. This doesn't require flying every published approach and missed approach procedure to every runway within the possible marginal area. Choosing a representative approach and missed approach will suffice. If warranted and circling is authorized for any instrument approach procedure at the airport, consideration should be given to circling around the airport in question at the minimum circling altitude. If more than one inoperative RU ("N-1") state is identified, configure the system in each "N-1" state in turn, and fly the associated routing/ approaches with each.

(c) Horizontal Transitions. Conduct this check at the request of Engineering Services only. Configure the WAM system per engineering direction. Fly any airway or ATC routing from outside the WAM system coverage area, through the WAM area, and back out of coverage, all at 100 feet below the maximum altitude(s). Maximum altitude in this case is defined as the highest altitude within a given sort box at which WAM coverage will be utilized by Air Traffic. Flying 100 feet below the designed altitude should prevent unnecessary coverage drop-outs due to momentarily exceeding the software controlled cut-off altitude. Note that this check will require configuring the automation display to include neighboring radars as well as the WAM coverage area.

(3) Evaluation. In addition to real-time assessment of system performance and coverage, conduct a post-flight analysis of the flight inspection positioning data to determine system accuracy. Facility Maintenance personnel must determine if the facility performance meets operational requirements.

9. Analysis.

a. Testing Precautions. Radar inspections should not be attempted during heavy precipitation, temperature inversions, or other atmospheric conditions which change the coverage from normal. Whenever a system parameter does not meet tolerances and cannot be adjusted within a reasonable length of time, discontinue the flight inspection until the discrepancy is resolved. This does not preclude the continuation of tests in an effort to resolve the problems.

b. Evaluation. Usable radar coverage does not mean a usable target return on every scan at every azimuth and all usable altitudes. Missed targets can be caused by antenna lobing, line-of-sight, aircraft attitude, or antenna tilt. Therefore, expect isolated or non-recurring target misses. If three or more consecutive misses are observed, verify if a hole exists in the radiation pattern and determine its size. If a hole or poor coverage is discovered, evaluate the operational effects.

c. Probing. Holes in radar coverage are probed in a manner similar to VOR to TACAN. The following procedure may be used as a guide:

(1) Horizontal. Fly through the area of the suspected hole to determine the inner and outer boundaries. Vary the aircraft position every 10° of radar azimuth until the lateral limits are established.

(2) Vertical. Fly through the center of the pattern established in the horizontal probing procedure at 1,000-foot increments to determine the upper and lower limits of the hole.

10. Surveillance Radar and WAM Tolerances.

Figure 14-5. Surveillance Radar, ATCRBS, and WAM Tolerances.

Parameter	Reference	Tolerance/ Limit
Target Strengths		
Broadband/ Reconstituted		
3—usable		Target leaves trail or persists from scan-to-scan without trail
2—usable		Target shows each scan, remains on the display for at least 1/3 of the scan
1—unusable		Weak target, barely visible, possible miss
0—unusable		No visible target
Narrowband		
1—usable		Visible target, satisfactory for ATC purposes
0—unusable		No visible target, unsatisfactory for ATC
Usable Target		Target which is not missed/ unusable on three or more consecutive scans
Orientation Maximum azimuth difference between actual and indicated for broadband and narrowband radar systems.	14.5.d	± 2°
Tilt	14.5.e	No airborne tolerance
Vertical Coverage (from inner to outer fringe)	14.5.g	Meets operational requirements at all altitudes
Horizontal Coverage	14.5.h	No tolerance
WAM Vertical Transition Handoff	14.8.b	No loss of coverage during transition
WAM General Coverage	14.8.c	Meets operational requirements
WAM Perimeter Coverage	14.8.d	Meets operational requirements
Approaches, Airways, Arrival and Departure Procedure Routes, Fixes	14.5.i 14.8.e	A usable target return must be maintained along the entire route or throughout the procedure
Radar Fix/ Map Accuracy (1) (2)	14.5.j	Within 3% of aircraft-to-antenna distance or 500 ft (1,000’ for ATCRBS), whichever is greater

Parameter	Reference	Tolerance/ Limit
WAM Fix/ Map Accuracy (1) (2)	14.8.f	500 ft, regardless of aircraft position
ASR Straight-In Approach	14.5.k	Within 500 ft of runway edge at MAP
ASR Circling Approach (1)	14.5.k	Within a radius of the MAP which is 3% of the aircraft to the antenna distance or 500 ft, whichever is greater
Altitude Readout	14.5.n 14.8.h	± 125 ft of altitude displayed in the cockpit relative to 29.92" Hg
Communications	14.8.i	See Chapter 8, Paragraph 5
Standby Equipment	14.5.r 14.8.j	Meet same tolerances as main (dual channel) equipment. See Chapter 4, Paragraph 17.b
Standby Power	14.5.s 14.8.k	See Chapter 4, Paragraph 17.c

(1) 3% exceeds 500 ft at an aircraft-to-antenna distance greater than 2.74 nm (16,667 ft)
(2) 3% exceeds 1,000 ft (ATCRBS) at an aircraft-to-antenna distance greater than 5.49 nm (33,333 ft)

11. Documentation. The Tech Ops office of concern, or military equivalent, will compile and complete the facility inspection performance report. The report will detail all coverage data obtained from ground testing, flight inspection aircraft, targets-of-opportunity, RDAS tools, and flight inspection reports. The report submitted by the flight inspector must contain only information evaluated by the flight inspection crew. At joint civil/military sites, a separate report will be published, under the direction of Air Combat Command and North American Aerospace Defense Command.

12. Facility Classification. The facility inspection performance report must reflect a facility classification determined by the facility engineer in charge (or military equivalent). The flight inspection report must reflect a facility classification jointly determined by the flight inspector and Facility Maintenance personnel. Inaccuracies beyond established tolerances in range and azimuth for fix/ map targets or surveillance approaches will be the basis for the flight inspector to restrict the system or to request removal from service until the condition is corrected.

Section 2. Precision Approach Radar (PAR)

13. Introduction. This section outlines Precision Approach Radar (PAR) flight inspection procedures. The PAR enables an air traffic controller to verbally vector an aircrew to a specific runway using a highly sensitive, rapid-update radar system. The PAR radiates a narrow pulse and beam width signal, which produces a high resolution aircraft target display in terms of range, azimuth and elevation. The pulsed beams radiate along a predetermined descent path up to 15° in elevation, extend 10 to 20 miles from the antenna, and cover a 20° azimuth sector. The typical PAR display shows two aircraft target plots. One plot shows aircraft vertical position and relative deviation from the planned glidepath (elevation). The second plot shows aircraft ground-track position and relative deviation from the planned approach course (azimuth). Aircraft-to-touchdown range may be determined from either plot.

14. Preflight Requirements.

a. Facility Maintenance Personnel. Prepare for flight inspection in accordance with the procedures outlined in Chapter 4.

b. Flight Personnel. The flight inspector is in charge of the PAR flight inspection. Flight personnel will prepare for the inspection in accordance with the procedure outlined in Chapter 4.

c. Special Equipment Requirements. PAR glidepath angle will be determined by AFIS, unless theodolite method is applied or the inspection is conducted in accordance with the requirements of a Military Contingency or Natural Disaster as described in Chapter 24. Aircraft with altimeters calibrated according to FAR 43, Appendix E, and FAR 91.170, or military specifications, may be used for PAR flight checks. Theodolite or AFIS is required as follows:

(1) During commissioning and/ or after accident inspection of the glidepath angle and the lower safe angle.

(2) Anytime a more definitive analysis is required (e.g., engineering, research, development) of either the glidepath or the course azimuth.

d. Theodolite Procedures. The RTT or theodolite will be positioned as follows:

(1) Glidepath Angle.

(a) Place the theodolite as close to the runway as possible, forward of the RPI, to minimize or eliminate elevation differences between RPI (touchdown) and theodolite locations. The touchdown reflector is usually abeam the RPI, but not always. Therefore, the Facility Data Sheet must be checked to establish the exact RPI location. Aircraft operations will dictate how close to the runway the theodolite can be located.

> Note: During the commissioning inspection of a new or relocated PAR, flight inspection personnel must coordinate closely with the procedures specialist and installation personnel to locate the predetermined RPI.

(b) The distance the theodolite must be moved forward of the RPI to have the eye-piece aligned on the glidepath angle can be computed in the same manner as solving for ILS glidepath angles or tapeline altitudes. For example, a theodolite with the eye-piece set at 5 ft at a glidepath angle of 3.0° would be positioned 95.4 ft forward of the RPI.

(2) Lower Safe Angle.

(a) If the lower safe angle emanates from the same RPI as the glidepath, the theodolite position will be the position determined for the glidepath.

(b) If the lower safe angle emanates from a point other than the RPI for the glidepath, the theodolite will be relocated. Position and align the theodolite in accordance with instructions for glidepath angle using the lower safe angle RPI.

(3) Course Alignment. Position the theodolite on runway centerline to evaluate course alignment at the runway threshold. Aircraft operations will dictate theodolite placement.

15. PAR Flight Inspections.

a. General. The PAR flight inspection evaluation is divided into three parts: Azimuth Radar; Elevation Radar; and System/ Controller performance. The system performance includes a comparison and evaluation of the PAR features, while controller performance is subjective.

b. Commissioning Inspections. PAR commissioning inspections establish a baseline for system performance. Future periodic inspections may be compared to the commissioning data to determine system health. The commissioning is the most thorough inspection and requires a correspondingly detailed plan and report.

c. Periodic Inspections. PAR approaches will be inspected on a periodic basis in accordance with Chapter 4.

d. Special Inspections. Special inspections are conducted to fulfill a particular need. If equipment changes or modifications to commissioned facilities change the PAR coverage, document the changes in the inspection report. Engineering, maintenance, and operations personnel will determine special inspection requirements. Special inspections will be conducted as specified in Chapter 4. A special flight inspection is required when one or more of the following PAR changes occur:

(1) Antenna change

(2) Glidepath angle change

(3) Reference Centerline alignment (CLA) to touchdown (TD) reflector height or placement change

(4) Cursor alignment voltage or setting change

(5) Any action changing the azimuth or elevation alignment

(6) Any action changing the PAR radiation pattern (e.g., tilt or rotation speed adjustment)

16. PAR Checklists. Use the checklist associated with the type antenna inspected. If the antenna type is not listed, use the "Generic PAR" checklist, and coordinate with facility engineers or operations to determine any additional inspection requirements. At locations where the PAR serves more than one runway, checks will be accomplished for each runway on commissioning inspections. Periodicity must be accomplished in accordance with Chapter 4, alternating runways, assuring all runways/ SIAP(s) associated with the PAR system are checked at least once each 540 days. The periodic inspection must be considered complete each time the periodic checklist is completed, and the Chapter 6 SIAP check is accomplished for the runway being inspected.

Checklist Legend

"A" Cursor	The normal, commissioned glidepath angle
AC	Antenna Change
ALS	Automatic Landing Subsystem
AZ	Azimuth
"B" Cursor	The lower safe limit, normally 0.5° below the A Cursor
C	Commissioning Inspection
Channel	Either "A" or "B" channel of dual receiver/ processor system
CP	Circular Polarization
CFAR	Constant False Alarm Rate
DBC	Database Change (Software or Firmware)
EL	Elevation
GP	Glidepath
LP	Linear Polarization
MTI/ MTD	Moving Target Indicator/ Moving Target Detector
P	Periodic Inspection

a. Generic PAR (FPN-40, FPN-62/ 63, MPN-14, TPN-18, TPN-44). This family of radar is characterized by mechanically scanned (moving) azimuth and elevation antennas. Displayed targets are not computer enhanced. The PAR may be part of a larger system containing an ASR.

Type Check	Reference Paragraph	Inspection				Measurements Required									
		C	AC AZ (3)	AC EL (3)	P	Cursor	Obstacle Clnc	Coverage	Range Accuracy	MTI /MTD	Angle Coincidence	Align-ment AZ	Align-ment GP	Deviation Accuracy	CP/ LP
Approach #1	14.17.a 14.17.h	X	X	X	X	A	X	X	X	X	X	X	X	X	X
Approach #2	14.17.a 14.17.k	X	X	X	X	B	X	X							
Lateral Coverage	14.17.f	(1)	(1)	(1)		A	X	X							
Azimuth Only	14.17.b	X	X				X	X				(4)			
Standby (2) Transmitter	14.17.n	X X		 X	X X	A B	 X	X X	X	X		X	X		X
Standby Power	14.17.o 4.17.c	X				A		X					X		
Alternate Angle	14.17.h	X		X		A		X					X		
Lights	14.17.l Chapter 7	X			X			X							
Comm	14.17.m	X			X			X							

NOTES:
(1) Maintenance request
(2) For generic (non-computer generated) PAR(s), inspect both the A and B Cursors when checking the standby transmitter.
(3) Apply commissioning tolerances when conducting a special inspection for antenna change (AZ or EL).
(4) Measure alignment at threshold.

b. GPN-22, TPN-25. These radars, which differ only in physical configuration and associated equipment, have an electrically scanned (non-moving) antenna. Displayed targets are computer generated. The system uses circular polarization only. The system consists of dual transmitters and dual receivers/ processors with EPROM cards. In normal use, selection of these units is automatic; for flight inspection, they must be manually selected at the radar site.

Type Check	**Reference Paragraph**	**Inspection Type**				**Measurements Required**										
		C (6) (7)	**AC (9)**	**P**	**DBC (7)**	**PAR Mode**	**Channel (5c)**	**Cursor**	**Obstacle Clnc**	**Coverage (2)**	**Range Accuracy**	**MTI/ MTD**	**Angle Coincidence**	**Align- ment AZ**	**Align- ment GP**	**Deviation Accuracy**
Approach #1	14.17.a 14.17.h	X	X	X	X	(3)	A	A	X	X	X	X	X	X	X	X
Approach #2	14.17.a	X			X	(4)	A	A	X	X	X	X	X	X	X	X
Approach #3	14.17.n	X	X	X		(3)	B	A	X	X	X	X	X	X	X	X
Approach #4	14.17.h 14.17.k	X	X	X		(3)	B	B	X	X						
Approach #5	14.17.k 14.17.n	X			X	(3)	A	B	X	X						
Azimuth Only	14.17.b	X	X			(3)	A		X	X				(10)		
Lateral Coverage	14.17.f	(1)	(1)			(3)	A	A	X	X						
Standby Equipment (5)	14.17.n	X		(5a)		(3)		A		X	X	X				
Standby Power (8)	14.17.o 4.17.c	X				(3)	A	A		X					X	
Alternate Angle	14.17.h	X	X			(3)	A	A		X					X	
Lights	14.17.l Chapter 7	X		X						X						
Comm	14.17.m	X		X						X						

NOTES:

(1) Maintenance Request

(2) Normal Coverage is 20 nm. Establish coverage limits during commissioning (or at maintenance request) by flying a 20-mile final approach; thereafter, controller/ maintenance personnel must monitor coverage on a daily basis using targets-of-opportunity.

(3) PAR Mode: Track Mode = NORMAL Close Control FTC = ON MTI = COHERENT

(4) PAR Mode: Track Mode = BACKUP (Scan Only at MR) FTC = OFF MTI = NON-COHERENT

(5) Commissioning requirements for standby equipment (consisting of a complete separate channel) can be completed by flying Runs 1, 2, and 5 to any one of the runways served. If standby equipment is only a separate transmitter, fly Run 1 from 20 nm to satisfy commissioning requirements.

(a) Check both receivers/ processors during a periodic check.

(b) It is only necessary to check the operating radar transmitter and database during a periodic check. However, attempt to alternate which transmitter is checked from periodic to periodic inspection.

(c) A-Channel/ B-Channel refers to which receiver/ processor is on-line.

	C	**P**
Radar Receivers/ Processors	X	X (5a)
Radar Transmitters	X	X (5b)
Database	X	X (5b)

(6) Parallel Runways. If one reference reflector and a common glidepath angle are used for parallel runways, only 5 runs are required for commissioning. Fly approaches # 1,# 2, and #3 on the left runway, #4 and #5 on the right runway and reverse the order for the opposite end. If each runway has a separate reference reflector and/ or angle, fly approaches #1,# 2, and #3 on the left runway, #1, #4, and #5 on the right runway and reverse the order for the opposite end.

(7) Each database version requires a flight inspection prior to operational use in order to verify the database data can be loaded into the PAR computer and the data produces the correct results. Documentation required for commissioning and equipment/ database changes:

(a) Transmitter Power

(b) Receiver sensitivity in normal, Coherent MTI, and Non-Coherent MTI

(c) Firmware Version Numbers

(d) Clutter reject setting (if required for approaches).

(e) Digital MTI baseline limiting settings

(f) Usable radar range on 20 nm radar

(8) Evaluate the operation on standby power during any of Runs 1, 3, 4, or 5.

(9) Apply commissioning tolerances when conducting a special inspection for antenna change. These types of PAR(s) do not have separate AZ and EL antennas.

(10) Measure alignment at threshold.

c. TPN-22. The AN/ TPN-22 Precision Approach Radar (PAR) is a transportable, computerized, pencil beam, 3-dimensional radar. The system is a track-while-scan radar. The radar uses phase and frequency scanning techniques with an electronically steered beam antenna array. The system uses circular polarization only. The system has additional capabilities requiring interface with specialized aircraft equipment; these features are not subject to flight inspection.

Type Check	Ref Para	Inspection Type				Measurements Required										
		C	AC	P	DBC	ALS PAR Mode	Video Mode	Cursor	Obstacle Clnc	Coverage	Range Accuracy	MTI/ MTD	Angle Coincidence	Alignment AZ	Alignment GP	Dev Accuracy
Approach #1	14.17.a	X	X	X	X	Auto (2)	Linear	A	X	X (5)	X	X	X	X	X	X
Approach #2	14.17.k	X	X	X	X	Auto (2)	Linear	B	X	X (5)					X	
Approach #3	14.17.a	X	X	X	X	Auto	MTI	A	X	X (5)	X	X	X	X	X	X
Approach #4	14.17.k	X	X	X	X	Auto	MTI	B	X	X (5)					X	
Approach #5	14.17.a	X	X		X	Man	CFAR	A	X	X (5)	X	X	X	X	X	X
Approach #6	14.17.h	X	X		X	Man	CFAR & MTI	A	X	X (5)					X	
Azimuth Only	14.17.b	X				Auto (2)	Linear		X	X				(6)		
Lateral Coverage	14.17.f	(1)	(1)					A	X	X						
Alternate Touchdown #1 (4)	14.17.h	X		X	X	Auto (2)	Linear	A		X	X				X	
Alternate Touchdown #2 (4)	14.17.h	X		X	X	Man	Linear	A		X	X				X	

TPN-22 (Continued)

Type Check	Ref Para	Inspection Type				Measurements Required										
		C	AC	P	DBC	ALS PAR Mode	Video Mode	Cursor	Obstacle Clnc	Coverage	Range Accuracy	MTI/ MTD	Angle Coincidence	Align-ment		Dev Accuracy
Alternate Touchdown #3 (4)	14.17.h 14.17.k	X	X	X	X	Man	Linear	B		X	X				X	
Standby Power (3)	14.17.o 4.17.c	X				Auto (2)	Linear	A		X						
Lights	14.17.l Ch. 7	X		X						X						
Comm	14.17.m	X		X						X						

NOTES:

(1) Maintenance request.

(2) A periodic check must be considered complete if Auto-Mode is inoperative. Note the condition on the flight inspection report. The PAR must be considered as "Restricted" and authorized for use in Manual-Mode only.

(3) IF EQUIPPED, standby power should be performed on the last run due to the extensive time required to reload the software and data.

(4) Alternate touch down (TD) points using the same glidepath angle may be available.

(5) Request usable distance from controller on each approach.

(6) Measure alignment at threshold.

d. MPN-25/ GCA(PAR)-2000/ FPN-68, TPN-31 (31/ A), FPN-67. The MPN-25 (USAF)/ PAR-2000/ FPN-68 produces computer-generated targets but has no special inspection requirements. It does not have conventional MTI capability, nor does it have controllable antenna polarization. Instead, the system uses RAIN and CLEAR Modes, which perform similarly to Circular and Linear Polarization (CP and LP), respectively. The TPN-31/ A (Marine), TPN-31, and FPN-67 (both Army) cannot alter MTD/ MTI functionality, nor can they alter antenna polarization; these systems do not have a backup transmitter or database. The PAR may be part of a larger system containing an ASR.

Type Check	**Reference Paragraph**	**Inspection Type**					**Measurements Required**								
		C	**AC AZ (4)**	**AC EL (4)**	**P**	**DBC**	**PAR Mode (2)**	**Cursor**	**Obstacle Clnc**	**Coverage**	**Range Accuracy**	**Angle Coinc**	**Align-ment AZ**	**Align-ment GP**	**Dev Accuracy**
Normal Appr	14.17.a 14.17.h	X	X	X	X	X	Rain	A	X	X	X	X	X	X	X
Lower Safe	14.17.k	X	X	X	X	X	Clear	B	X	X					
Lat Coverage	14.17.f	(1)	(1)	(1)			Clear	A	X	X					
AZ-Only (5)	14.17.b	X	X				Clear		X	X			(8)		
Standby (3) Transmitter	14.17.n	X			X			A		X	X		X	X	
Standby Power (7)	14.17.o 4.17.c	X						A		X				X	
Alternate Angle (6)	14.17.h	X		X		X		A		X				X	
Lights	14.17.l Chapter 7	X			X					X					
Comm	14.17.m	X			X					X					

NOTES:
(1) Maintenance Request
(2) Rain/ Clear Mode (polarization) is not controllable in TPN-31 (31/ A) and FPN-67.
(3) Periodic inspections of computer generated PAR(s) do not require flying the B Cursor when checking the standby transmitter. However, attempt to alternate transmitter inspections from one periodic to the next.
(4) Apply commissioning tolerances when conducting a special inspection for antenna change (AZ or EL).

(5) Most systems have an Azimuth-Only capability. However, if the controllers do not use the AZ-only approach, a check is not required.
(6) In addition to the alternate angle A-cursor, the user might request to check the alternate angle B-cursor.
(7) Switching the TPN-31 (31/ A) power source may take up to 40 minutes.
(8) Measure azimuth alignment at threshold.

17. PAR Detailed Procedures. The PAR approach is a vectored maneuver to a precision final. The final PAR controller uses the PAR display to communicate precision lateral and vertical deviation information to the flight inspection aircraft for evaluation.

Maintenance/ Engineering Personnel, in cooperation with operations personnel, will spot check all features available on the PAR and advise the flight inspector if any of these features are not available or are unusable. These features include Sensitivity Time Control (STC), Fast Time Constant (FTC), Circular Polarization (CP), and Constant False Alarm Rate (CFAR). On computer-generated radars, additional features include: Non-Coherent MTI (rain reject), Acquisition (ACQ high and low), Track Mode (normal and backup), STC (high and low), and Power (high and low). Normally, check the PAR in circular polarization (CP) and spot-check linear polarization, where applicable. Some computer-generated radars are limited to CP at all times.

Operational PAR scopes or displays will be used on all flight checks for target grading and guidance information. Data taken from the operational scopes must determine whether or not the facility meets the prescribed tolerances.

Suitability and approval of approach procedures previously developed by the procedures specialist are based on the flight check of the particular facility.

a. Azimuth Course Alignment. At the runway threshold, where alignment is most critical, the inspection pilot will visually evaluate course alignment. The average of all “on-course” measurements is the along-track azimuth alignment, and must meet the along-track course alignment tolerance. Resolve any singular, along-track out-of-tolerance measurements with the final controller and/ or PAR maintenance personnel. Use the following methods to determine course alignment:

(1) AFIS Method. This is the preferred method. Use the procedures in the appropriate AFIS equipment handbook, and limit AFIS azimuth alignment measurements to ranges beyond the decision height distance. Azimuth alignment measurements between decision height and runway threshold are limited to the Visual Method.

(2) Visual Method. Use this method if AFIS is not available. Azimuth alignment measurements between the decision height and runway threshold are limited to the Visual Method. With the aircraft established on final course approximately 10 to 12 miles to touchdown, proceed inbound at pattern/ glidepath intercept altitude and descend at a normal rate when “on course, on glidepath.” The final controller must furnish information to enable the flight inspector to fly the centerline azimuth. The controller statements should be limited to "left," "right," or "on-course." Range to touchdown should be given at least every mile. The flight inspector will determine, by visual reference to the runway, if the azimuth course alignment is straight, and coincides with the extended runway centerline.

(3) Theodolite Method. At some locations, theodolite may be necessary to supplement pilot observations, especially when the runway is extremely wide or is difficult to see. With the aircraft established on final course approximately 10 to 12 miles to touchdown, proceed inbound at pattern/ glidepath intercept altitude and descend at a normal rate when “on course, on glidepath.” Direct the final controller to furnish aircraft lateral position relative to runway centerline. The theodolite operator will continuously track the aircraft, and inform the pilot of the aircraft position relative to runway centerline. Limit theodolite along-track azimuth alignment measurements to ranges greater or equal to the decision height distance. Azimuth alignment measurements between decision height and runway threshold are limited to the Visual Method.

b. Azimuth-Only PAR. Some facilities have published “AZ ONLY” or “PAR w/o GS” procedures for use during an elevation radar outage. The azimuth-only procedure applies non-precision Required Obstacle Clearance (ROC) to the PAR obstacle clearance area. Therefore, an azimuth-only PAR approach may have lower minimums than an ASR approach to the same runway, since the ASR obstacle clearance area is larger. To inspect an azimuth-only PAR procedure, be established on final course approximately 10 to 12 miles to touchdown, proceeding inbound at pattern altitude. The final controller must furnish information to enable the flight inspector to fly the centerline azimuth. Upon reaching the FAF inbound, descend at approximately 400 ft per nautical mile to an altitude of 100 ft below the lowest MDA. Maintain this altitude to runway threshold and verify radar coverage and obstacle clearance. When using AFIS or theodolite, measure along-track azimuth alignment at ranges greater than 0.8 nm to threshold. Azimuth measurements between 0.8 nm and runway threshold are limited to the Visual Method. Alignment verification may be satisfied during the normal PAR approach inspection.

c. Course Deviation Accuracy. While maintaining runway centerline extended, deviate slightly to the right or left of centerline. Determine how far from centerline the aircraft deviates before the controller notices the deviation on the PAR display. The check is completed when the controller notices a “slight” deviation from centerline.

d. Range Accuracy. Verify PAR range accuracy, both video and fixed, by comparison with known reference points, such as AFIS, DME, documented navigation waypoints, marker beacons, etc. Altimetry may be used only when Chapter 24 tolerances are authorized. Distances must be stated in nautical miles to touchdown. Range accuracy verification requires a minimum of two distance checks; at least one check must occur between 10 and 5 miles, and at least one must occur within a mile to touchdown. Normally, azimuth and elevation range accuracy checks are made simultaneously.

Note: The radar operator should state the aircraft distance to touchdown, in nautical miles. If the stated distance is inaccurate, the flight inspector should ask if the PAR display compensates for Antenna-to-RPI (touch-down point) distance.

e. Distance Coverage. The usable distance coverage inspection (i.e., maximum PAR range) may be conducted simultaneously with a course alignment check. Starting beyond the distance coverage limit of the PAR, proceed inbound on runway centerline, and direct the controller to state the distance to touchdown when the aircraft first appears on the PAR display. Some PARs are usable to 20 miles, but due to the size of flight inspection aircraft, distance coverage may be less than expected. Azimuth and elevation coverage may be checked simultaneously. PARs with coverage greater than 10 nm should be checked at the minimum vectoring altitude. Alternate coverage checks between normal and MTI radar. Periodic coverage checks encompass only the area of operational use.

> Note: The radar operator should state the aircraft distance to touchdown, in nautical miles. If the stated distance is inaccurate, the flight inspector should ask if the PAR display compensates for Antenna-to-RPI (touch-down point) distance.

f. Lateral Coverage. Determine the PAR lateral coverage by flying perpendicular to the final approach course. Engineering or maintenance personnel will specify the altitude and distance to perform this check. Use AFIS, theodolite, or a large-scale chart to determine aircraft lateral position. The controller will state when radar contact is obtained and lost.

g. MTI/ MTD. The blind speeds for PAR systems are usually quite high due to the high pulse repetition frequency (PRF) required for good target definition. It may be difficult to perform a Moving Target Indicator/ Moving Target Detector (MTI/ MTD) check with certain types of small aircraft due to speed limitations. This check may be omitted if the aircraft speed necessary to test the system is impossible or impractical to attain. The check may be rescheduled when a faster aircraft is available. An airspeed notch within ± 20 knots of the computed blind speed may exist.

(1) During the commissioning inspection, check the MTI/ MTD feature to determine if there are any blind speeds which make it impossible to sustain radar contact. Maintenance or Operations personnel may request an MTI/ MTD system check on subsequent inspections. Maintenance personnel will provide a precomputed radar blind speed, which is actually targeted ground speed. With the MTI gated beyond 10 miles, direct the controller to state when a reduction in target brilliance occurs. Fly on centerline inbound from 10 miles, while varying speed above and below the precomputed blind speed. Note the ground speed range where a reduction in target brilliance occurs. Close coordination between the controller and aircrew is essential to determine the speed where MTI/ MTD has the greatest effect.

(2) When MTI/ MTD is required on the final approach, this information must be noted on the flight inspection report. The requirements for MTI do not constitute a facility restriction. Normally, both azimuth and elevation MTI/ MTD will be checked simultaneously.

(3) Radars with computer generated displays normally use synthetically-generated symbols during approaches. The normal radar (scan) mode must be checked to determine its usability for approaches. If unusable for approaches, determine the inner limit of usability so the feature can be used for control and traffic information outside of that point. Document the results of the scan mode inspection in the report remarks. If the scan mode is not usable for approaches, it will not cause a facility restriction, but must be documented on the Facility Datasheet.

h. Glidepath Angle & Alignment. During this check, the crew will measure the actual PAR glidepath angle, or "A-Cursor," while the ground controller verifies the glidepath and decision height cursors are properly aligned. Some PARs have multiple, controller-selectable glidepath angles. All published glidepath angles must be inspected prior to use. For periodic inspections, only the lowest published angle must be inspected.

(1) AFIS Method. AFIS is the primary method, unless another method has been coordinated or directed. The aircraft should proceed inbound from a point approximately 12 miles to touchdown, at the pattern altitude until the final controller advises the aircraft is on glidepath. Using the controller's verbal instructions, the pilot will fly the PAR centerline and glidepath, striving to maintain a stable aircraft attitude throughout the approach. Controller instructions should be given in terms of "above," "below," or "on glidepath." As the aircraft proceeds inbound, the AFIS operator must listen carefully to the controller's glidepath vectors, and input only the "on glidepath" hits into AFIS. Do not include on-path calls below the decision height. AFIS will average the inputs, and determine the actual glidepath angle.

(2) Theodolite Method. Position the theodolite according to instructions in Paragraph 14.5.d. Communications on a common frequency are essential for the theodolite operator, final controller, and flight inspector. After communications have been established at all three locations, the aircraft should proceed inbound from a point approximately 12 miles to touchdown, at the pattern altitude until the final controller advises the aircraft is on glidepath. Using the controller's verbal instructions, the pilot will fly the PAR centerline and glidepath, striving to maintain a stable aircraft attitude throughout the approach. Controller instructions should be given in terms of "above," "below," or "on glidepath." The theodolite operator will track the aircraft from the start of the inbound run, maintaining the horizontal cross-hair exactly on the aircraft as it descends on glidepath. As the aircraft proceeds inbound, the theodolite operator or assistant must listen carefully to the controller's glidepath vectors, and record the angle each time the controller states "on glidepath." Do not record on-path angles below the decision height. Average the angle measurements to determine the actual glidepath angle.

(3) Precision Range Mark Method. Determination of the glidepath angle using altimetry is authorized only while inspecting under the provisions of Chapter 24. When impractical to check the glidepath alignment using the above methods, radar may be used to verify aircraft distance to touchdown. If PAR range errors exist, this technique will not produce an accurate glidepath angle measurement. When performing this check, pre-calculate the expected altitudes corresponding to glidepath ranges at 6, 5, 4, 3, 2, and 1 mile to touchdown.

Instruct the PAR controller to give precise "on path" calls and to state exactly when the radar return crosses the range marks. Record the actual aircraft altitude at the various ranges. Use the measurements to calculate instantaneous glidepath angles at the various ranges. Average the instantaneous angles to determine the actual PAR glidepath angle. Although there is a small amount of altimeter lag when proceeding down the glidepath, the error introduced is negligible and can be disregarded. For a more-accurate measurement, consider standard atmospheric deviations, such as temperature and pressure. The straightness of the glidepath can be ascertained concurrently with the alignment check.

An alternative method is to fly a descending run on the glidepath and note the difference in altitude between range marks. The controller must provide range information each time an “on glidepath” call is given. The glidepath angle can be determined using the formulas in Appendix B, Paragraph 8.

i. Application of Glidepath Angle Tolerance. TERPS determines the “desired” PAR glidepath angle based on operational requirements and obstacle clearance criteria. Upon successful commissioning, the desired glidepath angle must be the published PAR glidepath angle. During an inspection, the ideal is for the measured angle to exactly match the desired angle. However, tolerances apply to permit slight deviation from the ideal. During a commissioning inspection, the measured angle must be within ±0.1° of the desired angle. For periodic inspections, the measured angle must be within ±0.2° of the desired and published PAR glidepath angle. Obstruction clearance criteria takes into consideration operational deviations as low as 0.2° below the ideal angle, and is the basis for the periodic inspection tolerance.

> Example: The Desired/ Published Angle = 3.00°; The Commissioning Inspection Measurement = 2.90° (This is the lowest satisfactory result, and within the ± 0.1° of the desired angle); The Periodic Inspection Measurement = 2.75° (This is unsatisfactory, and exceeds the desired/ published angle by more than ± 0.2°. Re-inspect the angle to verify, and request an adjustment if verified out of tolerance. A valid periodic angle measurement is 3.00 ± 0.2°)

j. PAR Coincidence. To prevent pilot confusion, the “as found” PAR glidepath guidance should coincide with existing precision approach guidance (i.e., ILS,GBAS GLS, WAAS LPV, and/ or MLS). Using AFIS or theodolite, verify the measured PAR glidepath angle is within ±0.2 degrees of any other published precision approach path angle to the same runway. If the PAR glidepath is not coincident, inform the owning agency and annotate on the flight inspection report. The owning agency will determine if a PAR adjustment is appropriate for the purpose of vertical coincidence. Due to the elliptical shape of the ILS glideslope near the ground, vertical coincidence with the PAR between Point "B" and touchdown is not required. Verifying PAR coincidence with other electronically-produced precision approaches is not the same as validating VGSI coincidence. Refer to Chapter 7, Paragraph 3.b(7) for VGSI coincidence guidance.

k. Lower Safe Limit Angle & Alignment. During this check, the crew will inspect the lower safe limit angle, also known as the “B-Cursor” or “Elevation Safety Cursor,” while the ground controller verifies proper B-Cursor alignment. The B-Cursor is typically aligned 0.5° below the primary glidepath. During this inspection, the flight crew will verify obstacle clearance from glidepath intercept to runway threshold. Record and report the B-Cursor angle during a commissioning-type inspection. Unless requested by Maintenance or Operations personnel, subsequent inspections do not require recording the B-Cursor angle. Using the same methods described in Paragraph 14.17.h., proceed as follows:

(1) Coordinate with the final controller, ensuring the planned descent vectors will be referenced to the Lower Safe Limit, or B-Cursor angle. Beginning from the pattern altitude, fly inbound from approximately 10 to 12 miles to touchdown until the final controller advises, “Approaching lower safe limit.” When the controller directs a descent, maintain the B-Cursor “on path” position while maintaining runway centerline extended. Strive to maintain a stable aircraft attitude throughout the approach. Controller instructions should be given in terms of "above," "below," or "on path." While established on the B-Cursor, verify the aircraft will safely clear all obstacles to the threshold. If it becomes necessary to pull-up to avoid an obstacle, advise the controller. If there is any doubt about the clearance from a particular obstacle, document the offending obstacle information on the flight inspection report for further analysis. Questionable obstacles must be evaluated by survey or other appropriate means prior to completing a satisfactory PAR flight inspection. The PAR facility is “unusable” so long as the Lower Safe Limit angle is not clear of obstacles.

(2) PAR displays which do not portray the Lower Safe Limit line must be checked in the same manner as above. However, during descent, the controller will supply the minimum allowable altitudes, below which a missed approach would be required. The crew must verify the aircraft will safely clear all obstacles to the threshold.

l. Lighting Systems. Lights must be inspected in accordance with applicable chapters of this manual.

m. Communications. During commissioning inspections, check all required frequencies from the final controller position. When flight inspection aircraft are not equipped for UHF communications, the inspection can be completed using VHF only. UHF coverage may be confirmed by an operational check of the PAR using local aircraft. Evaluate both primary and standby radios for clarity and coverage. These checks may be done within or beyond the radar service area.

n. Standby Equipment. Standby equipment, when installed, must be inspected in accordance with Chapter 4, Paragraph 17.b. For periodic inspections, review the previous report and attempt to perform the primary equipment checks on the equipment used as standby on the previous inspection. The standby equipment will be checked to ensure it is functioning in a manner equal to the primary equipment.

o. Standby Power. Standby power must be inspected in accordance with Chapter 4, Paragraph 17.c. The standby power may be checked on any approach required by the applicable checklist. It is not necessary to duplicate a run solely to check standby power.

18. Analysis. A flight inspection of a ground radar facility always uses the services of the ground controllers, maintenance, and/ or engineering personnel because of the inherent and unique characteristics of the entire system. The flight inspector is responsible to verify the PAR system meets flight inspection tolerances. Discrepancies attributed to controller technique should be brought to the attention of the ground supervisor.

19. PAR Tolerances. The PAR system must meet the following tolerances to be classified UNRESTRICTED. Facilities not meeting these tolerances may be RESTRICTED. The flight inspector is responsible to determine facility classification.

Parameter	Reference Paragraph	Inspection		Tolerance/ Limit
		C	P	
Azimuth Course Alignment (Along-Track)	14.17.a	X	X	Greater of 30 ft or 0.34° from runway centerline; use the runway point of intercept as the azimuth point of origin (1)
Azimuth Course Alignment (Threshold)	14.17.a	X	X	30 ft, referenced to runway centerline
Course Deviation Accuracy	14.17.c	X	X	Target presentation must be coincident with aircraft position
Range Accuracy	14.17.d	X	X	± 2% of true range
Usable Distance AZ and EL	14.17.e	X	X	Minimum of 7.5 nm to touchdown
Lateral Coverage	14.17.f	X	X	± 10° from procedural C/ L
Moving Target Indicator & Detector (MTI/ MTD)	14.17.g	X	X	Must not cause loss of usable target at other than blind speed
Glidepath Angle & Alignment	14.17.h	X		± 0.1° of published angle
			X	± 0.2° of published angle
Coincidence (Comparison of measured PAR angle with published ILS, MLS, GLS, LPV, and/ or VGSI angle)	14.17.j	X	X	± 0.2°
Lower Safe Limit Angle & Alignment	14.17.k	X	X	Clear of all obstacles from GSI to runway threshold
Standby Equipment	14.17.n	X	X	Same as primary

NOTES:

(1) 0.34° exceeds 30 ft at an aircraft-to-PAR distance greater than 0.83 nm (5,055 ft)

20. Adjustments. See Chapter 4, paragraph 17.g.

Chapter 15. Instrument Landing System (ILS)

Table of Figures

Chapter 15. Instrument Landing System (ILS)

Section 1. General

1. Introduction. This chapter provides instructions and performance criteria for certifying localizer and glidepath which operate in the VHF and UHF band. Flight inspection of the associated facilities used as integral parts of the instrument landing system (ILS) must be accomplished in accordance with instructions and criteria contained in their respective chapters of this order or in other appropriate documents.

Two basic types of localizers are single frequency and dual frequency. Localizers are normally sited along the extended centerline of the runway; however, some are offset from the extended centerline. Localizer type directional aids (LDA) may be located at various positions about the runway.

Another type of facility which provides azimuth guidance is the simplified directional facility (SDF). Two basic types of SDF facilities are the null reference and the phase reference.

The three basic image array glide slope systems are null reference, sideband reference, and capture effect. Endfire is a non-image array glide slope system.

Flight inspection techniques using the FAA automated flight inspection system (AFIS) are detailed in other directives. Where AFIS is available, these techniques must be used to accomplish the approved procedures in this chapter.

a. ILS Zones and Points. ILS zones and points are defined in Appendix A and are illustrated in Figures 15-1.

b. ILS Facilities Used for Higher Category Service. Some Category I ILS(s) are used to support higher than normal category of service, IAW Order 8400.13, Procedures for the Evaluation and Approval of Facilities for Special Authorization Category I Operations and All CAT II and III Operations. These facilities support SIAP(s) with authorized lower than Category I minima. These systems will be identified in the AIRNAV Database. They must be evaluated fully to the standards and tolerances of the higher category. When a facility is initially identified for use at the higher category, Flight Inspection Services, Technical Services will research the inspection history to determine which checks are required to bring the system to the higher standard.

c. Category I ILS Facilities (Localizer and Glide Slope Installed) Used to Support lower than Category I Operations. Many Category I ILS(s) are used below the standard Category I Decision Height of 200 ft through the use of autoland in Visual Meteorological Conditions (VMC), authorization of lower than Category I visibility minima, or published helicopter approaches. Use below Category I requires user knowledge of system suitability as indicated by the furthest ILS point where the localizer structure meets Category III standards.

(1) Qualifying Localizers must be evaluated for structure through Zone 5, and glide slope clearance below path must be evaluated to runway threshold. These limited checks are accomplished to evaluate the ILS's ability to provide service in the areas of expanded usage.

(2) Based on the results of the localizer structure checks, classification codes from FAA Order 6750.24, ILS and Ancillary Electronic Component Configuration and Performance Requirements, must be updated and published in the Airport/ Facility Directory. For example, when Category I Localizer structure is satisfactory through Zone 5, the Airport / Facility Directory for that facility will be upgraded to I/ E.

(3) If the Glide Slope clearance below path checks are not satisfactory to runway threshold, Localizer Zones 4 and 5 structure must still be evaluated for potential takeoff guidance through Zone 5 using the Rollout procedure.

d. 75 MHz Markers. The marker beacon is a VHF radio transmitter which propagates an elliptically-shaped (fan) vertical radiation pattern on an assigned frequency of 75 MHz. The radiation pattern is composed of a major and a minor axis. The major axis is defined as the longest diameter of the ellipse, while the minor axis is the shortest diameter. See Figures 15-2 and 15-3.

Functionally, maker beacons provide an aural and visual indication of station passage in association with facilities providing course guidance. Identification is provided by both a modulation frequency and a keying code.

Although marker beacons are basically of the same type and function, their nomenclature is generally divided into two categories: ILS markers and fan markers. The operational requirements and category are dependent upon instrument flight procedural application.

(1) ILS Markers Description. These markers are located on the approximate instrument runway centerline-extended in accordance with installation criteria specified in other documents. They are installed to indicate the position of an aircraft along the instrument approach course.

Outer Marker (OM)

Modulation Frequency. 400 Hz, Visual Signal—Illuminates the blue lamp.

Keying Code. Continuous dashes as a rate of two per second.

Middle Marker (MM)

Modulation Frequency. 1300 Hz, Visual Signal—Illuminates the amber lamp.

Keying Code. Alternating dots and dashes at a rate of 95 combinations per minute.

Inner Marker (IM)

Modulation Frequency. 3000 Hz, Visual Signal—Illuminates the white lamp.

Keying Code. Continuous dots at a rate of six dots per second.

(2) Fan Markers (FM) Description. These markers are generally associated with non-precision approach procedures. However, they may be associated with an ILS to serve as a localizer stepdown fix or MAP for circling approaches to secondary airports.

Modulation Frequency. 3,000 Hz, Visual Signal—Illuminates the white lamp.

Keying Code:

(a) Back Course Marker. Two dot pair at a rate of 95 pair per minute; older equipment 72 pair a minute.

(b) Other Installations. Morse code letter R (• — •). Where more than one approach marker is located in the same area, different identification keying is necessary to avoid confusion. The Morse code letters K (— •—), P (• — — •), X (— • • —), and Z (— — • •) will be used in the priority listed.

2. Preflight Requirements.

a. ILS Facilities Maintenance Personnel. Prepare for flight inspection in accordance with Chapter 4, Section 3.

b. ILS Flight Check Personnel. Prepare for flight inspection in accordance with Chapter 4, Section 3.

c. ILS Special Equipment Requirements. AFIS is the standard system for ILS flight inspection and must be used for all commissioning checks except where RTT is required to support military contingencies. RTT may be used for all other checks; however, it should not be used solely to bypass the need for facility data of sufficient accuracy to support AFIS. AFIS or RTT must be used for all categorization or After-Accident checks. Except as limited by this paragraph, a standard theodolite may be used as indicated below:

(1) CAT I/ II/ III Localizer periodic or special checks

(2) CAT I Glide Slope periodic or special checks

(3) CAT II/ III Glide Slope checks not requiring determination of actual path angle or path structure.

d. ILS Glidepath Origination Point. The glidepath origination point is required for AFIS-equipped aircraft. For image array glide slopes, engineering personnel must supply the latitude/ longitude of the antenna mast and the mean sea level elevation of the glidepath origination point. For non-image arrays, engineering personnel must supply the latitude, longitude, and mean sea level altitude of the glidepath origination point.

e. ILS Angular Reference. With the exception of Tilt Checks IAW Section 3 which are referenced to localizer deflection, all glide slope offset angular measurements are referenced to a point on a localizer centerline abeam the glide slope origination point.

Figure 15-1A(1). ILS Zones and Points.

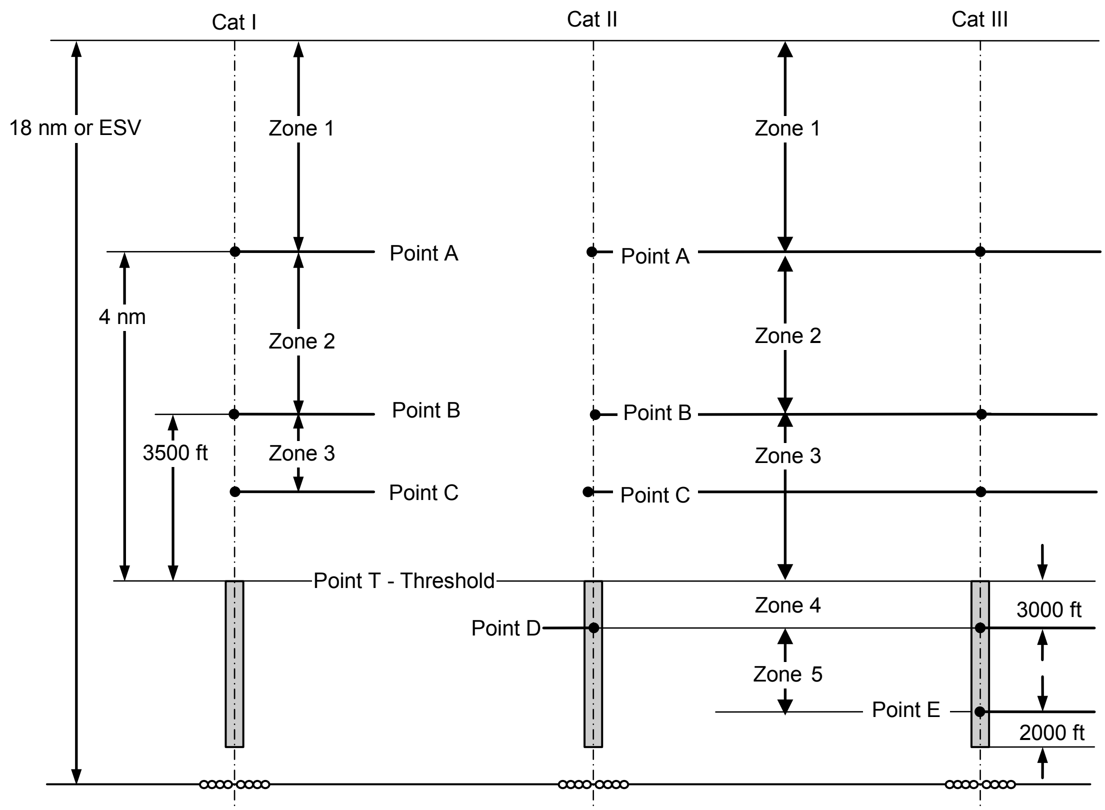


Figure 15-1A(2). Typical Offset ILS

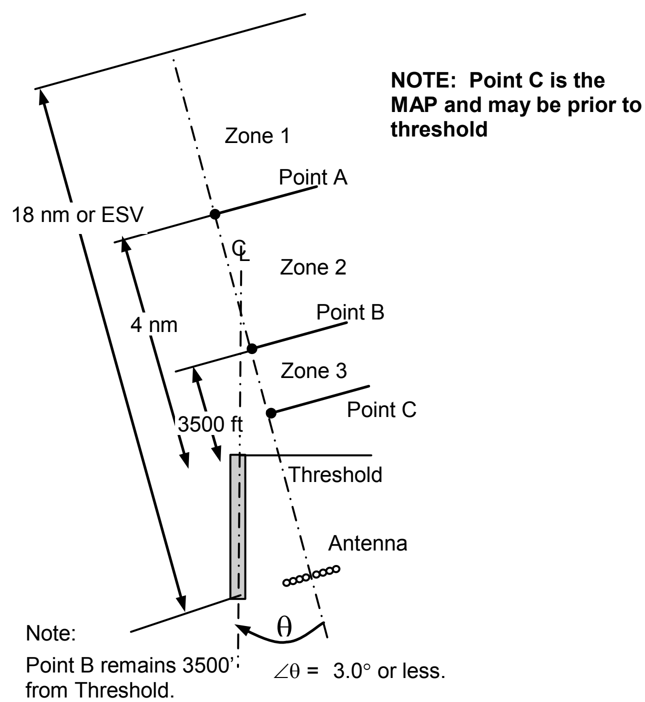


Figure 15-1A(3). Typical Offset Localizer.

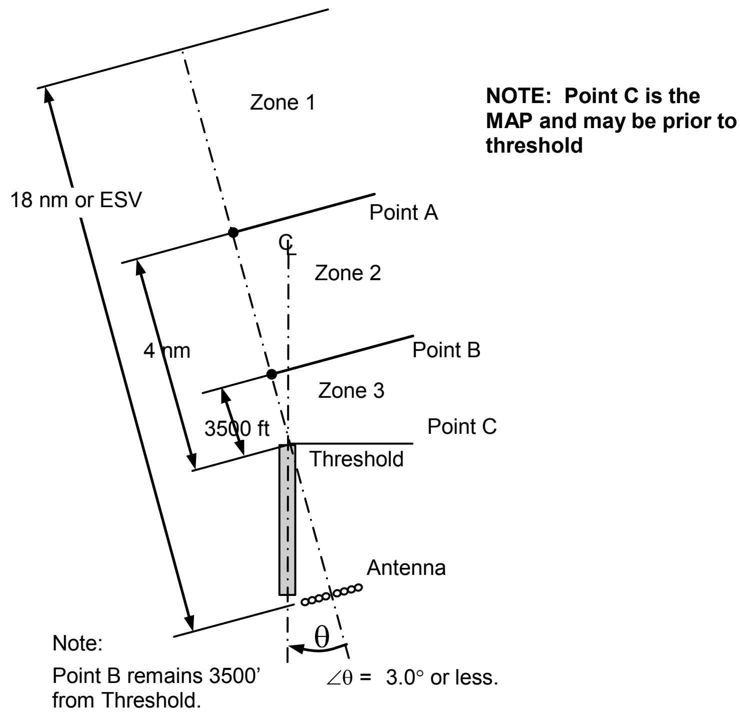


Figure 15-1B(1). LDA Configuration.

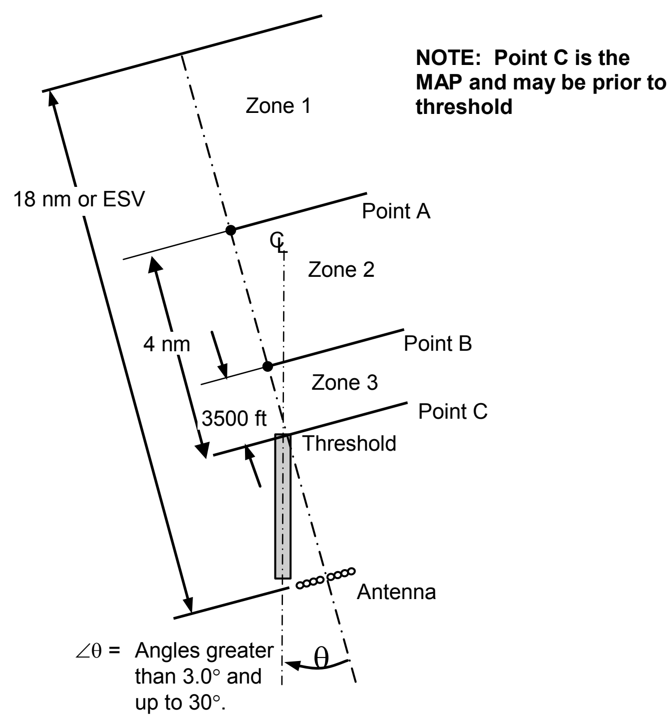


Figure 15-1B(2). LDA Configuration.

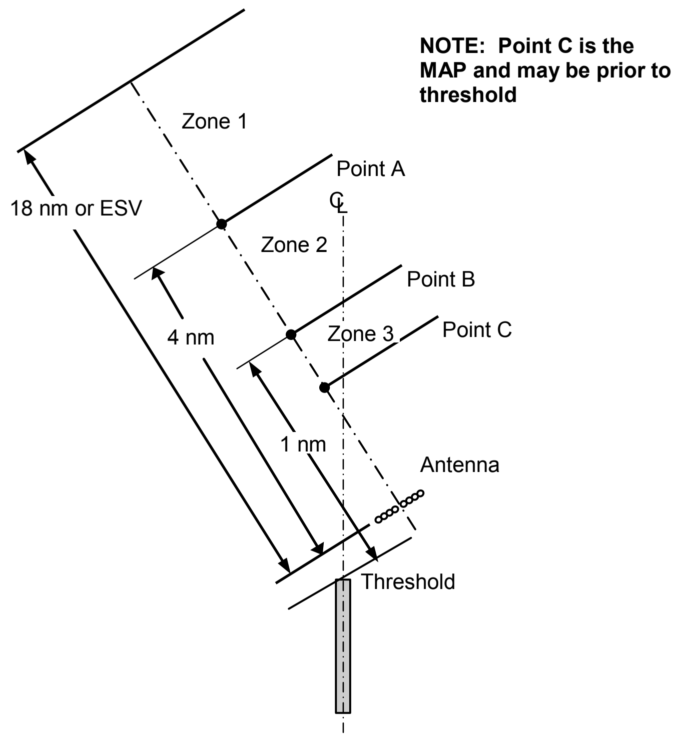


Figure 15-1B(3). Back Course Localizer/SDF.

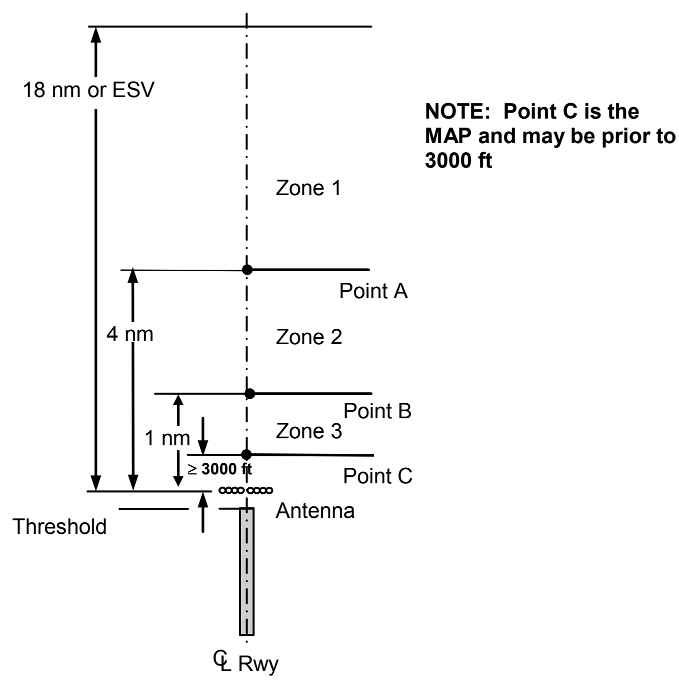
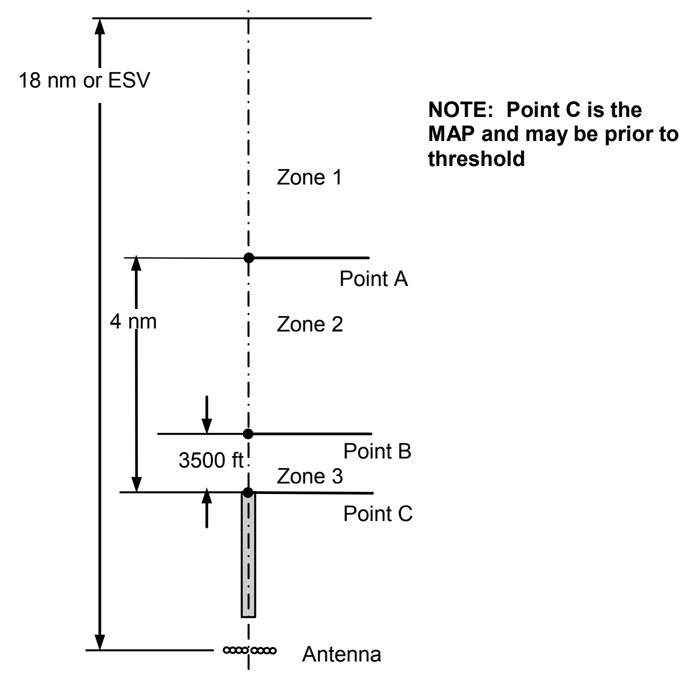


Figure 15-1B(4). Localizer/SDF Approach.



f. ILS Theodolite Procedures. The RTT or theodolite will be positioned in accordance with the following criteria:

(1) Glide Slope Image Array Systems

(a) First Method

(i) Through engineering survey data or by use of the theodolite itself, determine the difference in elevation, to the nearest inch, between the ground plane at the base of the antenna mast and the center of the runway opposite the mast. This can be accomplished by sighting with the theodolite to a surveyor's marker pole placed at the center of the runway opposite the mast or vice versa. If the crown of the runway is higher than the ground level at the antenna, the difference is treated as a minus value; if lower, the difference is a plus value. If the elevation difference determined above (minus value only) provides a comfortable eyepiece height, the theodolite may be positioned at that height at the base of the antenna mast and steps 2 through 5 disregarded.

Note: Where the elevation of the base of the antenna mast is more than 62 inches lower than the center of the runway opposite the antenna, alternate procedures to theodolite positioning should be considered. One such alternate is to apply steps 1 through 5 using an image position for the antenna base on the side of the runway opposite the facility.

(ii) Place the theodolite at the base of the glide slope antenna mast with the eyepiece 62 inches above the ground.

(iii) Sight along a line between the antenna mast and the center of the runway threshold with the eyepiece set at the commissioned or desired vertical angle.

(iv) Using a marker pole, determine the position on the ground along the line in Step 3 which is exactly 124 inches, plus or minus the elevation difference obtained from Step 1. For example, if the runway is higher, subtract the elevation difference from 124 inches, if lower, add the elevation difference to 124 inches.

(v) Establish the eyepiece height of the theodolite at 62 inches with the commissioned angle (or desired vertical angle) of the glidepath set in the theodolite.

(b) Second Method. This method applies to locations where the transverse slope between the glide slope antenna base and the runway edge is irregular, e.g., pedestal runway. The determination of the irregular transverse slope and use of this procedure must be made by engineering/ installation personnel.

(i) Place the theodolite at the base of the glide slope antenna mast with the eyepiece 62 inches above the ground.

(ii) Sight along a line between the glide slope antenna mast and the center of the runway threshold with the eyepiece set at the commissioned angle (or desired vertical angle).

(iii) Using a marker pole, determine the position on the ground where the optical angle passes through the 124-inch point of the marker pole. Mark this position for future use.

(iv) This is the correct position for placing the theodolite with the eyepiece 62 inches above the ground. To verify that the theodolite barrel is aligned to the optical line of the glidepath, adjust the vertical reference to a negative glidepath angle, rotate the azimuth 180° and sight on the point established in Step 1(b)1. If this point is not aligned to the horizontal crosshair, an error in establishing the theodolite position has occurred and the procedure should be accomplished.

(2) Endfire Glide Slope.

(a) The glidepath signal is considered to emanate from the phase center of the array and at the elevation plane determined by engineering personnel.

(b) The theodolite must be positioned using the data in paragraph (2)(a) corrected for eyepiece height.

(3) Localizer. The use of a theodolite, AFIS, or RTT is not required for any inspection on a localizer sited along runway centerline, regardless of category, providing performance can be satisfactorily evaluated by flying a visual centerline track.

The position of the theodolite, when used during localizer evaluations, will be placed on a line perpendicular to the localizer antenna array aligned so as to sight along the reciprocal of the calculated true course and at a point as close to the center of the array as possible.

(4) Aircraft Tracking.

(a) Glide Slope. The optimum tracking point on the flight inspection aircraft is the glide slope antenna.

(b) Localizer. The optimum tracking point on the flight inspection aircraft is the localizer antenna.

g. 75 MHz Marker Facilities Maintenance Personnel. The following information must be furnished to flight inspection prior to the commissioning check:

(1) The proposed operational configuration of any adjacent marker beacon facilities which could produce interference (e.g., simultaneous operation proposed or interlock device installed).

(2) Any facility alterations performed because of unique siting requirements (e.g., 8 KHz frequency separation between markers serving parallel approaches).

3. Flight Inspection Procedures.

a. Types of Inspections and General Procedures.

(1) ILS Site Evaluations. Site evaluations, if performed, are made prior to installation of permanent equipment. The need for a site evaluation, and additional requirements, must be determined by engineering personnel on the basis of individual site conditions.

(2) Periodic Checks. A periodic check without monitors must consist of an inspection of the localizer and glide slope transmitter that is on the air, plus the operating transmitter of the supporting NAVAID(s). If out-of-tolerance conditions are found, inspect the standby equipment, if available.

(3) Periodic with Monitors. Normally consists of a periodic performed on both primary and standby equipment, a monitor check on the operating transmitter, and a check on the operating transmitter of supporting NAVAID(s). Facilities that have dual parallel monitors require a monitor evaluation on one transmitter only. Matching transmitter power and phasing parameters is a maintenance action verifiable without airborne measurements. Facilities gathering reference data may request a special flight inspection to include a monitor check on both transmitters. Dual transmitter facilities with separate and dedicated monitors for each transmitter require monitor evaluation on each transmitter. On the same transmitter that monitors are checked, perform a normal localizer course width and/ or glide slope path width prior to checking the monitor conditions. Exception: for subordinate back courses, checking normal width prior to the monitor inspection is not required.

(4) Frequency Change. Following a localizer (SDF, LDA) or ILS frequency change, conduct a special inspection that fulfills the following requirements: Periodic with monitors (Pm), RF power monitor reference, and spectrum analysis.

(5) Other Component Changes. See Chapter 4, Section 1.

(6) Restrictions Based on Commissioning-Only Checks. When a facility restriction is based on a configuration normally checked only on commissioning inspections (e.g., localizer clearances in narrow or coverage with reduced power), document the condition and configuration on the Facility Data Sheet. Conditions found in these configurations do not require revalidation on periodic inspections.

(7) Restriction Removal. Restricted facilities must be evaluated on each inspection with the goal of removing restrictions that are no longer valid. Do not check configurations beyond the scope of the scheduled inspection, unless restriction removal can be expected. If the results of the current and last periodic interval inspections indicate a potential for restriction removal, notify Flight Inspection Services, Technical Services Team. They must review at least the last five years of inspection history. They must analyze the history and current results for maintenance actions, trends, seasonal differences, etc., to determine if restriction removal is appropriate. If an additional inspection is required, they must specify and schedule the required checks to be done with the next appropriate inspection. For those restrictions based on commissioning-only configurations, do not remove the restrictions without a check of those configurations.

(8) Back Course Use. A localizer back course used for missed approach guidance must meet the same checklist requirements and tolerances as one used for an approach.

(9) ILS Critical Area Checks. These checks are usually requested to determine the effects of permitting aircraft, vehicles, or other mobile objects to transition through ILS critical areas. The results of these flight inspections are valid only for the specific conditions existing at the time of the check and are not suitable for determination of facility performance status or reliability.

(10) Maintenance Request Checks. Items identified as “Maintenance Request” in the individual checklists are so labeled to support current FAA maintenance practices with current FAA equipment. They usually identify checks that can be performed using ground test equipment, as well as aircraft. While FAA maintenance may be able to do these checks, other maintenance activities may require flight inspection for these parameters. Flight inspection and maintenance personnel must discuss these items to ensure the adequacy of the flight check.

b. Standby Equipment – Localizer/ Glide Slope. Where dual equipment is installed, complete all checklist items for both sets of equipment, except as noted in the text of this chapter and the checklists. For FAA, U.S. Non-Federal civil, U.S. Army, and U.S. Navy/ Marine Corps facilities, standby transmitters should match the reference transmitter within the prescribed equality in normal maintenance limits during the same flight inspection. Applies to all type inspections when both primary and standby transmitters are evaluated in normal. If Maintenance is unable to adjust the transmitter within equality limits and the transmitter meets Paragraph 10.aand 10.b flight inspection tolerances, the transmitter may remain in service unless Maintenance elects to remove it from service.

Dual Transmitter Equality in Normal Maintenance Limits	
Localizer (Normal Only)	
Alignment	± 3 μA
Width	± 0.10°
Clearance	± 15 μA
Glide Slope (Normal Only)	
Angle	± 0.03°
Width	± 0.03°
Structure Below Path	± 0.20°

c. Standby Power – Localizer/ Glide Slope. Refer to Chapter 4, Section 3. If required, make the following checks while operating on standby power.

(1) Localizer. Course width, alignment, symmetry, modulation, and identification.

(2) Glide Slope. Modulation, width, angle, symmetry, and structure below path.

d. Expanded Service Volume (ESV). Where an operational requirement exists to use either or both the glide slope and localizer to altitudes and/or distances beyond the standard service volume, the facility(ies) must be inspected to the expanded altitudes and/or distances (in accordance with Chapter 22 Paragraph 2.b to determine that facility performance for the required parameters meets tolerances.

(1) Localizer. The localizer Standard Service Volume (SSV) is depicted in Figure 15-11. Use beyond these limits requires an ESV approved by spectrum management and validated by flight inspection.

(2) Glide Slope. The glide slope SSV is depicted in Figure 15-12.

e. Supporting NAVAID(s). These may consist of marker beacons, a compass locator, DME, and/or lighting systems. Additionally, some locations may require other types of NAVAID(s) to support the approach procedures. Verify RHO-THETA crossing radials associated with an ILS approach IAW Chapter 11.

f. Instrument Flight Procedures. See Chapter 6.

g. General Checklist. During a specific inspection, check the following items:

	A	**E**	**C**	**PM**	**P**
75 MHz Marker Beacons	X	-	X	X	X
Compass Locator	X	-	X	X	X
DME	X	-	X	X	X
Lighting Systems	X	-	X	X	X
Standard Instrument Approach Procedure (see Chapter 4, Section 2 and Chapter 6)	X	(1)	X	(1)	(1)

Note:
(1) As required by ground technical or flight inspection personnel

h. Facility Checklists by Type. Flight inspection requirements are contained in the following checklists and in the discussion paragraphs in this chapter. The checklists are provided as a guide and do not necessarily indicate a sequence of checks. Consult the text to ensure a complete inspection.

Legend:

Fc = Localizer front course

Bc = Localizer back course

C = Commissioning or commissioning-type equipment

E = Site evaluation

Pm = Periodic inspection with monitors

P = Periodic inspection without monitors

(1) Single Frequency Localizer, LDA(s), and SDF(s).

Note: Bc checks do not apply to uni-directional antennas.

Type Check	Reference Paragraph	Inspection				Facility Configuration	Measurements Required					
		E	C (6)	Pm (7)	P		Modulation	Width	Symmetry	Clearance	Alignment	Structure
Spectrum Analysis	15.4.a	Reserved										
Ident. & Voice	15.4.o	(1)	X	X	X							Fc & Bc
Modulation Level	15.4.b	X	X	X	X	Normal	Fc					
Modulation Equality (2) Caution: HMI	15.4.c	(1)	(1)			Carrier Only						
Phasing (3) Caution: HMI	15.4.e	(1)	(1)			Quadrature	Set to Value of Modulation Equality					
Width & Clearance (9)	15.4.f 15.4.k	X	X	X	X	Normal	Fc & Bc	Fc & Bc	Fc & Bc	Fc & Bc		
Clearance Comparability (10)	15.4.k(1)		X			As Required		Fc & Bc		Fc & Bc		
Alignment and Structure	15.4.g	X	X	X	X	Normal	Fc & Bc				Fc & Bc	Fc & Bc
Localizer Only Minima (10)	15.4.g(1)	X	X			Normal	Fc & Bc					Fc & Bc
Polarization (10)	15.4.n	X	X	X	X	Normal						Fc & Bc

Type Check	Reference Paragraph	Inspection				Facility Configuration	Measurements Required					
		E	C (6)	Pm (7)	P		Modulation	Width	Symmetry	Clearance	Alignment	Structure
Monitors (5)	15.4.i											
Width	15.3.a(3)	(1)	X (11)	X		Wide		Fc & Bc		Fc & Bc		
		(1)	X, (11)			Narrow		Fc		Fc		
Alignment Caution: HMI	15.4.i	(1)	(1)			Shifted Alignment					Fc	
RF Power Monitor Reference (8)(10)	15.4.j	(1)	X			Reduced RF Power				Fc & Bc		Fc & Bc
High Angle Clearance (10)	15.4.k(3)	X	X			Normal	Fc & Bc			Fc & Bc		
Standby Equipment	15.3.b 4.17.b		X	X								
Standby Power (10)	15.3.c 4.17.c		X			Normal	Fc & Bc	Fc & Bc	Fc & Bc		Fc & Bc	

Notes:

(1) Maintenance request

(2) Adjustments to carrier modulation balance will require a subsequent check of course alignment.

(3) Width and clearance should be measured prior to the phasing check. If, after the quadrature phase check, the width has remained the same or has narrowed and/or the clearances have increased from the first width and clearance check, then the phasing has been improved. Final determination of optimum phase should be discussed with Facilities Maintenance personnel.

(4) (Reserved)

(5) Facilities with dual transmitters and single solid state modulators—check both transmitters.

(6) Replacement of an antenna array with a different type (e.g., V-Ring elements to LPDA element, 8-element to 14-element), require commissioning inspection checks, except for those checks not required, as determined jointly by flight inspection and Facilities Maintenance personnel.

(7) Same type antenna replacements require PM checks, in addition to all of Zone 1 structure (Paragraph 15.4.g(3)) and localizer only structure checks (Paragraph 15.4.g(1)(b).
(8) Request RF level in watts from ground technician.
(9) Recheck clearances each 1,080 days at the lower standard altitude of 1,500 feet above the antenna or 500 feet above intervening terrain, whichever is higher.
(10) One XMTR Only
(11) Facilities maintained using FAA Order 6750.49 require monitor checks on one XMTR only.

(2) Dual Frequency Localizer.

Type Check	Reference Paragraph	Inspection				Transmitter Configuration		Measurements Required					
		E	C (4)	Pm (5)	P	Course XMTR	Clearance XMTR	Modulation	Width	Symmetry	Clearance	Alignment	Structure
Spectrum Analysis	15.4.a	Reserved											
Ident. & Voice	15.4.o	(1)	X	X	X								Fc & Bc
Power Ratio	15.4.d	(1)	(1)			Reduced RF Pwr	Normal						
Modulation Level	15.4.b	X	X			Normal	Off	Fc					
		X	X			Off	Normal	Fc					
		X	X	X	X	Normal	Normal	Fc					
Modulation Equality (2) *Caution: HMI*	15.4.c	(1)	(1)			Carrier Only	Off	Fc	Balance Determined by Maintenance				
		(1)	(1)			Off	Carrier Only	Fc	Balance Determined by Maintenance				
Phasing (3) *Caution: HMI*	15.4.e	(1)	(1)			Quad	Off		Set to Value of Modulation Equality				
		(1)	(1)			Off	Quad		Set to Value of Modulation Equality				

Type Check	Reference Paragraph	Inspection				Transmitter Configuration		Measurements Required					
		E	C (4)	Pm (5)	P	Course XMTR	Clearance XMTR	Modulation	Width	Symmetry	Clearance	Alignment	Structure
Width & Clearance	15.4.f	(1)	(1)			Off	Normal	Fc	Fc				
	15.4.k	X	X	X	X	Normal	Normal	Fc & Bc	Fc & Bc	Fc & Bc	Fc & Bc		
Clearance Comparability (7)(8)	15.4.k(1)		X			As Required	As Required		Fc & Bc		Fc & Bc		
Alignment and Structure	15.4.g	X	X	X	X	Normal	Normal	Fc & Bc				Fc & Bc	Fc & Bc
Localizer Only Minima (8)	15.4.g(1)	X	X			Normal	Normal	Fc & Bc					Fc & Bc
Polarization (8)	15.4.n	X	X	X	X	Normal	Normal						Fc & Bc
Monitors Width	15.4.i 15.3.a(3)		(1)			Wide	Normal		Fc				
		(1)	X, (9)			Narrow	Wide		Fc & Bc		Fc & Bc		
		(1)	X, (9)	X		Wide	Wide		Fc & Bc		Fc & Bc		
Dephase	15.4.i		(1)			ADV Phase	Normal		Fc				
			(1)			RET Phase	Normal		Fc				
			(1)			Normal	ADV Phase		Fc		Fc		
			(1)			Normal	RET Phase		Fc		Fc		

Type Check	Reference Paragraph	Inspection				Transmitter Configuration		Measurements Required					
		E	C (4)	Pm (5)	P	Course XMTR	Clearance XMTR	Modulation	Width	Symmetry	Clearance	Alignment	Structure
Alignment *Caution: HMI*	15.4.i		(1)			Shifted Alignment	Normal					Fc	
RF Power Monitor Reference (6)(8)	15.4.j	(1)	X			Reduced RF Power	Reduced RF Power				Fc & Bc		Fc & Bc
High Angle Clearance (8)	15.4.k(3)	X	X			Normal	Normal	Fc & Bc			Fc & Bc		
Standby Equipment	15.3.b 4.17.b		X	X									
Standby Power (8)	15.3.c 4.17.c		X			Normal	Normal	Fc & Bc	Fc & Bc	Fc & Bc		Fc & Bc	

Notes:

(1) Maintenance request

(2) Adjustments to carrier modulation balance will require a subsequent check of course alignment.

(3) Width and clearance should be measured prior to the phasing check. If, after the quadrature phase check, the width has remained the same or has narrowed and/or the clearances have increased from the first width and clearance check, then the phasing has been improved. Final determination of optimum phase should be discussed with Facilities Maintenance personnel.

(4) Replacement of an antenna array with a different type (e.g., V-Ring elements to LPDA element, 8-element to 14-element) require commissioning inspection checks, except for those checks not required, as determined jointly by flight inspection and Facilities Maintenance personnel.

(5) Same type antenna replacements require PM checks, in addition to all of Zone 1 structure (Paragraph 15.4.g(3)) and localizer only structure checks. (Paragraph 15.4.g(1)(b)).

(6) Request RF level in watts from ground technician.

(7) Recheck clearances each 1,080 days at the lower standard altitude of 1,500 feet above the antenna or 500 feet above intervening terrain, whichever is higher.

(8) One XMTR Only

(9) Facilities maintained using FAA Order 6750.49 require monitor checks on one XMTR only.

(3) Null Reference Glide Slope.

CODE: W/A/S = Width, Angle, Symmetry

Type Check	Reference Paragraph	Inspection				Facility Configuration	Measurements Required						
		E	C	Pm	P		Modulation	Width	Angle	Symmetry	Structure Below Path	Clearance	Structure
Spectrum Analysis	15.5.a	Reserved											
Engineering Support Tests (5) *Caution: HMI*	15.5.e	(1)	(1)			As Required							
Modulation Level	15.5.b	X	X	X	X	Normal	X						
Modulation Equality *Caution: HMI*	15.5.c	(1)	(1)			Carrier Only	X						
Phasing *Caution: HMI*	15.5.d	(1)	(1)			Quadrature	Set to value found in modulation equality						
Spurious Radiation	15.5.e(3)	(1)	(1)			Dummy Load Radiating Signal							X
W/A/S	15.5.f	X	X	X	X	Normal		X	X	X	X, (2)		
Structure	15.5.j	X	X	X	X	Normal	X		X				X
Clearance (5)	15.5.g	X	X			Normal						X	
Tilt (5)	15.5.i	X	X			Normal	X		X			X	
Mean Width (5)	15.5.h	(1)	X			Normal		X		X			

Type Check	Reference Paragraph	Inspection				Facility Configuration	Measurements Required						
		E	C	Pm	P		Modulation	Width	Angle	Symmetry	Structure Below Path	Clearance	Structure
Monitors Width	15.5.m 15.3.a(3)	(1)	X, (6)	X		ADV Phase		X	X		X, (2)	(3)	
		(1)	X, (6)	X		RET Phase		X	X		X, (2)	(3)	
		(1)	X, (6)	X		Wide		X	X		X, (2)	(3)	
			X, (6)			Narrow		X	X		X, (2)		
RF Power Monitor Reference (4) (5)	15.5.n	(1)	X			Reduced RF Power							
Standby Equipment	15.3.b 4.17.b		X	X									
Standby Power	15.3.c 4.17.c		X			Normal	X	X	X	X	X, (2)		

Notes:

(1) Maintenance request

(2) If structure below path tolerances cannot be met, clearance procedures and tolerances will be applied.

(3) Clearance Below Path (CBP) required on commissioning type inspections, one XMTR only.

(4) Request RF level in watts from ground technician.

(5) One XMTR Only

(6) Facilities maintained using FAA Order 6750.49 require monitor checks on one XMTR only.

(4) Sideband Reference Glide Slope.

CODE: W/A/S = Width, Angle, Symmetry

Type Check	Reference Paragraph	Inspection				Facility Configuration	Measurements Required						
		E	**C**	**Pm**	**P**		**Modulation**	**Width**	**Angle**	**Symmetry**	**Structure Below Path**	**Clearance**	**Structure**
Spectrum Analysis	15.5.a	Reserved											
Engineering Support Tests (7) *Caution: HMI*	15.5.e	(1)	(1)			As Required							
Modulation Level	15.5.b	X	X	X	X	Normal	X						
Modulation Equality *Caution: HMI*	15.5.c	(1)	(1)			Carrier Only	X						
Phasing *Caution: HMI*	15.5.d	(1)	(1)			As Required	SET TO VALUE FOUND IN MODULATION EQUALITY						
Spurious Radiation	15.5.e(3)	(1)	(1)			Dummy Load Radiating Signal							X
W/ A/ S	15.5.f	X	X	X	X	Normal		X	X	X	X, (2)		
Structure	15.5.j	X	X	X	X	Normal	X		X				X
Clearance (7)	15.5.g	X	X			Normal						X	
Tilt (7)	15.5.i	X	X			Normal	X		X			X	
Mean Width (7)	15.5.h	(1)	X			Normal		X		X			

Type Check	Reference Paragraph	Inspection				Facility Configuration	Measurements Required						
		E	C	Pm	P		Modulation	Width	Angle	Symmetry	Structure Below Path	Clearance	Structure
Monitors Angle	15.5.m 15.3.a(3)		(1)	(1)		High Angle (4)		X	X, (4)		X, (2)		
		(1)	X, (8)	X		Low Angle (4) (5)		X	X, (4)		X, (2)	(3)	
Width	15.5.m					Upper Antenna:							
			X, (8)	X		ADV Phase		X	X		X, (2)	(3)	
			X, (8)	X		RET Phase		X	X		X, (2)	(3)	
						Main Sideband :							
			(1)			ADV Phase		X	X		X, (2)		
			(1)			RET Phase		X	X		X, (2)		
		(1)	X, (8)	X		Wide		X	X		X, (2)	(3)	
			X, (8)			Narrow		X	X		X, (2)		
RF Power Monitor Reference (6) (7)	15.5.n	(1)	X			Reduced RF Power							
Standby Equipment	15.3.b 4.17.b		X	X									
Standby Power	15.3.c 4.17.c		X			Normal	X	X	X	X	X, (2)		

Notes:

(1) Maintenance request

(2) If structure below path tolerances cannot be met, clearance procedures and tolerances will be applied.

(3) Clearance Below Path (CBP) required on commissioning type inspections, one XMTR only.

(4) Check on one transmitter only if equipment has a common power divider and parallel monitors.

(5) Perform a final actual angle check at the completion of angle monitor inspection if maintenance adjusted low angle by any other means than attenuating the upper antenna

(6) Request RF level in watts from ground technician.

(7) One XMTR Only

(8) Facilities maintained using FAA Order 6750.49 require monitor checks on one XMTR only

(5) Capture Effect Glide Slope.
CODE: W/A/S=Width, Angle, Symmetry

Type Check	Reference Paragraph	Inspection				Facility Configuration	Measurements Required						
		E	C	Pm	P		Modulation	Width	Angle	Symmetry	Structure Below Path	Clearance	Structure
Spectrum Analysis	15.5.a	Reserved											
Engineering Support Tests (7) *Caution: HMI*	15.5.e	(1)	(1)			As Required							
Modulation Level	15.5.b	X	X	X	X	Normal:	X						
Modulation Equality *Caution: HMI*	15.5.c	(1)	(1)			Carrier Only	X						
Phasing Proc. 1 or 2 *Caution: HMI*	15.5.d(3)	(1)	(1)			As Required	SET TO VALUE FOUND IN MODULATION EQUALITY						
Phase Verification (4)	15.5.d(3)	(1)	X			As Required	X	X	X	X		X	
Spurious Radiation	15.5.e(3)	(1)	(1)			Dummy Load Radiating Signal							X
W/ A/ S	15.5.f	X	X	X	X	Normal		X	X	X	X, (2)		
Structure	15.5.j	X	X	X	X	Normal	X		X				X
Clearance (7)	15.5.g	X	X			Normal						X	
Tilt (7)	15.5.i	X	X			Normal	X		X			X	
Mean Width (7)	15.5.h	(1)	X			Normal		X		X			

Type Check	Reference Paragraph	Inspection				Facility Configuration	Measurements Required						
		E	C	Pm	P		Modulation	Width	Angle	Symmetry	Structure Below Path	Clearance	Structure
Monitors Width	15.5.m 15.3.a(3)	(1)	X, (8)	X		Middle Antenna ADV Phase		X	X		X, (2)	(3) (5)	
		(1)	X, (8)	X		RET Phase		X	X		X, (2)	(3) (5)	
		(1)	X, (8)			Narrow		X	X		X, (2)		
		(1)	X, (8)	X		Primary XMTR wide and clearance XMTR reduced modulation		X	X		X, (2)	(3)	
		(1)	(1)			Middle Antenna Attenuate		X	X		X, (2)		
		(1)	X, (8)	X		Upper Antenna Attenuate		X	X		X, (2)		
RF Power Monitor Reference (6) (7)	15.5.n	(1)	X			Reduced RF Power							
Standby Equipment	15.3.b 4.17.b		X	X									
Standby Power	15.3.c 4.17.c		X			Normal	X	X	X	X	X, (2)		

Notes:

(1) Maintenance request

(2) If structure below path tolerances cannot be met, clearance procedures and tolerances will be applied.

(3) Clearance Below Path (CBP) required on commissioning type inspections, one XMTR only.

(4) Normally required on only one transmitter. Perform on second transmitter at maintenance request.

(5) CBP not required if dephasing is equal to or less than the amount used for phase verification.

(6) Request RF level in watts from ground technician.

(7) One XMTR Only

(8) Facilities maintained using FAA Order 6750.49 require monitor checks on one XMTR only.

(6) Endfire Glide Slope Standard (capture effect in the horizontal plane)

CODE: W/ A/ S = Width, Angle, Symmetry

Type Check	**Reference Paragraph**	**Inspection**				**Facility Configuration**		**Measurements Required**						
		E	**C (4)**	**Pm**	**P**	**Primary XMTR**	**Clearance XMTR**	**Modulation**	**Width**	**Angle**	**Symmetry**	**Structure Below Path**	**Clearance**	**Structure**
Spectrum Analysis	15.5.a	Reserved				Reserved								
Engineering Support Tests (10)	15.5.e	(1)	(1)			As Required								
Modulation Level	15.5.b	X	X	X	X	Norm	Norm	X						
Modulation Equality Caution: HMI	15.5.c	(1)	(1)			Carrier Only	OFF	X						
W/A/S	15.5.f	X	X	X	X	Norm	Norm		X	X	X	X, (2)		
Structure	15.5.j	X	X	X	X	Norm	Norm	X		X				X
Clearance (10)	15.5.g	X	X			Norm	Norm						X	
Transverse Structure	15.5.k	X	X	(1)		Norm	OFF							X
Transverse Structure (7)	15.5.k	X	X	X, (10)		Norm	Norm							X
Tilt (10)	15.5.i	X	X			Norm	Norm	X		X			X	
Mean Width (10)	15.5.h	(1)	X			Norm	Norm		X		X			
Transverse Structure (7)	15.5.k	(1)	X	(1)		Norm	Reduced RF Power							X

Type Check	Reference Paragraph	Inspection				Facility Configuration		Measurements Required						
		E	C (4)	Pm	P	Primary XMTR	Clearance XMTR	Modulation	Width	Angle	Symmetry	Structure Below Path	Clearance	Structure
Clearance at 5° of LCZR course on G/S equip side (5) (7)	15.2.e 15.5.g	(1)	X			Norm	Reduced RF Power						X	
Clearance at 8° of LCZR course on side opposite G/S equip (5) (7)	15.2.e 15.5.g	(1)	X			Norm	Reduced RF Power						X	
Spurious Radiation	15.5.e(3)	(1)	(1)			Dummy Load	Dummy Load							X

Type Check	Reference Paragraph	Inspection				Facility Configuration		Measurements Required						
		E	C (4)	Pm	P	Primary XMTR	Clearance XMTR	Modulation	Width	Angle	Symmetry	Structure Below Path	Clearance	Structure
Monitors Width	15.5.m 15.3.a(3)	(1)	X, (11)	X		Wide	Norm		X	X		X, (2)	(3)	
		(1)	X, (11)			Narrow	Norm		X	X		X, (2)		
Phase	15.5.m	(1)	X, (11)	(4)		ADV Phase	Norm		X	X		X, (2)	(3)	
		(1)	X, (11)	(4)		RTD Phase	Norm		X	X		X, (2)	(3)	
Angle (6)	15.5.m	(1)	X, (11)	(1)		Main Array: Dephase for High Angle	Norm		X	X		X, (2)		
		(1)	X, (11)	X		Main Array: Dephase for Low Angle	Norm		X	X		X, (2)	(3)	
RF Power Monitor Reference (9) (10)	15.5.n	(1)	X			Reduced RF Power	Reduced RF Power							

Type Check	Reference Paragraph	Inspection				Facility Configuration		Measurements Required						
		E	C (4)	Pm	P	Primary XMTR	Clearance XMTR	Modulation	Width	Angle	Symmetry	Structure Below Path	Clearance	Structure
Transverse Structure	15.5.k		(1) (8) (11)			Norm	ADV front CLR ANT Phase							X
			(1) (8) (11)			Norm	RET front CLR ANT Phase							X
Standby Equipment	15.3.b 4.17.b		X	X										
Standby Power	15.3.c 4.17.c		X					X	X	X	X	X, (2)		

Notes:

(1) Maintenance request

(2) If structure below path tolerances cannot be met, clearance procedures and techniques will be applied.

(3) Clearance Below Path (CBP) required on commissioning type inspections, one XMTR only.

(4) On facilities without a quadrature phase monitor (Path 2 Detector), conduct dephase check on the width monitor with main sideband dephasing of ± 15° or less. If a quadrature phase monitor is installed, a commissioning check is required, but no periodic dephase check is needed.

(5) Clearance above and below path required. (See Paragraph 15.2.e.)

(6) Perform a final actual angle check at the completion of any angle monitor inspection.

(7) Perform also after antenna repair, replacement, modification, or any adjustment maintenance expects will change transverse structure and/or clearances.

(8) Not applicable to Single Clearance Antennas.

(9) Request RF level in watts from ground technician.

(10) One XMTR Only

(11) Facilities maintained using FAA Order 6750.49 require monitor checks on one XMTR only.

(7) 75 MHz Marker Beacon Checklist. Markers are installed as a constituent part of some other primary aid; therefore, they are inspected concurrently with the primary aid.

ILS AND FAN MARKERS

Inspections

Type Check	Reference Paragraph	Commissioning	Periodic	Antenna and/or Transmission Lines Replacement/ Adjustment
Spectrum Analysis	15.6.a	Reserved	Reserved	
Identification and Modulation Tone	15.6.b	X	X	X
Coverage	15.6.c			
Major Axis	15.6.c(2)	X	-	X
Minor Axis	15.6.c(1)	X	X	X
Proximity Check	15.6.d	X	-	X
Holding Fixes	15.6.f	X	-	X
Standby Equipment	15.6.g 4.17b	X	-	-
Standby Power	15.6.h 4.17c	X	-	-

Figure 15-2. Radiation Pattern – Plan View.

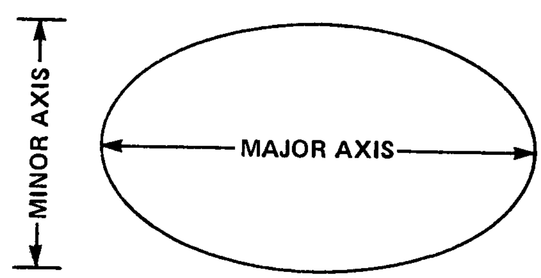
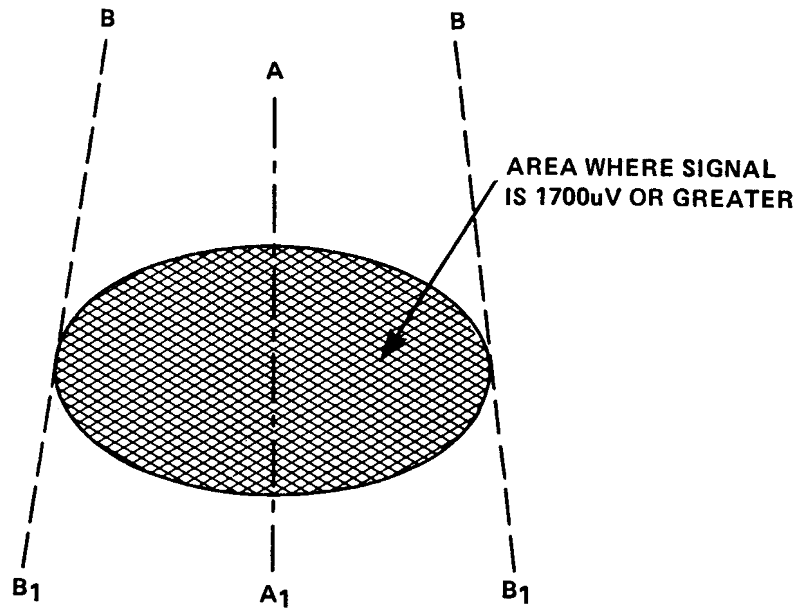


Figure 15-3. Marker Beacon Coverage.

A-A_1 - ELECTRONIC LOCALIZER ON-COURSE
NDB OR VOR/VORTAC SIGNAL

B-B_1 - LOCALIZER/SDF/LDA 75 μA 90 or 150 Hz OR OMNI-DIRECTIONAL 5° EITHER SIDE OF THE ELECTRONIC PROCEDURAL BEARING/RADIAL



Section 2. Localizer Flight Inspection Procedures.

4. Detailed Procedures – Localizers. Unless otherwise noted, the following procedures apply to all localizers, offset localizers, LDA(s), and SDF(s).

a. Spectrum Analysis. Reserved.

b. Modulation Level. This check measures the modulation of the radiated signal.

Approved Procedure—Front Course. Measure modulation while inbound on the localizer, between 10 miles and 3 miles from the localizer antenna, and on glidepath (at procedural altitude for localizer-only facilities). Preliminary checks may be made when transitioning the "on-course" position during course width and symmetry measurements; however, they must be validated while flying inbound on-course. Some dual frequency antennas do not provide enough clearance power to measure modulation on centerline. For these facilities, measure the clearance-only modulation level while inbound between 5 and 10° off course at the lower standard altitude of 1,500 ft above the antenna or 500 ft above intervening terrain, whichever is higher, with the clearance transmitter in the modulation balance configuration.

Approved Procedure—Back Course. Measure modulation by using the front course flight procedures described above. On single frequency localizers, adjustments to front course modulation will also affect the back course; therefore, adjustments are not required on the back course. Where a separate antenna provides clearance, as well as a back course, modulation checks and adjustments of the clearance transmitter(s) are valid only while on the back course, unless the course transmitter is OFF.

> Note: Modulation must be measured during the NORMAL configuration clearance checks required by Paragraph 15.4.k. Some receivers see excessive modulation as low clearances. Out-of-tolerance modulation must be a basis for restrictions on facilities installed or reconfigured with new type antennas* after January 1, 2000. Document the results in the report and facility data sheet for facilities that exceed the modulation tolerance and were installed or reconfigured with new type antennas* before January 1, 2000.

*Installed refers to newly commissioned facilities. New type antenna refers to a change from Log Periodic to V-Ring or vice-versa, a change from Capture Effect to Single Frequency or vice-versa, or a change in the number of elements in the antenna array.

c. Modulation Equality. This check is performed to obtain a crosspointer value, which will be used as a reference for phasing.

WARNING
HAZARDOUSLY MISLEADING INFORMATION
Misleading information is produced by this configuration. Ensure NOTAM is active. Monitor ATC communications for improper clearances to other aircraft.
WARNING

Note: FAA Glide Slopes must be OFF when the Localizer is producing HMI

Approved Procedure. Position the aircraft as outlined in Paragraph 15.4.b, Modulation Level. The angle of descent on an ILS must emulate the commissioned glide path when the glide slope is not radiating. Adjustments to modulation equality will require a subsequent check of course alignment.

d. Power Ratio Check. The purpose of this check is to measure the ratio of power between the course and clearance transmitters of dual frequency localizers.

Approved Procedure—Using the Spectrum Analyzer. Position the aircraft on the localizer on-course within 10 miles and in line-of-sight of the antenna or parked on the runway on-course in line-of-sight of the antenna. Compare the relative signal strength of the course and clearance transmitters with the course transmitter in RF power monitor reference and the clearance transmitter in normal.

Approved Procedure—Not Using the Spectrum Analyzer. Position the aircraft on the runway centerline/ on-course at or near the approach end of the runway in line-of-sight of the antenna. Use the AGC meter or equivalent and note the voltage level of the facility in the following configurations:

(1) Course transmitter at RF power monitor reference setting; clearance transmitter OFF.

(2) Clearance transmitter in normal; course transmitter OFF.

Compute the power ratio using the dual frequency power ratio formula (see Appendix B).

e. Phasing. The purpose of this check is to determine that the phase relationship between the sideband and carrier energy is optimum. The facility will normally be phased using ground procedures. No specific requirement exists for airborne phasing.

WARNING

HAZARDOUSLY
MISLEADING INFORMATION

Misleading information is produced by this configuration. Ensure NOTAM is active. Monitor ATC communications for improper clearances to other aircraft.

WARNING

Note: FAA Glide Slopes must be OFF when the Localizer is producing HMI.

Approved Procedure--Front Course. Since antennas vary greatly, obtain the correct azimuth for phasing the facility from Facilities Maintenance personnel. Fly inbound toward the antenna at an altitude and azimuth determined by Maintenance between 10 and 3 miles. Transmit the crosspointer values to assist the ground technician to adjust the phasing. The optimum quadrature phase condition is established when the microampere deflection is the same as that found when checking modulation equality.

Approved Procedure--Back Course. If maintenance requests phasing on the back course, apply the procedures described above.

f. Course Sector Width and Symmetry. The purpose of this check is to establish and maintain a course sector width and ratio between half-course sectors that will provide the desired displacement sensitivity required at the procedural missed approach point (MAP) or threshold and be within the limitations of the procedural protected area**.**

Approved Procedure. This procedure applies to the front course (and back course if it is used for an approach or missed approach). Measure the course sector width and symmetry between 6 and 10 miles from the localizer antenna at the lower standard altitude of 1,500 ft above the antenna or 500 ft above intervening terrain, whichever is higher. Technical Services Team must approve measurements inside 6 nm. On periodic checks, course width may be checked at distances from 6 to 14 nm from the localizer antenna. Verify any unusual/ out-of-tolerance indications at a distance of 10 nm or less. If the condition repeats, or if unable to verify due to weather or ATC restrictions, take appropriate NOTAM/ restriction action.

On periodic checks, higher altitudes may be used, provided a course width comparability check in the normal configuration is made (usually at commissioning) at the lower standard altitude of 1,500 ft above the antenna or 500 ft above intervening terrain, whichever is higher, and a higher altitude is used for the comparison. If comparability results are in tolerance and within ± 0.2°, subsequent inspections may be made at any altitude between the lower and higher altitudes used for comparability. If a comparability check has not been completed, an altitude 1,500 ft above the antenna or 500 ft above intervening terrain, whichever is higher, must be used to evaluate course width.

If the commissioned width is changed, reestablish width monitor references at the lower standard altitude of 1,500 ft above the antenna or 500 ft above intervening terrain, whichever is higher. If clearance comparability was satisfactory prior to the course width change, re-check the Procedure 1/ 2 configurations at the lower standard altitude. Further comparability checks at the desired higher altitude are not required if these minimum clearance levels are met.

(1) Basic Method. A crossing, perpendicular to the on-course, must be made in each direction, maintaining a constant airspeed (to average out any wind component) over a checkpoint of a known distance from the localizer antenna, i.e., outer marker, FAF, etc. If ground speed or along-track outputs are available, only one crossing is required. Measure the course sector width and calculate the symmetry (use the appropriate formulas in Appendix B).

(2) Theodolite or Tracking Device Method. Position the theodolite or tracking device in accordance with Paragraph 15.2.f, Theodolite Procedures. Only one crossing is required at the maximum distance that permits theodolite tracking. Maintain a constant airspeed. Reference the course sector width to the azimuth reference marks of the theodolite (usually spaced 5° apart). Measure the course sector width, using a device such as 10-point dividers, and calculate the symmetry.

> Note: An RTT may be used to track an aircraft throughout the course sector. Apply the course sector width received to the calibration of the RTT.

(3) Width Requirements. Localizers, offset localizers, and LDA(s) must be tailored to a course sector width not greater than 6° and a linear sector width of 700 ft at the following points:

(a) Point C for LDA and SDF

(b) Point B for runways less than 4,000 ft long and for runways which do not conform to precision instrument design standards.

(c) Point T for facilities supporting all other applications.

The tailoring requirement may be waived for facilities supporting other than CAT II or III operations if tailoring cannot be achieved due to siting constraints, performance derogation etc.; however, the final width must be established as close as possible to the optimum. The justification must be included in the flight inspection report. The decision to have other than a tailored course width is not a flight inspection function and must be made at the applicable Service Area or comparable military level. If the course sector width on a facility which supports a precision approach will not provide for at least 400 ft linear width at the runway threshold, the course must be restricted as unusable inside the point where the linear width is 400 ft. The commissioned course width of an SDF must be no greater than 12.0°. If the course width is adjustable, it must be tailored.

Some facilities with course widths less than 3.00° have had problems associated with aircraft overshooting turns to the approach course; pay particular attention to flyability with narrow widths.

g. Course Alignment and Structure. These checks measure the quality and alignment of the on-course signal. The alignment and structure checks are usually performed simultaneously; therefore, use the same procedures to check alignment and structure.

Approved Procedure. This procedure applies to the front course (and the back course if it is used for an approach or missed approach.

(1) General. Evaluate the course along the designed procedural azimuth from the furthest point required by the type of inspection being conducted throughout the remaining zones. Maintain the published or proposed procedural altitudes through each approach segment until intercepting the glidepath and then descend on the glidepath to Point C or runway threshold.

> Note: For FAA, U.S. Non-Federal civil, U.S. Army, and U.S. Navy/ Marine Corps facilities, the alignment must meet Maintenance Reference "Initial" tolerances IAW TI 8200.52, Chapter 15, any time alignment is adjusted, or at the end of a Periodic with Monitors inspection.

(a) For a localizer-only approach, the published or proposed procedural altitudes must be maintained in each segment, except the final segment must be flown as follows: Upon reaching the FAF inbound, descend at a rate of approximately 400 ft per mile (930 ft per minute at 140 knots; 800 ft per minute at 120 knots) to an altitude of 100 ft below the lowest published MDA and maintain this altitude to Point C, which is the MAP.

> Note: See Appendix A definition of Point C for localizer only approaches.

(b) For ILS approaches which support localizer-only minima, the procedure specified in (a) above must be used in addition to the run on normal glidepath during the following inspections: Site, Commissioning, and Specials for antenna system change; user complaint or site modifications; and on a periodic inspection any time there is a significant deterioration of localizer structure.

(c) For localizers which are aligned along the runway centerline, the aircraft may be positioned along the runway centerline by visual cues or theodolite. When RTT or AFIS equipment is used, the localizer on-course signal must be flown.

(d) Theodolite, RTT, or AFIS must be the method of evaluation for facilities which are not aligned along the runway centerline.

(e) LDA(s) oriented toward a non-descript point-in-space where adequate visual checkpoints are not available and AFIS runway updates are impractical, the alignment on commissioning-type inspections must be determined using Differential GPS AFIS "truth system", pseudo runway development or theodolite. Pseudo runway development based on surveyed airport checkpoints (runway ends, taxiways, etc.) must be approved in advance by Technical Services Team. Establish an equality of modulation reference for subsequent alignment and monitor comparison.

During subsequent periodic inspections, where AFIS updates are impractical, the localizer alignment may be determined to be either Satisfactory (S) or Unsatisfactory (U), in lieu of course alignment values (refer to Paragraph 6.13g.). If the actual alignment is required (i.e., SOIA), the use of Differential GPS AFIS "truth system", theodolite, or pseudo runway development is required.

(2) Roll-Out Procedures. The procedures below are required for all Category II/ III localizers. They are also required for all Category I localizers installed with runway lengths of 5,000 ft or greater. Offset localizers, localizers installed without glide slopes, SDF(s), LDA(s), and facilities currently with a classification of I/ A, B, or C, need not be checked. Rollout checks and the 50 ft ILS-3 comparison checks are required on both transmitters.

(a) Site, Commissioning, Reconfiguration and Categorization Inspections of centerline oriented facilities. Use the procedures in Paragraph 15.2.g(1) until reaching Point C. Cross Point C at 100 ft, runway threshold at approximately 50 ft, and continue on the extended glidepath angle to the touchdown point. Continue the landing roll and determine the actual course alignment for ILS Zones 4 and 5.

Measure the course structure from the actual alignment. If the actual alignment for Zones 4 and 5 cannot be determined using this method, taxi the aircraft along the runway centerline from abeam the glide slope to Point E. Record the raw crosspointer information and mark, abeam the glide slope, Point D and Point E. Manually calculate the actual course alignment and structure for each of the required zones.

This is also a comparison check intended to authorize the 50 ft run as a periodic check of Zone 4 and 5 structure. A comparison of structure results found on Rollout and on the 50 ft ILS-3 run is needed to determine if the expedient method of checking Zones 4 and 5 structure on the 50 ft run is valid for periodic checks. Satisfactory comparability must be defined as 3 μA or less difference between the results in each zone with both Rollout and 50 ft results being in-tolerance for that zone. Maximum structure in either zone does not have to occur at the same point on the runs to be comparable. Apply the 95% rule as specified in Paragraph 15.8.a to results outside normal tolerance.

The Zone 4 and Zone 5 structure analysis determined during Rollout procedures is the definitive pass/ fail criteria, taking precedence over the results of the 50 ft ILS-3 maneuver.

Document the Rollout and ILS-3 50 ft structure comparability results IAW Order 8240.36, Appendix 8. Submit FAA Form 8240-20, AVNIS Data Change Submission, to effect ILS Classification changes to the National Flight Data Center (NFDC).

When the Rollout check is found satisfactory on a Category I ILS and the comparability check is unsatisfactory, Technical Services Team must contact AeroNav Procedures Specialist and the regional All-Weather Operations representative to determine if any users are authorized IFR use below Category I minima. Technical Services Team will make the final determination as to the requirement for future Zone 4 and 5 rollouts on that facility, and transmit the appropriate ILS classification to NFDC.

Refer to the Rollout flow chart and associated Rollout code legend for the Zones 4 and 5 structure comparison process.

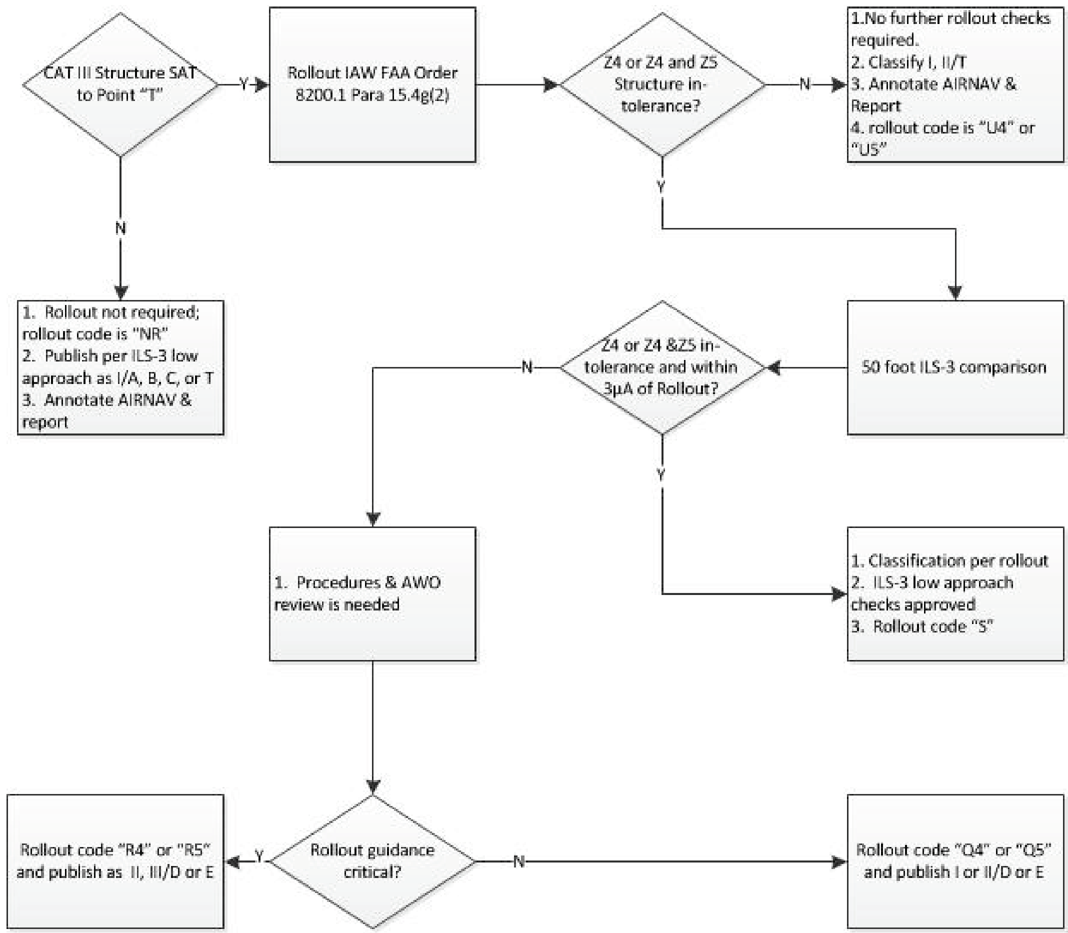
(b) Periodic or Special Inspections which require Structure Analysis. Except for those facilities that have been identified as "Rollout Required", use the procedures in Paragraph 15.4.g(1) until reaching Point C. Cross Point C at 100 ft, runway threshold at 50 ft, and then conduct a low approach at 50 to 100 ft, on runway centerline, throughout the required zones. If the aircraft cannot be maintained on centerline for evaluation of Zones 4 and 5 due to wind conditions, the evaluation may be conducted by taxiing the aircraft down centerline throughout Zones 4 and 5.

On a facility previously checked satisfactory for Zone 4 and Zone 5 Rollout / ILS-3 50 ft run structure comparability, if Zone 4 or Zone 5 structure appears to have deteriorated since the previous inspection or if out-of-tolerance structure is found, verify the results of this check by flying the rollout procedure listed in 15.4.g(2) above. If that structure has deteriorated to below Category III standards for facilities with published classification of I, II, III/ T, D, or E (as applicable), initiate NOTAM action and submit FAA Form 8240-20.

When periodic ILS-3 50 ft runs indicate improved Zone 4 and Zone 5 structure on localizers previously documented as "Rollout required" (due to unsatisfactory Zone 4 and Zone 5 Rollout / ILS-3 50 ft run comparability) identify the improvement to Flight Inspection Services, Technical Services Team. Technical Services Team must review the facility historical results to determine if the improvement is based on seasonal changes or long-term structure improvements, prior to any publication or NOTAM action.

As indicated in the chart below, periodic rollout checks are only required on localizers that have failed the comparability check, Zone 4 and Zone 5 Rollout is satisfactory, and a documented requirement exists where users are authorized IFR use below Category I minima.

Category	Code	Inspection
I/ II/ III	S	Z4 & Z5 inspect via 50 ft run and report airborne results in Field 8
I/ II	NR, U4, or Q4	Z4 & Z5 no inspection or reported results
I/ II	Q5 or U5	Z4 inspect via 50 ft run; no Z5 inspection or reported results
I/ II/ III	R4 or R5	Z4 & Z5 inspect via Rollout and report Rollout results in Field 8; report results of the 50 ft run in Remarks.



1. Use this criteria for CAT I, II, and III localizers
2. 354 foot structure exception applies
3. Do not accomplish a rollout if the localizer is restricted prior to Point "T", localizer is offset, is classified as I/A, B, or C; or the runway length is less than 5,000'
4. Complete a rollout comparison of Z4 only if Z4 structure is SAT and Z5 structure is out-of-tolerance.
5. The 3µA comparison value applies only if both the rollout and low approach are in-tolerance.
6. Rollout comparison checks for all existing facilities must be scheduled via special inspection request.
7. Existing facilities retain present classification, pending rollout analysis.
8. After rollout comparison, flight inspectors must submit an 8240-20 to change the rollout code to the appropriate code on the data sheet and publications.

Flight Inspection Services, Technical Services Team assigns the following codes to AVNIS facility data sheets to indicate Localizer eligibility for a Rollout check:

NR = Check is not required.

AC = Awaiting Rollout Check

Flight inspectors assign the following codes on the flight inspection report and via

FAA Form 8240-20 to change AVNIS facility data sheets to indicate the status of Rollout checks:

S = Rollout accomplished; results of both the Rollout and the 50 ft run are within Category III tolerance and compare within 3 μA.

U4 = Rollout accomplished; Zone 4 results do not meet Category II/ III tolerances.

U5 = Rollout accomplished; Zone 5 results do not meet Category III tolerances.

R4 = Rollout required for evaluation of Zone 4 and Zone 5. Rollout was accomplished; ground results meet Category II/ III requirements but do not compare with results of the 50 ft run in Zone 4.

R5 = Rollout required only for evaluation of Zone 5. Rollout was accomplished; ground results meet Category III requirements; comparison with the 50 ft run was Satisfactory in Zone 4 but Unsatisfactory in Zone 5.

Flight Inspection Services, Technical Services Team assigns the following codes to the AVNIS facility data sheets post flight inspection after contact with the AeroNav Procedures Specialist and regional All-Weather Operations representative:

Q4 = Periodic Rollout not required. Rollout accomplished; results meet Category II/ III requirements, but Zone 4 ground results do not compare with results of the 50 ft run. This code means that future evaluations of Zone 4 and Zone 5 must be through a Rollout Check but that it need not be done on periodic inspections, as these zones are not currently used for IFR. This code is only applied by Flight Inspection Services, Technical Services Teamand does not apply to Category III. Application to Category II is only appropriate IAW Order 8200.1, Paragraph 15.4.g(3) Note 2.

Q5 = Periodic Rollout not required. Rollout accomplished; results meet Category II/ III requirements, but Zone 5 ground results do not compare with results of the 50 ft run. This code means that future evaluations of Zone 5 must be through a Rollout Check but that it need not be done on periodic inspections, as these zones are not currently used for IFR. This code is applied only by Flight Inspection Services, Technical Services Team and is only used to easily display the non-comparable zone.

(3) Zones to be inspected for structure. All ILS localizers sited on the extended runway centerline must be inspected and analyzed through Zones 1, 2, 3, 4, and 5 (runways less than 5,000 ft long do not have Zone 5) on all inspections requiring alignment or structure validation. These localizers must be classified according to the furthest point at which the structure conforms to Category III tolerance.

Specific reporting instructions are contained in Order 8240.36. This classification is for autoland authorization. Other facilities must be inspected and analyzed in Zones 1, 2, and 3. See Appendix A and Figure 15-1 for zone identification.

Type Approach/ Facility	Zones Required for Unrestricted Service (1)
Category III	Zones 1, 2, 3, 4, and 5
Category II ILS	Zones 1, 2, 3, and 4 (see Paragraph 5.12j(9)
Category I ILS	Zones 1, 2, and 3
Other types of facilities or approaches	Zones 1, 2, and 3

Note 1: During site, commissioning, reconfiguration, categorization, antenna, and/or frequency change inspection—check all of Zone 1. All other inspections (i.e., periodic, periodic with monitors, etc.) evaluate structure from GSI or the FAF (whichever is further) through all other required zones. For After Accident Inspections, see Paragraph 4.14g. See Chapter 22 for ESV requirements.

Note 2: Category II localizers failing to meet structure tolerance in Zone 4 will not be shown as restricted on the flight inspection report; however, a NOTAM will be issued. See Chapter 5, Section 1.

(4) Alignment Areas. Determine the course alignment in the following areas:

Front Course	From	To
CAT I, II, III	One mile from runway threshold	Runway threshold
ILS Zone 4	Runway threshold	Point D
ILS Zone 5	Point D	Point E
Offset Localizers	One mile from runway threshold	Runway threshold or abeam runway threshold
LDAs and SDFs	One mile from Point C	Point C
Back Course		
All Types of Facilities	Two miles from the antenna	One mile from the antenna

Note: When a restriction occurs in an area where alignment is normally analyzed, measure alignment through manual or AFIS analyzation of the average course signal in the following areas:

From	To
One mile from the start of the restriction	The start of the restriction.

h. Glide Slope Signal on Localizer Back Course. Evaluation of localizer back course approaches must also include an evaluation for active glide slope signals. Glide slope signals that result in flag or CDI activity must be cause for immediate action to alert pilots to disregard all glidepath indications on the back course approach (i.e., NOTAM). Ensure the alert will be printed on the localizer back course instrument approach chart.

i. Monitor References. The inspector must ensure that the facility is set at the monitor reference prior to each check. Monitor references must be checked IAW Paragraph 15.3.a(3) when prescribed by the checklist and when applicable on special inspections. At the conclusion of any width monitor inspection, return the facility to normal, and check and report the resulting course sector width and symmetry.

Approved Procedure—Width Reference. Use the flight procedure and methods described in Paragraph 15.4.f. At the conclusion of any width monitor inspection, return the facility to normal, and check and report the resulting course sector width and symmetry.

Approved Procedure—Alignment Reference. This check is performed to assure the monitors will detect a specific shift of the localizer course, and must only be accomplished upon special request from the FAA region or appropriate military authority. This check may be accomplished on the front course or on the back course, using the procedures described in Paragraph 15.4.g.

It is not necessary to verify ground alignment monitor checks in the air or to verify airborne alignment monitor checks on the ground. Request the course be misaligned to the monitor alarm limits each side (90 Hz/ 150 Hz) of the operational course. Both the recorder and the visual display must be used to verify course alignment shifts. During any inspection, the monitor limits must be referenced to the designed on-course alignment according to facility category.

(1) Ground. After the airborne localizer alignment has been determined, position the aircraft near the runway threshold where the stable crosspointer is received. The aircraft may be displaced as much as 75µA from the on-course signal. (This option is authorized, providing the sensitivity of the course sector width is linear.) The received course indication must be referenced to the alignment found airborne. Request that maintenance shift the course to both of the monitor limit points and then return to normal.

At facilities that are installed offset to the runway, the alignment monitor limits may be established with the aircraft on the ground within 75µA of the on-course signal; but the aircraft must not be positioned closer than 3,000 ft from the antenna array. If these two conditions cannot be met, perform this check in the air.

If monitors are initially checked on the ground and alignment is then adjusted based on airborne analysis, a monitor re-check is not required, providing the following criteria are met:

- In-tolerance flag/ modulation and AGC exist.
- Crosspointer is stable.
- Crosspointer data are recorded as found during adjustment and at the final setting.

- The monitor shift on the ground, when applied to the new airborne alignment, is in tolerance.

- Monitor settings are not changed after the alignment is adjusted.

(2) Airborne. Perform airborne alignment monitor checks while inbound on the designed procedural azimuth (on localizers aligned along runway centerline, the aircraft should be aligned with the centerline extended). Measure the alignment shifts to monitor limits by recording the instantaneous course displacements or course shifts as referenced to runway centerline extended. If feasible, this may be accomplished on one run during which both limit points and a return to normal are recorded.

(3) Equality of Modulation. When course alignment is satisfactory and a monitor inspection is required, localizers may be evaluated for monitor references using equality of modulation method. This method may be used on all categories of localizers with the concurrence of maintenance personnel. All facilities must be flown to establish the alignment in a normal operating configuration. Once the alignment has been established, maintenance will set up an equality of modulation configuration. The equality used to establish the alignment will become the reference for the subsequent monitor readings. When requested, maintenance personnel will unbalance the modulation to achieve the monitor reference point. Measure the displacement in microamps, repeat the procedure in the other direction, then restore to normal. This may be accomplished in the air or on the ground and need not be performed on centerline. Use of this method will be noted in the remarks section of the flight inspection report.

WARNING

HAZARDOUSLY MISLEADING INFORMATION

Misleading information is produced by this configuration. Ensure NOTAM is active. Monitor ATC communications for improper clearances to other aircraft.

WARNING

Note: FAA Glide Slopes must be OFF when the localizer is producing HMI

j. RF Power Monitor Reference. This inspection is conducted to determine that the localizer meets specified tolerances throughout the service volume while operating at reduced power.

Approved Procedure. This procedure applies to the front course (and the back course if it is used for an approach or missed approach). This check must be conducted with the facility operating at reduced power. Check for interference, signal strength, clearances, flag alarm, identification, and structure as follows. Steps:

(1) Fly an arc across the localizer course at 18 miles* from the antenna at 4,500 ft above antenna elevation throughout Sector 1.

(2) Fly an arc across the localizer course at 18 miles* from the antenna at 2,000 ft above the threshold elevation or 1,000 ft above intervening terrain, whichever is higher. If 1,000 ft above intervening terrain is higher than 4,500 ft above antenna elevation, the localizer must be restricted. Determine a distance where terrain clearance is within the SSV for a localizer restriction distance. The facility must have an ESV for use outside the SSV.

(3) Proceed on course, inbound from 18 miles*, until reaching 7° above the horizontal (measured from the localizer antenna) or Point C, whichever occurs last, at 2,000 ft above threshold elevation, or 1,000 ft above intervening terrain, whichever is higher.

(4) Fly an arc throughout Sectors 1 and 2 (and 3, if procedurally required) across the localizer course 1,500 ft above the antenna or 500 ft above intervening terrain, whichever is higher, at 10 miles** from the antenna. Altitude is intended to be single altitude. If unable to maintain minimum terrain clearance within the SSV, restrict the facility accordingly.

> Note: See Chapter 22 for additional ESV requirements. If the ESV altitude is within the SSV distance, special consideration will be applied to localizer support.
> * 25 miles from the antenna for ICAO Service Volumes.
> ** 17 miles from the antenna for ICAO Service Volumes.

k. Clearance. Clearances are measured to ensure that the facility provides adequate off-course indications throughout the service volume (or ESV, whichever is greater).

Approved Procedure. This check applies to the front course (and the back course if it is used for an approach or missed approach). The clearance orbit will be conducted at a radius between 6 to 10 miles from the antenna at the lower standard altitude of 1,500 ft above the antenna or 500 ft above intervening terrain, whichever is higher. On periodic checks, clearances may be checked to a distance of 14 nm from the localizer antenna. Verify any unusual/ out-of-tolerance indications at a distance of 10 nm or less. If the condition repeats, or if unable to verify due to weather or ATC restrictions, take appropriate NOTAM/ restriction action.

(1) Clearance Comparability. In some cases it may be necessary to perform clearance measurements at altitudes higher than the lower standard altitude of 1,500 ft above the antenna or 500 ft above intervening terrain, whichever is higher (e.g., weather, restricted airspace, or ATC limitation). After commissioning, higher altitudes may be used, provided a comparability check is made (usually at commissioning) documenting clearances at the lower standard altitude of 1,500 ft above the antenna or 500 ft above intervening terrain, whichever is higher, and the higher altitude. If comparability results are satisfactory, subsequent inspections may be made at any altitude between the lower and higher altitudes used for comparability. If a comparability check has not been completed satisfactorily, altitudes above the lower standard altitude of 1,500 ft above the antenna or 500 ft above intervening terrain, whichever is higher, must not be used to evaluate clearances.

On commissioning/ reconfiguration type checks, to include new type antenna installations/ replacements, this comparison must be accomplished.

> Note: The lower altitude is recommended and should be attempted on all inspections. Clearance checks above the lower standard altitude of 1,500 ft above the antenna or 500 ft above intervening terrain, whichever is higher, should be the exception.

The difference between Procedures 1 and 2 involve airborne analysis only. Procedure 1 will be used for all facilities, unless the lowest clearance condition configuration at the desired higher altitude produces higher clearances better than the same configuration at the lower standard altitude. Procedure 2 allows slightly higher clearances at the desired higher altitude. However, Procedure 2 can only be used if the more stringent clearance tolerances are applied at the lower standard altitude. See the clearance comparability flow charts in this paragraph for clarification. Comparability is required in unrestricted areas of coverage and on one transmitter only. If comparability is unsatisfactory, clearly document the reason.

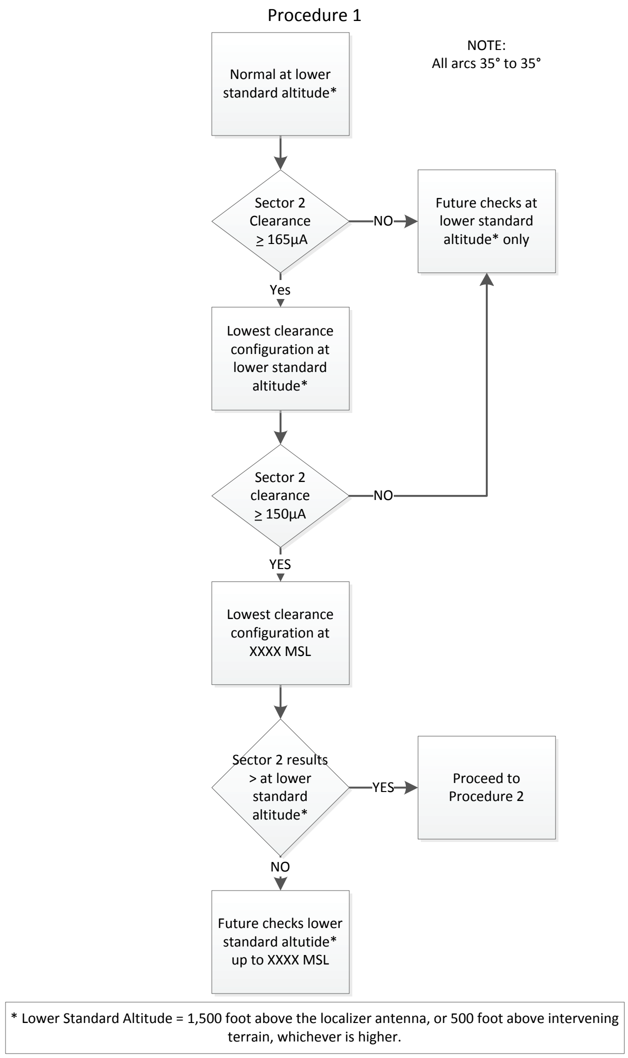
(a) Procedure 1. Perform the following clearance runs from 35° on each side of course. Lower standard altitude is defined as 1,500 ft above the antenna or 500 ft above intervening terrain, whichever is higher.

(i) Evaluate clearances in Normal Configuration at the lower standard altitude. If the lowest Sector 2 clearances are less than 165 μA, the check is UNSAT.

(ii) Evaluate clearances at the lower standard altitude in the wide or narrow alarm reference configuration which produced the lowest measured clearances. If the lowest Sector 2 clearances are less than 150 μA, the check is UNSAT.

Note: If either (i) or (ii) is UNSAT, no further comparability checks (including Procedure #2) are required.

(iii) Evaluate Clearances in the Lowest Clearance Configuration at Desired Higher Altitude. Repeat the configuration that produced the lowest Sector 2 clearances from Paragraph (a)(i) or (a)(ii) above at the desired higher altitude. If the lowest clearances as measured at the higher altitude are greater than those found at the lower standard altitude, the check is UNSAT, proceed to comparability Procedure #2.

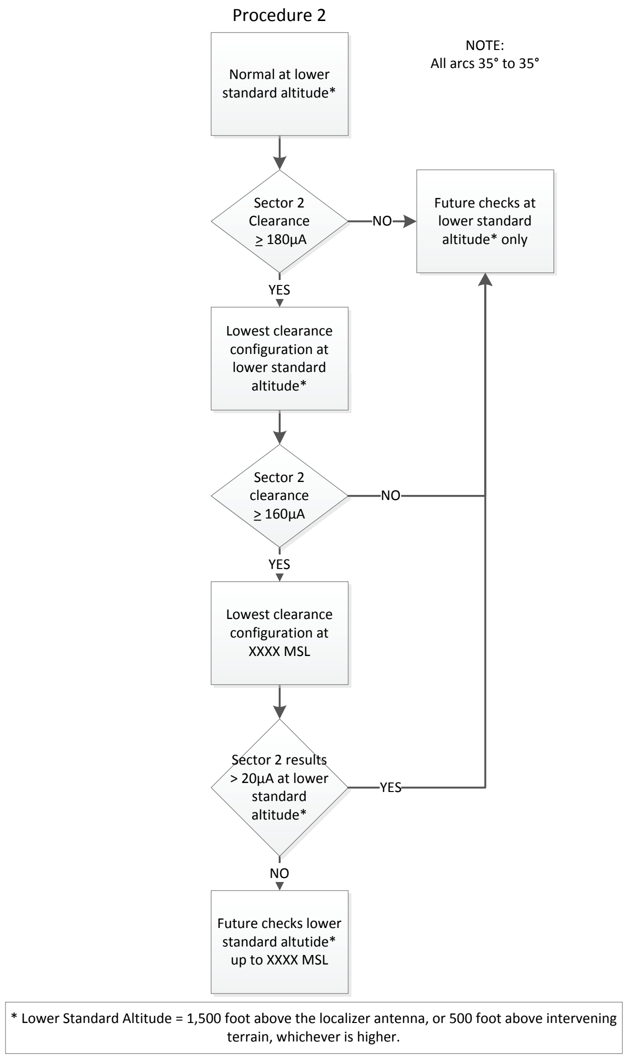


(b) Procedure 2. Perform the following clearance runs from 35° on each side of course. Lower standard altitude is defined as 1,500 ft above the antenna or 500 ft above intervening terrain, whichever is higher.

(i) Evaluate clearances in Normal Configuration at the lower standard altitude. If the lowest Sector 2 clearances are less than 180 µA, the check is UNSAT.

(ii) Evaluate clearances in Lowest Clearance Configuration (wide or narrow alarm reference) at the lower standard altitude. If the lowest Sector 2 clearances are less than 160 µA, the check is UNSAT.

Note: If Step (b)(ii) is UNSAT, further comparability checks are not required.



(iii) Evaluate Clearances in the Lowest Clearance Configuration at Desired Higher Altitude. Repeat the configuration from Paragraph (b)(i) or (b)(ii) above that produced the lowest Sector 2 clearances at the desired higher altitude. If the lowest clearances measured at the higher altitude are more than 20 µA greater than those found at the lower standard altitude, the check is UNSAT, and subsequent checks must be conducted at the lower standard altitude of 1,500 ft above the antenna or 500 ft above intervening terrain, whichever is higher.

Note: The normal or alarm reference condition that causes the lowest clearances will not always be a periodic monitor check condition. Document the flight inspection report and the data sheet with the configuration that produces the lowest clearance values. Inspections to remove a restriction based on clearances must include a check of all clearance commissioning configurations. See Paragraph 15.3.a(7).

(c) Additional Clearance Comparability Requirements. If Procedure 1 or 2 clearance comparability is SAT, perform the following checks on one transmitter for historical reference.

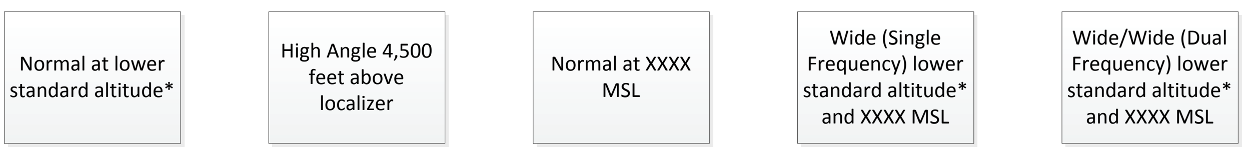
(i) Course and Clearance Transmitters Wide (dual frequency)/ Course Transmitter Wide (single frequency) at the lower standard altitude of 1,500 ft above the antenna or 500 ft above intervening terrain, whichever is higher.

(ii) Course and Clearance Transmitters Wide (dual frequency)/ Course Transmitter Wide (single frequency) at Desired Higher Altitude.

(iii) Normal Configuration at the Desired Higher Altitude (if this altitude is different from the Paragraph 15.4.k(3) High Angle Clearance Check).

Note: Evaluate the configurations in (c)(i) and (c)(ii) above only if Procedure 1 or 2 clearance comparability is SAT.

COMMISSIONING TYPE CLEARANCE CHECKS



* Lower Standard Altitude = 1,500 foot above the localizer antenna, or 500 foot above intervening terrain, whichever is higher.

(2) Inspections.

(a) Commissioning. Check clearances in both normal and the monitor limit configurations described in the appropriate checklist.

(b) Facilities documented with Procedure 2 comparability must be re-checked at the lower standard altitude of 1,500 ft above the antenna or 500 ft above intervening terrain, whichever is higher, when clearances are found at less than 160 µA in any configuration on any check. If the re-check at lower standard altitude is satisfactory, the comparability check must be accomplished again, or higher altitudes will not be used to check clearances.

(c) Verify clearances at the lower standard altitude of 1,500 ft above the antenna or 500 ft above intervening terrain, whichever is higher, at least every 1,080 days. This check determines if environmental changes affect clearances at the lower standard altitude of 1,500 ft above the antenna or 500 ft above intervening terrain, whichever is higher, while not affecting clearances at the higher altitudes. Fly one clearance run (normal or monitor reference) at the lower standard altitude of 1,500 ft above the antenna or 500 ft above intervening terrain, whichever is higher. Values less than 200 µA may indicate a potential clearance problem; however, if the minimum clearances required to authorize checks at higher altitudes are maintained at the lower standard altitude, higher altitudes may continue to be used.

(3) High Angle Clearance. This check determines that the transmitted signals provide proper off-course indications at the upper limit of the service volume and must be conducted during a site evaluation, commissioning inspection, or when a change in location, height, or type of antenna is made.

Approved Procedure. This check applies to the front course (and the back course if it is used for an approach or missed approach). This check is only required on one transmitter.

(a) Fly a 10-mile arc through Sectors 1 and 2 (and 3, if procedurally required), at 4,500 ft above the antenna.

(b) If clearances are out-of-tolerance, additional checks will be made at decreasing altitudes to determine the higher altitude at which the facility may be used.

l. Coverage. Coverage must be evaluated concurrently with each required check during all inspections.

m. Reporting Fixes, SID(s)/ DP(s) STAR(s), and Profile Descents. Refer to Figure 15-4. The localizer, SDF, or LDA may be used to support fixes, or departure, en route, and arrival procedures. Under these circumstances, navigation is accomplished by using some other facility such as VOR or an NDB. Facility performance of all facilities involved must be checked to ensure that all coverage parameters are within tolerance.

This must be accomplished during a commissioning inspection, when new procedures are developed or redesigned, or on appropriate special inspections (e.g., user complaints). When fixes are located within the RHO-THETA FISSV and ILS SSV (see definitions in Appendix A), coverage throughout the fix displacement area can be predicted (fix displacement evaluation is not required).

Note: If the procedural altitude is below 1,500 ft above the antenna and higher than 500 ft above intervening terrain within the ILS SSV, evaluate the localizer at the procedural altitude. Out-of-tolerance indications must result in denial of the procedure but will not affect localizer service volume.

If the fix is not contained within the localizer and/or glide slope SSV, an ESV must be established to support the procedure IAW Chapter 22.

(1) Required Coverage.

(a) LOC (A) B1 to B2. This requirement is satisfied by service volume validation and need not be repeated.

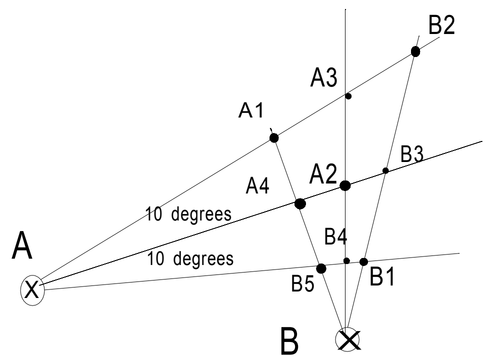
(b) VOR (B) A1 to B2 (R ± 4.5°). Does not need to be checked if within the VOR/ NDB FISSV.

(c) VOR (B) A3 to B4.

(2) SID(s)/ DP(s). Check on-course structure throughout the area of intended use. Check clearance in Sector 1 at the termination point at the minimum authorized altitude.

(3) STAR(s) and Profile Descents. Fly these procedures as proposed or as published. Check facility performance when checking STAR(s) and profile descents in accordance with Paragraph m.(1) above, with fixes.

Figure 15-4.



n. Polarization Effect. The purpose of this check is to determine the effects that vertical polarization may have on the course structure.

Approved Procedure. This check applies to the front course (and the back course if it is procedurally used), and may be accomplished concurrently with the course structure check. This check is only required on one transmitter.

Fly inbound on-course within unrestricted coverage prior to the FAF and roll the aircraft to a 20° bank left and right. Actuate the event mark at the maximum banked attitude.

o. Identification and Voice. This check is made to ensure identification and voice (if installed) is received throughout the coverage area of the localizer.

SDF(s) have a three-letter coded identifier. Localizers and LDA(s) have a three-letter coded identifier preceded by the code letter I.

Approved Procedure. This procedure is applicable to the front course (and the back course if it is procedurally used).

Record the identification during all checks. Check voice transmissions when on-course and at the maximum distance at which course structure is being evaluated.

> Note: Some localizers will not transmit an ID when in a monitor configuration. Ensure ID is SAT while in normal. If the ID does not transmit in reduced RF power when completing the service volume checks, check the ID throughout a normal arc at the lowest altitude at the furthest usable distance.

A localizer must be restricted if identification cannot be received in all areas of required coverage.

A localizer must not be restricted solely because the voice/ ATIS cannot be received. In this event, advise the procedures specialist and/or Air Traffic Operations personnel.

Section 3. Glide Slope Flight Inspection Procedures.

5. Detailed Procedures – Glide Slope.

a. Spectrum Analysis. (Reserved)

b. Modulation Level. This check measures the modulation of the radiated signal.

Approved Procedure. Measure the modulation of the glidepath while inbound on the localizer/ glidepath course between 7 and 3 miles from the glide slope antenna with a signal strength of 150 µV or greater.

c. Modulation Equality. This check establishes the balance of the carrier signals. This check should be made prior to any phasing checks and will be used as the reference for phasing.

WARNING

HAZARDOUSLY MISLEADING INFORMATION

Misleading information is produced by this configuration. Ensure NOTAM is active. Monitor ATC communications for improper clearances to other aircraft.

WARNING

Note: FAA Localizers must be OFF when Glide Slopes are transmitting HMI.

Approved Procedure. Have maintenance personnel configure the facility to radiate carrier signal only. When checking capture effect facilities, the primary transmitter radiates this configuration while the clearance transmitter is off or in dummy load.

Use the procedure described in Paragraph 15.5.b, Modulation Level. While descending, call out the balance to Facilities Maintenance personnel. Zero µA is optimum. An imbalance in excess of 5µA must be adjusted towards optimum.

d. Phasing. This check determines that the correct carrier and sideband-only phase relationship are distributed to the antennas.

WARNING
HAZARDOUSLY MISLEADING INFORMATION
Misleading information is produced by this configuration. Ensure NOTAM is active. Monitor ATC communications for improper clearances to other aircraft.
WARNING

Note: FAA Localizers must be OFF when Glide Slopes are transmitting HMI

Approved Procedure. Phasing may be performed on the ground (by maintenance) or in the air. Consult the appropriate checklist in Paragraph 15.3.h. Proceed inbound from 10 miles from the glide slope antenna along the localizer procedural ground track at 1/3 to 1/2 of the glidepath angle. Maintain this angular descent until reaching runway threshold. Do not make facility adjustments inside 4 miles during the angular descent. Record the crosspointer throughout the phasing run. The flight inspection technician should relay the microammeter indications to the Facilities Maintenance personnel. Have maintenance adjust the phaser until the crosspointer is approximately the same value found during the modulation equality check.

Analysis. Analyze the crosspointer trace during the descent. If the microammeter value varies from the average between 1/2 mile from the threshold and runway threshold, the antenna offset may be incorrect and should be checked (antenna offset is most accurately established and set by maintenance).

Note: A comparison of airborne and ground phasing data should be made by maintenance personnel in order to determine if optimum phasing has been established.

(1) Null Reference Phasing. Make the following checks and phase the facility in the configurations listed below:

Sidebands Radiating in Quadrature to Carrier. Perform the maneuver described in “Approved Procedure” above.

(2) Sideband Reference Phasing. Make the following checks and phase the facility in the configuration listed below:

(a) Upper Antenna Feed in Dummy Load. Have Facilities Maintenance personnel insert a 90° section in the main sideband line. Conduct a level run at 1,000 ft above site elevation between 10 to 5 miles from the glide slope antenna. Adjust the phaser to the value found during the modulation equality check.

When phasing is completed, remove the 90° section and check for ful fly-down signal. This indicates that the lower antenna sensing is correct. If full fly-up signal is indicated, sensing is incorrect and the facility must be adjusted.

(b) Radiate Upper and Lower Antennas with a 90-degree section in the Main Sideband Phaser. Use the procedure described in Paragraph 15.5.d, Phasing. Have maintenance adjust the upper antenna phaser to the value found during the modulation equality check. When this value is attained, remove the 90° section from the main sideband line. Ensure that a fly-up signal is received when the aircraft is below the glidepath.

(3) Capture Effect. Capture effect glide slopes are normally phased on the ground by maintenance personnel; however, they may request airborne phasing. The airborne phase verification procedure must be accomplished on commissioning inspections and when requested by maintenance. This procedure confirms that correct phasing has been achieved.

(a) Airborne Phase Verification Procedure. This procedure helps maintenance to determine if proper phasing exists. Both transmitters may be checked if standby equipment is installed.

Airborne Phase Verification Procedures

		PARAMETER						
Steps	**Checks**	**Modulation**	**Width**	**Angle**	**Symmetry**	**Structure Below Path**	**Clearance**	**Path Structure**
(a)	Modulation (7)	X						
(b)	Modulation Equality (7)	X						
(c)	Normal Configuration (8)	X	(1)	(2)	X	X	(6a)	X
(d)	Main Sideband Phaser Dephased Advance* Retard* (8)(9)		(3) (3)	(4) (4)		X X		
(e)	Middle Antenna Phaser Dephased Advance* Retard* (8)		(3) (3)	(5) (5)		X X	(6b) (6b)	
(f)	Normal (8)	X	X	X		X		

Notes:

(1) Adjust glidepath width to 0.70° ± 0.03°.

(2) Facility must be adjusted to within 0.05° of commissioned angle for commissioning type inspections.
(3) Width— 0.1° sharper or 0.2° wider than normal.
(4) Angle—± 0.1°.
(5) Angle—± .05°.
(6) Clearance—At a recommended angle of 1.0° from 4 miles to runway threshold, maintaining at least the minimum microamp level.
If obstruction clearance is a limiting factor, an acceptable higher fixed angle may be used.
(a) 180 µA or better.
(b) 150 µA or better
(7) Maintenance request
(8) Clearance transmitter is energized throughout steps (c) – (f).
Footnotes (3), (4), (5), and (6) are expected results only. The tolerances in Paragraph 15.10.b apply. The Maintenance Reference "INITIAL" tolerances (TI 8200.52) apply if establishing a reference.
* Actual degrees advance or retard to be determined by Maintenance.
(9) Required on commissioning checks; may be accomplished at Maintenance Request on other type checks.

(b) Airborne Phasing. When airborne phasing is requested, use the procedure described in Paragraph (b)(i) or (b)(ii) below, or other alternate procedures specified by maintenance. Facilities Maintenance personnel must determine which procedure is to be used.

(i) Airborne Phasing Procedure No.1. Confirm that maintenance has established normal carrier sideband ratios and that ground phasing is complete.

Note: The clearance transmitter is de-energized throughout Steps (1)-(4).

Airborne Phasing Procedure No. 1

Steps	Type Check	Reference Paragraph	Configuration	Unit of Interest
(1)	Modulation Level	15.5.b	Carrier Only	In Tolerance
(2)	Modulation Equality	15.5.c	Carrier Only	Crosspointer 0μA ± 5μA
(3)	Phasing	15.5.d	*Upper to Middle Antenna* Lower Antenna—Dummy Load Middle Antenna—Radiate Carrier + Sidebands Upper Antenna—Radiate Sidebands Main Sideband Phaser—Quadrature	Crosspointer centered about the value found in step (2).
(4)	Phasing	15.5.d	*Lower to Upper and Middle Antenna* Lower Antenna—Radiate Carrier + Sidebands Middle Antenna—Radiate Carrier + Sidebands Upper Antenna—Radiate Sidebands Main Sideband Phaser—Quadrature	Same as above.
(5)	Phase Verification	15.5.d(3)(a) Steps (c)-(f)	Clearance Transmitter Energized	

(ii) Airborne Phasing Procedure No. 2. This procedure only applies to those facilities in which it is possible to separate carrier and sideband signals in the APCU (Amplitude and Phase Control Unit). Confirm that Facilities Maintenance personnel have established normal carrier sideband ratios and that ground phasing is complete.

Note: The clearance transmitter is de-energized throughout Steps (1)-(4).

Airborne Phasing Procedure No. 2

Steps	Type Check	Reference Paragraph	Configuration	Unit of Interest
(1)	Modulation Level	15.5.b	Carrier Only	In Tolerance
(2)	Modulation Equality	15.5.c	Carrier Only	Crosspointer 0μA ± 5μA
(3)	Phasing	15.5.d (See Note a below)	*Lower to Middle Antenna Phasing* Lower Antenna—Radiate Carrier Only Middle Antenna—Radiate Sidebands Only Upper Antenna—Dummy Load Main Sideband Phaser—Quadrature	Crosspointer centered about the value found in step (2).
(4)	Phasing	15.5.d (See Note b below)	*Lower to Upper Antenna Phasing* Lower Antenna—Radiate Carrier Only Middle Antenna—Dummy Load Upper Antenna—Radiate Sidebands Only Main Sideband Phaser—Quadrature	Crosspointer centered about the value found in step (2).
(5)	Phase Verification	15.5.d(3)(a) Steps (c)-(f)	Clearance Transmitter Energized	

Notes:

a) Step (3) phasing runs should be accomplished at an elevation angle of 1/2 the glidepath angle (or up to 2/3 of the angle if terrain prevents the lower angle.)

b) Step (4) Phasing runs should be accomplished at an elevation angle equal to the glidepath angle.

(iii)Alternate Phasing Procedure. Ground maintenance may dephase an antenna and ask flight inspection to provide data from a level run, expecting a symmetrical change in the width or angle. The results are factored into a formula to determine optimum phasing settings. Maintenance may dephase lower-to-upper and/or lower-to-middle antennas.

- Upper antenna Procedures. Maintenance will dephase the upper antenna a known amount (e.g., 57°). Fly a level run (standard ILS-2 profile) and provide the following values: path angle, path width, SBP, and symmetry. Expect a symmetrical lowering of the path angle for equal amounts of advance and retard. The ideal amount of glide angle change, i.e., an expected typical value is 0.2 – 0.3°.

- Middle Antenna Procedures. Dephasing the middle antenna should result in a symmetrical widening of the path width and lowering of the structure below path angle for equal amounts of advance and retard. Fly a level run (standard ILS-2 profile) and provide the following values: path angle, path width, SBP, and symmetry.

Note: These procedures alleviate the "chasing of the plane" when trying to adjust the facility phasing with the aircraft on a descent path. It is sometimes easier to make calculated phase adjustments on the ground than it is to adjust real-time as the aircraft relays microampere readings on final approach.

e. Engineering and Support Tests. These tests are made at maintenance request, on one transmitter only. Their purpose is to assist the Facilities Maintenance personnel to make measurements that they are not able to make and/or confirm from the ground.

(1) Null Check. The antenna null check is an engineering support check and is not conducted unless requested by engineering/ maintenance personnel. This check is conducted to determine the vertical angles at which the nulls of the individual glidepath antennas occur. It can be conducted on all image array systems. No procedures exist for the non-image arrays.

WARNING

HAZARDOUSLY MISLEADING INFORMATION

Misleading information is produced by this configuration. Ensure NOTAM is active. Monitor ATC communications for improper clearances to other aircraft.

WARNING

Note: FAA Localizers must be OFF when Glide Slopes are transmitting HMI

Approved Procedure. Use the level run method described in Paragraph 15.5.f while the facility is radiating carrier only (sidebands dummy loaded) from one of the antennas. A level run and analysis must be made for each antenna.

Analysis. Compute the angles from the nulls, which appear on the recording as dips in the AGC. If the AGC dips are broad, as in the case of the first null of the upper antenna of a capture effect glide slope, angle measurements may have to be accomplished by measuring the second and/or third null.

(2) Antenna Offset. This check is performed to establish the horizontal antenna displacements on the mast. Offset affects the phase relationship of the glidepath signal as the aircraft approaches the runway threshold. Low clearances, and/or a fly-down signal between Point B and the runway threshold may be caused by improper offset. Antenna offsets can be accurately determined and positioned by Facilities Maintenance personnel without flight inspection assistance.

WARNING

HAZARDOUSLY MISLEADING INFORMATION

Misleading information is produced by this configuration. Ensure NOTAM is active. Monitor ATC communications for improper clearances to other aircraft.

WARNING

Note: FAA Localizers must be OFF when Glide Slopes are transmitting HMI

Approved Procedure. Perform a phasing check in accordance with Paragraph 15.5.d. After optimum results are achieved in the far field (1/2 mile from the runway threshold and beyond), park the aircraft on centerline at the runway threshold. With the facility still in quadrature phase, have Facilities Maintenance personnel adjust the horizontal displacement in the antennas (the top most antenna should be closer to the runway than the bottom). As the antennas are being adjusted, relay crosspointer indications to Facilities Maintenance personnel. The optimum setting is the same as the displacement found during the quadrature phasing checks. Take a final reading when the antenna is secured and personnel are not on the mast. Check the effects of the antenna offset adjustment in the far and near fields by performing another phasing check.

Note: If the crosspointer is not stable when the aircraft is parked at the runway threshold, then the antenna offset cannot be established on the ground. In this case: (1) have maintenance readjust the antenna offset based on the final phasing run; (2) re-fly the last 3,000 ft from the runway threshold in accordance with Paragraph 15.5.d, and analyze the results based on the “Analysis” section of the paragraph.

(3) Spurious Radiation. This check is performed to determine if any glide slope signal exists in the final approach segment with the facility configured in dummy load.

Approved Procedure. Fly a low approach on runway centerline, commencing at least 4 miles from the facility. Using a spectrum analyzer or the glide slope receiver traces, compare any signals that are received during the approach with the results found while the facility is transmitting normally.

f. Angle Width, Symmetry, and Structure Below Path. These parameters may be measured from the results of one level run, except when the actual path angle is required (for specific ILS categories and on various types of inspections). In this case, determine the angle by the actual path angle method.

(1) Angle. Two methods are used to determine the glidepath angle. They are the level run method and the actual path angle method, as explained in this section. The actual path angle method must be used to measure the path angle during site, commissioning, after-accident inspections, special inspections at maintenance request, and confirmation of out-of-tolerance conditions for Category I glide slopes. It must also be used during any inspection to determine the reported angle for Category II and III glide slopes. The level run method may be used for measuring the glidepath angle of CAT I facilities subsequent to the commissioning inspection. It should be used for measuring the glidepath angle during monitor checks (for any ILS category), engineering support checks, etc.

> Note: During any inspection in which actual path angle is measured, the angle found on the level run, in normal configuration, must be compared to the actual path angle. The difference between these angles must become a correction factor that must be applied to all subsequent monitor angles determined by the level run method. Where actual path angle is greater, add the difference to the level run angle; where actual path angle is less, subtract the difference from the level run angle.

Approved Procedures--Level Run. Position the aircraft beyond the 190 μA/ 150Hz glidepath point on the localizer on-course or procedural designed azimuth. Maintain a constant altitude and airspeed. Fly the established level run altitude corrected to true. The established level run altitude should be 1,500 ft above the antenna or 500 ft above terrain, whichever is higher, but a different altitude may be established (e.g., due to airspace, unmeasurable crosspointer transitions, comparability to actual path angle, or a lower altitude to obtain 190 μA). Document the established altitude on the facility data sheet.

> Note: Altitude limitation of the established level run altitude may be adjusted for weather during periodic-type flight inspections. Altitude adjustment does not apply for commissioning, reconfiguration, after accident, or any inspection where a monitor reference is established.

(a) Theodolite Method. Position the theodolite or tracking device in accordance with Paragraph 15.2.f, Theodolite Procedures. Proceed inbound recording 1,020 Hz reference marks from the theodolite. Measure width, angle, symmetry, and structure below path by referencing the recording at the 190µA/ 150Hz, 75µA/ 150Hz, on path, 75µA/ 90Hz points with the theodolite 1,020 Hz marks which are usually spaced at 0.2° intervals.

> Note: An RTT may be used to track an aircraft through the path sector. Apply the path sector width received to the calibration of the RTT.

(b) Altimeter and Ground Speed Method. Fly inbound. Mark checkpoints with the event mark and identify them on the recording. Checkpoints are normally the outer marker and the glide slope antenna; however, any two checkpoints separated by a known distance may be used. A distance for each point (i.e., 190µ A, 75 µA, 0 µA, and 75 µA) is determined by using time/ distance ratios. The appropriate angle, width, symmetry, and structure below path are calculated from these values.

Approved Procedures – Zone 2 Actual Path Angle

- AFIS Method. See appropriate AFIS manual.
- RTT Method. Determine the actual path angle from the straight line arithmetic mean of all deviations of the differential trace occurring in ILS Approach Zone 2. The arithmetic mean can be determined either by using a compensating polar planimeter or by averaging 2-second samples of the deviations in Zone 2 (smaller sampling interval may be used, e.g., 1-second samples).
- Standard Theodolite Method. Sufficient positioning information must be obtained to determine the actual path angle, and the presence of bends, reversals, and shorter term aberrations; therefore, more than one run may be required.

(2) Width. Path width is the width in degrees of the Half ILS Glide Path Width Sector. Path width measurements are obtained from level runs.

Some facilities have step characteristics of the crosspointer transition which may preclude the use of the 75 µA points.

When steps are encountered, the following procedure is recommended to determine which level run measurement points should be used for path width analysis:

(a) Perform a mean width check IAW Paragraph 15.5.h.

(b) Fly a normal level run using 60 µA measurement points.

(c) Fly a normal level run using 90 µA measurement points.

(d) On subsequent level runs, use the measurements points, from (b) or (c) above, which most closely match the path width results measured on the mean width check. If the steps continue to affect the level run results, consider another altitude, or evaluate all Normal and monitor reference widths using the mean width method.

If a point other than 75 μA is used to measure path widths, that point must be used on all subsequent checks and inspections.

(3) Symmetry. Symmetry is determined from the data obtained during level run angle and/or width measurements. If points other than the 75 μA points are used for measuring the path width, they must also be used for the symmetry measurements. Symmetry is the balance of the 2 sectors, 90Hz/ 150Hz. The glidepath should be as symmetrical as possible; however, there normally is some imbalance. If the level run symmetry is not acceptable, the AFIS, RTT, or theodolite must be used to determine the mean symmetry (see Mean Width). Apply the mean symmetry as a correction factor to level runs; annotate on the data sheet. If the symmetry still remains out-of-tolerance, the facility must be removed from service.

(4) Structure-Below-Path. This check determines that the 190μA/150Hz point occurs at an angle above the horizontal which is at least 30 percent of the commissioned angle. The structure below path is determined from the data obtained during the level run angle or width measurements. Altitudes lower than the established level run altitude may be required to make this measurement.

> Note: The structure-below-path point does not have to occur within the service volume of the facility to be a valid check, provided the signal strength and flag alarm current indications are within appropriate tolerances.

If the 190 μA/ 150Hz point, in any facility configuration, cannot be found, conduct a clearance below path check starting at the edge of the service volume. Apply the appropriate tolerance. During monitor dephase checks, the structure-below-path angles, as compared to the normal SBP, indicate performance of the below path sensitivity of the glide slope. The information may be used by maintenance for system optimization.

g. Clearance. This check is performed to assure that positive fly-up indications exist between the bottom of the glidepath sector and obstructions. Clearances above the path are checked to ensure that positive fly-down indication is received prior to intercepting the first false path.

Approved Procedure

(1) Clearance Below the Path. Starting at the FAF or GSI distance (whichever is further), fly along the localizer centerline (and the areas specified by the checklists). For glide slopes associated with offset localizers or LDA(s), check to Point "C". For the 5 and 8° endfire checks, check only to Point "B". For all glide slopes with runway centerline localizers, check centerline clearances to runway threshold. Check that the required amount of fly-up signal exists (180 μA in normal, 150 μA in any monitor limit condition) from the FAF/ GSI to the following points:

(a) CAT I not used below 200 ft Decision Altitude (DA) -- ILS point "C" for an unrestricted glide slope; or the point at which the glide slope is restricted. When clearances are checked to threshold, document the results as satisfactory or unsatisfactory between Points “C” and “T” on the flight inspection report.

(b) CAT I used below 200 ft DH and all CAT II/ III --Runway threshold .

(2) Clearance Above the Path. Check that 150 μA fly-down occurs prior to the first false path. Perform this check during all level runs in accordance with the approved procedure, Paragraph 15.5.f.

h. Mean Width. This check, performed on all commissioning inspections, and per maintenance request to verify questionable path width and/or symmetry results induced by inconsistent level runs, is used to determine the mean width of a glidepath between ILS Points "A" and "B". This check may also be used to determine the mean symmetry of the glidepath. Theodolite, RTT, or AFIS must be used. The path width should be established, as nearly as possible, to 0.7° prior to the check.

Approved Procedure. Fly inbound on the localizer on-course maintaining 75 μA above the glidepath between ILS Point "A" and "B". Repeat the same run at 75 μA below the glidepath, and again while on the glidepath.

Determine the mean width from the angle found above and below the glidepath and calculate symmetry from the on-path angle.

i. Tilt. This check verifies that the glidepath angle and clearances are within the authorized tolerance at the extremities of the localizer course sector. Apply the actual angle correction factor to the level run angles in the Tilt check.

Approved Procedure. With the glide slope facility in normal, measure clearances below the path at the localizer 150 μA point either side of centerline from the GSI to Point B. At the established level run altitude, measure the path angle, modulation, and clearance above path at the localizer 150 μA point either side of centerline, using the level run method. This check is only required on one transmitter.

j. Structure and Zone 3 Angle Alignment. These checks measure structure deviations and Zone 3 angle alignment. Measurements are made while the facility is operating in a normal configuration.

Approved Procedure. Fly inbound on the glidepath and localizer course from 10 miles from the glide slope antenna through all zones. See Chapter 22 for ESV requirements. The structure must be evaluated in all zones and the CAT II and III angle alignments in Zone 3. Angle alignment must be evaluated using the RTT or AFIS. The angle alignment (or deviation of the mean angle from Point B to Point T) is affected by siting, phasing, and antenna offset factors that may not affect the measured Zone 2 angle.

(1) Inspections

(a) During site, commissioning, reconfiguration, categorization, antenna, and/or frequency change, evaluate the structure by using the entire procedure described above.

(b) During all other inspections (i.e., periodic, periodic with monitors, etc.) this evaluation can be accomplished from the GSI or FAF (whichever is further) by using the procedure described above.

k. Transverse Structure--Endfire Glide Slope. This is a measurement of the horizontal structure of the glidepath and is directly related to on-path structure, tilt, and clearance. On any inspection after commissioning, where transverse structure is checked, compare the course and clearance normal results with those from the last results on file. Notify maintenance of any significant changes (see "Analysis" below). Perform a tilt check on the affected side(s) if the glide slope microamp deflection at the localizer 150 μA point exceeds angle tolerances.

Approved Procedure. Fly an arc of at least 12° each side of localizer centerline at the FAF distance and FAF altitude corrected to true altitude. The arc must be referenced laterally to localizer centerline abeam the glide slope antenna. If the FAF is less than 5.0 miles from the glide slope, the arc distance must be changed to at least 5 miles. (*As the received glidepath is affected by aircraft distance and altitude, it is critical that these parameters do not vary during the arc.)* The arc may be flown either clockwise or counter-clockwise. Record both localizer and glide slope crosspointers: The AFIS plot sensitivity should be set to allow ease of trace analysis.

Analysis. No tolerance is applied to transverse structure, but the following results are expected for all facility configurations in the checklist where the transverse structure is recorded. Results exceeding the expected values will require engineering analysis prior to final resolution. Engineering uses results of these checks to adjust antenna pedestal locations and signal levels. Multiple runs may be required to optimize the antenna arrays. See Figure 15-5 for a sample plot.

(1) Within the localizer course sector, the change of the glide slope signal should not exceed *64 μA of 150 Hz or *48 μA of 90 Hz from the crosspointer value found on the localizer on-course. *This analysis applies to a 3.0° commissioned glide slope angle. See the following table:

+10%/-7.5% Angle Alarm/Transverse Structure Microamp Value

Commissioned Angle	Low Angle (°/μA)	High Angle (°/μA)
2.5°	2.32°/ 38 μA (90 Hz)	2.75°/ 53 μA (150 Hz)
3.0°	2.78°/ 48 μA (90 Hz)	3.30°/ 64 μA (150 Hz)
3.5°	3.24°/ 55 μA (90 Hz)	3.85°/ 75 μA (150 Hz)

(2) From the edge of the localizer course sector to 8° from the localizer on-course, signals should not exist that are greater than 48 μA in the 90 Hz direction from the glide slope crosspointer value found on the localizer on-course.

(3) In the event any part of the transverse structure does not meet the recommended value due to a deflection into the 90 Hz direction, verify that adequate 150 Hz fly-up signal exists in this area while clearing obstructions. These data should be included in the engineering analysis prior to final resolution.

l. Coverage. Coverage must be evaluated concurrently with each required check during all inspections.

m. Monitors. The purpose of these checks is to measure glidepath parameters when the facility is set at the monitor reference. The inspector must ensure that the facility is set at the monitor reference prior to each check. Monitor references must be checked when prescribed by the checklist, and when applicable on special inspections. At the conclusion of any monitor inspection, the facility must be returned to normal, and the following checks performed and results reported: Angle, Width, Symmetry, and Structure Below the Path.

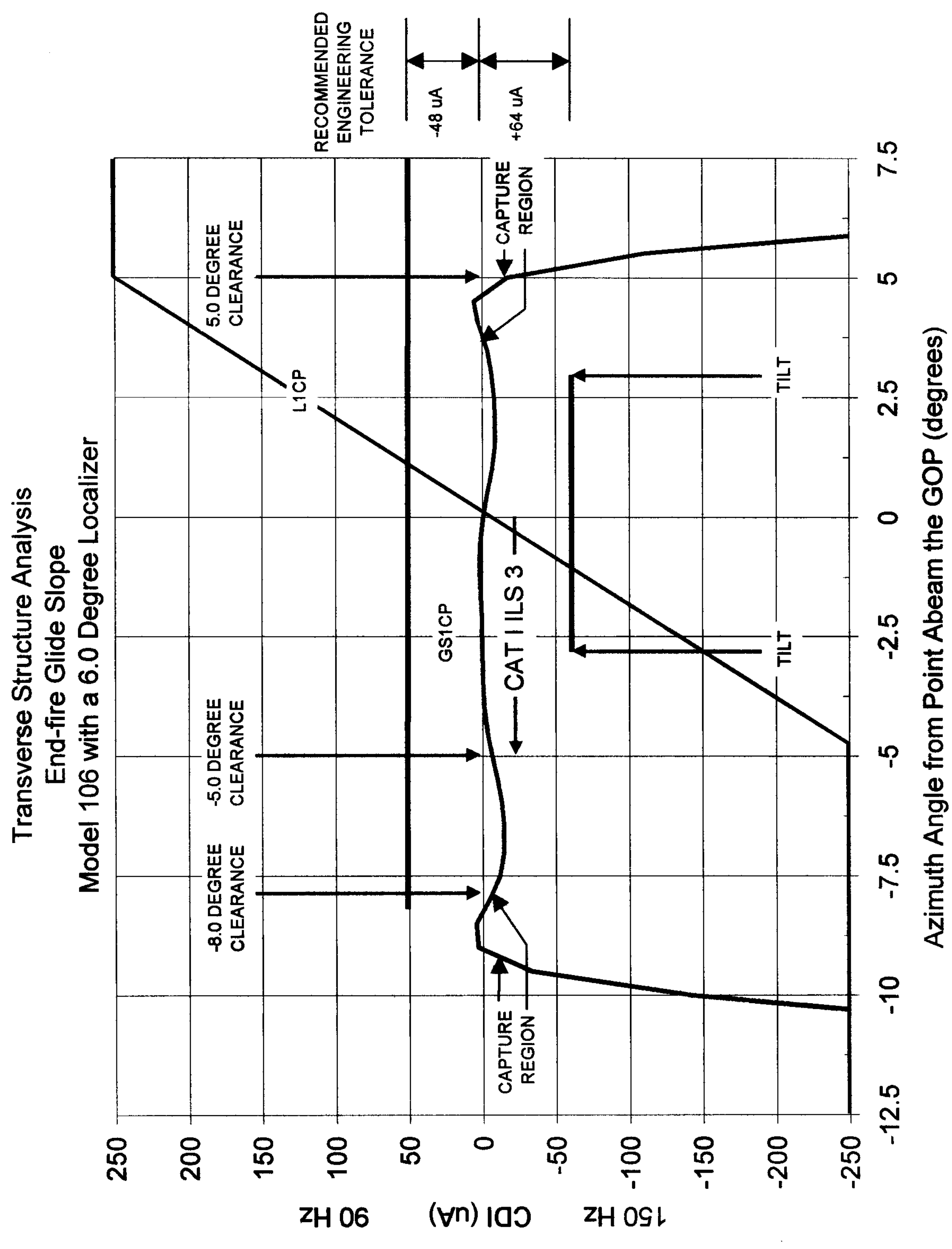
Approved Procedure. Use the level run method (Paragraph 15.5.f) to measure width, angle, and structure below the path in the monitor limit conditions. Check clearances in accordance with Paragraph 15.5.g.

n. RF Power Monitor Reference. This check is conducted to determine that the glide slope meets specified tolerances throughout its service volume while operating at reduced power.

Approved Procedure. The glidepath transmitter must be placed in reduced power setting for this check (both primary and clearance transmitters for capture effect and endfire glide slopes). This check must be made on the localizer on-course and 8° each side of a point on localizer centerline abeam the glide slope origination point. While maintaining an altitude equal to 0.45 times the commissioned angle at 10 nm, fly inbound from 10 nm from the facility to the interception of the lower sector of the glidepath (i.e., the point nearest the glidepath at which 150 μA occurs). Fly through the glidepath sector and check clearances above the path.

> Note 1: In situations where less than 150 μA fly-up signal is received, descend to an altitude which will provide at least 150 μA fly-up while providing adequate obstacle clearance at 10 miles. See Chapter 22 for ESV requirements.
>
> Note 2: Endfire. The endfire glide slope antenna array is orientated toward the runway. The normal fly-up/ fly-down signal ends at approximately 5° on the antenna side of the runway; therefore, you will have only 150 Hz clearance signal at 8° on the antenna side of the runway. The provisions of Paragraph 15.8.d will apply to this situation.

Figure 15-5.


Transverse Structure Analysis
End-fire Glide Slope
Model 106 with a 6.0 Degree Localizer
RECOMMENDED ENGINEERING TOLERANCE
-48 uA
+64 uA
5.0 DEGREE CLEARANCE
-5.0 DEGREE CLEARANCE
-8.0 DEGREE CLEARANCE
CAPTURE REGION
CAPTURE REGION
L1CP
GS1CP
CAT I ILS 3
TILT
TILT
90 Hz
CDI (uA)
150 Hz
250
200
150
100
50
0
-50
-100
-150
-200
-250
-12.5
-10
-7.5
-5
-2.5
0
2.5
5
7.5
Azimuth Angle from Point Abeam the GOP (degrees)

Section 4. 75 MHZ Marker Beacon Flight Inspection Procedures.

6. Introduction.

a. Spectrum Analysis. (Reserved)

b. Identification and Modulation Tone. The purpose of this check is to ensure that the correct modulation tone and keying code are transmitted without interference throughout the area of required coverage. Keying rate is checked by Facility Maintenance personnel.

Approved Procedure. Record and evaluate the keying code while flying in the radiation pattern at the proposed or published altitude(s). Check that the audio modulation tone is correct by noting that the proper light comes on for the type marker being inspected, e.g., the OM illuminates the blue lamp.

c. Coverage. This check is conducted to assure that the facility will provide a radiation pattern that supports operational requirements without interfering with other facilities or instrument flight procedures. All of the commissioning coverage requirements must be completed with any adjacent marker beacons removed from service to preclude a misrepresentative coverage analysis caused by signal intermixing. The aircraft marker beacon sensitivity must be set at the low position for all checks.

(1) Minor Axis. This check is performed to measure the actual width and quality of the radiation pattern along the procedural course where it will be used.

Approved Procedure. Fly through the marker beacon signal while inbound on the electronic course providing approach guidance. Maintain the published minimum altitude to check marker beacons that support nonprecision approaches. For markers that support precision instrument flight procedures, the preferred method is to fly down the glidepath. An alternate procedure is to maintain the altitude at which the glide slope intersects the marker location. If the facility supports both precision and nonprecision procedures and the difference between the respective intercept altitudes exceeds 100 ft, conduct the initial check at both altitudes. Thereafter, either altitude may be used.

> Note: Outer Marker Coverage will be considered satisfactory when the width is between 1,350 and 4,000 ft; 2,000 ft is the optimum width.

(2) Major Axis. This measurement is conducted to verify that the marker beacon provides adequate coverage by measuring the width of the minor axis at the extremities of a predefined off-course sector. There is no requirement to flight inspect major axis coverage for inner markers. It is not necessary to obtain the limits of actual coverage unless requested as an engineering assist.

Approved Procedure. Fly though the marker beacon signal while positioned on the course or microamp displacement which defines the required coverage limits (see Figure 15-3. Marker Beacon Coverage.). Maintain the altitudes required for the minor axis measurements.

(a) Coverage Limits. The required coverage limits are predicated upon the type facility providing course guidance.

(b) Unidirectional facilities (e.g., LOC/ LDA/ SDF). Coverage must be provided 75 μA each side of the localizer on-course signal, with the facility in Normal.

(c) Omnidirectional facilities (e.g., VOR, NDB). Coverage must be provided 5° each side of the on-course signal.

d. Proximity Check. These inspections supplement the basic coverage checks to assure operational compatibility between a marker beacon sited in close proximity to another marker beacon(s). The check may be performed prior to the commissioning inspection as a type of a site evaluation. It must be performed on each applicable marker beacon prior to authorizing operational use.

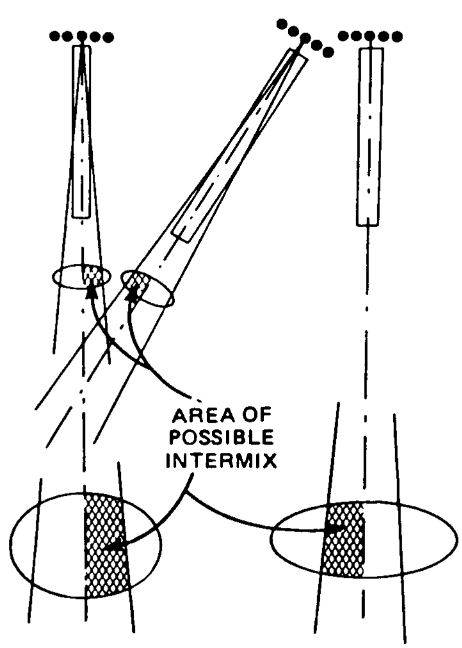
(1) Marker Beacon Signal Intermix. This check is conducted to determine if there is unacceptable signal derogation caused by the simultaneous operation of two or more marker beacons in close proximity.

Approved Procedure. Perform periodic checklist items with all marker beacons operating as proposed. In addition, check the major axis at the lowest procedural altitude on the side of the marker beacon closest to the adjacent marker. Assure that in-tolerance parameters and the following conditions are met:

(a) No adverse audio interference, i.e., heterodyne.

(b) Distinct fix indication that is not vague or distorted.

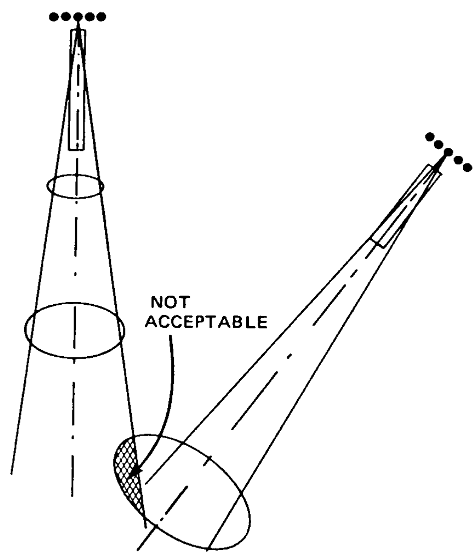
Figure 15-6. Marker Beacon/Procedure Intermix.



(2) Marker Beacon/ Procedure Overlap. This check is conducted to assure that there are no false marker beacon indications present along an instrument approach course, which would authorize a premature descent prior to the point at which the actual fix position/ marker beacon occurs. This situation could exist if the "intruding" marker beacon signal had the same modulation, even though the identifications may differ. Conduct this check only if it is suspected that this condition exists.

Approved Procedure. The flight inspector will position the aircraft at the extremity of the approach course (150 μA or 5°, as appropriate) nearest the potentially misleading marker beacon at the minimum procedural altitude. If the signal intrusion into the approach area is at or above 1,700 μV, the procedure must be suspended until the signal intrusion can be reduced to less than 1,700 μV. If the signal cannot be reduced, the procedure must be denied or the misleading marker removed from service.

Figure 15-7. Marker Beacon Overlap.



e. Measurement Methods. Formulas appropriate to the following measurement methods are listed in Appendix B.

(1) Ground Speed. Using an approved unit that provides a ground speed readout, derive the average ground speed and note it on the recording. Ascertain the time required to traverse the pattern, then calculate the width using time and ground speed.

(2) True Airspeed. Maintaining a constant true airspeed and altitude, traverse the marker beacon pattern on the appropriate course. A reciprocal flight must be made in the opposite direction to eliminate the effects of wind. Calculate the width using the true airspeed and time for each crossing.

(3) Known Distance. When the distance between two points on, or reasonably close to, the desired track are known (marker to runway, etc.), maintain a constant indicated airspeed and altitude throughout the segment and calculate the width by proportioning the marker distance to the known distance.

f. Holding Fixes. Marker beacons which will be used as a fix for holding or any other instrument flight procedural use, at altitudes above those noted in Paragraph 15.6.c must be checked for major and minor axis coverage at the highest proposed altitude. If performance is not satisfactory and cannot be corrected by facility adjustment, the operational altitudes will have to be revised or procedural use denied.

g. Standby Equipment. See Chapter 4, Section 3. This equipment must be checked in the same manner as the main equipment.

h. Standby Power. Refer to Chapter 4, Section 3. If the check is required, complete periodic checklist requirements on one set of equipment while operating on standby power.

Section 5. Analysis (ILS and Marker Beacons).

7. Analysis. A detailed analysis of the measurements and calculations made during the course of the flight inspection provides an overall picture and permanent record of facility performance.

8. ILS Analysis.

a. Structure Tolerances (95% Rule). Application of course structure analysis contained in this paragraph applies to all zones (1, 2, 3) of glidepaths and all zones of localizers (1, 2, 3, 4, & 5) and SDF(s), including back courses. This provision does not apply to glide slope rate of change/ reversal (see Paragraph 15.8.b). For Category II/ III facilities, the applicable region or military command engineering staff must be notified of initial application of this criteria. If course or path tolerances are exceeded, analyze the course/path structure as follows:

(1) Where course/ path structure is out-of-tolerance in any region of the approach, the flight recordings will be analyzed in distance intervals of 7,089 ft (1.17 nm) centered about the region where the out-of-tolerance or aggregate of out-of-tolerance condition(s) occurs. Two 7,089 ft areas must not overlap.

(2) Where necessary to avoid overlap, centering the interval about the out-of-tolerance region may be disregarded.

(3) It is not permissible to extend the 7,089 ft segment beyond the area checked, i.e., service volume or ESV, whichever is greater, or the point closest to the runway where analyzation stops.

(4) The course/ path structure is acceptable if the aggregate structure is out of tolerance for a distance equal to or less than 354 ft within each 7,089 ft segment.

b. Rate of Change/ Reversal in the Slope of the Glidepath. The following analysis of the path angle recording must be accomplished during all inspections where AFIS, RTT, or other tracking devices are being used. It applies to all categories of ILS.

(1) Inspect the glidepath corrected error trace/ differential trace in Zones 2 and 3 for changes and/or reversals in the trend of the slope of the path trace.

(2) If the trace (or trend), on either or both sides of the point where a change in direction occurs, extends for at least 1,500 ft along the approach with an essentially continuous slope (see Figure 15-10. Rate of Change/Reversal in the Slope of the Glide Path.), this qualifies as a "measurable rate of change reversal", subject to further analysis.

(3) If one or more rate of changes/ reversals meets the condition in b(2). above, draw a straight line through the average slope that covers at least a 1,500 ft segment *each side of the point of change.* It is permissible to extend the straight line of the average slope to inside Point C if required, in order to obtain the 1,500 ft segment. Determine the change-in-slope by measuring the divergence of the two lines at a point 1,000 ft from their intersection.

(4) NOTAM Action. The use of facilities which do not meet the change/ reversal tolerance must be limited by a NOTAM (see Chapter 5, Section 1) that withholds authorization for autopilot coupled approaches below an altitude (MSL) which is 50 ft higher on the glidepath than the altitude at which the out-of-tolerance condition occurs. Compute the MSL altitude for such a restriction based on the commissioned angle of the facility.

(a) Category I facilities that do not meet the change/ reversal tolerance must not be classified "restricted" due to the change/ reversal. However, NOTAM action must be taken and advise AeroNav Products.

(b) Category II and III facilities are required to meet the established change/ reversal criteria. If a change/ reversal is found, the facility must be classified "restricted" and issue a Cat II/ III procedures NOTAM. Additional NOTAM action per Chapter 5, Section 1 also applies.

c. Application of Localizer Coverage Requirements. The maneuvering areas described in the approved procedures of this chapter define the standard service volume in which coverage tolerances must be maintained in order for a localizer to be assigned a facility classification of "UNRESTRICTED". The localizer may still be usable when coverage does not meet tolerances throughout the standard service volume, depending on the effect of the restriction on procedural use. In evaluating such effects, all coverage criteria must be considered; however, for an UNRESTRICTED classification, the following criteria must also be met:

(1) Clearances

(a) Tolerance Application. Deviations in any sector to less than 100 μA are not acceptable. In Sectors 2 and 3, momentary deflections of the crosspointer to less than the tolerances are acceptable, provided that the aggregate area does not exceed 3° of arc in Sectors 2 and 3 combined in one quadrant. Such an area is acceptable on both sides of the localizer. Additionally, all the above criteria are applicable to the back course.

Note: One quadrant is defined as that area between the localizer on-course and a point 90° to the antenna.

(b) Restrictions. If a localizer is restricted in Sector 2, it may still support a procedure turn as long as the instrument flight procedure does not use the restricted area and satisfactory performance of the procedure turn is confirmed by flight inspection.

(c) Momentary deviations of the localizer cross pointer in Sector 1 can be averaged without further evaluation, provided the cross pointer deviation does not present a noticeable effect on flyability or create a possible false course. Questionable reversals of trend or excessive irregular flattening of the course ("steps") require an evaluation of the effect on the procedure. When this condition occurs, refly the Sector 1 arc on one transmitter at the standard service volume limit at 2,000 ft above the threshold elevation, or 1,000 ft above intervening terrain, whichever is higher, at a maximum ground speed of 170 knots. Evaluate for noticeable effects on flyability and possible false course indications. The procedure must be removed if reversals of trend have noticeable effects on flyability or flyable false course indications occur. If this check is satisfactory for flyability, document the facility data sheet (e.g., "Deviations in Sector 1 clearance linearity evaluated on the front course/ back course (as appropriate) and the results found satisfactory IAW 8200.1 Paragraph 15.8.c(1)(c); Date mm/dd/yr").

(2) Distance Requirements

(a) Restrictions to localizer coverage at distances less than the standard service volume are permitted, provided the localizer meets all coverage tolerances throughout all procedural approach segments and at the maximum distance at which the procedure turn may be completed.

(b) Restrictions above the prescribed width, clearance, and coverage altitudes are acceptable, provided a step-down fix, etc., can be added to the appropriate approach segment which restricts descent to within the altitude/ distance at which acceptable coverage was achieved.

(3) Vertical Angle Requirements

(a) If in-tolerance coverage cannot be maintained up to 7° as required in the RF power monitor check, the localizer may still be used for CAT I and nonprecision operations on a restricted basis; however, the localizer must be classified as "unusable" if in-tolerance coverage cannot be maintained up to 4° or 1° greater than the commissioned glidepath angle, whichever is greater (both measured from the localizer).

(b) If vertical angle coverage is limited but the localizer can be used on a restricted basis as outlined above, a NOTAM must be issued which restricts the localizer as "unusable" above a specified altitude, both at the threshold and at least one other point, usually the FAF (see example in Chapter 5, Section 1). Note the angle at which unsatisfactory coverage occurred and evaluate its effect on the nonprecision MDA, maximum holding altitudes, and missed approach instructions/ protected areas.

d. Application of Glide Slope Coverage Requirements. The RF Power Monitor check described in Paragraph 15.5.n defines the lateral and longitudinal standard service volume of the glide slope. The approved procedure specifies to check for clearances above the path. If there is no defined glidepath or clearance above path, the glide slope must be restricted as unusable beyond a point referenced angularly to runway centerline at which no glidepath or clearance above path is provided. See an example in Chapter 5, Section 1. The glide slope must meet the tilt tolerance and the RF power monitor tolerance.

e. CAT III Adjust and Maintain. Normal localizer width/ alignment and glide slope angle checks on Category III ILS systems are required to be maintained at tighter than monitored values. Results that exceed these values, but do not exceed flight inspection tolerances IAW Paragraph 15.10.a and 10.b, should not be considered out-of-tolerance, and no discrepancies should be noted on the Daily Flight Log. When a value exceeds the "adjust and maintain" limits, the flight inspector must issue an ILS Maintenance Alert IAW Paragraph 15.8.f and document the circumstances on the flight inspection report.

(1) Inspections Not Involving Maintenance Personnel. When CAT III facilities are found operating beyond these tighter values, repeat the run(s) to confirm the measurement and, if repeatable, advise Maintenance immediately.

(a) If Maintenance is unable to respond and make adjustments, document the circumstances on the flight inspection report. A Maintenance Alert must be issued IAW Paragraph 15.8.f. The facility will remain CAT III unless downgraded by Maintenance.

(b) If Maintenance is available, remain on station to check the adjusted parameters and document the circumstances on the flight inspection report. Issue a Maintenance Alert IAW Paragraph 15.8.f. Do not leave the facility operating CAT III beyond the "Adjust and Maintain" values; the facility must be downgraded.

(2) Inspections Requiring Maintenance Personnel:

(a) Remain on station until "adjust and maintain" parameters are within limits, unless Maintenance terminates the inspection. If the adjusted parameters are not corrected, document the circumstances on the flight inspection report. Issue a Maintenance Alert IAW Paragraph 15.8.f.

(b) Do not leave the facility operating CAT III beyond the "Adjust and Maintain" values; the facility must be downgraded.

(3) Adjust and Maintain Values:

Localizer Alignment	± 4μA
Localizer Width (Commissioned Width)	± 10%
Glide Slope Angle (Commissioned Angle)	± 4%

f. ILS Maintenance Reference Tolerances and Alerts. To prevent out-of-tolerance results, some maintenance activities have more restrictive requirements than the tolerances listed in Paragraph 15.10.

Note: For FAA, U.S. Non-Federal civil, U.S. Army, and U.S. Navy/ Marine Corps facilities, the Maintenance Reference "Initial" alignment tolerance must be applied as the "As Left" value on **all** Periodic with Monitor type checks.

(1) Reference Values. These values are the various power, modulation balance, phasing, and other settings established by Air Traffic Technical Operations Maintenance personnel and evaluated during flight inspection. The "maintenance tolerances" used to establish these references are designed to ensure that ILS operation at the reference settings will not exceed flight inspection tolerances during normal operation. FAA Order 6750.49, ILS Maintenance Handbook, requires FAA, non-Federal U.S. civil, U.S. Army, and U.S. Navy/ Marine Corps facilities to meet “Initial” airborne tolerances at any time a reference value is established. When the ILS is maintained by using these reference values, Maintenance is permitted to replace and adjust facility components without benefit of a flight inspection, and the facility is allowed to exceed these “Initial” tolerances during normal conditions.

However, if maintenance chooses to adjust the ILS to a new reference setting, if the facility is found operating beyond the periodic tolerances in Paragraph 15.10.a and 10.b, or when reference values are to be validated, new values must be established. Advise Maintenance when results are beyond these values. If, after repeated attempts, the results are beyond the “Initial” tolerances but within Paragraphs 15.10.a and 10.b flight inspection tolerances, and Maintenance personnel desire to restore the facility, continue the inspection and document the circumstances on the flight inspection report and the Daily Flight Log. TI 8200.52 details the airborne measurements required per specific maintenance adjustments should those maintenance actions invalidate or create reference values.

(a) Airborne Measurements of ILS References

(i) Even though an abnormal condition is used primarily to evaluate one parameter, such as glide slope width, the secondary measurements of angle and structure below path (SBP) must also meet the "Initial" tolerances. Likewise, Width and SBP are also required to remain within "Initial" values when Angle references are adjusted.

(ii) Do not use the term "Alarm" on a reference inspection; instead use "Reference Value" when requesting the abnormal conditions.

(iii) Provide Width, Angle (corrected by ILS-3), Symmetry (no tolerance in abnormal conditions), and SBP on all ILS-2 runs. If the angle correction factor is not established at the beginning of the check, ensure the corrected values are transmitted to maintenance before flight inspection departs the area.

(iv) Provide width, symmetry (in Normal only), and low clearances on all ILS-1 runs.

(v) Provide the marker minor axis measurements when establishing references for those facilities.

(vi) Request acknowledgement of all data transmitted to maintenance.

(vii) If any report value changes as a result of a review during report preparation or quality review, contact the ground technician and provide the corrected numbers. This is to ensure that the recorded maintenance data matches the flight inspection report. *If the ILS maintenance data does not match the corresponding flight inspection results, the maintenance data is invalid pending another flight inspection.*

(viii) Localizer alignment monitor references are not based on airborne measurements, IAW Order 6750.49; Technical Operations Service Area approved special request is required.

(ix) Dual Transmitter Facilities. Standby transmitters should match the reference transmitter within the prescribed equality limits during the same flight inspection. Applies to any type inspection when both primary and standby transmitters are evaluated. If Maintenance is unable to adjust transmitter within equality limits and meets Paragraph 15.10.a and 10.b flight inspection tolerances, the transmitter may remain in service unless Maintenance elects to remove it from service.

(2) ILS Maintenance Alert. Facilities serving the National Airspace System (NAS) and all U.S. Air Force facilities must be provided an ILS maintenance alert as follows:

(a) Category I/ II. An ILS maintenance alert must be provided by flight inspection following a normal periodic check without monitors or other check when maintenance is not present if a measured flight inspection parameter is 60 percent or more of the flight inspection tolerance. This applies to the following critical monitored parameters:

(i) CAT I/ II Localizer course widths

(ii) Localizer alignment

- CAT I ILS, Localizer only, and SDF(s) aligned along runway centerline ≥ 9 μA
- CAT II ≥ 6 μA
- Offset localizers, Offset SDF(s), LDA(s), and Independently Monitored Back Courses ≥ 12 μA
- Other Back Courses ≥ 39 μA

(iii) Glide slope path widths ≤ 0.58° / ≥ to 0.82°

(iv) CAT I /II Glide Slope Angles

(b) Category III. An ILS maintenance alert must be provided by flight inspection when a CAT III facility is found operating beyond the “Adjust and Maintain" limits specified in Paragraph 15.8.e, regardless if the value(s) were corrected.

(c) The flight inspector must forward the ILS maintenance alert results by FAX or telephone (when FAX is unavailable) to the FICO. The FICO must enter the results on FAA Form 8240-11, Appendix 11, FAA Order 8240.36 (current version) and forward the results by FAX or telephone (when FAX is unavailable) to the Technical Operations Service Area Maintenance Engineer within 24 hours. For U.S. Air Force facilities, notify the appropriate Major Command (MAJCOM) headquarters. When the results are forwarded by telephone, enter the name of the person contacted in the Remarks block on FAA Form 8240-11, which must be forwarded to the Technical Operations Service Area Maintenance Engineer.

(d) When a measured flight inspection parameter exceeds the flight inspection tolerance, if Air Traffic Technical Operations Maintenance is available and on site, request an evaluation of the parameter that has exceeded tolerance and determine whether it can be corrected. If the parameter that exceeded tolerance is corrected, leave the facility in service. Check the standby transmitter, if available. If not available, remove the facility from service and issue a NOTAM.

g. Glide Slope Snow NOTAM. During periods of heavy snow accumulation, Air Traffic Technical Operations personnel may NOTAM glide slope facilities as “due to snow on the XXX (appropriate identifier), glide slope minima temporarily raised to localizer only.” Category II/ III operations are not authorized during the snow NOTAM. The following guidance is to be followed when an ILS is scheduled for a periodic inspection when a snow NOTAM is in effect and the flight inspection window is exceeded. Localizer flight checks must be conducted as normally scheduled. Glide slope flight checks must be accomplished dependent upon the following conditions:

(1) If the NOTAM indicates localizer only for all categories of aircraft, then an approach evaluation must be made to determine angle and structure. All out-of-tolerance conditions must be reported to maintenance. After the snow NOTAM is canceled, flight inspection of the glide slope will be in accordance with Chapter 4, Section 2. On the Daily Flight Log (DFL) code the glide slope periodic inspection as incomplete. In the “Remarks” section of the DFL, indicate “Snow NOTAM”.

(2) If the NOTAM indicates glide slope minima raised to localizer only for Category D aircraft, follow the procedure outlined in Paragraph 15.8.f(1) above--the only exception being that any out-of-tolerance condition must generate a discrepancy and the appropriate NOTAM. Restoration flight check must be scheduled as an “Unscheduled Special (U).”

(3) If the glide slope supports Category II/ III approach procedures, the glide slope will only be evaluated to Category I tolerances. Restoration of Category II/ III facilities, after the snow NOTAM is removed, will be considered as a periodic overdue inspection in accordance with Chapter 4, Section 2.

(4) Monitor check must not be accomplished while the snow NOTAM is in effect. Flight inspection after the snow NOTAM is canceled must be considered as a periodic overdue in accordance with Chapter 4, Section 2.

(5) If the approach is satisfactory, a Category I periodic check will be complete when a level run to check width and symmetry is accomplished and no out-of-tolerances are found. Entries on the DFL must be normal.

h. Threshold Crossing Height (TCH)/ Reference Datum Height (RDH).

(1) CAT I. FAA Order 8260.3, TERPS Instrument Procedures, limits the CAT I procedural TCH to a maximum of 60 ft. Minimum TCH varies per the wheel crossing height of the user aircraft. TCH is normally determined by procedures personnel and is not evaluated by flight inspection. Order 8240.47 may be applied for Category I facilities if jointly deemed advantageous by flight inspection and facilities engineering personnel.

Note: Specific requirements must be met prior to application of Order 8240.47.

(2) CAT II/ III. FAA Order 8240.47 must be applied.

i. Adjustments. See Chapter 4, Section 3. When equipment performance characteristics are abnormal but within tolerances, they should be discussed with maintenance personnel to determine if adjustments will increase the overall performance of the systems. Following any adjustment to correct an out-of-tolerance condition, the appropriate monitor(s) must be checked and proper monitor operation verified.

9. 75 MHz Marker Analysis.

a. There must be no "holes" in the area of coverage for middle and inner markers (See Figures 15-8A - C).

b. Momentary reductions in RF signal levels for outer and fan markers are acceptable, provided the reduction is 300 ft or less in duration. The reduction is considered as part of the total width (See Figure 15-8B. 75 MHz Marker Width Measurement A to B Equals Width (includes the hole)).

c. Figure 15-8C illustrates an out-of-tolerance condition.

Figure 15-8A. Typical 75 MHz Marker Width Measurement.

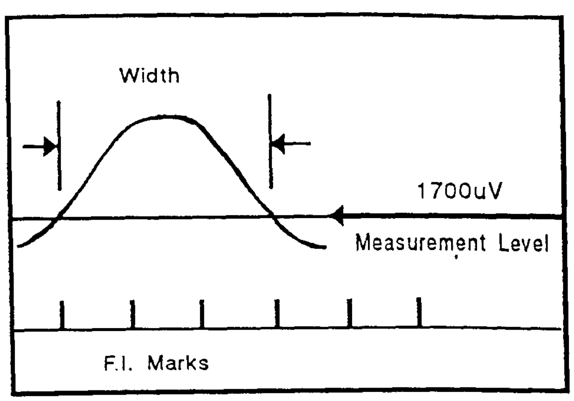


Figure 15-8B. 75 MHz Marker Width Measurement A to B Equals Width (includes the hole)

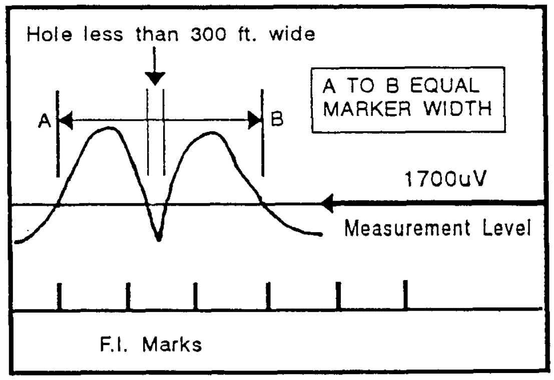


Figure 15-8C. Example of Patterns Not Meeting Criteria Widths A & B Are Not Additive

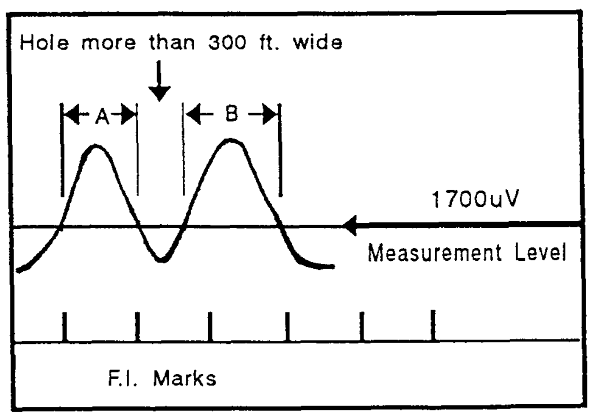


Figure 15-9. Application of Structure Tolerance -- CAT. II & III.

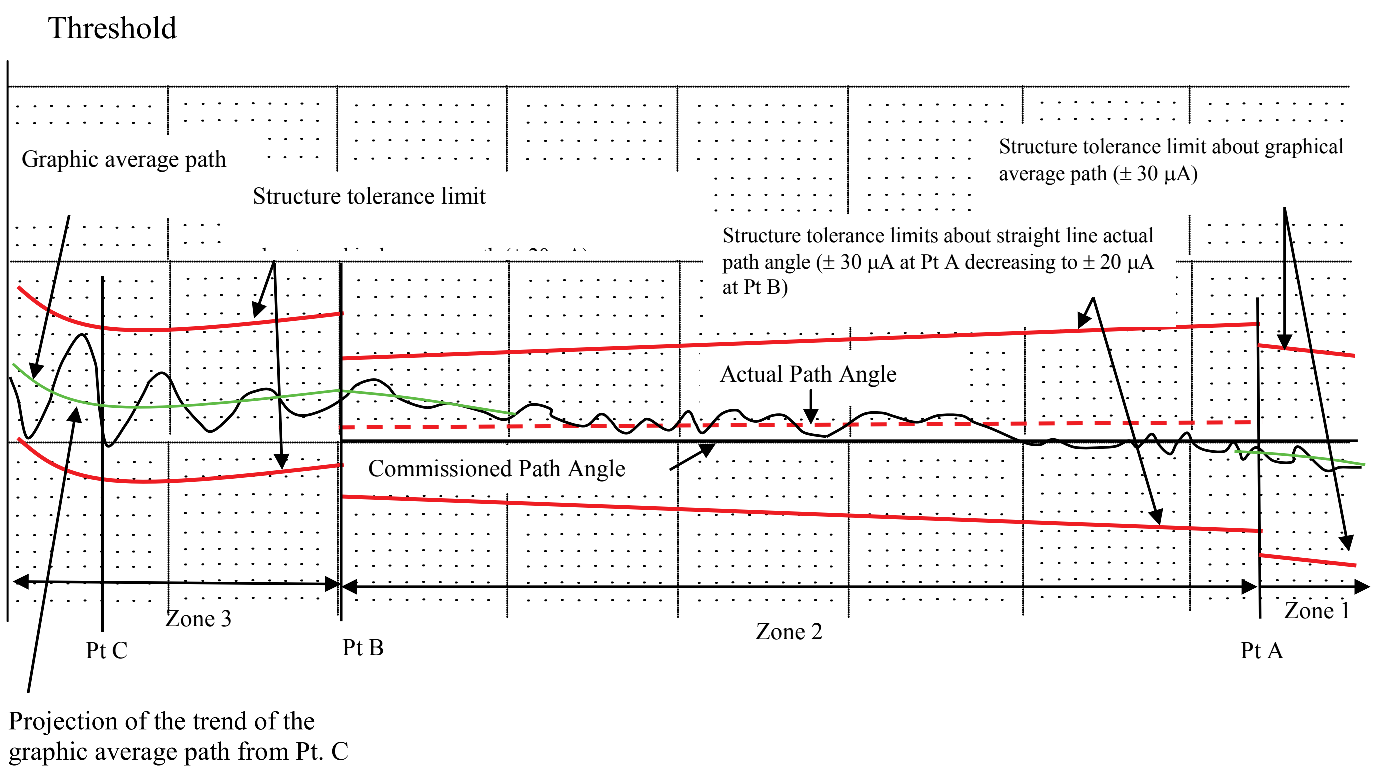
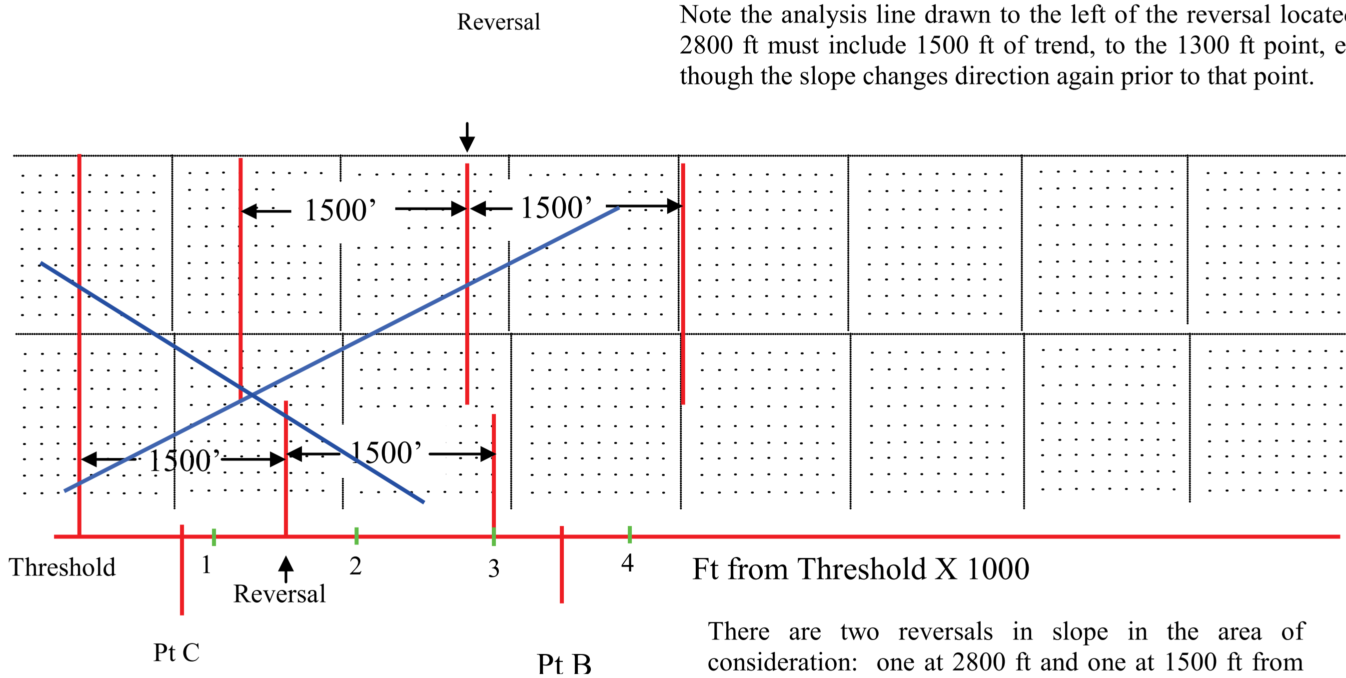


Figure 15-10. Rate of Change/Reversal in the Slope of the Glide Path.

Note the analysis line drawn to the left of the reversal located at 2800 ft must include 1500 ft of trend, to the 1300 ft point, even though the slope changes direction again prior to that point.



There are two reversals in slope in the area of consideration: one at 2800 ft and one at 1500 ft from the threshold. Each reversal meets the requirement that the slope or trend on at least one side of the break extends for at least 1500 ft.

Figure 15-11. Localizer Standard Service Volume.

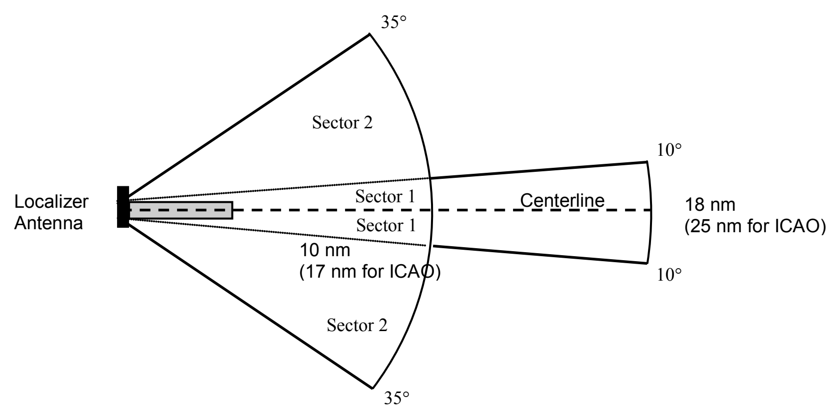
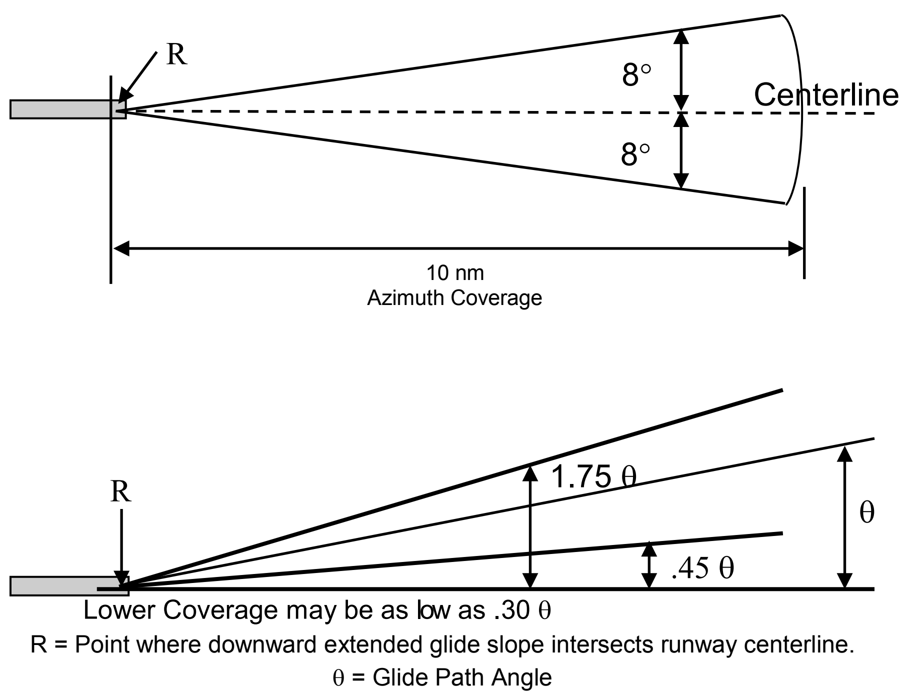


Figure 15-12. Glide Slope Standard Service Volume.



Section 6. Tolerances.

10. Tolerances.

CODES:

C — Tolerances that are applied to site, commissioning, reconfiguration, and categorization inspection.

P — Tolerances that are applied to any inspection subsequent to the inspections outlined in Code C.

a. Localizers.

Parameter	Reference Paragraph	Inspection		Tolerance/ Limit
		C	P	
Spectrum Analysis	Reserved			
Modulation Level	15.4.b	X	X	36 – 44% as measured IAW Paragraph 15.4b 30% - 60% throughout the service volume of all localizers installed or reconfigured with new type antennas after 01/01/2000. For existing systems, note in the flight inspection report areas where modulation exceeds 60%. For two-frequency systems, the standard for maximum modulation percentage does not apply at or near azimuth where the course and clearance signal levels are equal in amplitude (i.e., at azimuths where both transmitting systems have a significant contribution to the total modulation percentage).
Power Ratio	15.4.d	X		The course transmitter power level must be at least 10 dB greater than the clearance transmitter.
Phasing	15.4.e	As Required		No tolerance.

Parameter	Reference Paragraph	Inspection		Tolerance/ Limit
		C	P	
Width—	15.4.f			Maximum—6.0° (SDF-12.0°). CAT II & III tailored to 700 ft. Precision approach—400 ft minimum course width at the threshold.
Front Course		X		± 0.1° of the commissioned width.
			X	Within 17% of the commissioned width.
Transmitter Differential (Front Course)			X	The difference in the normal widths must not be greater than 0.5° or 10% of the commissioned width, whichever is least.
Back Course		X		Between 3.0° and 6.0°
			X	Between 2.49° and 7.02° in normal or monitor alarm condition.
		X	X	SDFs — Within 10% of the front course sector width.
Symmetry (Front Course Only)	15.4.f	X	X	With the facility in normal: 45-55%.

Parameter	Reference Paragraph	Inspection C	Inspection P	Tolerance/ Limit
Alignment	15.4.g			
Front Course and Independently Monitored Back Courses		X		Within ± 3 µA of the designed procedural azimuth. Within +/- 8 µA for Offset localizers, Offset SDFs, and LDAs Within +/- 10 µA for independently monitored back courses
			X	For ILS(s), localizer-only on centerline and SDF(s) on centerline. From the designed procedural azimuth: CAT I ± 15 µA. CAT II ± 11 µA. CAT III ± 9 µA. Offset Localizers, Offset SDF(s), and LDA(s) ± 20µA Back Course ± 20 µA. At the conclusion of a monitor inspection or when alignment is adjusted, FAA, U.S. non-Federal civil, U.S. Army, and U.S. Navy/ Marine Corps facilities' reference transmitter must be ≤ 3µA for straight-in facilities
Back Course (Facilities subordinate to front course.)		X	X	Designed procedural azimuth ± 65 µA.

Parameter	Reference Paragraph	Inspection C	Inspection P	Tolerance/ Limit
Course Structure	15.4.g			
Front Course		X	X	Zone 1—From the graphical average course: CAT I, II, III ± 30 µA to Point A SDF: ± 40 µA to Point A
NOTE: For localizer only approaches (ILS facilities), including RF alarm, and when alignment is determined as S/ U, structure may be measured from graphical average course				Zone 2—From the actual course alignment: CAT I: ± 30 µA at Point A; linear decrease to ± 15µA at Point B. CAT II, III: ± 30 µA at Point A; linear decrease to ± 5 µA at Point B, SDF: ± 40 µA at Point A; linear decrease to ± 20µA at Point B. Zone 3—From the actual course alignment: CAT I: ± 15 µA at Point B; ± 15µA at Point C. SDF: ± 20 µA at Point C. Zones 3 & 4—From the actual course alignment. CAT II, III: ± 5 µA at Point B; ± 5 µA to Point D. Zone 5—From the actual course alignment. CAT III: ± 5 µA at Point D; linear increase to ± 10 µA at Point E.
Back Course		X	X	Zone 1—From the graphical average course: ± 40 µA to Point A. Zone 2—From actual course alignment: ± 40 µA at Point A; linear decrease to ± 20 µA at Point B. Zone 3—From actual course alignment ± 20 µA at Point B; ± 20 µA at Point C.
Front and Back Course	15.8.a	X	X	Exception: An aggregate out-of-tolerance condition for 354 ft may be acceptable in a 7,089-foot segment.

Parameter	Reference Paragraph	Inspection		Tolerance/ Limit
		C	P	
Monitors	15.4.i			
Alignment				The course alignment monitor must alarm when the actual course alignment signal shifts from the designed procedural azimuth by no greater than:
Front Course Facilities aligned along the runway		X	X	CAT I ILS and SDF(s) aligned along runway centerline ± 15 μA CAT II ± 11 μA CAT III ± 9 μA.
Offset Localizers, Offset SDFs, and LDAs		X	X	± 20 μA from the designed procedural azimuth when using actual course alignment references, i.e., AFIS, theodolite, etc..
Localizers, SDF's, and LDA's where alignment is determined to be satisfactory by visual observations		X	X	±20 μA from established equality of modulation reference.
Width Front Course & Independently Monitored Back Courses		X	X	Not more than ± 17% of the commissioned width.
Back Course		X	X	2.49 – 7.02°
RF Power	15.4.j	X		Maintained at or above: Signal Strength—5 μV Flag Alarm—No Flag or indication of invalid signal Clearance and Structure—in tolerance.
Coverage	15.4.j	X	X	At or greater than: Signal Strength—5 μV Flag Alarm—No Flag or indication of invalid signal Clearance and Structure — in tolerance Interference—must not cause an out-of-tolerance condition.

Parameter	Reference Paragraph	Inspection C	Inspection P	Tolerance/ Limit
Clearances (Front and Back Course) Facility in Normal configuration Facility in any alarm configuration	15.4.k	X X	X X	As measured from the procedural designed azimuth: Sector — Minimum Clearance 1 — Linear increase to 175 µA then maintain 175 µA to 10°. 2 — 150 µA (see note). 3 — 150 µA (see note). Clearances are reduced 15 µA from the clearance required in normal.
Front and Back Course in normal or alarm	15.4.k	X	X	Exception: Momentary crosspointer deflections to less than the tolerance are acceptable in sectors 2 and 3, provided the aggregate area does not exceed 3° of arc in one quadrant. Deviations in any sector to less than 100µA are not acceptable.
Polarization	15.4.n	X	X	Polarization error not greater than: CAT I ± 15 µA CAT II ± 8 µA CAT III ± 5 µA
Identification and Voice	15.4.o	X	X	Clear, correct; audio level of the voice equal to the identification level. The identification must have no effect on the course. Voice modulation must not cause more than 5µA of course disturbance.

b. Glide Slopes.

Parameter	Reference	Inspection		Tolerance/Limit
		C	P	
Spectrum Analysis	Reserved			
Modulation Level	15.5.b	X		78 – 82%
			X	75 – 85%
Modulation Equality	15.5.c	As Required		Zero μA ± 5μA
Phasing and Airborne Phase Verification	15.5.d	As Required		No Tolerance
Engineering & Support Tests	15.5.e	As Required		No Tolerance
Width	15.5.f	X		0.7° ± 0.05° (Site Survey, USAF test van: 0.7° ± 0.1°)
			X	0.7° ± 0.2°
Angle	15.5.f	X		Within ± 0.05° of the commissioned angle. (Site Survey, USAF test van: ± 0.1° of the commissioned angle)
			X	Within + 10.0% to -7.5% of the commissioned angle.
Transmitter Differential		X		± 0.10°
			X	± 0.20°
Alignment	15.5.j			CAT I — Not applicable
		X	X	CAT II and III (Also CAT I authorized use below CAT I minima) Zone 3 ± 37.5 μA about the commissioned angle at Point B; expanding linearly to ± 48.75 μA about the commissioned angle at Point C; expanding linearly to ± 75 μA about the commissioned angle at ILS reference datum.
Tilt	15.5.i	X	X	Within + 10.0% to -7.5% of the commissioned angle. Clearance Above Path, Modulation Clearance Below Path - 180μA

Parameter	Reference	Inspection		Tolerance/Limit
		C	P	
Reference Datum Height (RDH)	15.5.h	X		CAT I: Maximum 60 ft CAT II and III: 50 to 60 ft. (Also CAT I authorized use below CAT I minima)
Symmetry	15.5.f	X	X	The following criteria are applied with the facility in a normal configuration: CAT I 67-33%. CAT II 58-33%. (Also CAT I authorized use below CAT I minima). CAT III 58-42%.
Structure below Path	15.5.f	X	X	190 µA of fly-up signal occurs at an angle which is at least 30% of the commissioned angle.
		X	X	Exception: If this tolerance cannot be met, apply clearance procedures and tolerances.
Clearance Below the Path	15.5.g	X	X	Adequate obstacle clearance at no less than 180 µA of fly-up signal in normal (150 µA in any monitor limit condition).
Above the Path		X	X	150 µA of fly-down signal occurs at some point prior to the first false path.

Parameter	Reference	Inspection C	Inspection P	Tolerance/Limit
Structure	15.5.j			
With AFIS or Tracking Device.		X	X	Category I Zone 1- From graphical average: ± 30 µA Zone 2 – From actual path angle: ± 30 µA Zone 3 – From graphical average: ± 30 µA Category II and III (Also CAT I authorized use below CAT I minima) Zone 1 – From graphical average ± 30 µA Zone 2 - From actual path angle ± 30 µA at Point A, then a linear decrease to ± 20 µA at Point B. Zone 3 – From graphical average ± 20 µA
Without AFIS or tracking device			X	Category I Zone 1– From graphical average: ± 30 µA Zone 2 – From graphical path angle: ± 30 µA Zone 3 – From graphical average: ± 30 µA
	15.8.a	X	X	Exception: An aggregate out-of-tolerance condition for 354 ft may be acceptable in a 7,089-foot segment.
Change/ Reversal	15.8.b	X	X	25 µA per 1,000 ft in a 1,500-foot segment.
Coverage	15.5.n	X	X	At or greater than: Signal Level: 15 µV Flag Alarm: No Flag or indication of invalid signal Fly-up/ Fly-down Signal: 150 µA Clearance and Structure in tolerance. Interference must not cause an out-of-tolerance condition.
Monitor Reference Values	15.5.m			
Angle		X	X	Within + 10.0% to -7.5% of the commissioned angle
Width		X	X	0.9° maximum. 0.5° minimum.

Parameter	Reference	Inspection		Tolerance/Limit
		C	P	
RF Power	15.5.n	X		Not less than: Signal Level—15 µV Fly-up/ Fly-down Signal: 150 µA Flag Alarm: No Flag or indication of invalid signal

c. 75 MHZ Marker Tolerances. Marker beacons must meet these tolerances or be removed from service. The following tolerances are applied with the receiver sensitivity in low.

Parameter	Reference Paragraph	Tolerance/Limit
Electromagnetic Spectrum	Reserved	Interference must not cause an out-of-tolerance condition.
Identification	15.9.b	Distinct, correct, constant throughout the coverage area; and clearly distinguishable from any other markers.
Modulation	15.9.b	The modulation must illuminate the following lights: OM - Blue Light (400 Hz) MM - Amber Light (1,300 Hz) IM - White Light (3,000 Hz) FM - White Light (3,000 Hz)

Parameter	Reference Paragraph	Tolerance/Limit
Coverage	15.9.c	With a constant signal at or above 1,700 microvolts (µV), the following widths must be provided:
Minor Axis	15.9.c(1)	
ILS Outer Marker		Width must not be less than 1,350 ft or more than 4,000 ft
ILS Middle Marker		Width must not be less than 675 ft or more than 1,325 ft
ILS Inner Marker		Width must not be less than 340 ft or more than 660 ft
Fan Markers		
Used for a missed approach or step-down fix in the final approach segment		Width must not be less than 1,000 ft or more than 3,000 ft
All others		Same as ILS Outer Marker
		Exception: Outer and fan markers are allowed “holes” in the area of coverage provided that it is less than 300 feet in duration
Major Axis	15.9.c(2)	
ILS Outer Marker *		Minimum: 700 ft Maximum: 4,000 ft Those markers installed to serve dual runways must not exceed 4,000 ft within the normal localizer width sector of 150 µA, either side of the procedural centerline.
ILS Middle Marker *		Minimum: 350 ft Maximum: 1,325 ft
ILS Inner Marker *		Not Applicable
All Others *		Any duration not to exceed the respective minor axis tolerance.
		Exception: Outer and fan markers are allowed “holes” in the area of coverage provided that it is less than 300 feet in duration
Separation		A separation between the 1,700 µV points of succeeding marker patterns which provide a fix on the same approach course; e.g., MM to IM, must be at least 709 ft.

* As measured along the minor axis at the extremities of the pre-defined off-course sector.

11. Adjustments. See Chapter 4, Section 3. When equipment performance characteristics are abnormal but within tolerances, they should be discussed with maintenance personnel to determine if adjustments will increase the overall performance of the systems. Following any adjustment to correct an out-of-tolerance condition, the appropriate monitor(s) must be checked and proper monitor operation verified.

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Chapter 16. Microwave Landing Systems (MLS)

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Table of Checklists and Tables

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Chapter 16. Microwave Landing Systems (MLS)

Section 1. General

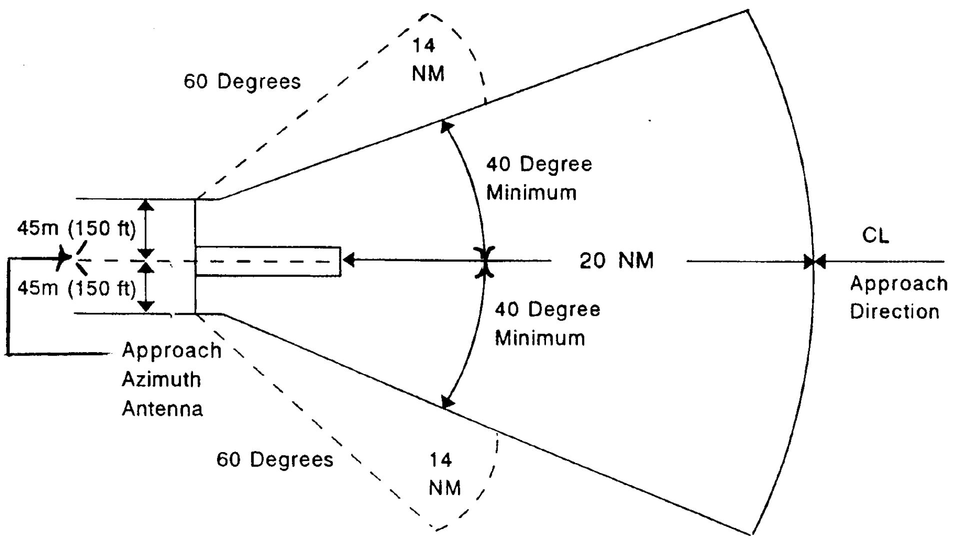
1. Introduction. This chapter details the flight inspection procedures and tolerances to be applied to microwave landing systems (MLS).

a. Coverage Ability. The MLS is capable of providing approach guidance with pilot selectable azimuth and elevation angles within the limits set by transmitted data words. Within these limits or proportional guidance, CDI deflection is proportional to aircraft deviation from the selected azimuth. Outside the proportional guidance area, the azimuth clearance guidance provides full-scale deflection. The typical service volume provides lateral coverage to 40° each side of antenna boresight, but the standard service volume may extend laterally to 60°. The elevation guidance is proportional throughout its coverage. To mitigate the effects of reflections, the limits of the antenna scan can be reduced laterally and/or vertically. Azimuth, elevation, and DME coverage is normally evaluated concurrently on all checks except some monitor checks.

b. MLS Service Volumes. The MLS standard and optional service volumes are depicted in Figures 16-1 and 2.

Figure 16-1. Approach Azimuth/Data Coverage.

<u>Horizontal Coverage</u>



dashed lines = optional service volume

<u>Vertical Coverage</u>

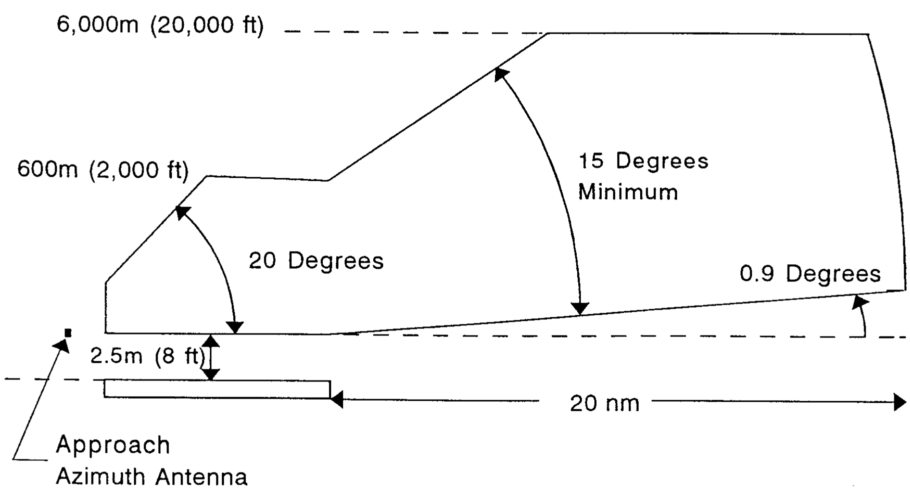
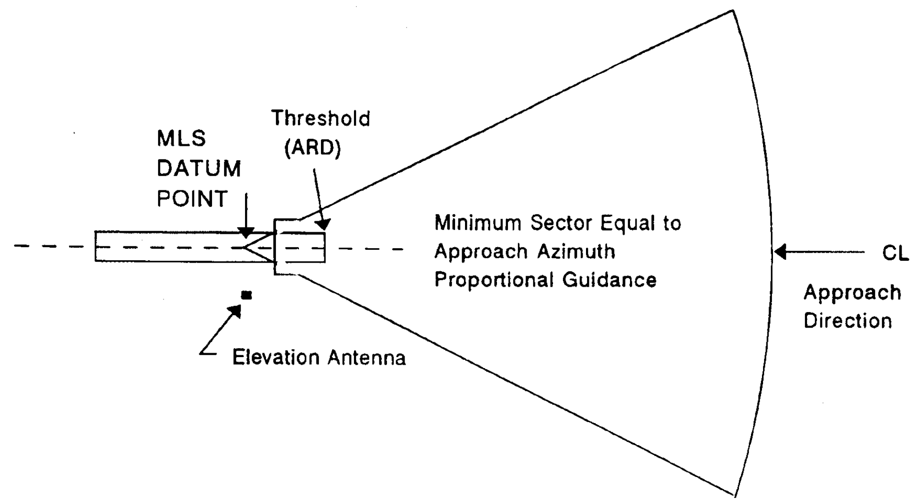
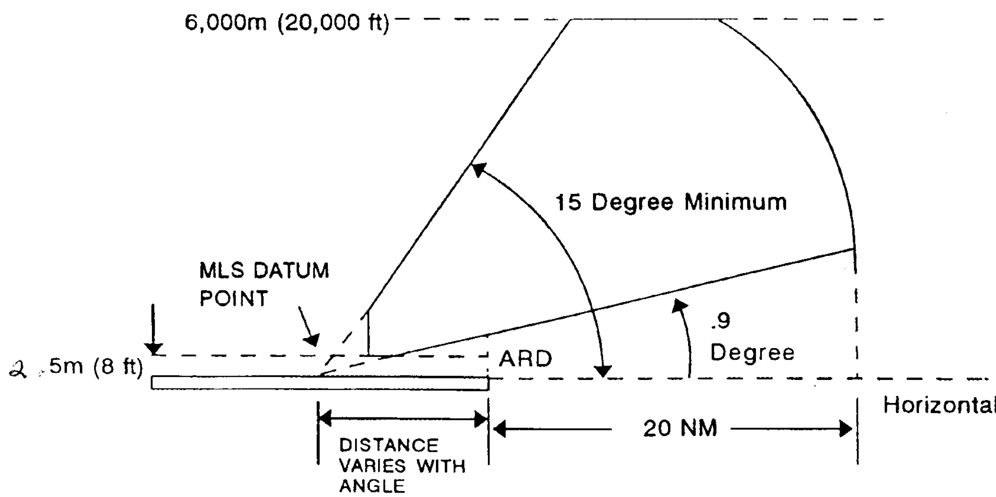


Figure 16-2. Approach Elevation Coverage.

<u>Horizontal Coverage</u>



<u>Vertical Coverage</u>



MLS Points and Zones

Figure 16-3. Standard MLS.

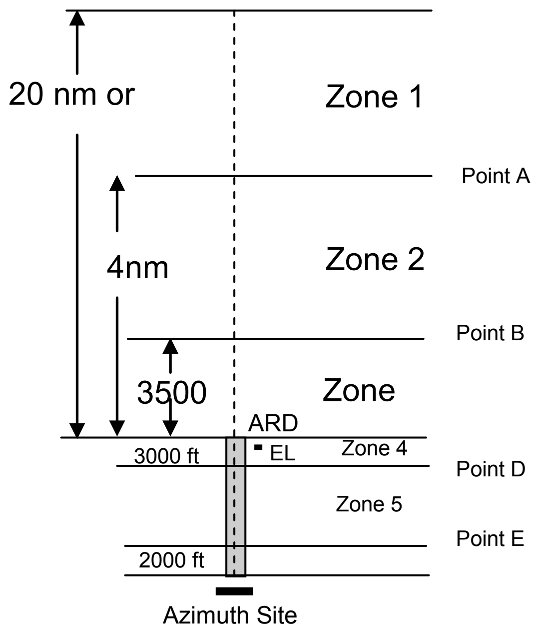
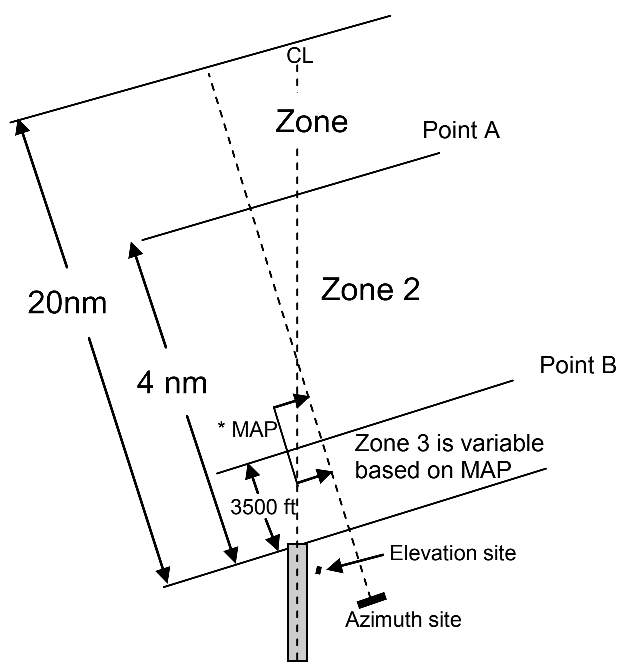


Figure 16-4. Offset MLS.



*MAP is variable based on decision altitude

Figure 16-5. Collocated MLS.

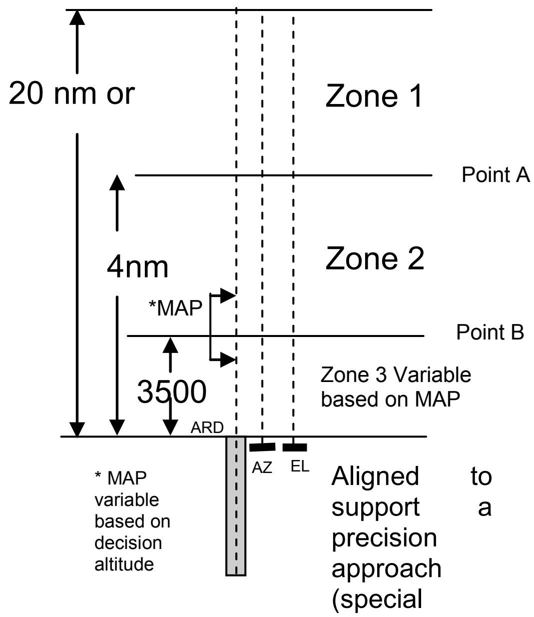
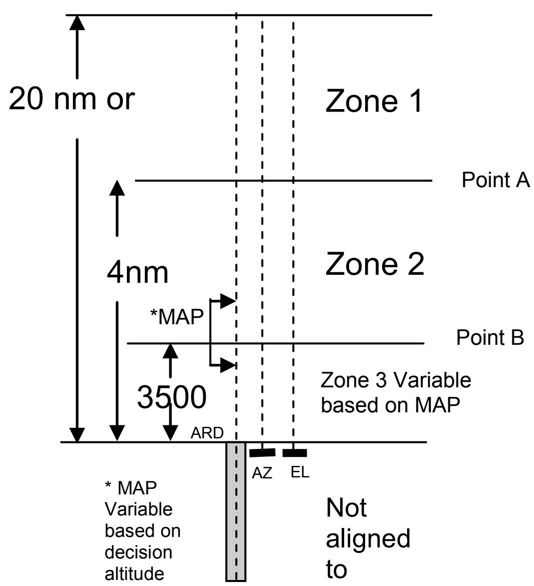


Figure 16-6. Point in Space MLS.



2. Preflight Requirements.

a. Review of all facility data and computation of facility error budget.

b. Review of facility horizontal and vertical terrain and obstruction profiles to determine line-of-sight characteristics and areas of possible signal anomalies. These profiles will be provided by installation engineering personnel if obstruction definition is critical to the facility performance.

Section 2. Microwave Landing System (MLS)

3. Flight Inspection Procedures.

a. Checklist.

MLS Checklist.

Type Check	Reference Paragraph	Inspection			Antenna Change		Measurements Required					
		C	**P**	**FC***	**AZ**	**EL**	**Configuration**	**Structure**	**Alignment**	**Data**	**Coverage**	**Clearance**
Data Word Verification	16.3.b(8)	X	X	X	X	X	Norm			X		
Lateral Coverage	16.3.b(1)	X			X	X	RF Power	X			X	X
Vertical Coverage	16.3.b(2)	X			X	X	RF Power	X			X	
Ref Arc	16.3.b(1)	X	X	X	X	X	Norm	X		X	X	X
Approach AZ	16.3.b(3)	X, 2	X	X	X		Norm	X	X	X		
Approach EL	16.3.b(3)	X, 2	X	X	X	X	Norm	X	X			
AZ Monitor	16.3.b(4)	X	1				Align Ref		X			
EL Monitor	16.3.b(4)	X X	1 1				HI Angle LO Angle		X X		 3	
DME	16.3.b(7)	X	X				Norm				X	
OCI Orbit	16.3.b(5)	1					Norm			X		X
Ident	16.3.b(6)	X	X				Norm				X	
Polarization	16.3.b	X	X	X			Norm					

Notes:
1. Engineering or maintenance request
2. Additional Approach from Service Volume Limits at Minimum RF Power
3. Coverage below path.

* = Frequency Change

b. Detailed Procedures

(1) Lateral Coverage. Coverage arcs are used to define and certify the lateral and distance limits of AZ, EL, and DME coverage. Evaluate proportional guidance and clearance coverage.

(a) Service Volume Arc. A commissioning inspection maneuver to define and certify the operational range, lateral, and vertical limits of the MLS service volume. Perform the inspection with the facility operating at the lowest computed power required to establish adequate signal coverage for the intended service volume.

(i) Positioning. Start the arc at the maximum usable distance and 5° outside the edge of the service volume limit. Maintain an altitude equal to the minimum glide path (MGP). If signal coverage of all MLS components cannot be maintained at the MGP, the MLS must be restricted. There is no requirement to certify the lower, 0.9°, or higher, 20,000 ft, limits of lateral coverage unless procedurally or operationally required. The Optional Service Volume Arc should be flown at a distance of 14 nm.

(ii) Inspection

- There must be no less than 10° proportional guidance either side of the procedural on course.
- While traversing the azimuth proportional guidance sectors, record azimuth and elevation deviation. Deviation crosspointer fluctuations greater than 0.5° that exceed 2° of arc, and all MLS receiver unlocks, must be validated by radial flight, using the procedures outlined in Paragraph 16.3.b(2) (Vertical Coverage).

(b) Reference Arc. A commissioning and periodic arc throughout the proportional guidance area to assure azimuth and elevation signal coverage at the lower edge of elevation deflection sensitivity.

(i) Positioning. At a distance of between 5 and 10 nm from the ARD, start the arc 5° outside the edge of the service volume. Vertical altitude must be computed to equal the MGP x 0.75 at the distance flown. The distance and altitude at which the arc is flown on commissioning will be recorded on the Facility Data Sheet. This must be the reference for periodic evaluations.

(ii) Altitudes. The approximate (including earth curvature) arc altitudes above site elevation are computed below for selected angles and distance. Maintaining a centered elevation crosspointer at the correct distance will give a more precise altitude and is the preferred method of flying the arcs. See Table 16-1 for reference arc altitudes.

Table 16-1. MLS Reference ARC Altitudes.

MGP ANGLE	MGP @ 20 nm	MGP x 0.75 @ 5 nm	MGP x 0.75 @ 6 nm	MGP x 0.75 @ 7 nm	MGP x 0.75 @ 8 nm	MGP x 0.75 @ 9 nm	MGP x 0.75 @ 10 nm
2.5	5659	1017	1225	1436	1648	1862	2077
2.6	5871	1056	1273	1491	1711	1933	2157
2.7	6084	1096	1321	1547	1775	2005	2237
2.8	6297	1136	1369	1603	1839	2077	2316
2.9	6509	1176	1416	1659	1903	2148	2396
3	6722	1216	1464	1714	1966	2220	2476
3.1	6935	1256	1512	1770	2030	2292	2555
3.2	7147	1295	1560	1826	2094	2363	2635
3.3	7360	1335	1608	1882	2158	2435	2715
3.4	7573	1375	1655	1937	2250	2507	2794
3.5	7786	1415	1703	1993	2285	2579	2874
4	8851	1614	1942	2272	2604	2937	3273
4.5	9917	1814	2182	2552	2923	3296	3672
5	10985	2013	2421	2831	3243	3656	4071
5.5	12054	2213	2661	3111	3562	4015	4470
6	13126	2413	2901	3391	3882	4375	4870

(iii)Inspection

- There must be no less than 10° proportional guidance either side of the procedural on course.
- While traversing the proportional guidance sectors, record azimuth and elevation deviation. Deviation crosspointer fluctuations greater than 0.5° that exceed 2° of arc, and all MLS receiver unlocks, must be

(2) Vertical Coverage

(a) Purpose

(i) A commissioning maneuver to evaluate vertical coverage of the azimuth and elevation on the procedural azimuth and at + 10° each side.

(ii) Validate elevation and azimuth deviation crosspointer fluctuations noted on arcs.

(b) Positioning. Accomplish this check by performing a level run at an altitude equal to MGP x 0.75 as calculated at the FAF distance, starting at the standard service volume. While flying inbound, determine the angle at which a consistent satisfactory signal is achieved. If this angle is higher than 0.9°, the facility must be restricted. If the angle found is greater than MGP x 0.75, the facility is unusable.

(c) Inspection. Record deviation, PFN, and CMN. Observe the azimuth and elevation crosspointers for excessive signal aberrations which may indicate multipath or signal shadowing. Observe the elevation crosspointer for a smooth linear transition terminating between 15 and 20°.

(i) When fluctuations exceed ± 0.5° within ± 10° of the procedural on course, fly the approach offset 5° on the affected side(s) of the procedural on course and apply PFN and CMN tolerances. If the 5° offset approach is satisfactory, the approach may be placed in service.

(ii) Validation of deviations noted on arcs must be discussed with maintenance personnel for corrective action. If not correctable, the area in question must be restricted.

(iii) Increases in the minimum EL lower scan limit may present an erroneous crosspointer indication at elevation angles below the scan limit. The elevation coverage should be restricted below the adjusted lower scan limit.

(iv) Increases in the minimum EL lower scan limit made after determination of normal path structure requires a recheck of the EL approach guidance inside the FAF.

(3) MLS Approaches

(a) Purpose. The approach should be the first maneuver flown during a commissioning, reconfiguration, or restoration flight inspection, so that the azimuth and elevation course and coverage may be optimized to the desired procedural alignment. This maneuver is performed to verify that the azimuth and elevation facilities will satisfactorily support the proposed or published approach and categories of intended use.

(b) Positioning. Approaches must be evaluated on the designed procedural azimuth and the minimum glidepath, unless otherwise indicated. For the purpose of evaluating structure, optimizing azimuth and elevation alignments, and conducting periodic inspections, start the approach at a distance not closer than the published FAF, GSI, or 6 miles from runway threshold, whichever is greater. For commissioning, fly the approach on the MGP from the desired service volume limits at normal power and while the facility is at minimum RF power.

(c) MLS Approaches Which Support Azimuth Only Minima. The final approach segment of azimuth only minima must be checked during site evaluation, commissioning, and special inspections for azimuth antenna change and anytime there is significant deterioration of azimuth structure. Upon reaching the FAF inbound, descend at a rate of approximately 400 ft per mile (930 ft per minute at 140 knots; 800 ft per minute at 120 knots) to an altitude of 100 ft below the lowest published MDA and maintain this altitude to the MAP.

(d) Inspection

(i) Azimuth facilities sited along runway centerline with Decision Altitudes of 200 ft or less must be evaluated through Zones 1, 2, and 3 (also Zones 4 and 5 if autoland or CAT II/ III operations are authorized) on all inspections requiring alignment and structure measurements; elevation guidance on these facilities must be evaluated to the ARD. All other facilities must be evaluated to 100 ft below Decision Altitude (DA).

Note: During site, commissioning, reconfiguration, categorization, antenna, and/or frequency change inspection—check all of Zone 1.

All other inspections (i.e., periodic, periodic with monitors, etc.) evaluate structure from published FAF, GSI, or 6 nm (whichever is further) through all other required zones.

(ii) Approved RTT and/or AFIS methods must be used for the approach evaluation. The facility error budget will provide all tolerances to be used during commissioning and periodic flight inspection. Mean course error (MCE) must be established prior to application of PFE tolerances. Exclude data in areas that are restricted due to facility performance.

(iii)For azimuth facilities sited along runway centerline IAW Figure 16-3, with a Decision Altitude at or below 200 ft, the azimuth MCE must be determined and reported as found in the 1.0 nm segment ending at the ARD. For other facilities, use the 1.0 nm segment, ending at 100 ft below DA. For elevation facilities, determine the glide angle in Zone 2 as defined in Figures 16-3, 4, and 5.

(iv) Visual Autoland or Category II or III Operations Authorized. On commissioning inspections, cross Point C at 100 ft, runway threshold at approximately 50 ft, and continue on the extended glidepath angle to the touchdown point. Continue the landing roll and determine the actual course alignment for Zones 4 and 5. Measure the course structure from the actual alignment. If the actual alignment for Zones 4 and 5 cannot be determined using this method, taxi the aircraft along the runway centerline from abeam the elevation site to Point E. Record the raw crosspointer information and mark, abeam the elevation site, Point D and Point E. Manually calculate the actual course alignment and structure for each of the required zones.

(4) Monitor References

(a) Purpose: To provide Facilities Maintenance personnel reference readings to be used in the validation of facility monitoring parameters. Facility discrepancies must be assigned if the alignment shift results in out-of-tolerance PFE at any distance on the approach.

(b) Inspection

(i) Azimuth monitor references must be established after the facility is optimized to a MCE within ± 0.02° of the designed procedural azimuth. After the MCE is established, have maintenance personnel shift the system to one side, record the reference, shift the same amount to the other side, record the reference, then restore to normal. Azimuth monitors can also be established on the ground when parked within proportional guidance, maintaining line-of-sight at the maximum practical distance from the antenna. When azimuth monitors are checked on the ground, algebraically add the azimuth shift to the reported maximum PFE on the approach.

(ii) Elevation monitor references are established airborne and require the MGP to be established within ± 0.02° of the commissioned angle prior to accomplishment. Request an elevation angle change of no greater than 0.10° high, record the reference, have the elevation angle changed to no greater than 0.10° low, record the reference, then restore to normal.

(iii) If the elevation lower scan angle limit is increased to improve PFE, recheck normal EL path structure.

(c) Below Path Coverage Evaluation. Perform this check during a commissioning flight inspection when in low angle alarm. Three runs are required, one on procedural centerline, and at 2° either side of centerline. With the MGP selected for evaluation, fly at an angle equal to [(MGP° x 0.75) - 0.25°]. Ensure a full-scale fly up indication is maintained on the elevation signal and AZ guidance and obstacle clearance can be maintained from the FAF to the MAP.

(5) Out-of-Coverage Indication (OCI). The purpose of the OCI check is to ensure that no false angle decoding occurs outside of proportional guidance coverage areas. This check is accomplished at maintenance request if there are procedural requirements beyond the service volume. Fly an orbit radius of 6 to 10 miles about the azimuth facility for this check. The aircraft will be flown at an altitude as close to the MGP that line of site with the MLS facilities will allow. During the orbit, note the position of any decoded angles lasting longer than 4 seconds or 1.5° of arc, whichever is greater. Return to the area after completing the orbit and manually program the decoded angle into the receiver. If the angle can be locked onto and flown as a radial, even though an OCI signal is present, the problem must be corrected, or the facility restricted. MMLS does not have OCI capability.

(6) Identification. The purpose of the identification check is to ensure correct identification is received throughout the coverage area. Validate the identification by listening to the Morse code or recording Basic Data Word 6.

(7) DME. The DME must be evaluated as a DME/ N throughout all areas of coverage. MLS DME is specified by ICAO to transmit the three-letter ID, dropping the preceding M. Evaluate DME accuracy IAW Chapter 11. Currently commissioned facilities transmitting 4-letter on DME (e.g., M-XXX) function must be left in service.

(8) Data Words. The receiver uses transmitted data words containing facility siting and approach information to process AZ and EL angle information, identify the station, and determine crosspointer sensitivity. Basic data words are used for all approaches. Auxiliary data words are used for RNAV or Computed Centerline Approaches. Some stations may not transmit all auxiliary data words. The AFIS, loaded with the correct facility data, is the standard for comparison with transmitted data words. See Table 16-2 for a breakdown of individual data words. If using non-AFIS equipment, the data words supplied by the Facility Data Sheet are the standard. On commissioning, data word discrepancies must be resolved with Facilities Maintenance before placing the facility in service; any intentionally missing data words must be documented on the Facility Data Sheet.

Table 16-2. MLS DATA WORD TRANSLATOR.

Word	Description	AFIS Term	Least Signification Bit
Basic 1	AZ ant to Threshold Dist AZ proportional neg limit AZ proportional pos limit Clearance signal type	F DIS F PNLM F PPLM C TYPE	100 mtr 2° 2° 0=pulse/1=scan
Basic 2	Minimum glidepath angle	E MPA	0.1°
	Apch EL Status	EL/F/BZ	0=abnormal/1=normal
	Apch AZ Status	EL/F/BZ	0=abnormal/1=normal
	Back AZ Status	EL/F/BZ	0=abnormal/1=normal
	DME Status	DME ST	(1)
Basic 3	AZ Beamwidth	F BMW	0.5°
	EL Beamwidth	E BMW	0.5°
	DME Distance	DDIS	12.5 mtr
Basic 4	AZ Mag Orientation	F ALN	1° (2)(3)
	Back AZ Orientation	B ALN	1°
Basic 5	Back AZ neg prop limit	B PNLM	2°
	Back AZ pos prop limit	B PPLM	2°
	Back AZ Beamwidth	B BMW	0.5°
Basic 6	MLS Identification	FAC ID	
AUX 1	AZ antenna offset	F OFF	1 mtr (3)(5)
	AZ antenna to Datum Point distance	F DIS	1 mtr (3)
	AZ alignment with Rwy C/L	F ALN	0.01° (3)(5)
	AZ coordinate system	AZ C/P	0=Conical/1=planar
	AZ antenna phase center height	AZ HT	1 mtr
AUX 2	EL antenna offset	E OFF	1 mtr (5)
	Datum point to threshold distance	MLS DIS	1 mtr (3)
	EL antenna phase center height	E HT	0.1 mtr
	Datum point elevation	MLS HT	1 mtr (6)
	Threshold Height	RWY HT	0.1 mtr

Word	Description	AFIS Term	Least Signification Bit
AUX 3	DME offset	DME OFF	1 mtr (3)(5)
	DME to datum point distance	DME DIS	1 mtr (3)
	DME antenna height	DME HT	1 mtr
	RWY stop end distance	RWY SND	1 mtr (6)
AUX 4	Back AZ ant offset	B OFF	1 mtr (5)
	Back AZ to datum point distance	B DIS	1 mtr
	Back AZ align with rwy C/L	B ALN	0.01° (5)
	Back AZ coord sys	BZ C/P	0=Conical/1=Planar
	Back AZ ant phase center height	B HT	1 mtr

Notes:

(1) DME status codes:
0 0 DME inoperative or not available
0 1 Only initial approach or DME/ N
1 0 Final approach mode std 1 available
1 1 Final approach mode std 2 available

(2) Magnetic orientation is 180° from procedural front course azimuth.

(3) Computed centerline critical values

(4) Distances and heights are with respect to MLS datum point.

(5) Negative number indicates left of C/ L looking from threshold to stop end.

(6) May be zero or actual value.

4. Analysis

a. Azimuth PFE, PFN, and CMN will be evaluated over any 40-second interval of radial flight within the coverage area. Measured parameters must be in tolerance for no less than 95% of the interval measured. PFE tolerances must only be applied with use of AFIS or RTT.

b. Elevation PFE, PFN, and CMN will be evaluated over any 10-second interval of radial flight within the coverage area at or above 0.9°. Measured parameters must be in tolerance for no less than 95% of the interval measured. PFE tolerances must only be applied with use of AFIS or RTT when flown radially.

c. Manual analysis of PFN can be determined by measuring the signal deviations from the mean azimuth or elevation angle that have a duration greater than:

(1) 6.3 seconds for azimuth

(2) 2 seconds for elevation

d. Manual analysis of CMN can be determined by measuring the signal deviations from the mean azimuth or elevation angle that have a duration less than:

(1) 10.4 seconds for azimuth

(2) 6.3 seconds for elevation

(3) CMN filter bandpass frequency overlaps a portion of the PFE bandpass frequency. The resultant CMN signal will be superimposed upon the PFE component, resulting in a larger error than is actually present. CMN must be reported after subtraction of the PFE component.

e. Monitor limits are determined by the maximum PFE found in the alarm configurations. If monitors are checked airborne, make separate runs, measuring PFE in each configuration. If the AZ alignment monitor is checked on the ground, algebraically add the amount of alignment change to the PFE value found on the normal approach.

5. Tolerances

a. Facility Error Budgets. Due to the unique siting requirements of each MLS installation and the resulting difference in tolerances, a MLS error budget must be computed for each facility. The location of the azimuth site determines the Reference Point to be used in the computation of the error budget. The EL error budget reference point must coincide with the AZ.

(1) ARD when the azimuth is sited along or within 1.00° of runway centerline. (See Figure 16-3), and a 200 ft or less Decision Altitude is published.

(2) 100 ft below the MAP when the azimuth is:

(a) Sited along or within 1.00° of runway centerline (See Figure 16-3), and a Decision Altitude above 200 ft is published.

(b) Offset. (See Figure16-4).

Note: Azimuth antennas installed with a distance to Missed Approach Point/ Decision Altitude greater than 9,115 ft must have a tolerance of 0.11° for PFN and 0.22° for PFE applied at the MAP.

(c) Co-located azimuth with elevation. (See Figure 16-5).

(d) Heliports which are considered to be those facilities with less than 2,300 ft between the azimuth and the approach reference datum when sited along runway centerline.

(e) Non-precision approach aid terminating at a point in space and not aligned with a precision runway. (See Figure 16-6.)

b. Application of Tolerance Degradation Factors. Tolerances are specified as the calculated or standard value at the reference point, either ARD or MAP. As shown in Table 16-3, these tolerances may be widened (in most cases to an indicated maximum value) by the indicated degradation factors with increasing distance, lateral, or elevation displacement from the reference point. To calculate azimuth tolerance at a given point, use the following steps, in order:

(1) Determine the tolerance at the reference point, using the formula in Appendix B.

(2) Define the measurement point in distance, lateral angle, and elevation angle from the reference point

(3) C/ L Distance Degraded Tolerance

(a) Multiply the tolerance at the reference point by the distance degradation factor. This gives the maximum boresight tolerance at 20 nm.

(b) Subtract the tolerance at the reference point from the tolerance at 20 nm. This gives the maximum degradation.

(c) Divide the maximum degradation by 20, giving the degradation increment (degrees per nm).

(d) Multiply the degradation increment by the mileage from ARD of the measurement point, then add the original tolerance at the reference point. The result is the tolerance on C/ L (boresight) at the distance of the measurement point.

(4) Laterally Degraded Tolerance

(a) Multiply the distance degraded tolerance from Step (3)(d) above by the off-course degradation factor, giving the maximum degradation at 40 (60)° at the specified distance.

(b) Subtract the C/ L value from the value at 40°. The result is the maximum degradation.

(c) Divide the maximum degradation by 40 to get the degradation Increment (degrees per degree).

(d) Multiply the degradation increment by the number of degrees off-course at the measurement point; add this value to the value from Step (3)(d) above. This gives the tolerance at the measurement distance and lateral offset.

(5) Vertically Degraded Tolerance (above 9° only).

(a) Multiply the distance and laterally degraded tolerance from Step (4)(d) above by the vertical degradation factor, giving the maximum tolerance at 15° elevation at the specified distance and lateral offset.

(b) Subtract the distance and laterally degraded value (Step (4)(d)). The result is the maximum degradation.

(c) Divide the maximum degradation by the number of degrees difference from the MGP and 15° to get the degradation increment (degrees per degree).

(d) Multiple the degradation increment by the number of degrees above the MGP at the measurement point; add this value to the value from (4)(d). This gives the tolerance degraded by all three factors.

The tolerance to be applied is the greater of either the value calculated above, or the maximum, as listed in the individual facilities listed below:

Example:
Given: AZ to ARD distance – 7,965 ft, MGP – 3.0°
PFE tolerance at ARD from Paragraph 16.5.e – 20 ft
Find: AZ PFE tolerance at 14 nm from ARD, @ 10° off-course, @ 12°

Table 16-3. Tolerance Degradation Computation.

14b step	Calculation	Result	Definition
(1)	Arctan (20 / 7,965)	0.1438	Tolerance at ARD
(3)(a)	(0.1438 x 1.2)	0.1726	Tolerance @ 20 nm on C/L @ 3.00°
(3)(b)	(0.1726 – 0.1438)	0.0288	Maximum Degradation
(3)(c)	(0.0288 / 20 nm)	0.0014 per nm	Degradation Increment
(3)(d)	(0.0014 x 14 nm) + 0.1438	0.01634	Tolerance @ 14 nm on C/L @ 3.00°
(4)(a)	(0.1634 x 1.5)	0.2451	Tolerance @ 14 nm @ 40°
(4)(b)	(0.2451 – 0.1634)	0.0817	Maximum Degradation
(4)(c)	(0.0817 / 40°)	0.0020 per degree	Degradation Increment
(4)(d)	(0.0020 x 10°) + 0.1634	0.1834	Tolerance @ 14 nm @ 10° @ 3.00°
(5)(a)	(0.1834 x 1.5)	0.2751	Tolerance @ 14 nm @ 10° @ 15°
(5)(b)	(0.2751 – 0.1834)	0.0917	Maximum Degradation
(5)(c)	(0.0917 / 12°)	0.0076	Degradation Increment
(5)(d)	(0.0076 x 9°) + 0.1834	0.2518	Tolerance @ 14nm @ 10° @ 12°

c. Standby Equipment must meet the same tolerances as the primary equipment.

d. Alignment must be reported as the average flight inspection angle. Facilities found with an alignment that exceeds 60% of the allowable PFE must generate a maintenance alert IAW Paragraph 15.8.e.

e. Individual System Tolerances

(1) Standard Facilities

(a) Centerline Azimuth Facilities

Parameter	Reference Paragraph	Inspection C	Inspection P	Tolerance/Limit at ARD	Maximums	Degradation Factors
Alignment (MCE)	16.3.b(3)	X X	 X	0.02 0.05 Military non-autoland only PFE tolerances apply		
PFE	16.4	X	X	20 ft not to exceed 0.25°	<9° EL=0.25° >9° EL=0.50°	(1)
PFN	16.4	X	X	11.5 ft not to exceed 0.25°	<9° EL=0.25° >9° EL=0.50°	(1)
CMN (Autoland Authorized)	16.4	X	X	10.5 ft not to exceed 0.10° within 10° from C/ L More than 10° from C/ L = .20	0.10°	(2)
Runway Area (Autoland Authorized)	16.4	X	X	Zones 4 and 5 PFE/ PFN/ CMN tolerances are equal to the linear (footage) values at the ARD.		
CMN (Cat I Minima)	16.3.b(3)	X	X	0.10° within 10° of rwy C/ L 0.20° beyond 10° from rwy C/ L	0.10° 0.20°	
Alignment Monitor	16.3.b(4)	X	X	PFE tolerances apply		

Notes:

(1) On C/L at 20 nm = 1.2 x ARD value
At 40° off course = 1.5 x C/ L value at same distance from ARD.
At 60° off course = 2.0 x C/ L value at same distance from ARD.
From +9 to +15° EL = 1.5x value at same distance and direction

(2) Linear increase to 0.10° at 20 nm.

(b) Offset Azimuth, Azimuth Collocated with Elevation, and Heliport Azimuth Facilities

Parameter	Reference Paragraph	Inspection		Tolerance/Limit @ Reference Point	Maximums	Degradation Factors
		C	P			
Alignment (MCE)	16.3.b(3)	X		0.02°		
			X	PFE tolerances apply		
PFE	16.4	X	X	28 ft not to exceed 0.50	0.50°	(1)
PFN	16.4	X	X	14 ft not to exceed 0.50	0.50°	(1)
CMN	16.4	X	X	0.20°	0.20°	
Alignment Monitor	16.3b(4)	X	X	PFE tolerances apply		

Note:
(1) On procedural C/ L at 20 nm=1.2 x Reference Point value
At 40° off course = 1.5 x procedural C/ L value at same distance from Reference Point
From +9 to +15° EL = 1.5 x value at same distance and direction from Reference Point

(c) Azimuth and Elevation Facilities Not Aligned as a Precision Approach Aid to a Runway

Parameter	Reference Paragraph	Inspection		Tolerance/Limit @ Reference Point	Maximums	Degradation Factors
		C	P			
Alignment (MCE)	16.3b(3)	X	X	(1)		
PFE	16.4			No requirements		
PFN	16.4	X	X	0.50°		None
CMN	16.4	X	X	0.20°		None

Note:
(1) Alignment must be considered satisfactory when the flight inspector determines that the azimuth on course and elevation rate of descent allow safe completion of the procedure as published.

(d) Elevation

Parameter	Reference Paragraph	Inspection		Tolerance/Limit @ 3.0° @ Reference Point	Maximums	Degradation Factors
		C	P			
Alignment (MCE)	16.3.b(3)	X	X	0.02° PFE tolerances apply		
PFE	16.4	X	X	0.133		(1) (2) (5)
PFN	16.4	X	X	0.087		(1) (2) (5)
CMN (autoland authorized)	16.4	X	X	0.05	Within 10° of rwy C/ L = 0.10° Beyond 10° of rwy C/ L = 0.20°	(3) (4)
CMN (Cat I minima)	16.3.b(3)	X	X	0.10	Within 10° of rwy C/ L = 0.10° Beyond 10° of rwy C/ L = 0.20°	
Alignment Monitor	16.3.b(4)	X	X		PFE tolerances apply	

Notes:

(1) On C/ L at 20 nm = 1.2 x ARD value

(2) At 40° off course = 1.2 x C/ L value at same distance from Reference Point
At +15° EL = 2.0 x value at same distance and direction from Reference Point

(3) Linear increase to 0.10° at 20 nm

(4) At 40° off course = 2.0 x C/ L value at same distance from Reference Point

(5) With decreasing elevation angle: The PFE and PFN limits from +3° (or 60% of the MGP, whichever is less) to the coverage extreme, are degraded linearly by a factor of 3 times the value at the Reference Point.

f. Data Words. The AFIS is the reference for the correctness of the received data words (data sheet for non-AFIS). Due to calculation rounding and feet/ meter conversion, some apparent errors occur. When the received data words do not match the AFIS expected values, the differences must be resolved with Facilities Maintenance. The following data words, if transmitted, have acceptable tolerances; all other values must match.

(1) Basic Data Words

Word	Description	Tolerance
Basic 1	AZ to threshold distance	± 1 Meter
Basic 3	DME distance	± 1 Meter

(2) Auxiliary Data Words

Word	Description	Tolerance
AUX 1	Az to Offset	± 1 Meter
	Az to MDPT	± 1 Meter
	Az Ant Height	± 1 Meter
AUX 2	El Ant Offset	± 1 Meter
	MDPT Distance	± 1 Meter
	El Ant Height	± 0.1 Meter
	MDPT Height	± 1 Meter
	Threshold Height	± 0.1 Meter
AUX 3	DME Offset	± 1 Meter
	DME to MDPT Distance	± 1 Meter
	DME Ant Height	± 1 Meter
	Rwy Stop End Distance	± 1 Meter

Section 3. Mobile Microwave Landing System (MMLS)

6. Introduction

a. The MMLS is a tactical landing aid designed for rapid installation. MMLS may be installed in a split-site configuration or, more commonly, in a collocated configuration. The split-site configuration is essentially the same as any other MLS installation, requiring no special procedures other than for coverage checks. For split-site installations, the standard flight inspection procedures of Paragraph 16.3.b are used.

b. In the collocated configuration**,** the Azimuth (AZ) and DME are sited with the elevation (EL) and provide a computed centerline approach for a normal runway or assault landing zone (ALZ). The antenna is typically 150 to 300 ft from centerline with distance from threshold dependent upon desired Minimum Glide Path (MGP). The AZ guidance is boresighted parallel with procedural centerline.

c. Procedural centerline is usually runway centerline, but unusual siting conditions may cause an offset situation. The standard flight inspection receiver will see the course as parallel to the procedural centerline and will not be guided to the runway. In the collocated configuration, a specialized receiver (e.g., CMLSA or multi-mode Receiver) capable of developing a "Computed Centerline," uses the AZ and DME to compute a procedural centerline based upon the facility data words. For a collocated facility providing a computed centerline, the procedures of Paragraph 16.8 are used.

d. The MMLS does not transmit a clearance signal and will be restricted laterally if the proportional guidance limits are reduced from the normal ± 40°. MMLS facilities are designed for 15 nm service volume. In addition, the RF power of the MMLS is monitored but not adjustable. The 20 nm checks flown at the normal RF power will simulate the power alarm condition. All DOD MMLS facilities must be restricted beyond 15 nm. Standard service volume and the coverage checks may be further reduced to 2 nm greater than the farthest procedural need; the facility must be restricted beyond the checked distance. Most restrictions will be due to reflections or signal screening. These restrictions should be placed at the distance of occurrence.

If an MMLS is confirmed to have inadequate signal strength, it must be restricted beyond a distance equal to 0.75 times the distance of the out-of-tolerance signal.

7. Checklist

Mobile MLS Checklist

Type Check	**Reference Paragraph**	**Inspection**			**Antenna Change**		**CEU Change (1)(2)(3)**	**DEU Change**	**Measurements Required**				
		C2	**P2**	**FC***	**AZ**	**EL**			**Configuration**	**Structure**	**Alignment**	**Data**	**Coverage**
Data Word Verification	16.8.e	X	X	X	X	X	X		Norm			X	
Lat Covg	16.8.a	X			X	X		X (5)	Norm	X			X
Vert Covg	16.8.b	X			X	X			Norm	X			X
Ref Arc	16.8.a	X	X	X	X	X			Norm	X		X	X
Approach AZ	16.3.b(3)	X,	X	X	X		X	(6)	Norm	X	X	X	
Approach EL	16.3.b(3)	X	X	X		X	X	(6)	Norm	X	X		
AZ Monitor	16.3.b(4) 16.8.d	X	(1)				X		Align Ref		X		
EL Monitor	16.3.b(4) 16.8.d	X X	(1) (1)				X X		Hi Angle Lo Angle		X X		 (4)
DME	16.3.b(7) 16.8.g	X	X					X	Norm				X
Ident	16.3.b(6) 16.8.f	X	X				X	X	Norm				X
Computed Centerline Validation	16.8.c	X							Norm		X		

Notes:

(1) Engineering or maintenance request

(2) Commissioning of MMLS facilities with backup CEU(s), perform Periodic and "CEU Change" checklists on backup CEU.

(3) MMLS Redeployment. If the system was removed and reinstalled in its previous configuration and exact location with no changes, perform a "P" and "CEU Change" Checklist.

(4) Coverage below path. Required on commissioning-type inspections.
(5) 20 nm coverage arc required
(6) Azimuth/ Elevation analysis is not required for a DEU change; evaluate the DME with the aircraft configured on the approach.
*FC = Frequency Change

8. Detailed Procedures for Collocated MMLS Providing Computed Centerline Approach. The procedures for inspecting standard MLS installations contained in Paragraph 16.3.b are modified as necessary to support computed centerline approaches. Use those procedures except as directed below.

a. Coverage Arcs. Arcs are flown only to measure the proportional guidance limits. The minimum limit on the equipment side of the runway is 10° beyond the published front course azimuth. On the other side, the minimum is the greater of either 10° beyond the azimuth from the MAP to the AZ antenna OR 5° beyond the azimuth from the threshold to the AZ antenna (see Figure 16-9). See Table 16-4 for coverage arc altitudes.

EXCEPTION: For ALZ operations where touchdown within 500 ft of threshold is essential, the non-equipment side limit may be decreased, as long as coverage is provided to at least 100 ft below Decision Altitude. To preclude difficulties with the vertical coverage check if the proportional guidance limit is set to the same value as the minimum required coverage, attempt to widen the proportional guidance at least an additional 2°.

Table 16-4. MMLS Reference ARC Altitudes.

MGP ANGLE	MGP @ 20 nm	MGP x 0.75 @ 5 nm	MGP x 0.75 @ 6 nm	MGP x 0.75 @ 7 nm	MGP x 0.75 @ 8 nm	MGP x 0.75 @ 9 nm	MGP x 0.75 @ 10 nm
2.5	5659	1017	1225	1436	1648	1862	2077
2.6	5871	1056	1273	1491	1711	1933	2157
2.7	6084	1096	1321	1547	1775	2005	2237
2.8	6297	1136	1369	1603	1839	2077	2316
2.9	6509	1176	1416	1659	1903	2148	2396
3	6722	1216	1464	1714	1966	2220	2476
3.1	6935	1256	1512	1770	2030	2292	2555
3.2	7147	1295	1560	1826	2094	2363	2635
3.3	7360	1335	1608	1882	2158	2435	2715
3.4	7573	1375	1655	1937	2250	2507	2794
3.5	7786	1415	1703	1993	2285	2579	2874

MGP ANGLE	MGP @ 20 nm	MGP x 0.75 @ 5 nm	MGP x 0.75 @ 6 nm	MGP x 0.75 @ 7 nm	MGP x 0.75 @ 8 nm	MGP x 0.75 @ 9 nm	MGP x 0.75 @ 10 nm
4	8851	1614	1942	2272	2604	2937	3273
4.5	9917	1814	2182	2552	2923	3296	3672
5	10985	2013	2421	2831	3243	3656	4071
5.5	12054	2213	2661	3111	3562	4015	4470
6	13126	2413	2901	3391	3882	4375	4870

b. Vertical Coverage. Accomplish this check by a level run starting at 20 nm from the antenna. The azimuth for the vertical coverage checks on the equipment side of the runway is 10° past the published front course azimuth. On the other side, fly the farther of either 10° from antenna boresight azimuth or the minimum proportional guidance limit as described in Paragraph 16.8.a. If the proportional guidance limits are set at the minimum required limits and cannot be expanded, it is permissible to fly the vertical coverage 2° inside of the minimum limits of proportional guidance. Document on the flight inspection report if these runs are flown inside of the standard azimuths. (See Figure 16-9.)

c. Computed Centerline Approaches. Techniques for checking computed centerline procedures depend on the equipment used for the checks. Some flight inspection equipment is limited to checking only the antenna boresight signal while others can evaluate the computed centerline.

(1) If the flight inspection equipment is capable of determining structure and alignment of the computed centerline and elevation signal while flying the approach course, measure these parameters on the computed centerline IAW the AFIS manual. The procedural evaluation may be accomplished using the AFIS only if the aircraft can be navigated along the computed centerline by reference to the AFIS.

(2) If using theodolite or AFIS not capable of measuring the computed centerline, the azimuth boresight signal must be evaluated. When using theodolite, position the instrument in-line with the antenna center and use normal procedures. To inspect the azimuth boresight using AFIS, create a "pseudo runway" (see Figure16-7). The centerline of this "runway" passes through the AZ antenna. Runway updates are through markers on centerline at each end of the "runway". The television positioning system (TVPS) must be used unless suitable visual cues are present to accurately determine centerline and runway ends. Facility data is changed in the AFIS to use the "pseudo runway" and must be used as the reference for AZ alignment and structure measurements. When using AFIS, actual, or "pseudo runway" data may be used for coverage arcs or vertical coverage checks. Coordinates of the "pseudo runway" threshold and updating method used must be documented on the commissioning report and Facility Data Sheet.

(a) MCE is determined in a 1 nm segment ending at the MAP.

(b) Analysis of the azimuth inside the MAP is for coverage only.

(3) Elevation. Actual runway data and normal procedures must be used for all elevation angle and structure validation when using theodolite or AFIS with or without computed centerline capability.

(4) Procedural Evaluation. On commissioning and for any change in procedural azimuth or changes in data words affecting azimuth determination, the procedure must be validated using a "computed centerline" receiver or AFIS capable of providing equivalent pilot indications. For periodic inspections including SIAP and COV checks, a standard receiver (using Pseudo Runway procedures) may be used if:

(a) Azimuth PFE is within the tolerances specified in Paragraph 16.10.e.

(b) Basic and Auxiliary Data Words critical to computed centerline determination match those used during final approach course certification of the current SIAP (See Table 16-3).

d. Monitors. MMLS AZ and EL monitor limits must be evaluated at the actual alarm points. Optimize the AZ and EL Mean Course Errors to within 0.05° before checking monitor PFE limits. Figure 16-8 depicts the azimuths to be flown for coverage below path evaluations.

e. MMLS Data Words. The MMLS data words generated by the equipment are calculated from the equipment siting and procedural information input by the installer. The equipment may use an input to generate more than one data word, and some of these words are labeled differently in the MMLS than the received words. Table 16-5 translates these words.

Table 16-5. MMLS Data Word Translator.

Word	Description	MMLS Term	AFIS Term	Least Signification Bit
Basic 1	AZ ant to Threshold Dist	DATUM/THR (5)	F DIS	100 mtr
	AZ proportional neg limit	AZ LOW LIM	F PNLM	2°
	AZ proportional pos limit	AZ UPR LIM	F PPLM	2°
	Clearance signal type	(1)	C TYPE	0=pulse/1=scan
Basic 2	Minimum glidepath angle	MIN GP	E MPA	0.1°
	Apch EL Status	FLD MON	EL/F/BZ	0=abnormal/ 1=normal
	Apch AZ Status	FLD MON	EL/F/BZ	0=abnormal/ 1=normal
	Back AZ Status	(1)(4)	EL/F/BZ	0=abnormal/ 1=normal
	DME Status	DEU/NORM/BYP	DME ST	(2)
Basic 3	AZ Beamwidth	(1)	F BMW	0.5°
	EL Beamwidth	(1)	E BMW	0.5°
	DME Distance	AZ/DATUM DIST	DDIS	12.5 mtr
Basic 4	AZ Mag Orientation	AZ MAG ORIENT	F ALN	1° (3)(6)
	Back AZ Orientation	(4)	B ALN	1°
Basic 5	Back AZ neg prop limit	(4)	B PNLM	2°
	Back AZ pos prop limit	(4)	B PPLM	2°
	Back AZ Beamwidth	(4)	B BMW	0.5°
Basic 6	MLS Identification	3-letter entry	FAC ID	
AUX 1	AZ antenna offset	AZ OFFSET DIST	F OFF	1 mtr (8)(6)
	AZ antenna to Datum Point distance	AZ/DATUM DIST	F DIS	1 mtr (6)
	AZ alignment with Rwy C/L	AZ W/CL	F ALN	0.01° (8)(6)
	AZ coordinate system	(1)	AZ C/P	0=Conical/1=planar
	AZ antenna phase center height	AZ ANT HGT	AZ HT	1 mtr

Word	Description	MMLS Term	AFIS Term	Least Signification Bit
AUX 2	EL antenna offset	EL OFFSET DIST	E OFF	1 mtr (8)
	Datum point to threshold distance	DATUM/THR	MLS DIS	1 mtr (6)
	EL antenna phase center height	EL ANT HGT	E HT	0.1 mtr
	Datum point elevation	DATUM ELEV	MLS HT	1 mtr (9)
	Threshold Height	THRESH HGT	RWY HT	0.1 mtr
AUX 3	DME offset	AZ OFFSET DIST	DME OFF	1 mtr (8)(6)
	DME to datum point distance	AZ/DATUM DIST	DME DIS	1 mtr (6)
	DME antenna height	AZ ANT HGT	DME HT	1 mtr
	RWY stop end distance	STOP END DIS	RWY SND	1 mtr (9)
AUX 4	Back AZ ant offset	(4)	B OFF	1 mtr (8)
	Back AZ to datum point distance	(4)	B DIS	1 mtr
	Back AZ align with rwy C/L	(4)	B ALN	0.01° (8)
	Back AZ coord sys	(4)	BZ C/P	0=Conical/1=Planar
	Back AZ ant phase center height	(4)	B HT	1 mtr

Notes:

(1) Factory set, no field input

(2) DME status codes: 0 0 DME inoperative or not available

- 0 1 Only initial approach or DME/ N available (normal MMLS status)
- 1 0 Final approach mode std 1 available
- 1 1 Final approach mode std 2 available

(3) Magnetic orientation is 180° from procedural front course azimuth.

(4) Back azimuth not used.

(5) Split-site configuration is combined value: AZ/ DATUM DIST DATUM/ THR

(6) Computed centerline critical values

(7) Distances and heights are with respect to MLS datum point.

(8) Negative number indicates left of C/ L looking from threshold to stop end.

(9) May be zero or actual value.

f. ID. To preclude confusion with DME indications, ensure the MMLS identification is not the same as any other DME source used for any approach or missed approach guidance.

g. DME. When the MMLS is placed in an abnormal configuration for monitor checks or adjustments, the DME continues transmitting, but the pulse spacing is changed to 33 microseconds. With the normal "Y" channel DME spacing of 30 microseconds, some receivers may remain locked onto the DME signal. This indication is not hazardous and should be disregarded.

9. Analysis.

a. Azimuth PFE, PFN, and CMN will be evaluated over any 40-second interval of radial flight within the coverage area. Measured parameters must be in tolerance for no less than 95% of the interval measured. PFE tolerances must only be applied with use of AFIS or RTT.

b. Elevation PFE, PFN, and CMN will be evaluated over any 10-second interval of radial flight within the coverage area at or above 0.9°. Measured parameters must be in tolerance for no less than 95% of the interval measured. PFE tolerances must only be applied with use of AFIS or RTT when flown radially.

c. Manual analysis of PFN can be determined by measuring the signal deviations from the mean azimuth or elevation angle that have a duration greater than:

(1) 6.3 seconds for azimuth

(2) 2 seconds for elevation

d. Manual analysis of CMN can be determined by measuring the signal deviations from the mean azimuth or elevation angle that have a duration less than:

(1) 10.4 seconds for azimuth

(2) 6.3 seconds for elevation

(3) CMN filter bandpass frequency overlaps a portion of the PFE bandpass frequency. The resultant CMN signal will be superimposed upon the PFE component, resulting in a larger error than is actually present. CMN must be reported after subtraction of the PFE component.

e. Monitor limits are determined by the maximum PFE found in the alarm configurations. If monitors are checked airborne, make separate runs, measuring PFE in each configuration. If the AZ alignment monitor is checked on the ground, algebraically add the amount of alignment change to the PFE value found on the normal approach.

10. Tolerances.

a. Facility Error Budgets. An MMLS error budget must be computed in the same manner as one done for an MLS. Due to the unique siting requirements of each MMLS installation and the resulting difference in tolerances, an MLS error budget must be computed for each facility. The location of the azimuth site determines the reference point to be used in the computation of the error budget. The EL error budget reference point must coincide with the AZ.

(1) ARD when the azimuth is sited along or within 1.00° of runway centerline (See Figure 16-3), and a 200 ft or less Decision Altitude is published.

(2) 100 ft below the MAP when the azimuth is:

(a) Sited along or within 1.00° of runway centerline (See Figure 16-3), and a Decision Altitude above 200 ft is published.

(b) Offset. (See Figure16-4).

NOTE: Azimuth antennas installed with a distance to Missed Approach Point/ Decision Altitude greater than 9,115 ft must have a tolerance of 0.11° for PFN and 0.22° for PFE applied at the MAP.

(c) Co-located azimuth with elevation. (See Figure 16-5).

(d) Heliports which are considered to be those facilities with less than 2,300 ft between the azimuth and the approach reference datum when sited along runway centerline.

(e) Non-precision approach aid terminating at a point in space and not aligned with a precision runway. (See Figure 16-6.)

b. Application of Tolerance Degradation Factors. Tolerances are specified as the calculated or standard value at the reference point, either ARD or MAP. As shown in Table 16-3, these tolerances may be widened (in most cases to an indicated maximum value) by the indicated degradation factors with increasing distance, lateral, or elevation displacement from the reference point. To calculate azimuth tolerance at a given point, use the following steps, in order:

(1) Determine the tolerance at the reference point, using the formula in Appendix B.

(2) Define the measurement point in distance, lateral angle, and elevation angle from the reference point

(3) C/ L Distance Degraded Tolerance

(a) Multiply the tolerance at the reference point by the distance degradation factor. This gives the maximum boresight tolerance at 20 nm.

(b) Subtract the tolerance at the reference point from the tolerance at 20 nm. This gives the maximum degradation.

(c) Divide the maximum degradation by 20, giving the degradation increment (degrees per nm).

(d) Multiply the degradation increment by the mileage from ARD of the measurement point, then add the original tolerance at the reference point. The result is the tolerance on C/ L (boresight) at the distance of the measurement point.

(4) Laterally Degraded Tolerance

(a) Multiply the distance degraded tolerance from Step (3)(d) above by the off-course degradation factor, giving the maximum degradation at 40 (60)° at the specified distance.

(b) Subtract the C/ L value from the value at 40°. The result is the maximum degradation.

(c) Divide the maximum degradation by 40 to get the degradation Increment (degrees per degree).

(d) Multiply the degradation increment by the number of degrees off-course at the measurement point; add this value to the value from Step (3)(d) above. This gives the tolerance at the measurement distance and lateral offset.

(5) Vertically Degraded Tolerance (above 9° only).

(a) Multiply the distance and laterally degraded tolerance from Step (4)(d) above by the vertical degradation factor, giving the maximum tolerance at 15° elevation at the specified distance and lateral offset.

(b) Subtract the distance and laterally degraded value (Step (4)(d)). The result is the maximum degradation.

(c) Divide the maximum degradation by the number of degrees difference from the MGP and 15° to get the degradation increment (degrees per degree).

(d) Multiple the degradation increment by the number of degrees above the MGP at the measurement point; add this value to the value from (4)(d). This gives the tolerance degraded by all three factors.

(6) The tolerance to be applied is the greater of either the value calculated above, or the maximum, as listed in the individual facilities listed below.

Example:
Given: AZ to ARD distance – 7,965 ft, MGP – 3.0°
PFE tolerance at ARD from Paragraph 16.5.e – 20 ft
Find: AZ PFE tolerance at 14 nm from ARD, @ 10° off-course, @ 12°

Table 16-6. Tolerance Degradation Computation.

14b step	Calculation	Result	Definition
(1)	Arctan (20 / 7,965)	0.1438	Tolerance at ARD
(3)(a)	(0.1438 x 1.2)	0.1726	Tolerance @ 20 nm on C/L @ 3.00°
(3)(b)	(0.1726 – 0.1438)	0.0288	Maximum Degradation
(3)(c)	(0.0288 / 20 nm)	0.0014 per nm	Degradation Increment
(3)(d)	(0.0014 x 14 nm) + 0.1438	0.01634	Tolerance @ 14 nm on C/L @ 3.00°
(4)(a)	(0.1634 x 1.5)	0.2451	Tolerance @ 14 nm @ 40°
(4)(b)	(0.2451 – 0.1634)	0.0817	Maximum Degradation
(4)(c)	(0.0817 / 40°)	0.0020 per degree	Degradation Increment
(4)(d)	(0.0020 x 10°) + 0.1634	0.1834	Tolerance @ 14 nm @ 10° @ 3.00°
(5)(a)	(0.1834 x 1.5)	0.2751	Tolerance @ 14 nm @ 10° @ 15°
(5)(b)	(0.2751 – 0.1834)	0.0917	Maximum Degradation
(5)(c)	(0.0917 / 12°)	0.0076	Degradation Increment
(5)(d)	(0.0076 x 9°) + 0.1834	0.2518	Tolerance @ 14nm @ 10° @ 12°

c. Standby Equipment must meet the same tolerances as the primary equipment.

d. Alignment must be reported as the average flight inspection angle. Facilities found with an alignment that exceeds 60% of the allowable PFE must generate a maintenance alert IAW Paragraph 15.8.e.

e. Individual System Tolerances

(1) MMLS Facilities Authorized for no Lower than Category I Minima Use by Military Aircraft Only

(2) Facilities checked using these tolerances must be restricted. If applicable, the flight inspection reports must be annotated IAW Chapter 24.

(3) Split-Site Centerline Azimuth

Parameter	Reference Paragraph	Inspection		Tolerance/Limit at ARD	Maximums	Degradation Factors
		C	P			
Alignment (MCE)		X		0.05°		
	16.3.b(3)		X	PFE tolerances apply		
PFE	16.4	X	X	28 ft not to exceed 0.50°	0.50°	(1)
PFN	16.4	X	X	14 ft not to exceed 0.50°	0.50°	(1)
CMN	16.3.b(3)	X	X	0.20°		
Alignment Monitor	16.3.b(4)	X	X	PFE tolerances apply		

Note:
(1) On C/ L at 20 nm = 1.2 x MAP value

(4) Azimuth Collocated with Elevation

Parameter	Reference Paragraph	Inspection		Tolerance/Limit @ Reference Point	Maximums	Degradation Factors
		C	P			
Alignment (MCE)	16.3.b(3)	X	X	0.05° PFE tolerances apply		
PFE	16.4	X	X	35 ft not to exceed 0.50°	0.50°	(1) (2)
PFN	16.4	X	X	66% of allowable PFE	0.50°	(1) (2)
CMN	16.3.b(3)	X	X	0.20°	0.20°	None
Alignment Monitor	16.3.b(4)	X	X	PFE tolerances apply		

Notes:

(1) On C/ L at 20 nm = 1.2 x Reference Point value

(2) At 40° off course = 1.5 x C/ L value at same distance from Reference Point

(5) Elevation

Parameter	Reference Paragraph	Inspection		Tolerance/Limit @ Reference Point	Maximums	Degradation Factors
		C	P			
Alignment (MCE)	16.3.b(3)	X	X	0.05° PFE tolerances apply		
PFE	16.4	X	X	0.30°	0.30°	None
PFN	16.4	X	X	0.133°	0.133°	None
CMN	16.3.b(3)	X	X	0.20°	0.20°	None
Alignment Monitor	16.3.b(4)	X	X	PFE tolerances apply		

f. Data Words. The AFIS is the reference for the correctness of the received data words (data sheet for non-AFIS). The transmitted data words from the MMLS facility must be correct. Due to calculation rounding and feet/ meter conversion, some apparent errors occur. When the received data words do not match the AFIS expected values, the differences must be resolved with Facilities Maintenance. The following data words, if transmitted, have acceptable tolerances; all other values must match.

(1) Basic Data Words

Word	Description	Tolerance
Basic 1	AZ to threshold distance	± 1 Meter
Basic 3	DME distance	± 1 Meter

(2) Auxiliary Data Words

Word	Description	Tolerance
AUX 1	Az to Offset Az to MDPT Az Ant Height	± 1 Meter ± 1 Meter ± 1 Meter
AUX 2	El Ant Offset MDPT Distance El Ant Height MDPT Height Threshold Height	± 1 Meter ± 1 Meter ± 0.1 Meter ± 1 Meter ± 0.1 Meter
AUX 3	DME Offset DME to MDPT Distance DME Ant Height Rwy Stop End Distance	± 1 Meter ± 1 Meter ± 1 Meter ± 1 Meter

Figure 16-7. Pseudo Runway.

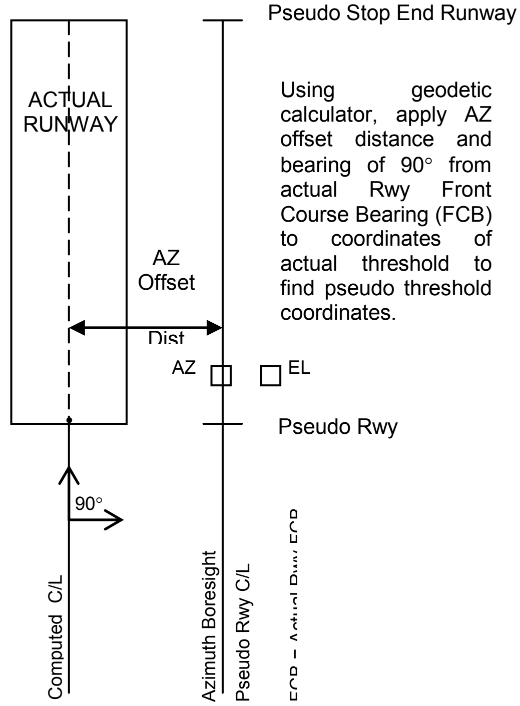


Figure 16-8. Azimuth for Coverage Below Path. (Computed Centerline Facilities)

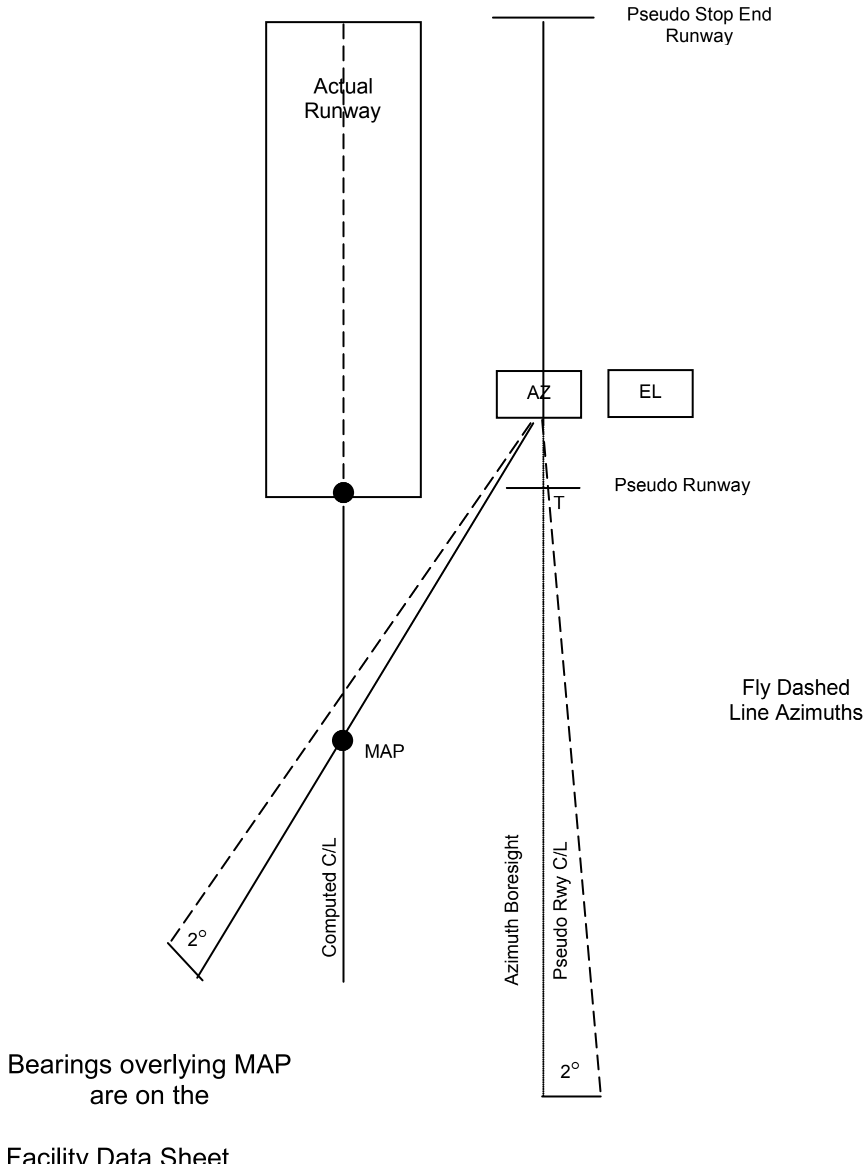
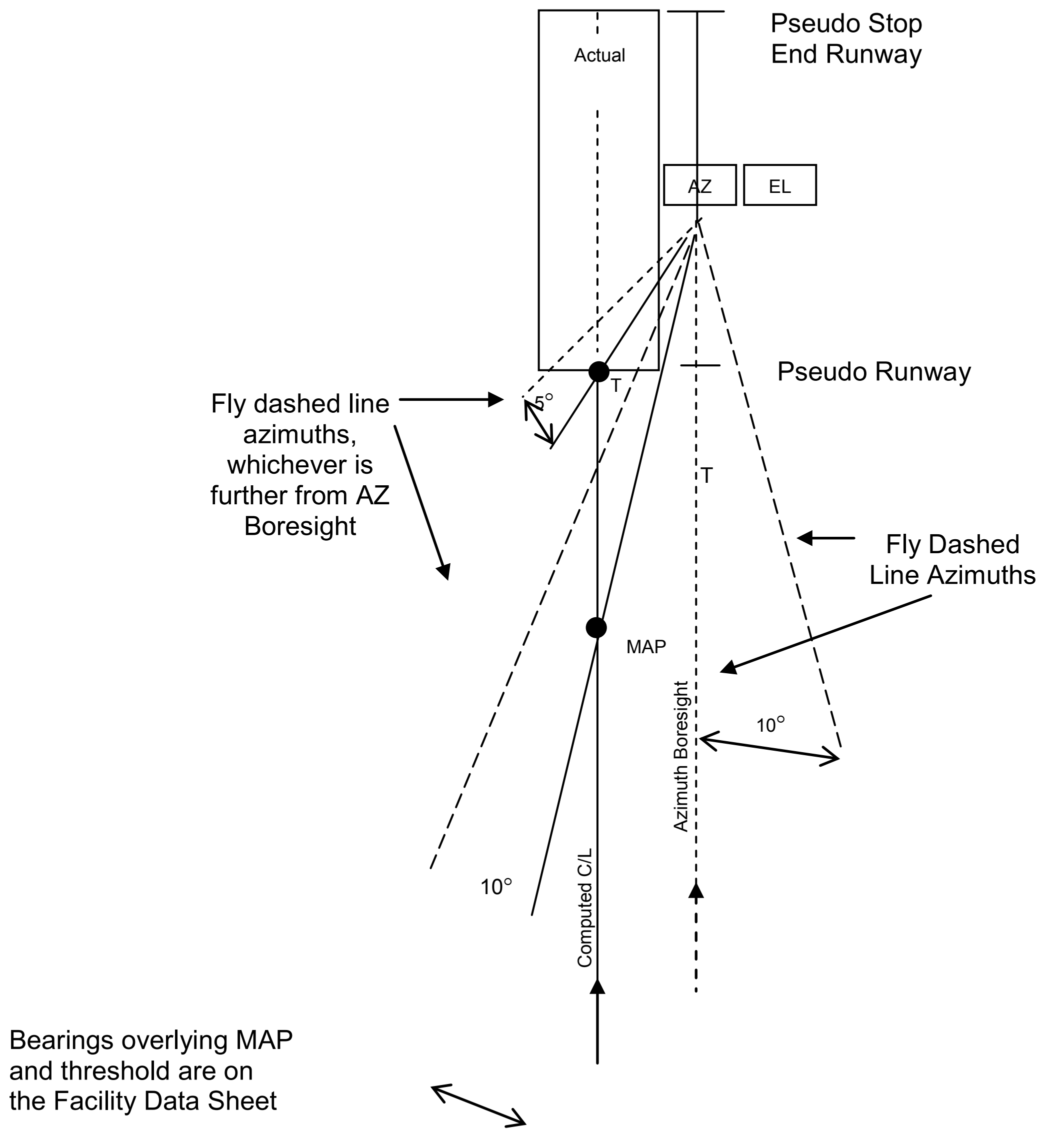


Figure 16-9. MMLS Coverage Validation and Minimum Proportional Guidance.



Chapter 17. Ground Based Augmentation System (GBAS)

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Chapter 17. Ground Based Augmentation System (GBAS)

1. Introduction. GBAS is a safety-critical system consisting of the hardware and software that augments the Global Positioning System (GPS) Standard Positioning Service (SPS) to provide precision approach and landing capability. The positioning service provided by GPS is insufficient to meet the integrity, continuity, accuracy, and availability demands of precision approach and landing navigation. GBAS provides a precision approach service and a positioning service, which provides horizontal position information to support RNAV operations in the terminal area. GBAS augments the GPS SPS in order to meet these requirements. These augmentations are based on differential GPS concepts. GBAS refers to any system compliant with the existing ICAO standards.

The FAA version of GBAS is the Local Area Augmentation System (LAAS). LAAS will provide the precision approach and positioning services defined by the ICAO GBAS standards, plus additional services. LAAS focuses its service on the airport area to provide for departure, terminal, precision approach, and surface navigation operations. LAAS will yield the extremely high accuracy, availability, continuity, and integrity necessary for Category I, II, and III precision approaches. It is expected that the end-state configuration will pinpoint the aircraft's position to within one meter or less with a significant improvement in service flexibility.

GBAS is comprised of ground equipment and avionics. The ground equipment includes four reference receivers and associated antennas, an electronics cabinet, and a very high frequency (VHF) data broadcast (VDB) transmitter and associated antenna. The ground equipment is complemented by GBAS avionics installed on the aircraft.

The VDB broadcasts the GBAS signal throughout the GBAS coverage area to avionics in GBAS-equipped aircraft. The GBAS reference receivers independently measure GPS satellite pseudo-range and carrier phase and generate differential carrier-smoothed-code corrections that are eventually broadcast to the user via a 31.5 kbps VHF data broadcast (in the 108 – 118 MHz band) that also includes safety and approach geometry information. Aircraft landing at a GBAS-equipped airport will be able to perform precision approach operations to at least Category I weather minima. The GBAS approach charts are titled "GLS RWY xx" (GBAS Landing System).

The navigation guidance on terminal segments for the aircraft to transition into a GBAS precision approach final (or missed approach) may be provided by either RNAV or ground-based systems (e.g., VOR). Use of the appropriate chapter(s) in this order is required for flight inspection of procedural segments for obstructions, procedural design, navigation guidance, and RNAV coding. This chapter provides inspection guidance and tolerances for any system meeting ICAO GBAS minimum standards.

2. Preflight Requirements. The Flight Inspector must prepare for the flight inspection in accordance with this order. For each GBAS to be evaluated, the inspector must determine the type and number of approach procedures to be supported and if approach procedures to parallel runway groups will be provided. En route and terminal procedural segments transitioning into the GBAS final may require inspection of ground facilities or Area Navigation (RNAV) segments. Refer to the appropriate chapters of this order for requirements and tolerances.

Due to the criticality of data, the inspector must ensure that all required data is based upon the same reference datum (NAD83/ NAVD88, ITRF00/ WGS84, etc.). This includes the facility data sheet, proposed approach procedures, FAS Data, GBAS facility reference point (as defined on the facility data sheet and broadcast in the Type 2 message), differential GPS (if used), the runway coordinates, and elevations.

Prior to mission departure, confirm Flight Inspection System (FIS) access to each individual procedural FAS data binary file and verify the cyclic redundancy check (CRC) remainder matches the FAA Form 8260-10 data (or equivalent). This ensures no errors occurred during data transfer (data file integrity). Any corruption of data during transfer must be resolved prior to conducting the inspection.

a. Inspection System Calibration. Since the VDB antenna may radiate both horizontally (GBAS/ H) and elliptically (GBAS/ E) polarized signals, the FIS will be calibrated for both polarizations. The calibration must include data for the airborne antenna pattern and cable loss.

b. D_{max} Determination. The GBAS may or may not utilize a D_{max} function. If applicable, determine from the airport data sheet the maximum use distance (D_{max}) for precision approach and positioning service volume coverage evaluation.

c. GBAS Position, Velocity, and Time (PVT) Mode. Currently, GBAS does not provide IFR-certified (approved) PVT services; these services may be implemented in the future. If PVT services will be provided, Item (1) below will be completed prior to the flight.

(1) PVT Service Inspection: (Reserved)

(2) Enabling PVT Services. Flight inspection systems requiring the PVT services to be enabled in order for the FIS to display and collect data will require coordination with ground facility personnel to ensure the GBAS PVT services are enabled prior to starting the inspection.

> Note: The ground system configuration may require up to 35 minutes for transitions between Non-PVT (PVT disabled) services and PVT services enabled.

Upon completion of the inspection, ground facility personnel must disable the PVT services and return the system to its normal operating configuration. Once the system has been restored to its normal operating configuration, a final normal approach must be performed to confirm course guidance. Course guidance verification can be completed by flying a minimum of one GLS approach

d. GBAS FAS Data Block Validation. The FAS data block consists of data elements that prescribe the precision three-dimensional geometric path in space that an aircraft will fly on final approach. Particular attention should be paid to the data accuracy in the FAS data block for GBAS flight procedures. Corruption of ellipsoid height data can have adverse effects on the FIS announced TCH value and the location of a glide path by displacing the glide path forward or aft along track of the intended procedural design.

Errors in this data can quickly lead to an unacceptable or hazardous flight path. There are several sources for data errors, with survey data errors as the most common, along with incomplete terrain and obstacle data. GBAS uses an earth-centered, earth-fixed (ECEF) reference system.

Conversions between geodetic datums can induce errors. Vertical datum differences can result in positioning errors, causing the FIS announced TCH for GBAS procedures to be higher or lower than designed. It is imperative that procedural data and airport data are matched for the flight inspection and for the date of procedure publication.

e. GBAS Supporting Parallel Runways. When the GBAS to be evaluated supports approach procedures to parallel runways, approach sectors are defined. An approach sector bounds the area of airspace common to all the approach procedures having the same approach and landing direction. Thus, a set of parallel runways will have two approach sectors associated with them, one for each landing direction. The methodology for evaluation of the approach sector, as opposed to assessing each runway end individually, permits sufficient assessment of each approach procedure while improving the efficiency of the inspection by eliminating redundant VDB coverage assessments. Some parallel runway sites **may not** be appropriate for application of this procedure due to excessive distance between the parallels, environmental issues between the parallels, the stagger between runway thresholds, location of VDB antenna relative to the course for the procedures, etc. A thorough engineering analysis may be required for runways with separations exceeding 4,000 feet (e.g., KDFW RWY 13L/ RWY 31R and RWY 13R/ 31L) and/or when the difference in the setbacks of the runway thresholds as measured parallel to the runway centerline exceeds 2,500 feet (e.g., KAUS 17R and KAUS 17L).

(1) Determine the coordinates for both the fictitious approach sector alignment point (FASAP) and fictitious approach sector landing threshold point (FASLTP) for each approach sector. The approach sector centerline runs parallel to the runway centerlines and is located midway between the centerlines of the outer-most runways (see Figure 17-1). The FASAP and FASLTP are located abeam the furthest most runway stop end and threshold, respectively, and on the approach sector centerline as illustrated in Figure 17-1.

(2) Determining Parallel Runway Left/ Right Sector Limit Boundary (Figure 17-2).

(a) For the left-most runway: The left limit of course centerline boundary is defined by the full-scale of “fly right” on the cockpit course deviation indicator (CDI).

(b) For the right-most runway: The right limit boundary is defined by the full-scale of “fly left” on the cockpit CDI.

f. GBAS Supporting TAP Procedures. (Reserved)

g. GBAS Supporting Airport Surface Operations. (Reserved)

Figure 17-1. Determining Approach Sector Centerline, FASAP, and FASLTP.

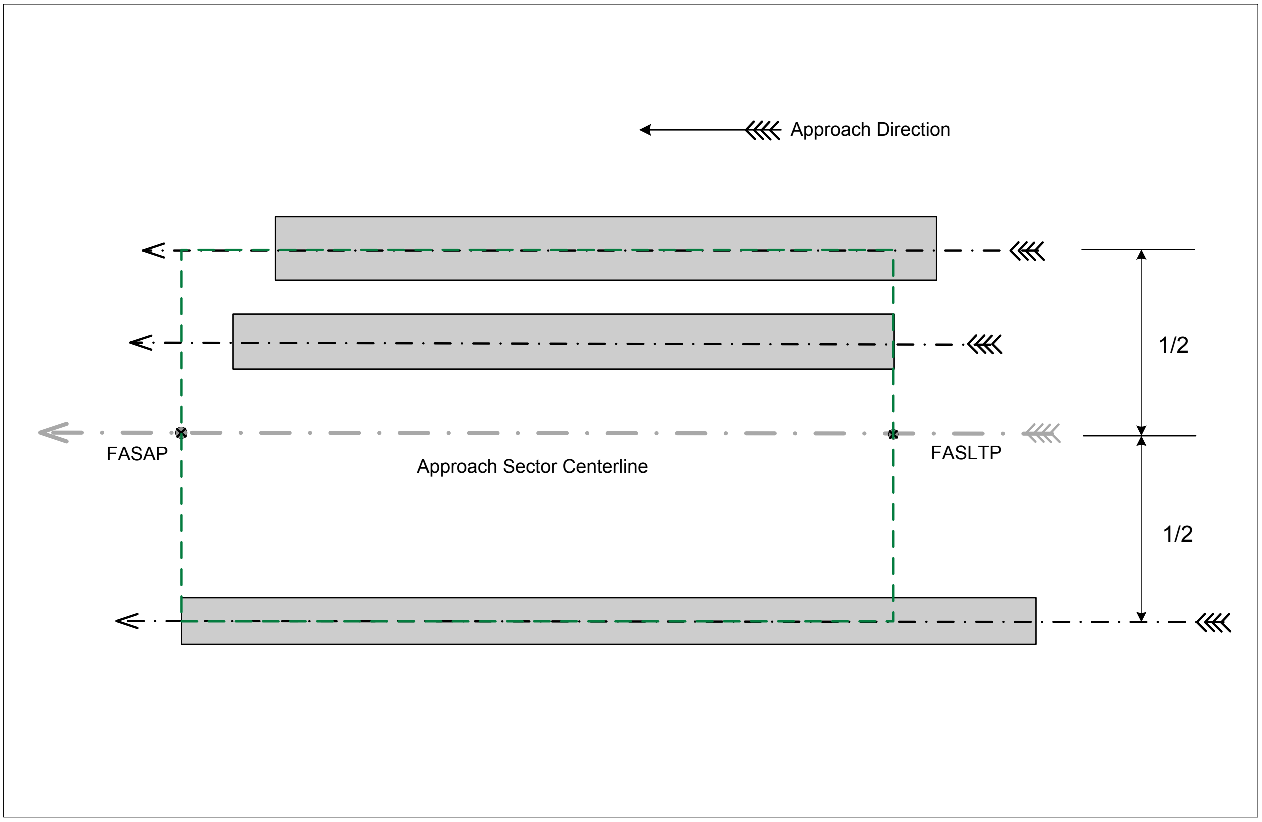
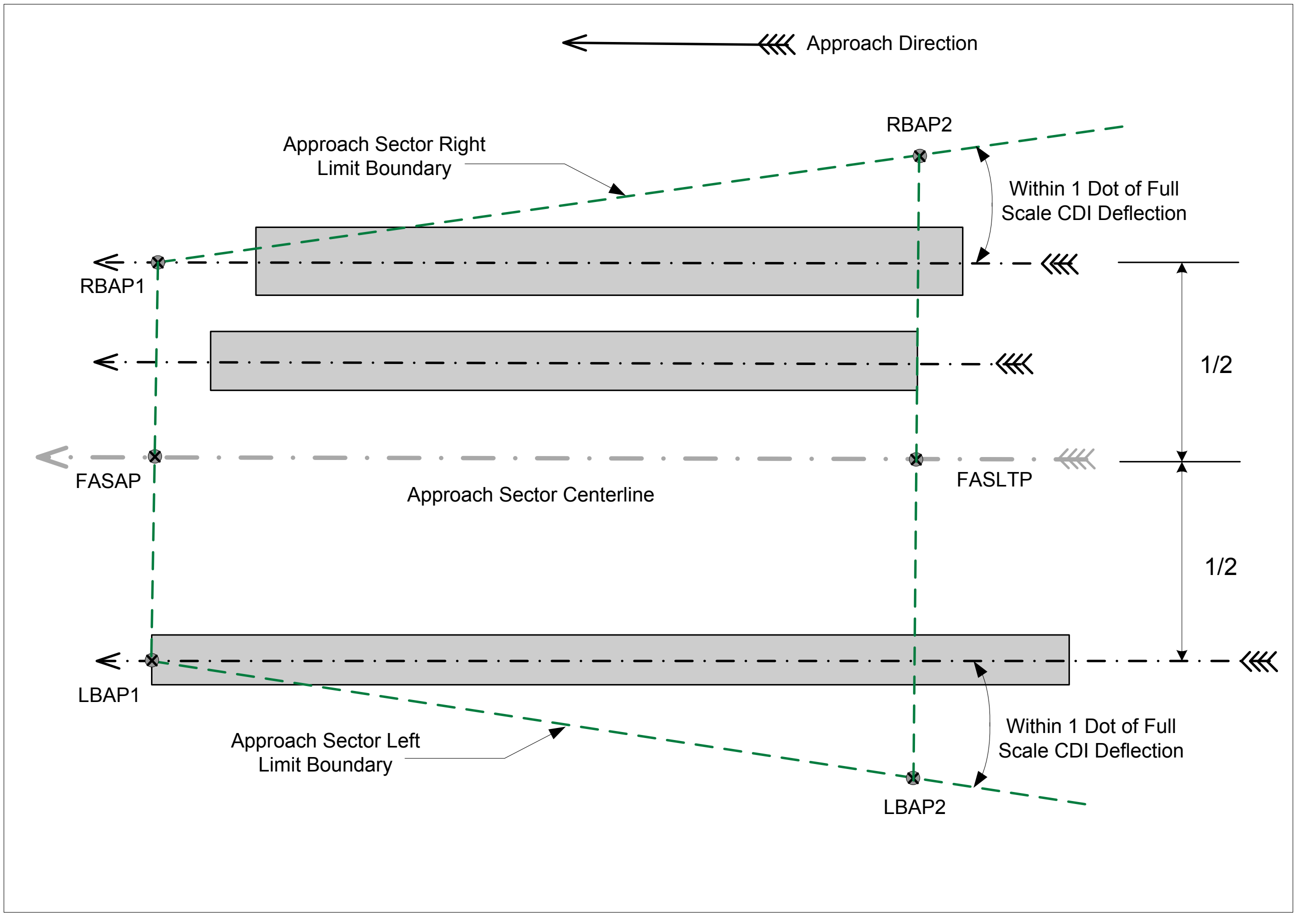


Figure 17-2. Determining Right/ Left Boundary and Boundary Alignment Points.



3. Flight Inspection Procedures:

a. Checklist

Type Inspection	**Paragraph Reference**	**C**	**P**
VHF Data Broadcast (VDB) Coverage	17.3.b 17.3.d(1)	X	 X
Terminal Area Path (TAP)	17.3.c(1) 17.3.d(3)	X	 X
Initial and Intermediate Approach Segment	17.3.c(2)	X	
Final Approach Segment	17.3.c(3)	X	
Missed Approach Segment	17.3.c(4)	X	
Instrument Approach Procedure	17.3.c(5)	X	
Final Approach Segment (FAS) Data	17.3.f(2)	X	
FAS Data Message Type 4 Alert Limits	17.3.f(4)	X	X
FAS Data CRC	17.3.f(7) 17.3.d(2)	X	 X
Broadcast VDB Message Type 2	17.3.f(2)	X	X
Airport Surface	17.3.c(6) 17.3.d(4)	X	 X
Polarization	17.3.b(1)	X	X
SIAP	Chapter 6 17.3.c(5)	X	X
RFI	Chapter 23 17.3.f(6)	X	X

(1) Maintenance Procedures That Require a Confirming Flight Evaluation. The requirements for performing confirming flight evaluations after maintenance activities are located within the appropriate ground equipment maintenance manuals (e.g., Technical Instruction Book, Maintenance Handbook, and Commercial Instruction Book). The extent of the evaluation will depend on the specific ground equipment design and the particular maintenance activity performed.

(2) Flight Inspection Types:

(a) Commissioning: A comprehensive evaluation of the GBAS system and Standard Instrument Approach Procedures (SIAP(s)). See checklist.

(b) Periodic. VDB coverage along the lower orbit will be based on signal-strength assessments and loss of signal. The altitude established for the lower orbit during commissioning must be used. The GBAS broadcast FAS data block CRC must be evaluated and documented for each SIAP. Approach obstacle verification scheduling must be completed in accordance with Chapter 4.

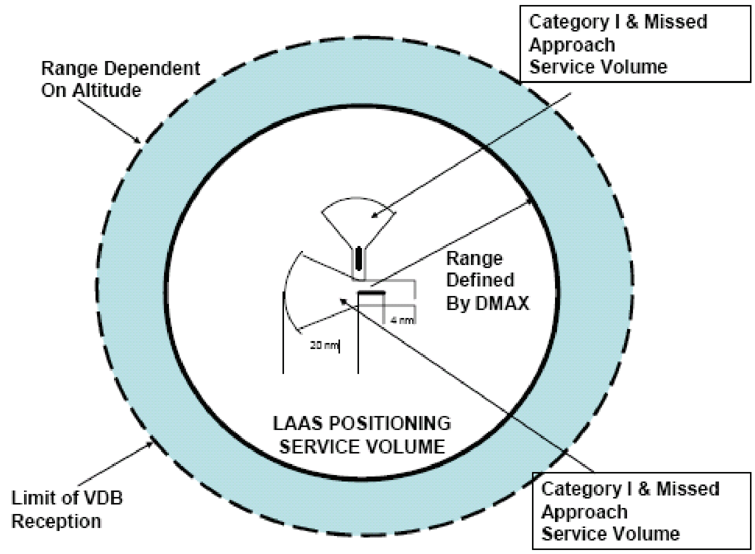
(c) Special. A special inspection will be required when a user complaint is confirmed, an existing approach is modified, or after certain maintenance activities identified within the appropriate ground equipment maintenance manuals.

b. GBAS VDB Coverage. The service volume for GBAS is constrained by both the radio frequency (RF) signal coverage provided by the ground-based VDB antenna(s) and maximum range (Dmax) from the GBAS for which the broadcast differential corrections are applicable (See Figure 17-3). RF signal coverage refers to those regions where the signal strength is sufficient to provide continuous reception by the aircraft of the data broadcast. RF signal coverage can extend beyond the airport terminal area, dependent on the output power of the VDB transmitter, VDB antenna type, aircraft altitude, and the horizon (line-of-sight) profile about the VDB antenna site.

For LAAS, the maximum use distance, Dmax, is site dependent and determined by the operational needs and supporting analysis that ensure system integrity is met. FAA certified LAAS Ground Facilities (LGF(s)) are required to support a Dmax value of at least 23 nm. The Dmax distance is referenced to the centroid of the LGF reference receivers.

The aircraft must be within the range defined by Dmax in order for the GBAS avionics to output differentially corrected information. That is, the GBAS differentially-corrected positioning service (i.e., PVT output) and course guidance are available when within the RF coverage volume out to the distance indicated by Dmax.

Figure 17-3. LAAS Coverage/ Service Volume (courtesy RTCA DO-245).



(1) VDB Signal Polarization. The GBAS VDB antenna radiates either a horizontally (GBAS/H) or elliptically (GBAS/E) polarized signal. This allows the data broadcast to be tailored to the operational requirements of the local airborne user community. The majority of aircraft will be equipped with a horizontally polarized VDB receive antenna, which can receive the VDB signal from either a horizontally or elliptically polarized VDB broadcast antenna. Aircraft equipped with a vertically polarized antenna will receive the vertical component of the elliptically polarized signal. Polarization is spot-checked once during the inspection and can be completed anywhere valid VDB signal is available.

(2) VDB Coverage Evaluation. The service volume of the VDB must encompass the area of intended terminal and approach operations. Since D_{max} defines the outer limit of the service volume, D_{max} must be set appropriately for each facility. The suitability of the value used for D_{max} will be evaluated for each GBAS. In addition, RF signal (minimum power) coverage within the service volume will be evaluated for procedurally significant airspace (procedure-based coverage assessment).

VDB coverage will be evaluated based on strength assessments, loss of signal, and data continuity alerts. The GBAS will be re-configured as required for flight inspection. The power output must be at the minimum RF power alarm point. The initial coverage checks will confirm the minimum RF power alarm point. Data continuity can be verified by validating correct FIS sensor status while in the GBAS reception area and positive GBAS course guidance as indicated on the CDI. No data continuity alerts are allowed while within the VDB approach coverage assessment areas in Table 17-1.

(a) VDB Coverage Assessment. Orbits are required at the extremes of the VDB coverage volume. The orbit maneuver is used primarily to check the lateral VDB coverage volume of the GBAS. GBAS coverage will be verified by flying an orbit at the maximum distance required to support the terminal and approach procedures (typically 20 – 30 nm). The orbit radius is based on the latitude/ longitude position of the GBAS VDB antenna. Two orbits are required during the commissioning coverage evaluation:

- At a height above the antenna elevation as computed using Equation 1;

Equation 1: Orbit Altitude (ft) = Ec + (95.5 x D) - 137

Notes:

1. Where Ec is the Earth Curvature (ft) = $(D)^2$ x (0.883)
2. D is the horizontal distance from the VDB antenna to the limit of coverage in nautical miles. For installations where the VDB antenna and the GBAS reference point are not co-located, the distance D may be larger than D_{max} (≈23 nm) to ensure flight inspection orbits encompass all GBAS procedure segments.
3. For LGF(s) in the United States, D is approximately 23 nm
4. The MSL orbit altitude (True) may be rounded up to the nearest 100’
5. For D = 23 nm, the orbit height is 2526.6’ above the VDB antenna
6. VDB coverage requirements may vary by installation and use requirements

OR

At the minimum altitude required to meet Air Traffic Service requirements.

Note: The minimum altitude required to meet Air Traffic Service requirements must not be lower than that defined by Equation 1. If the minimal altitude required by air traffic services is higher than the altitude derived from the equation, a coverage restriction based upon the higher altitude will be required.

- At 10,000 ft above the antenna elevation.

Clear line-of-sight (LOS) from the VDB transmit antenna may not exist for the entire lower VDB coverage orbit. This may cause loss of data continuity in the VDB signal. In this case, an additional orbit, partial or whole as required, should be performed at the lowest altitude where clear LOS from the VDB transmit antenna exists. Establish facility restriction(s) and take appropriate NOTAM action based upon facility performance IAW Chapter 5, Section 1.

Note: Facility coverage assessments are performed with the facility operating at the lowest broadcast power (RF power) authorized for the facility to remain in operation. The GBAS provides for monitoring of the RF power, including an alarm point for low power.

1 Facilities Broadcasting D_{max}: Verify VDB data continuity, GBAS course guidance, and signal strength are satisfactory inside D_{max}. Verify D_{max} functionality by transitioning the aircraft beyond the designated D_{max} value and verifying a data continuity alert indication and loss of GBAS course guidance. When transitioning from beyond $D_{max, to}$ inside D_{max}, data continuity must transition to GBAS. Positive GBAS course guidance must be displayed when in the approach coverage assessment areas in Table 17-1. Flagged course guidance in areas of non-use should not result in a failed inspection

2 Facilities Not Broadcasting D_{max}**:** (Reserved)

(b) Procedure Coverage Assessment**.** Initial coverage assessments are performed with the VDB transmitter power set at the RF power alarm point of the VDB monitor.

1 Terminal Area Path (TAP). (Reserved)

2 Approach Coverage. Table 17-1 provides the requirements for assessing VDB coverage for each approach procedure. The maneuvers listed in Table 17-1 are intended to provide assessment of the coverage requirements illustrated in Figure 17-4. For a GBAS servicing multiple runways, each approach procedure must be evaluated in accordance with Table 17-1, except for the case of parallel runways.

When the GBAS to be evaluated supports approach procedures to parallel runways, approach sectors are defined, one for each landing direction. Table 17-2 provides modified requirements for assessing parallel runway configurations. The measured values are the same as those specified in Table 17-1

3 Airport Surface Coverage. (Reserved)

Table 17-1. VDB Approach Coverage Assessment (See Notes 3 and 5).

Requirement	Evaluation Area	Method	Evaluation Criteria
Normal Approach	From 20 nm to LTP	Fly on Path, on course	No CDI Flags
Lower Limit of Approach	From 20 nm to LTP	From 21 nm and 5,000' above GBAS, fly on course, intercept and fly glide path within 1 dot of full scale below path	No CDI Flags Note 1 Note 2
Upper Limit of Approach	From 20 nm to LTP	From 21 nm and 7000'-8,000' above GBAS, fly on course, intercept and fly glide path within 1 dot of full scale above path.	No CDI Flags Note 1 Note 2
Left Limit of Approach Note 4	From 20 nm to LTP	From 21 nm, fly on path and offset course to within 1 dot of full scale of "fly right".	No CDI Flags Note 2
Right Limit of Approach Note 4	From 20 nm to LTP	From 21nm, fly on path and offset course to within 1 dot of full scale of "Fly left".	No CDI Flags Note 2
Coverage from MVA Note 4	From 20 nm to 7º glide path	From 21 nm on course and the MVA or 2,500 feet above LTP, whichever is higher, fly at level altitude until 7º path. Note: If possible, continue beyond 7º to determine extent of VDB coverage over the airport.	No CDI Flags Note 1
Coverage from Upper Service Volume Note 4	From 20 nm to 7º glide path (13.4 nm to Glide Path Intercept Point (GPIP))	From 21 nm on course and 10,000' above LTP, fly at level altitude until 7ºpath.	No CDI Flags Note 1
Missed Approach	From Decision Altitude to 4nm from departure end of runway	Fly runway course, climb at 200' per nm or minimum climb gradient specified	No CDI Flags
Roll Out	From Runway End to Runway End	Taxi Along Runway	No Lateral CDI Flags

Notes:

(1) Determine that guidance is available and the CDI is active at the upper and lower vertical procedure extremities. No CDI Flags will indicate positive GBAS course guidance, data continuity, adequate VDB signal strength, and GPS signal reception.

(2) Determine that guidance is available and the CDI is active at the lateral procedure extremities.

(3) VDB transmitter power set at the lower limit of the VDB monitor.

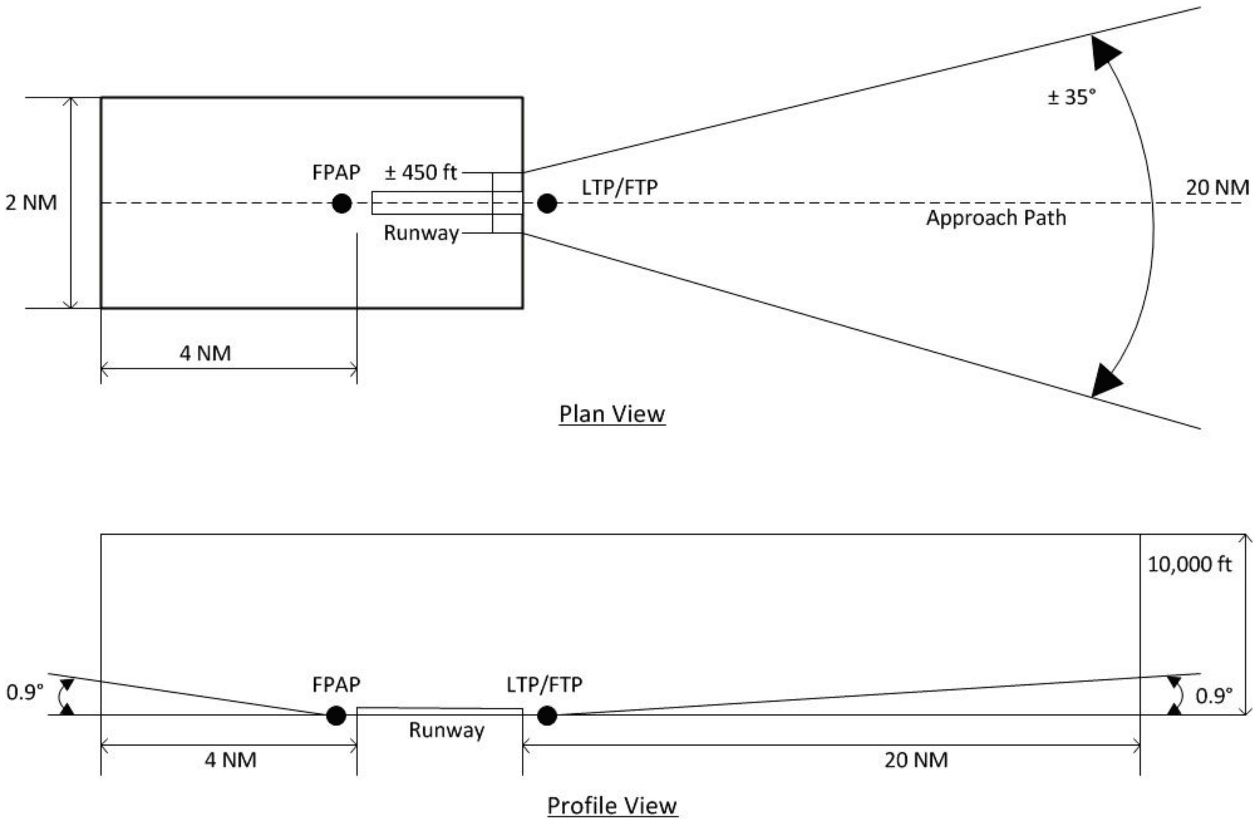
(4) See Table 17-2 for requirement when evaluating parallel runway configurations.

(5) Within GBAS positioning service volume, verify data continuity

Table 17-2. VDB Approach Coverage Assessment – Parallel Runways.

Requirement	**Evaluation Area**	**Modified Method**	**Performed For**
Normal Approach	From 20 nm to LTP	No change	Each approach procedure
Lower-Limit of Approach	From 20 nm to LTP	No change	Each approach procedure
Upper-Limit of Approach	From 20 nm to LTP	No change	Each approach procedure
Left-Limit of Approach	From 20 nm to abeam FASLTP	From 21 nm, fly on path and on sector left boundary to within 1 dot of full scale of "fly right".	For left limit of each approach sector
Right-Limit of Approach	From 20 nm to abeam FASLTP	From 21 nm, fly on path and on sector right boundary within 1 dot of full scale of "fly left".	For right limit of each approach sector
Coverage from MVA	From 20 nm to 7° glide path	From 21 nm, on approach sector centerline and the MVA or 2,500' above FASLTP, whichever is higher, fly at level altitude until 7° path relative to FASLTP.	For each approach sector centerline
Coverage from Upper Service Volume	From 20 nm to 7° glide path (13.4 nm to GPIP)	From 21 nm, on course and 10,000' above FASLTP fly at level altitude until 7° path relative to FASLTP.	For each approach sector centerline
Missed Approach	From Runway Stop End to 4 nm	No change	For each approach procedure
Roll Out	From Runway End to Runway End	No change	Once for each runway

Figure 17-4. Approach Coverage Requirements.



c. Aircraft Positioning. The instrument approach procedure must be validated to ensure flyability and safety. This evaluation and analysis must be performed in accordance with this order. Use of an RNAV-coded procedure to overlay the Initial and Intermediate segments will assist in analysis of those segments.

> **Note:** All vertical guidance from the GBAS is differentially corrected GPS altitude.

(1) Terminal Area Path (TAP). (Reserved)

(2) Initial and Intermediate Approach Segments. Fly the procedure from the Initial Approach Fix (IAF)/ Intermediate Fix (IF) to the Final Approach FIX (FAF) while maintaining procedural altitudes.

(3) Final Approach Segment (FAS). Fly the final segment at procedural altitudes until intercepting the glide path, and descend on the glide path to the LTP/ FTP. Procedures that support azimuth only approaches must be evaluated to the MAP.

(4) Missed Approach Segment (MAP). Fly the missed approach procedure from the MAP using the procedural waypoints or associated navigation systems.

(5) Standard Instrument Approach Procedure (SIAP). The instrument approach procedure must be validated to ensure flyability and safety.

(6) Obstructions. Controlling obstacles must be verified.

(7) Airport Surface. (Reserved)

d. Periodic Evaluation. The purpose of a periodic evaluation is to ensure there has not been any degradation of the VDB coverage due to environmental changes or equipment repair/ replacement and there are no new sources of RF interference.

(1) VDB Coverage. VDB coverage along the lower orbit will be evaluated based on signal-strength assessments and loss of signal. The altitude established for the lower orbit during commissioning must be used.

(2) FAS Data Block. The GBAS broadcast FAS Data CRC will be checked for each SIAP to ensure there has been no change or corruption. The FAS Data CRC evaluation may be performed and documented anywhere VDB reception is valid.

(3) Terminal Area Path (TAP). (Reserved)

(4) Airport Surface. (Reserved)

e. Special Evaluation. A special flight inspection evaluation is required subsequent to select maintenance actions. Special inspection must be performed when:

- There has been a modification of the instrument approach procedure
- A new procedure has been added to a commissioned facility
- Changes to the GBAS configuration are made, such as hardware/ software changes, having the potential to affect the internal navigation database or coding/ construction of the VDB messages.
- There is a change in VDB antenna, antenna type, or antenna location.
- Physical changes occur at the site having the potential to affect GPS signal reception and VDB coverage or in response to multiple user complaints.
- As specified within the appropriate ground equipment maintenance manuals (Technical Instruction Book, Maintenance Handbook, Commercial Instruction Book). The extent of the evaluation will depend on the specific ground equipment design and the particular maintenance activity performed.

(1) VDB Coverage. As predicated by the reason for the special, VDB coverage is evaluated at the altitude established for the lower orbit during commissioning, and in operationally utilized areas where coverage is predicted or known to be affected. VDB coverage along the lower orbit will be evaluated based on signal-strength assessments and loss of signal. VDB power output must be at the RF power alarm point.

(2) Approach Procedures. For each modified or new SIAP, the GBAS broadcast FAS Data CRC should be checked to ensure there has been no change or corruption. A normal approach will be flown for modified instrument approach procedures (see Table 17-1). A normal approach, as well as upper, lower, left, and right limit coverage profiles will be flown for new procedures (if coverage has not been previously checked) (see Table 17-1).

(3) Terminal Area Path (TAP). (Reserved)

(4) Airport Surface. (Reserved)

f. Flight Inspection Analysis. Flight inspection of GBAS procedures determines if the procedure is flyable and safe. ARINC 424 coded data will be used to compare the coded path against the actual flight 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 procedures, as applicable, to determine the necessary changes. When existing procedures are found unsatisfactory, notify the procedures designer immediately for Notice to Airman (NOTAM) action. The inspector must evaluate the following items:

(1) VDB Coverage. VDB signal must be validated throughout the defined service volume by ensuring that the minimum signal-strength requirements are met and that there are no data continuity alerts.

(2) Procedural Design and Database Integrity. Flight inspection requires that the approach path be evaluated to verify that the instrument approach procedure delivers the aircraft to the desired aiming point as designed by the procedure. The FAS Data CRC remainder (Message Type 4 from the GBAS) will be compared with the procedural design data to ensure no data changes or data corruptions have occurred. The Message Type 2 will be verified and documented to ensure no data changes have occurred. Initial, Intermediate, and Missed Approach segments must be evaluated to determine that they meet procedure design requirements. Required obstacle clearance must be met. A flight inspection system analysis is required to validate FAS data elements for lateral alignment, TCH, and glide path angle.

Note: The official source document GBAS FAS data files may be transferred directly into the FIS via electronic media. This can provide a method for comparison that will serve as confirmation the actual GBAS transmitted FAS data (Message Type 4 from the GBAS) is exactly the same as that on the official source documentation for the flight procedure.

(3) RNAV Segments. Ensure 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.

(4) FAS Vertical/ Lateral Alert Limits. The applicability, or accuracy, of the differential corrections degrade with both increased distance from and height above the GBAS, specifically, the reference receiver antenna locations. The vertical/ lateral protection levels (VPL/ LPL) must not exceed the vertical/ lateral alert limits (FASVAL/ FASLAL) for the differential corrections and satellite status information to be applicable. The protection levels account for both the distance and height offsets between the GBAS and user location. If the protection levels become larger than the alert limits for a given procedure, a data continuity alert will be issued. The FASVAL and FASLAL for approach and missed approach procedures are contained in the Message Type 4 broadcast by the GBAS.

During periodic inspections, verify broadcast FASVAL and FASLAL values. Inspect VPL/ LPL only when the final approach segment is flown.

(5) GPS Satellite Parameters. The following parameters must be documented at the time anomalies are found during any phase of the flight inspection:

Parameter	**Expected Values**
LPLGBAS	≤ 40m (1), ≤ 69.15m Max
VPLGBAS	≤ 10m (1), ≤ 43.35m Max
HDOP	≤ 4.0
VDOP	≤ 4.0
HIL	≤ 0.3nm
FOM	≤ 22meters
Satellites Tracked	5 Minimum
Signal-to-Noise Ratio (SNR)	30 dB/ Hz minimum

Note: There are no flight inspection tolerances applied to these parameters. However, they may provide useful information should GPS signal anomalies or interference be encountered.

(1) The expected values for LPL (i.e. ≤ 40m) and VPL (i.e. ≤ 10m) are relative at a 200 ft Decision Altitude. Values linearly increase with distance from the runway threshold.

(6) Frequency Interference (Spectrum Analysis). The RF spectrum from 1559 to 1595 MHz should be observed when GPS parameters indicate possible RF interference. Monitor the GBAS VDB frequency during all inspections. Monitor the GPS or other appropriate frequencies anytime interference or anomalies are suspected and document all spectrum anomalies for analysis. Other validation checks may be requested by facilities maintenance. Interference signals are not restrictive unless they affect receiver/ sensor performance. Loss of differential data is an indication of interference, multi-path, or shadowing of the VHF transmission. The RF Spectrum ± 100 kHz either side of the VHF Data Link (VDL) frequency must be observed on the spectrum analyzer in the case of suspected interference.

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). 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.

During a GLS procedure, document all spectrum anomalies.

> Note: Report interference to the FICO, who will in turn forward the report to the ATCSCC/ Spectrum Assignment and Engineering Office.

(7) CRC Remainder. The FAS data integrity must be confirmed by an exact match of the FAS Data CRC remainder as documented on FAA Form 8260-10 (or equivalent) and the FAS Data CRC remainder computed by the FIS and the GBAS avionics.

(8) Restriction(s). In order for the GBAS to be classified “UNRESTRICTED”, coverage tolerances must be met throughout the service volume. Restrictions to GBAS coverage at distances less than the service volume are permitted, provided the GBAS meets all coverage tolerances throughout all procedural approach segments. When facility restrictions are based on a commissioning only type of inspection (e.g., VDB unusable above 8,000’), document the condition and type of inspection check on the Facility Data Sheet. Conditions found in these type checks do not require revalidation on periodic inspections. Establish facility restriction(s) and take appropriate NOTAM action based upon facility performance IAW Chapter 5, Section 1.

(9) Documentation. GBAS reports must be completed in accordance with FAA Order 8240.36, Flight Inspection Report Processing System. Restrictions must be defined and documented on flight inspection reports. All recordings and documentation (paper **and** electronic) must be retained and handled in accordance with FAA Order 8200.1.

g. Tolerances. Flight Inspection Reference System. FIS with differential GPS (DGPS) corrected data or TVPS will be used to provide FAS data analysis.

Parameter	**Paragraph Reference**	**Tolerances**
Terminal Area Path	17.3.c(1)	(Reserved)
Airport Surface	17.3.c(6)	(Reserved)
Initial/ Intermediate Approach Segment	17.3.c(2)	FAA Order 8200.1, Chapters 6 and 13
Final Approach Segment	17.3.c	
GBAS RPI (Morse Code)[1]	17.3.f(2)	Exact Match
FAS Data CRC	17.3.f(2)	Exact Match
Glide Path Angle	17.3.f(2)	$\pm 0.05^0$
Lateral Alignment	17.3.f(2)	$\pm 0.1^0$ true course
TCH	17.3.f(2)	± 2m
Message Type 4 Alert Limits	17.3.f(3)	
FASLAL		40 m
FASVAL		10 m Note: Values apply at 200' DA point to LTP/ FTP
Missed Approach Segment	17.3.c(4)	FAA Order 8200.1, Chapters 6 and 13
Broadcast VDB Message	17.3.b	Required message types
Coverage VDB, minimum field strength, horizontal polarization		>-99 dBW/m2 or >215 µV/m
Coverage VDB, minimum field strength, vertical polarization		>-103 dBW/m2 or>136 µV/m
RF Interference	17.3.f(6)	Interference must not cause out-of-tolerance condition or loss of GBAS data continuity.
Maximum Use Distance (D_{max})	17.3.b(2)(a)	As defined by GBAS Site

The RPI may be verified visually or aurally (via Morse code), depending on the aircraft integration. Flight inspection aircraft will display the RPI for verification with the relevant approach chart.

Chapters 18 and 19.

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Chapter 20. Flight Inspection of VFR Aeronautical Charts.

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Chapter 20. Flight Inspection of VFR Aeronautical Charts.

1. Introduction. This chapter describes the procedures used to perform flight inspection of FAA Visual Flight Rules (VFR) Aeronautical Charts. These include Sectional Aeronautical Charts and their associated Terminal Area and VFR Flyway Planning Charts, Helicopter Route Charts, and the Grand Canyon VFR Aeronautical Chart. Data gathered is used to update VFR charts and obstruction data for the FAA Minimum Safe Altitude Warning System (MSAW) program. VFR charts will be evaluated on an on-demand, as needed basis and have no minimum periodic interval.

a. Sectional Aeronautical Chart. Sectional Aeronautical Charts are designed for visual navigation use by slow and medium speed aircraft. The topographic information consists of contour lines, shaded relief, drainage patterns, and an extensive selection of visual checkpoints and landmarks used for flight under VFR. Cultural features include cities and towns, roads, railroads, and other distinct landmarks. The aeronautical information includes visual and radio aids to navigation, airports, controlled airspace, special-use airspace, obstructions, and related data.

b. Terminal Area Chart (TAC). The TAC depicts airspace designated as Class B. While similar to Sectional Charts, the TAC has more detail on a larger scale chart. The TAC is used by pilots operating to and from airfields underlying or near Class B airspace.

c. Charted VFR Flyway Planning Chart. This chart is printed on the reverse side of selected TAC Charts. The coverage is the same as the associated TAC. Flyway planning charts depict flight paths and altitudes recommended for use to bypass high traffic areas. Ground references are provided as a guide for visual orientation.

d. Grand Canyon VFR Aeronautical Chart. This chart covers the Grand Canyon National Park area. It is designed to promote aviation safety, flight free zones, and to facilitate VFR navigation in this popular area. The chart contains aeronautical information for general aviation VFR pilots on one side and commercial VFR air-tour operators on the other side.

e. Helicopter Route Chart. This chart displays aeronautical information useful to helicopter pilots navigating in areas of high concentrations of helicopter activity. Information depicted includes helicopter routes, heliports with associated frequency and lighting capabilities, NAVAID(s), and obstructions. In addition, pictorial symbols, roads, and easily identified geographical features are portrayed.

2. Preflight Requirements. Prior to each VFR Aeronautical Chart flight inspection mission, the inspector(s) will meet with the National Aeronautical Charting Office (NACO) VFR Flight Inspection Program (VFIP) coordinator and cartographers to discuss any issues for the inspection.

When VFR Aeronautical Chart flight inspection operations will be conducted in areas affecting air traffic, the inspector must coordinate with Air Traffic Control (ATC).

3. Detailed Procedures. Current chart copies are compared with the corresponding geographic areas. The inspector will evaluate and verify topographic and cultural data (roads, railroads, power lines, antennas, urban areas, etc.) depicted on the charts for accuracy and navigational usefulness.

a. Flight Line Track. Flight line tracks will be established to ensure systematic and complete coverage of the entire chart area. Cardinal directions should normally be used unless limited by terrain, localized weather, ATC, or other factors. Flight line spacing may vary to accommodate different levels of visibility and densities of charted features, but should not normally be spaced more than 12 nm.

b. Altitudes. The flight line track must be flown at altitudes that will ensure that the pilots can clearly observe the relative position of all objects and their characteristic details. The inspection should normally be performed at altitudes between 2,000 to 5,000 feet above ground level (AGL).

c. Weather. VFR Aeronautical Chart flight inspection must be conducted in VFR conditions.

4. Analysis and Evaluation. Inspectors must record their notes on an annotated VFR chart field sheet. Field sheets are considered source data and must be retained and archived by NACO.

The inspector(s) will recommend corrections and changes and resolve questions and discrepancies raised by NACO cartographers that cannot be resolved by source review in the office.

Chapter 21. Helicopter.

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Chapter 22. Flight Inspection of Expanded Service Volume (ESV) for Ground Based Navigational Aids.

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Chapter 22. Flight Inspection of Expanded Service Volume (ESV) for Ground Based Navigational Aids.

1. Introduction. This chapter provides information concerning flight inspection's role with an Expanded Service Volume (ESV) and the ESV process. Service Volume (SV) is defined as 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.

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 in the appropriate chapter for the specific facility type.

c. Expanded Service Volume (ESV) - An ESV is a volume of airspace, outside of a facility's Standard Service Volume (SSV), that is approved for operational use by Spectrum Engineering, and where a facility meets the applicable flight inspection requirements. An ESV is validated by flight inspection when requested by the FAA's Air Traffic Service or procedure specialist and approved by frequency management of the Airway Facilities Division.

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

2. Detailed Procedures

a. Rho-Theta. ESV(s) are required only when procedural use is predicated on a NAVAID's performance outside of the SSV, as illustrated in Appendix C, Figures C-5A – F. Evaluate ESV(s) on one transmitter only. When required, an ESV may be revalidated by orbital flight at the ESV distance and lowest approved altitude. Lateral limits of the area should encompass allowable radial misalignment or applicable fix displacement area. There is no need to inspect the upper limits of an ESV unless interference is reported or suspected.

In most applications, the VOR is the primary facility supporting procedural use (i.e., airways, fixes, intersections). When evaluating facilities supporting procedural uses, record all component signals. If any NAVAID component (i.e., VOR, TAC, or DME) does not meet flight inspection parameter tolerances, document the results as follows.

(1) Within the applicable 25 or 40 nm flight inspection service volume, complete the appropriate flight inspection report form(s) and restrict the NAVAID accordingly.

(2) Beyond the applicable flight inspection service volume but within the SSV, complete the appropriate flight inspection report form(s) and document flight inspection results on the procedures package forms. No facility restriction is required.

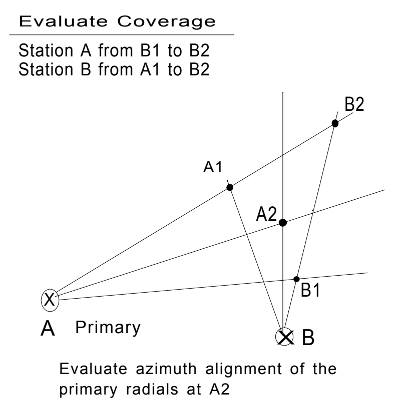
(3) Beyond the applicable SSV, complete the appropriate flight inspection form(s), ESV forms, noting the component(s) which will not support the ESV, and document the results on the procedures package forms. No facility restriction is required.

For flight inspections beyond the applicable 25 or 40 nm distance, complete only the fields of the flight inspection report forms for the NAVAID components identified for procedural use.

(4) En Route Radial Fixes Located Beyond the FISSV

(a) If the fix is located beyond the FISSV of any facility that supports the fix, the appropriate fix displacement coverage evaluation must be accomplished for that facility. When establishing a fix that is located beyond the FISSV, the station(s) are evaluated on the furthest side from the facility of the fix to ensure that usable signals exist. Evaluations must include modulations, identification, roughness and scalloping, alignment, and signal strength.

Figure 22-1



The radials of the primary facility are evaluated at ± 4 nm or ± 4.5° either side of the primary radial, whichever is greater. The crossing radial is evaluated at ± 3.6°.

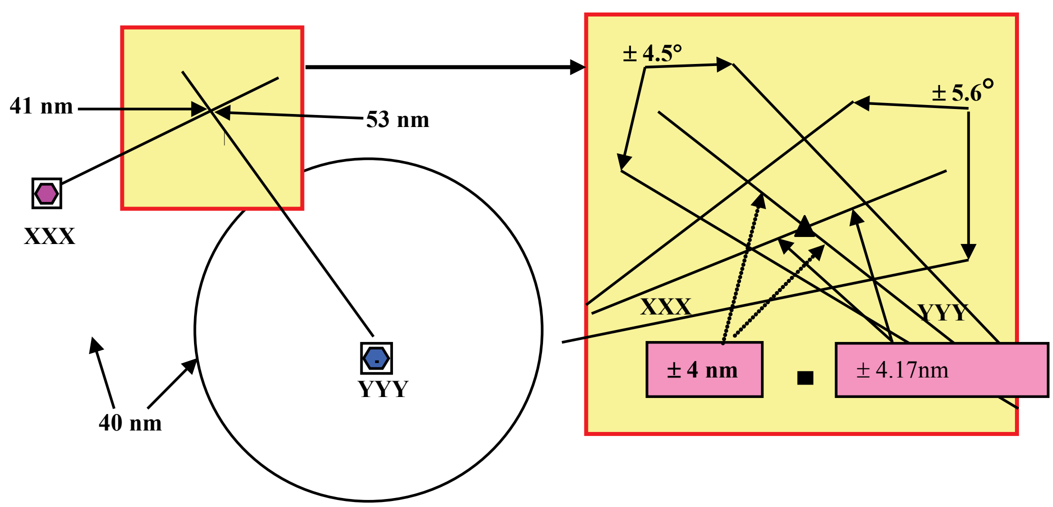
> Note: The primary facility provides primary course guidance to the intersection. If either facility can be the primary, then evaluate both at ± 4 nm or ± 4.5°. If the crossing facility is an NDB, the primary facility is evaluated ± 5° of the NDB on-course bearing. In Figure 22-1, if Station B were an NDB providing the crossing radial, A1 and B2 would each be 5° from the NDB crossing bearing, and Station B would be evaluated from A1 to B2.

(b) Coverage Evaluation. The radials of the primary facility are evaluated at ± 4 nm or ± 4.5°, whichever is greater. At a distance of 50.8 nm, 4 nm equals 4.5° off course. When a fix is beyond 40 nm but within 50.8 nm of the primary facility, the degrees off course that equals 4 nm must be calculated. In Figure 22-2, XXX is the primary facility, and the fix is located 41 nm from the facility. A determination of the degrees off course that equals 4 nm at 41 nm can be made using the chart in Appendix C, Figure C-7. For this example, the offset radials equal ± 5.6° at 41 nm.

When the radials of the primary facility are beyond 50.8 nm, the offset radials will be ± 4.5°. An alternative method may be used for the coverage evaluation. Beyond 40 nm but within 50.8 nm, you may fly an arc about the facility at a distance equal to the fix distance plus 4 nm or 4.5°, whichever is greater (3.6° for crossing radials). Using the chart in Appendix C, Figure C-7, determine the degrees off course equal to 4 nm at the fix distance to determine the appropriate start and stop point of the arc. For the example in Figure 22-2, we will assume both facilities may be primary. Therefore, Facility XXX arc would be flown at 45.17 nm (41 nm plus 4.17 nm which is the distance that equates to 4.5° at 53 nm) from ± 5.6°. The arc about Facility YYY would be flown at 57 nm (53 nm plus 4 nm which is the greater of 4.5° or 4 nm at 41 nm). For radials beyond 50.8 nm, the arc will remain ± 4.5°, but the distance that must be added to the fix distance arc will increase as the distance outbound increases (see Appendix C, Figure C-7).

(c) Stand-Alone DME Fixes must be evaluated for coverage ± 4 nm or 4.5⁰ (whichever is greater) at 5 nm greater than the fix distance.

Figure 22-2



b. Instrument Landing System (ILS). When an operational requirement exists to use either or both the localizer and glide slope to altitudes and/or distances beyond the normal service volume, the facilities must be inspected to the expanded altitudes and/or distances (in accordance with the respective RF alarm reference checks) to determine that facility performance for the required parameters meets tolerances. Place particular emphasis on signal strength, interference, clearances, and structure. If a localizer or glide slope cannot support ESV requirements, the ESV must be denied. The facility must not be classified as restricted solely because it fails to support the ESV. Check ESV(s) during a commissioning inspection, when new procedures are developed or changed so as to require localizer or glide slope use beyond the normal service volume, or on appropriate special inspections (e.g., user complaints). ESV checks are required on one transmitter only.

(1) Localizer. The most common ESV is one to support intercepting the localizer greater than normal distances The validated minimum altitude in the ESV area may be higher than the lower standard altitude of 1,500 ft above the antenna or 500 ft above terrain, whichever is higher, within the SSV. These minimum altitudes, as well as the maximum authorized, must be specifically documented on the flight inspection report and the Facility Data Sheet.

Approved Procedure. This procedure applies to the front course (and the back course if it is used for an approach or missed approach). This check must be conducted with the facility operating at reduced power. Check for interference, signal strength, clearances, flag alarm, identification, and structure as follows:

(a) Fly an arc across the localizer at the ESV distance and the highest ESV altitude, throughout Sector 1.

(b) Repeat the arc, except fly at the lowest ESV altitude.

(c) Proceed inbound at the lowest ESV altitude to the SSV limits (18/ 25 nm) from the antenna). This run may also be used for localizer Zone 1 structure analysis.

Note: If the ESV includes one procedural altitude, only one ESV arc is required, and the ESV will be approved at that one altitude.

(2) Glide Slope. To validate an ESV, calculate the altitude at 0.45 times the commissioned angle at the ESV distance. Use that altitude to fly the checks listed below, starting no closer than the ESV distance. The ESV checks replace the standard 10-mile checks. If the facility is unsatisfactory, perform the ESV check at a higher altitude that provides 150 μA fly-up indications and coverage requirements. Approve the ESV at the requested altitude and distance if these requirements can be met at any altitude between 0.45 times the commissioned angle and the requested ESV altitude.

(a) Approved Procedure. The glidepath transmitter must be placed in reduced power setting for this check (both primary and clearance transmitters for capture effect and endfire glide slopes). This check must be made on the localizer on-course and 8° each side of a point on localizer centerline abeam the glide slope origination point. While maintaining the altitude at 0.45 times the commissioned angle at the ESV distance, fly inbound to the interception of the lower sector of the glidepath (i.e., the point nearest the glidepath at which 150 μA occurs). Fly through the glidepath sector and check clearances above the path

> Note: Endfire. The endfire glide slope antenna array is orientated toward the runway. The normal fly-up/ fly-down signal ends at approximately 5° on the antenna side of the runway; therefore, you will have only 150 Hz clearance signal at 8° on the antenna side of the runway. The provisions of Paragraph 15.51d will apply to this situation.

(b) Glide slope structure must be analyzed while flying inbound on the glidepath and localizer course from the ESV distance to 10 miles from the glide slope antenna. This evaluation may be conducted in normal or RF reduced power setting.

(3) Reporting Fixes, Transition Areas, SID(s)/ DP(s), STAR(s), and Profile Descents. Refer to Figure 22-3. The localizers, SDF, or LDA may be used to support fixes or departure, en route, and arrival procedures. Transitions may be published through airspace which are beyond the localizer, SDF, or LDA service volume. Under these circumstances, navigation is accomplished using some other facility such as VOR or NDB. If the fix is not contained within the localizer and/or glide slope SSV (see definition in Appendix A), an ESV must be established to support the procedure.

(a) Required Coverage

(i) LOC (A) B1 to B2

(ii) VOR (B) A1 to B2 (R±4.5°). Does not need to be checked if within the VOR/ NDB FISSV.

(iii)VOR (B) A3 to B4.

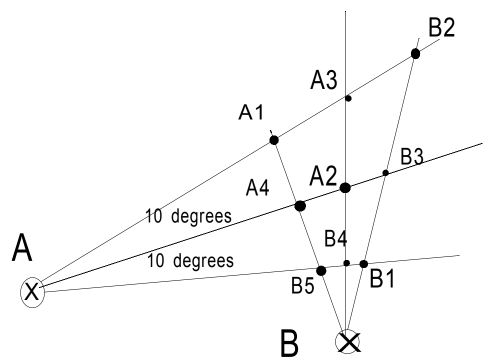
(b) Transitions. When a transition (or missed approach routing) is designed to traverse localizer course Sector 3 or airspace which is outside the commissioned service volume, and the transition termination point is not identified with a facility other than the localizer course, check clearance and coverage throughout the entire transition airspace at the minimum authorized altitudes. This will normally be an approach segment from a facility or fix to intercept a localizer final approach. Termination points not requiring clearance validation are: DME fixes on transition radial, waypoint, compass locator, lead radials, fixes made up from other than the localizer, and “radar required” fixes. Examples of a transition requiring clearances would be a radial to the localizer only or a radial to a marker beacon on the localizer course.

Evaluate Coverage
LOC (A) B to A2
VOR (B) B to A2

(c) Standard Instrument Departure (SID(s))/ Departure Procedure (DP(s)). Check on-course structure throughout the area of intended use. Check clearance in Sector 1 at the termination point at the minimum authorized altitude.

(d) Standard Terminal Arrival Route (STAR(s)) and Profile Descents. Fly these procedures as proposed or as published. Check facility performance when checking STAR(s) and profile descents in accordance with Paragraphs (a) and (b) above, with fixes.

Figure 22-3



c. Microwave Landing System (MLS). An ESV will be validated by flight inspection only when requested by the FAA's Air Traffic Service or procedure specialist and approved by frequency management of the Airway Facilities Division.

d. Nondirectional Beacon (NDB)

(1) Evaluate obstructions or hazards for impact on intended procedures and advise the procedure specialist. Evaluate the signal for excessive needle oscillation, weak or garbled ident, and interference. Coverage at distances greater than the orbit radius will be certified for specific routes or transitions. The flight inspector must fly intended routes or transitions at the minimum altitudes and maximum distances as depicted in the flight procedure document. For satisfactory performance, the facility must meet the tolerances in Chapter 12, Section 2. If the facility does not support the procedure, the flight inspector must determine the minimum altitudes and maximum distances that meet all the tolerances in Chapter 12, Section 2 and forward this information to the procedure specialist.

(2) Expanded Service Volume (ESV) on commissioned facilities will be established at normal power. At facilities where dual transmitters are installed, evaluate ESV(s) on one transmitter only.

(3) Tolerances. NDB(s) that meet tolerances throughout the area of intended use are classified as UNRESTRICTED. Facilities that do not support routes or transitions outside of coverage as listed in Chapter 12, Section 1 will not be restricted, but use of the facility for that purpose will be denied.

e. Distance Measuring Equipment (DME). Chapter 11, Section 3 provides instructions and performance criteria for certifying standard distance measuring equipment (DME). The flight inspection validation of an ESV for DME can be performed separately but is normally checked in conjunction with the more detailed check of the associated ILS, MLS, VOR, or TACAN facility. When conducting a flight inspection for ESV of DME, independent of an associated facility, check the following:

- Accuracy
- Identification
- Coverage

f. Area Navigation (RNAV)—Procedural Routes Predicated on DME/ DME Position Estimation. This paragraph addresses expanded service volume (ESV) guidance for inspection of RNAV procedures requiring a DME/ DME infrastructure.

Expanded Service Volume (ESV) requirements: The RNAV-Pro prediction tool will evaluate the Operation Service Volume (OSV) of each DME facility along the route of flight. The OSV includes the Standard Service Volume (SSV), plus any approved facility ESV(s), minus any restricted areas. The prediction tool will propose ESV(s) for the DME facilities that may provide insufficient procedural DME coverage.

DME/DME procedural ESV(s) data logged during flight inspection will be evaluated by the RNAV-Pro Office using the post flight analysis tool. RNAV-Pro will assign the status of SAT/UNSAT based upon post flight analysis and forward the satisfactory ESV results to the Expanded Service Volume Management System (ESVMS) for processing.

> Note. ESV(s) for RNAV DME/DME are not facility ESVs and will be considered as procedural ESVs for DME/DME procedures only. The ESV(s) will be indicated on the datasheet with a TO: and FROM: radial, furthest distance, and lowest altitude. DME/DME ESVs will not be revalidated during inspections requiring ESVs to be revalidated.

During the inspection, if a Critical or 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.

3. Expanded Service Volume Process

a. FMO-Approved Limits. When a proponent requests an ESV, the FMO ensures the calculated signal level from the desired (D) facility is sufficient and signal levels from any undesired (U) transmissions are low enough to provide a satisfactory D/ U ratio throughout the area of use. Usually, these values are predicted to be satisfactory at the requested altitude, azimuth, and distance limits. Flight inspections are required to verify satisfactory signal strength and quality (structure, modulation, etc.). In the event that the signal does not meet flight inspection tolerances at the requested and FMO-approved limit, the ESV must be restricted to the limit of satisfactory coverage.

(1) In some cases, the FMO calculations predict satisfactory signal level and/or frequency protection to some point less than requested. This is indicated on FAA Form 6050-4, Expanded Service Volume Request, by a Part II entry of "Restricted" and definition of the FMO-approved limit. This limit may be due to factors used in the FMO modeling process and not detectable through flight inspection. For example, at the requested distance, the D/ U ratio is unsatisfactory, but flight check only sees a clean signal, meeting flight inspection tolerances. We could then erroneously approve an ESV where there is insufficient frequency protection. In this example, the flight inspection should not extend beyond the Part II Restricted distance or lowest altitude.

(2) Occasionally, frequency protection is not a problem, but desirable signal strength is calculated to be marginal. The FMO would note in a Part II remark that they approve of an ESV to a given point less than requested, and defer the final approval contingent on a successful flight check at the requested limit. In this case, the flight inspection should be to the requested distance and at the lowest requested altitude.

(3) It must be understood that flight inspection does not approve any part of an ESV beyond that which is approved by the FMO.

b. Clarity of Flight Inspection Results. Some flight inspection comments in Part III of FAA Form 6050-4 have been misleading. As can be seen from Issue 1, the final flight inspection approval can only be equal to or more restrictive than the FMO-approved limit. If the FMO approves exactly what was originally requested and the signal strength and quality meet flight inspection tolerances to the requested distance and lowest altitude, the flight inspector should check the APPROVED block in Part III. In the Remarks section, define the limits of the ESV by facility component, azimuth/ bearing, distance, and Minimum Reception Altitude (MRA) and Maximum Authorized Altitude (MAA). Any other situation requires a Part III entry of RESTRICTED and a definition of the ESV limits. Facility components, such as VOR and TACAN, which result in different coverage limits, should be defined individually.

c. Expanded Service Volume (ESV) Facilities. When a facility no longer supports an ESV, the facility is not restricted, but a NOTAM must be issued for the instrument flight procedures predicated on that ESV

4. Flight Inspection Tolerances. To adequately support a proposed ESV of airspace, facility performance must meet all operational tolerances as described in applicable chapter and conform to the process described in Paragraph 22.3 above. Facilities which do not meet tolerances beyond the FISSV must not be restricted; however, procedural use must be denied.

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Chapter 23. Radio Frequency Interference Detection

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Chapter 23. Radio Frequency Interference Detection

1. Introduction. Radio frequencies providing services in the National Airspace System (NAS) are subject to continued and increasing interference disruptions. This chapter describes the role of flight inspection and presents techniques of flight inspection in the detection and location of Radio Frequency Interference (RFI) to Communications, Navigation, and Surveillance (CNS) systems, including satellite Global Positioning System (GPS).

a. Airborne investigation of RFI is usually the last resort and should not be used until all reasonable ground methods have been exhausted. In general, if an interfering signal can be received on the ground, it can be located through ground investigation. In few instances, usually in remote areas, it may be impractical to use any ground methods. If the source of interference is not near a ground receiver, it may only affect the airborne reception and must be located through use of an aircraft. Although the aircraft has pinpointed some RFI sources, it is generally sufficient to narrow the location down to an area small enough to cover with ground equipment.

b. Types of Interferers. Interference to CNS systems may take several forms, from broadband noise to narrow-band signals. Interference may be constant or intermittent, either predictable or random. Most interference is unintentional, although there have been instances of intentional disruption of air traffic radio services by individuals or groups for various purposes. Knowing the signal characteristics of the various types of interference is a key factor in locating their source.

(1) Unintentional interference to CNS systems is usually the result of defective equipment or intermodulation of two or more frequencies. Most cases requiring airborne investigation are due to spurious emissions from defective electric or electronic devices. Many frequencies generated by malfunctioning equipment are not stable and may drift, impacting several victim frequencies.

(2) Intentional interference is usually directed at VHF communications frequencies. Some intentional interference has been disguised as unintentional, but the majority of cases involve voice or music transmitted from a normal VHF transceiver. . Intentional interference to any NAS CNS safety radio frequency services is an illegal activity and may result in criminal violation as applicable in Title 18 of the Code of Federal Regulations. Some cases may involve “Phantom Controllers” attempting to misdirect aircraft which requires investigative methods and results to be treated as confidential legal information to avoid compromising any prosecution of the offenders.

2. Preflight Requirements

a. Facility Maintenance Personnel. Tasking for a formal airborne RFI investigation must be initiated by National Operations Control Center (NOCC) Spectrum Engineering Services Liaison through Flight Inspection Central Operations (FICO). Airborne RFI missions for routine, unintentional interference require an engineering desk analysis of aircraft pilot reports. The analysis must provide an initial starting flight pattern for the airborne mission. For complex or intentional disruption of service, an RFI mission task force team may be establish and the team must ensure ground and air efforts are coordinated. Such coordination should include non-VHF communications and alternate aircraft call signs as necessary for task force covert operations..

b. Flight Personnel. Unless both systems are simultaneously accessible by one person, it may be advantageous to have two technicians, one using the spectrum analyzer, and the other using the Direction Finding (DF) equipment. If the RFI signal is difficult to find, consultation or participation of local Technical Services Operations Group (TSOG) or national Frequency Management Officer (FMO) personnel may be necessary. Phone contacts list of these additional personnel should be kept in the aircraft.

3. Flight Inspection Procedures. Use the equipment and techniques described in Section 23.5, Detailed Procedures, for missions dispatched to search for RFI. Flight inspection crews should be alert to any suspected interference throughout regular flight activities. Any interference received must be recorded and should be investigated as thoroughly as possible within the constraints of equipment capabilities and mission limits.

a. If interference is suspected within the Standard or Expanded Service Volume of a facility undergoing flight inspection, attempt to get the facility shut down and verify the presence and characteristics of the interfering signal. If time and circumstances permit, try to identify and locate the source. If it is not readily found, report the findings to the TSOG or Regional FMO for ground analysis before further airborne attempts.

b. If RFI is affecting radio services used for normal flight operations, use the applicable techniques described in Section 23.5, Detailed Procedures, to analyze the problem. Documenting the signal characteristics at multiple airspace locations is critical data that will aid TSOG and FMO personnel in determining the next steps in the investigation.

4. Checklist. There are no specific checklist items for RFI detection and location.

5. Detailed Procedures.

a. Airborne Equipment.

(1) DF Equipment. The DF receiver system produces a strobe indication giving a Line of Bearing (LOB) from the aircraft to the transmission source. Following the strobe will bring the aircraft to the signal source. Usually, the aircraft is too high on the initial pass over the signal source for its identification. A descending 270° turn to pass over the signal from a different direction may aid in its location.

(2) Spectrum Analyzer. Many interfering signals are not on the affected frequency but are within the victim receiver's bandwidth. Tuning the DF receiver to the affected frequency with its bandwidth set too narrow will degrade its effectiveness. Use the spectrum analyzer to find the center frequency and effective bandwidth of any signals that appear close enough to the victim frequency to be the likely interferer. Some spurious RFI signals will show a drifting pattern on the analyzer screen. This may require increasing the frequency span of the spectrum analyzer to view the full behavior motion of the RFI signal. Spurious RFI signals drifting from a lower frequency to a higher frequency may be related to Industrial type equipment.

(3) Flight inspection receivers can be tuned slightly above or below the affected facility frequency to find a peak in signal strength through the flight inspection equipment. This may help find the center frequency of the interference source.

(4) Audio Recording. Flight inspection aircraft should be equipped with audio recorders capable of recording from the various communications or navigational radios as selected by the crew. Record the interference whenever practical to assist FMO personnel in characterizing the signals.

(5) Autonomous GPS recording capability is available in some flight inspection aircraft. It continually monitors the GPS signal for any anomalies and stores up to 24 "events" of unsatisfactory GPS data. The airborne technician should monitor this capability and report any new "Events" to the FICO.

b. Search patterns are usually based either on signal strength or a homing receiver. The signal strength methods are less accurate but may be accomplished with more basic equipment.

(1) Hot/ Cold. This method requires the aircraft to go closer or further from the interferer while the signal strength or best signal to noise ratio (SNR) is noted. If the aircraft travels in a straight line, the peak of the signal should be when the transmitter is directly off the aircraft wing. Another track flown 90° from the first will provide another peak. Sequentially flying a "box pattern" of decreasing size where maximum signal levels have been recorded will locate the interference.

(2) The second method, particularly useful for finding GPS interference, requires antennas both on the top and bottom of the aircraft feeding separate sensors. With the bottom antenna fed to a receiver or spectrum analyzer and the top to a GPS receiver, the aircraft is banked to both sides. As the GPS interference will be from the ground, banking the aircraft away from the interferer exposes the bottom sensor antenna to more of the interfering signal, decreasing the SNR. It also shades the top antenna from the ground interference and increases the SNR on that receiver. No significant change while banking either left or right indicates the interference is in front or behind the aircraft. Changes in direction can eventually narrow the search area.

(3) Triangulation. A radiation source can be located by using the DF Receiver to get LOB from two or more locations. Using a geodetic calculator program with an "Intersection" function, the coordinates of the receiver(s) and the lines of bearing (True) are input, and the result is the coordinates of the intersection. It is important to use the correct aircraft heading reference (true or magnetic) to correlate with the DF receiver direction reference. The more samples taken with the receiver locations separated by several miles increase the accuracy of the intersection coordinates.

6. Analysis.

a. Intermittent Interference. Some interference occurs intermittently in either a random or predictable time pattern. Locating these type signals is sometimes very difficult and may take several attempts, with each attempt gathering one or more receiver coordinates and lines of bearing. Each piece of information gathered should be filed together with all data reevaluated as new information is obtained. Assuming the interference source is not physically moving, time has no impact on the data quality. Interfering signals may also move in frequency, i.e., sweep through the victim band. In this case, the bandwidth on the Spectrum Analyzer should be increased. They may also change in modulation, i.e., change in appearance on the spectrum analyzer when the bandwidth is narrow.

b. Analyze the interfering signal as much as possible, using the equipment and techniques in Table 23-1, to provide as much information as possible to the TSOG and FMO personnel.

Table 23-1

System	**Record Audio**	**Detune Receiver**	**Spectrum Analyzer**	**Oscilloscope**
VHF/ UHF Comm	X	X	X	
NDB/ ADF	X	X	X	
VOR/ ILS	X	X	X	
TACAN/ DME		X	X	X
MLS		X	X	X
GPS			X	
VHF		X	X	X
DATALINK				

7. Tolerances. Tolerances applicable to specific facilities are contained in their individual chapters of this order.

8. Adjustments. Adjustments to systems to mitigate RFI will be as directed by the applicable system engineer.

9. Records and Reports. Complete a flight inspection report for the affected facility, using the form designated for that type facility, IAW FAA Order 8240.36. Reports on intentional interference and the original audio or signal trace recordings of such RFI must be maintained as evidentiary material for possible use in legal action. Copies of such recordings may be made available to FAA TSOG and FMO personnel or other applicable Government agencies for their use. Release of other copies must be in accordance with the Freedom of Information Act (FOIA).

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Chapter 24. Military Contingency and Natural Disaster Flight Inspection Procedures

Chapter 24. Military Contingency and Natural Disaster Flight Inspection Procedures

Section 1. General

1. Introduction. The potentially catastrophic consequences of a major natural disaster or the need to respond quickly to a military combat operation necessitates advanced planning and definition of operational requirements. The ability to provide sustained flight inspection support for the numerous and diverse requirements which may exist will be predicated upon the use of abbreviated flight inspection procedures. Flight inspection will greatly depend on both air traffic and facility maintenance support preparations.

a. Purpose. The guidance, procedures, and tolerances contained in this chapter describe the minimum facility performance standards when contingency situations require deviation from normal standards. Basic flight inspection requirements and methods of taking measurements apply to the contingency chapter unless specific guidance or tolerances are given. Facilities/ procedures which have been placed in operation using these procedures must be re-inspected to normal standards as soon as circumstances permit.

b. Authority. The authority to implement these provisions may be exercised by either the military or FAA. When military authority determines that an operational situation dictates the application of these procedures and tolerances, the appropriate flight inspection activity and the FAA Flight Inspection Services (AJW-3) Manager, Flight Inspection Operations Office must be notified. Application to civil facilities will be determined by appropriate FAA authority, who must notify both Flight Inspection Operations and the appropriate military authority.

2. Flight Inspection Requirements

a. Personnel Requirements. Flight inspection personnel, performing facility/ procedure inspection and certification using the provisions of this chapter, must be authorized and qualified to perform flight inspection duties.

b. Aircraft and Equipment

(1) If necessary, equipment which has exceeded calibration due dates may be used for flight inspection under the following sections. Calibrated equipment must be used when the facility is subsequently inspected using standard procedures.

(2) The use of other than a flight inspection-configured aircraft may be necessary. Reliability of such equipment must be established before use by the flight inspector. Examples of test methods available to verify the accuracy of uncalibrated flight inspection systems or aircraft not equipped with a flight inspection system are:

(a) Comparison with a facility verified by maintenance or another flight inspection aircraft, as operating normally.

(b) Comparison with two or more facilities in operation.

(c) Use of a VOT or similar radiated test signal.

3. Flight Inspection Documentation and Reports

a. All facilities/ procedures inspected using the provisions of this chapter must be assigned a status classification of restricted. All flight inspection records must be retained until the facility/ procedure can be inspected using normal procedures and tolerances.

b. In the event that flight inspection equipment is inoperative or not available, flight inspections will continue to meet operational requirements until replacement or repair is practical. Under these circumstances, the flight inspection crew is responsible for documenting all of the applicable data displayed by instrumentation at their duty positions. All such manually-acquired data must be identified in the remarks section of the flight inspection report. The facility/ procedure must be reflown with operational flight inspection equipment when conditions permit.

c. Completion and distribution of flight inspection reports are secondary to the accomplishment of flight inspection. At the conclusion of the inspection, the flight inspector must pass the facility status to the air traffic control watch supervisor. This will suffice as the official report until the written report has been completed and distributed.

d. The flight inspector must ensure that flight inspection reports are completed and submitted for processing. Each parameter specified in this section's flight inspection procedures checklists must be reported. Flight inspection reports may be handwritten using reproducible ink.

e. Records and reports must reflect that the inspection was accomplished using MILITARY CONTINGENCY FLIGHT INSPECTION PROCEDURES or NATURAL DISASTER FLIGHT INSPECTION PROCEDURES, as appropriate. If only the final and missed approach segments were inspected, annotate the facility is in operation for "approach use only."

Section 2. Military Contingency Procedures

4. Inspection Types

a. Only special and commissioning type flight inspections will be conducted under the procedures contained in this section. A commissioning flight inspection under this section will provide a limited-use facility where only the desired instrument procedures are supported.

b. After-accident flight inspection must follow normal procedures to the maximum extent possible.

5. Frequency of Inspection

a. Non-precision. All non-precision facilities will be re-commissioned using this section or the applicable chapter of this manual, as conditions warrant, within the period of 180 to 360 days after the previous contingency inspection. If the facility goes more than 360 days without being re-commissioned, and the controlling military commander wishes to continue to use the facility, it will convert to a "For Military Use Only" facility as described in Paragraph 24.8d, and the appropriate NOTAM(s) must be issued.

b. Precision. All precision facilities will be re-commissioned using this section or the applicable chapter of this manual, as conditions warrant, within the period of 90 to 180 days after the initial contingency inspection. If the precision facility was re-commissioned using contingency procedures with the 90 to 180 period, the facility periodicity would transition to 180 days, then 270 days. Due date window for subsequent inspections is ± 60 days. If after the initial inspection the facility goes more than 180 days without being re-commissioned or due date windows for subsequent inspections are not met, and the controlling military commander wishes to continue to use the facility, it will convert to a "For Military Use Only" facility as described in Paragraph 24.8d, and the appropriate NOTAM(s) must be issued.

c. RNAV SIAP(s). When conducting a special inspection to satisfy periodic inspection requirements for RNAV SIAP(s), flying the actual procedure is not required. However, an obstacle assessment must be conducted through the final and missed approach segments. Follow the guidance in Chapter 6. The requirement to conduct obstacle assessment may be evaluated independent of a SIAP inspection.

6. Pre-Inspection Requirements. The combatant commander being supported, or appropriate designee, is required to supply the flight inspection crew with the necessary support to accomplish the mission. This may include, but is not limited to, crew and airplane bed down, current intelligence, threat assessment, theater Special Instructions (SPINs), entry in the Air Tasking Order (ATO), and, if deemed necessary, escort aircraft. The flight inspection crew must provide proper documentation to gain access to any classified information.

a. Prior to arriving on location, the flight inspector mission commander or the controlling military office must contact the airfield operations commander and the navigation aid maintenance supervisor in order to coordinate the following items:

(1) Arrival time

(2) Operational requirements as defined by the airfield operations commander.

(3) Airspace requirements for conducting the flight inspection profile.

(4) Anticipated support such as refueling, ground transportation for a theodolite operator, etc.

b. The airfield operations commander must accomplish the following prior to arrival of the flight inspection aircraft.

(1) Make final determination regarding operational requirements for the facilities and SIAP(s) requiring flight inspection, and be prepared to brief changes on initial contact.

(2) Coordinate airspace requirements and obtain necessary clearances from appropriate airspace control authorities for conducting the inspection.

(3) If required, designate and brief an air traffic controller to work the flight inspection aircraft.

(4) Provide current Facility Data Sheet (FAA Form 8240-22) for each facility to be inspected.

c. The navigation aid maintenance supervisor must:

(1) Ensure adequate radio communications are available and operational.

(2) Assign qualified maintenance personnel to support the flight inspection of the equipment being inspected.

(3) Assist the airfield operations commander in completing FAA Form 8240-22 (Facility Data Sheet) for each facility to be inspected.

(4) Arrange for ground transportation for the theodolite operator if necessary.

7. Instrument Procedures

a. Approach Procedure

(1) The minimum flight inspection required to certify SIAP(s) predicted on ground-based facilities is the inspection of the final approach and missed approach segments. Area navigation (RNAV) procedures require the inspection of the intermediate, final, and missed approach segments. A night inspection is not required for an airfield/ runway conducting military only operations.

(2) If an approach must be established, the flight inspector may be responsible for establishing final and missed approach segments. Both segments of the procedure must be flown and recorded to establish and document flyability, accuracy, reliability, and obstacle clearance. The flight inspector must record the SIAP on the flight inspection report and provide the air traffic control watch supervisor with adequate detail for issuance of the NOTAM.

(3) In all cases, the flight inspector must determine, through visual evaluation, that the final and missed approach segments provide adequate terrain and obstacle clearance.

(4) If a circling maneuver is desired, the flight inspector must comply with Paragraph 6.14. Otherwise, a NOTAM stating that circling is not authorized must be issued.

b. En Route and Transition Coverage. If there is a need for facility coverage to provide en route and environment guidance, air traffic control may use aircraft of opportunity to fly the transition procedure. Pilot reports of satisfactory cockpit instrument performance and controller evaluation of radar target strengths are sufficient for air traffic control to determine usability.

c. Departure Procedure. The minimum flight inspection required to certify departure procedures is that the departure provides adequate terrain and obstacle clearance and satisfactory navigational guidance in the initial departure segment.

d. Communications. Communications inspections will be conducted concurrently with other inspections. User aircraft may be used.

8. Facility Status and NOTAM(s)

a. Prior to beginning the inspection, the flight inspector must ascertain from the air operations commander the intended operational use of the facility. After completing the inspection, the inspector must determine the facility status and advise the air traffic control watch supervisor prior to departing the area.

b. Upon being advised of the status, the air traffic control watch supervisor must ensure issuance of applicable NOTAM(s). As a minimum, the NOTAM must include who can use the procedure and any limiting conditions. Lengthy NOTAM(s) which describe NAVAID(s) in great detail will not be issued. The flight inspector must subsequently record the NOTAM text in the Remarks section of the applicable flight inspection report.

c. NOTAM Examples. The following are examples of conditions and prescribed NOTAM(s).

(1) Approach procedures checked using military contingency section. NOTAM: Kandahar AB, Afghanistan, KAF TACAN, restricted to OPERATION ENDURING FREEDOM. HI TACAN RWY 3 approach only.

(2) Circling not checked, final and missed approach segments checked using military contingency section. NOTAM: Baghdad International, Iraq, BAP TACAN, restricted to OPERATION IRAQI FREEDOM. HI TACAN RWY 15L & HI TACAN RWY 33R approach use only. Circling NA.

(3) Approaches and departures checked using military contingency section. NOTAM: Basrah International, Iraq, BAR TACAN, restricted to OPERATION IRAQI FREEDOM. TACAN RWY 14, TACAN RWY 32 approaches & MGOUG ONE DEP only.

(4) PAR checked using military contingency section. NOTAM: Bagram AB, Afghanistan, PAR RWY 03, restricted to OPERATION ENDURING FREEDOM.

d. The flight inspector has the authority and responsibility for determining that a NAVAID can safely and adequately support the operations intended under contingency conditions. However, military commanders have final authority and responsibility for operation of military facilities which are not part of the common system, and may elect to use those facilities FOR MILITARY MISSIONS. Additionally, the military may elect to use a military or civil NAVAID, which is part of the common system, even though that NAVAID is considered unusable by the flight inspector. In all such cases, the military commander that controls the NAVAID is responsible for issuing the appropriate NOTAM advising that the NAVAID is in operation "For Military Use Only" and stating which aircraft are authorized to use it.

In that flight inspection supports the ground maintenance organization or host nation aviation authority, care should be taken not to mistake the facility status assigned by a flight inspection as the last and only step required for authorizing a facility for use. There is potential for confusion, especially when ownership of a facility and maintenance responsibility is transferred to the host nation in which it is located, and flight inspection services are still being provided by another country or military organization.

Section 3. Natural Disaster Procedures

9. Inspection Types. Only special type flight inspections will be conducted under the procedures contained in this section.

10. Frequency of Inspections

a. Non-precision. All non-precision facilities will be re-inspected using this section or the applicable chapter of this manual, as conditions warrant, within the period of 180 to 360 days after the previous contingency inspection. If the facility goes more than 360 days without being re-inspected, the FICO must initiate NOTAM action to remove them from service.

b. Precision. All precision facilities will be re-inspected using this section or the applicable chapter of this manual, as conditions warrant, within the period of 90 to 180 days after the initial contingency inspection. If the precision facility was re-inspected using contingency procedures with the 90 to 180 period, the facility periodicity would transition to 180 days, then 270 days. Due date window for subsequent inspections is ± 60 days. If after the initial inspection the facility goes more than 180 days without being re-inspected or due date windows for subsequent inspections are not met, the FICO must initiate NOTAM action to remove them from service.

11. Facility Status and NOTAM(s). Prior to beginning the inspection, the flight inspector must ascertain from air traffic control the intended operational use of the facility. After completing the inspection, the inspector must determine the facility status for emergency use and advise the air traffic control watch supervisor prior to departing the area. NOTAM(s)/ Restrictions must be issued for airspace within the Flight Inspection SSV not checked, i.e., "PWA VOR: Approach Use Only", or "IRW VORTAC Azimuth and DME unusable 031° cw 009°; 010° cw 030° beyond 15 nm".

Upon being advised of the status, the air traffic control watch supervisor must ensure issuance of applicable NOTAM(s). Unusable SIAP(s), or portions thereof, must be included in the NOTAM (e.g., ELP VOR and TACAN: VOR SIAP Runway 26L unusable TACAN SIAP Runway 26L unusable). The NOTAM for a civil facility must be issued as a NOTAM D to ensure that information is made available using the most expeditious method. Lengthy NOTAM(s) which describe NAVAID(s) in great detail will not be issued. The flight inspector must subsequently record the NOTAM text in the Remarks section of the applicable flight inspection report.

Section 4. Flight Inspection Procedures/Tolerances

12. ILS Glide Slope

Checks Required	Tolerances/Procedures
Modulation	The modulation and carrier energy level is such that the flag is hidden in the area identified as usable.
Angle	± 0.5° of desired or commissioned angle.
Coverage	Minimum 15 µV signal, 2 nm outside OM or FAF, whichever is further.
Clearance (1)	Signal provides a minimum 150 µA (full scale) fly up through to 1,000 ft from threshold, and clear all obstructions
Width, Symmetry, and Structure Below Path (SBP) (1)	(Level Run) Width 0.7° ± 0.2; Symmetry 67 – 33%; Structure Below Path: 190 µA point occurs at or above 30% of the commissioned angle. If can't meet SBP tolerance, clearance procedures and tolerances will be applied.
Course Structure	45 µA from graphical average for all zones if restricted to hand-flown, non-coupled approaches. Standard tolerances apply if used for coupled approaches.
Flyability	Any condition that may induce confusion will render the facility unusable.
PAR Coincidence	0.2°. If PAR/ ILS coincidence cannot be established, a NOTAM must be issued.

Note:
(1) When supporting an operation that may require long-term use of the same facility before normal inspection procedures can be used, a clearance-below-path check is not required on subsequent Chapter 24 inspection of the same ILS facility, provided no changes have been made to the system that would normally require a clearance check in Chapter 15. A significant shift in SBP from previous inspections should be investigated further, including flying a clearance below path.

Note: These tolerances and procedures are valid for Category I minimums only. If operational requirements dictate the restoration/ commissioning to Categories II or III standards, the flight inspector must use normal procedures (see Chapter 15).

13. ILS Localizer

Checks Required	**Tolerances/Procedures**
Identification	Sufficient information to identify the facility. ID must not render the facility unusable.
Modulation	The modulation and carrier energy level is such that the flag is hidden at all times in the area identified as usable.
Coverage	15 nm minimum coverage area with 5 μV minimum signal, not less than 10° each side of procedural course.
Course Structure	± 45 μA from graphical average for all zones if restricted to hand-flown, non-coupled approaches. Standard tolerances apply if used for coupled approaches.
Alignment	30 μA from designated procedural azimuth.
Clearance	150 μA minimum throughout established coverage area
Obstructions	Evaluate obstruction effect on procedure
Flyability	Any condition that may induce confusion will render the facility unusable.
Polarization	± 30 μA

Note: These tolerances and procedures are valid for Category I minimums only. If operational requirements dictate the restoration/ commissioning to Categories II and III standards, the flight inspector must use normal procedures (see Chapter 15).

14. Markers/Beacons

Checks Required	**Tolerances/Procedures**
Horizontal Coverage	5° each side beyond procedural use at 3 nm beyond procedural use
Vertical Coverage Alignment/ Angle	3 nm beyond furthest procedural use at 0.75 MGP; only required on procedural azimuth 0.10° from optimum
Path Following Error	AZ 0.50°/ EL 0.40°
Control Motion Noise	Approach AZ/ MGP 0.30°, if used for hand-flown, non-coupled approaches. Standard tolerance for coupled use. Other areas, 0.8°.
Low Angle EL Clearance	Fly 0.75 MGP, adequate AZ and EL guidance and obstruction clearance FAF to MAP on procedural AZ, observe each side for obstructions within 2° laterally.
Data Words	Multiply acceptable tolerances contained in Paragraph 16.34f by a factor of 3.0.
DME	No unlocks in final approach segment, accuracy 3.0% of charted distance, or 0.2nm, whichever is greater
IDENT	Correct as published
PAR/ ILS Angle Coincidence	0.20°. If coincidence cannot be established, a NOTAM must be issued.

Note: These tolerances and procedures are valid for Category I minimums only. If an operational marker or beacon is not available for establishing aircraft position in relation to runway threshold, other methods of position identification (DME fix, radar fix or crossing radial) may be substituted.

15. Microwave Landing System

Checks Required	Tolerances/Procedures
Horizontal Coverage	5° each side beyond procedural use at 3 nm beyond procedural use
Vertical Coverage Alignment/ Angle	3 nm beyond furthest procedural use at 0.75 MGP; only required on procedural azimuth 0.10° from optimum
Path Following Error	AZ 0.50°/ EL 0.40°
Control Motion Noise	Approach AZ/ MGP 0.30°, if used for hand-flown, non-coupled approaches. Standard tolerance for coupled use. Other areas, 0.8°.
Low Angle EL Clearance	Fly 0.75 MGP, adequate AZ and EL guidance and obstruction clearance FAF to MAP on procedural AZ, observe each side for obstructions within 2° laterally.
Data Words	Multiply acceptable tolerances contained in Paragraph 16.34f by a factor of 3.0.
DME	No unlocks in final approach segment, accuracy 3.0% of charted distance, or 0.2nm, whichever is greater
IDENT	Correct as published
PAR/ ILS Angle Coincidence	0.20°. If coincidence cannot be established, a NOTAM must be issued.

16. VOR

Checks Required	Tolerances/Procedures
Identification	Sufficient information to identify the facility. ID must not render any parameter unusable.
Sensing and Rotation	Correct
Polarization	± 4.0o
Modulation	AM: 25 to 35% FM Deviation Ratio: 14.8 - 17.2 9960: 20 - 35% with voice 20 - 55% without voice Modulation exceeding the listed tolerances is acceptable, using the following criteria: .05 nm in any 1.0 nm segment from FAF to MAP 0.25 nm in any 5 nm segment from sea level up to 10,000 ft MSL 0.5 nm in any 10 nm segment from 10,001 to 20,000 ft MSL 1.0 nm in any 20 nm segment above 20,000 ft MSL
Approach	Alignment within + 2.5°. Structure not to exceed ± 6.0°. Inspect from FAF to MAP.
Missed Approach	Meets flyability constraints until clear of obstructions and course is established.
En Route	Alignment within ± 4.0°. Structure not to exceed ± 6.0°.
Monitors	To be set and checked by maintenance. Flight inspection will verify when practical.
Standby Equipment	Will be checked by transmitter change on approach and en route radials.
Coverage	Sufficient to support requirements.
Flyability	Any condition that may induce confusion will render the procedure or facility unusable.
Voice	Voice must not render any parameter unusable.

Notes:
Check crosspointer, FLAG, and AGC when arriving and departing VOR coverage area, and during all other phases of the inspection when practical.
Alignment orbit, coverage orbit, transmitter differential, and inspection of radials 5° each side of final approach radial are not required.
Final approach segments may be inspected inbound or outbound.

17. TACAN

Checks Required	Tolerances/ Procedures
Identification	Sufficient information to identify the facility. ID must not render any parameter unusable.
Sensing and Rotation	Correct
Polarization	± 4.0°
Distance Accuracy	3% of charted distance or 0.2 nm, whichever is greater
Approach	Alignment within ± 2.5°. Structure not to exceed ± 6.0°. ¼ nm aggregate azimuth, DME unlock, or out-of-tolerance structure permitted. Inspect from FAF to MAP.
Missed Approach	Meets flyability constraints until clear of obstructions and course is established.
En Route	Alignment within ±4.0o. Structure not to exceed ±6.0°. 1.0 nm aggregate azimuth, DME unlock, or out-of-tolerance structure permitted in any 5 nm of radial flight.
Monitors	To be set and checked by maintenance. Flight inspection will verify when practical.
Standby Equipment	Will be checked by transponder change on approach and en route radials
Coverage	Sufficient to support requirements.
Flyability	Any condition that may induce confusion will render that procedure or facility unusable.

Notes:
Check crosspointer, FLAG, and AGC when arriving and departing TACAN coverage area, and during all other phases of the inspection when practical.
Alignment orbit, coverage orbit, transmitter differential, and null checks are not required.
Final approach segments may be inspected inbound or outbound.

18. Shipboard TACAN

Checks Required	Tolerances/Procedures
Identification	Sufficient information to identify the facility. ID must not render any parameter unusable.
Sensing and Rotation	Correct
Polarization	± 4.0
Distance Accuracy	3% or 1.0 nm, whichever is greater
Approach	Alignment within ±2.5°. Structure not to exceed ±6.0°· ¼ nm aggregate azimuth, DME unlock, or out-of-tolerance structure permitted. Fly the radial from a minimum of 7 nm and 700 ft MSL to pass over the ship at 300 ft MSL.
En Route	Alignment within ± 4.0°. Structure not to exceed ± 6.0°. 1.0 nm aggregate azimuth, DME unlock, or out-of-tolerance structure permitted in any 5 nm of radial flight.
Equipment Stability	Stability will be checked during radial inspection by requesting the ship to turn left 15° and then right 15°. Advise the ship's personnel of any change in azimuth or alignment during the turns.
Standby Equipment	Will be checked by transponder change on approach and en route radials
Flyability	Any condition that may induce confusion will render that procedure or facility unusable

19. PAR

Checks Required	Tolerances/Procedures
Course Alignment	Sufficient to guide an aircraft down the runway centerline extended, within ± 50' of runway centerline at threshold. Helicopter-only approaches require delivery to within 50' either side of desired touchdown point.
Glidepath Alignment	± 0.5° of the commissioned angle. If PAR/ ILS coincidence (± 0.2°) cannot be established, a NOTAM must be issued.
Lower Safe Limit	Clear all obstacles to threshold
Coverage	Sufficient to meet operational requirements.
Range Accuracy	5% of true range and sufficient to determine when aircraft is over threshold
Flyability	Any condition that may induce confusion will render the facility unusable.

Note: Aircraft with altimeters calibrated according to FAR 43, Appendix E, and FAR 91.180, or military specifications, may be used for PAR flight checks.

20. ASR/ ATCRBS Radar

Checks Required	Tolerances/ Procedures
Azimuth Accuracy	En route--within ± 5° Approaches: 1. Straight-in within 500' of the edges of the runway at the MAP. 2. Approach to airport/ circling within a radius of the MAP which is 5% of the aircraft-to-antenna distance or 1,000', whichever is greater.
Range Accuracy	Approach and en route within 5% of fix-to-station distance or 500', whichever is greater.
Coverage	Sufficient to support requirement. Targets of opportunity may be used by air traffic personnel. Standard vertical and horizontal coverage profiles not required.

21. Homing Beacons

Checks Required	Tolerances/Procedures
Identification	Sufficient information to identify the facility.
Coverage	En route--± 15° needle swing. Approach--± 10° needle swing. Sufficient signal to support required use.
Station Passage	Approximately over the station at all altitudes
Flyability	Any condition that may induce confusion will render the procedure or use unusable.

22. DF Facilities

Checks Required	Tolerances/Procedures
Same as standard	See Chapter 8

23. VGSI

Checks Required	Tolerances/Procedures
Glidepath Alignment	Actual angle need not be determined but must be safe and adequate to support requirements as determined by flight inspector. If angle is measured, ± 0.5° of the commissioned angle. Angle must be suitably coincident with PAR/ MLS/ ILS to preclude pilot confusion or must be NOTAMed as non-coincidental.
Lower Safe Limit	Clear all obstacles to threshold.
Coverage	Sufficient to meet operational requirements/
Transitions	All light boxes must transition from red to white in the correct sequence.
Flyability	Any condition that may induce confusion will render the facility unusable.

24. RNAV Procedures

Parameter	**Tolerance/ Limit**
Procedure Design (FMS or AFIS calculated values)	
Route/ DP/ SID/ STAR True Course to next WP Distance to next WP	 ± 1° ± 0.1 nm
Initial/ Intermediate Approach Segment True Course to next WP Distance to next WP	 ± 1° ± 0.1 nm
Final Approach Segment True Course to next WP Distance to next WP	 ± 1° ± 0.1 nm
Missed Approach Segment True Course to next WP Distance to next WP	 ± 1° ± 0.1 nm
Vertical Path	± 0.1°
FMS/ GPS	
GPS Integrity	RAIM
DME Supported RNAV	
DME Accuracy	≤ 0.20 nm

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Appendix A. 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.

> 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) Longitude. Represents the longitude 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 Longitude 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) – Latitude. 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 electronic 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 Flight Inspection Services (AJW-3) 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 □A 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 □A 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 ≤ 40 meters. The vertical criterion is based on the WAAS Vertical Alarm Limit (VAL) being > 12 meters and ≤ 50 meters. RNAV WAAS LPV procedures can be supported to HAT of ≥ 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. AJW-3 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 109 times (a unit); giga

M 106 times (a unit); mega

k 103 times (a unit); kilo

h 102 times (a unit); hector

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 1-10-7 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

AJW-3 : Office of Flight Inspection Services

AWOS : automatic weather observation system

az Az- : azimuth

El Baz : azimuth-elevation

BCM : back azimuth horizontal guidance

bcn : back course marker

BFTA : beacon

BPS : beacon false target analysis

BIT : bits per second

BRITE : a digit in a binary coded decimal

BUEC : brite radar indicator tower equipment

BW : backup emergency communications

c : beam width

C : centi (=10-2)

°C : Celsius

: 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 (=109)
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 (-102); 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 (=103)

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 (=106)

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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Appendix B. Formulas.

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Appendix B. Formulas.

1. Introduction. The following formulas and methods of calculation are presented as a ready reference.

2. General. The following information is of a general nature, and use of it may be applicable to more than one facility.

a. Constants Used in this Order. Following is a list of constants used in this order. Others are unique to a particular formula and can be found in reference material concerning the subject.

Constant	Definition/Derivation
6076.1	feet per nautical mile
3600	seconds per hour
106	tan 1° (6076.1)
0.00943	
0.0159	
0.592	

b. Rounding. Measurements and calculations should be carried to one decimal place more than that required for tolerance application. Then apply the following criteria to round off a measurement.

Numbers 1 to 5 - round off to zero

Numbers 6 to 9 - round off to the next higher value.

Example: Glidepath Course Width:

$0.755^{\circ} = 0.75^{\circ}$ and
$0.756^{\circ} = 0.76^{\circ}$

Exception: When a value exceeds a tolerance, it must not be rounded off to an in-tolerance condition.

Example: Glidepath Course Width:

= 0.903° is out of tolerance.

c. Time Average.

$$T_{av} = \frac{2(T_1 \times T_2)}{(T_1 + T_2)}$$

Where:
T_{av} = Time average
T_1 = Time to cross in one direction
T_2 = Time to cross in opposite direction

d. Conversion of Knots to Feet per Second.

$$V = \frac{6076.1 \times V_k}{3600}$$

Where:
V = Velocity (ft per sec)
V_k = Velocity (knots)

e. Slant Angle.

$$\angle = \text{arc tan} \frac{A}{D}$$

Where:
A = Altitude above the horizontal (ft)
D = Geodetic distance (ft)
$\angle$ = Slant Angle (degrees)

f. Slant Range to Chart Distance.

$$S = \frac{D}{\cos \angle}$$

Where:
D = Geodetic distance (ft)
S = Slant range distance (ft)
∠ = Slant Angle (degrees)

g. Chart Distance to Slant Range.

$$D = S \cos \angle$$

Where:
D = Geodetic distance (ft)
S = Slant range distance (ft)
∠ = Slant angle (degrees)

h. Radio Line of Sight.

$$D = 1.23\ (\sqrt{H_r} + \sqrt{H_t})$$

Where:
D = Radio Line of Sight Distance (nm)
Hr = Height of receiving antenna (ft)
Ht = Height of transmitting antenna (ft)

i. Earth Curvature.

$$Ec = (D)^2(0.883)$$

Where:
Ec = Earth Curvature (ft)
D = Distance from a point (nm)

3. TACAN.

Modulation Percentage 135 and 15 Hz

$$15\text{ Hz modulation} = \frac{(V_1 + V_2) - (V_3 + V_4)}{(V_1 + V_2) + (V_3 + V_4)}$$

$$135\text{ Hz modulation} = \frac{(V_1 + V_3) - (V_2 + V_4)}{(V_1 + V_2) + (V_3 + V_4)}$$

Where:
V_1 = Max of 135 Hz and 15 Hz
V_2 = Min of 135 Hz at max of 15 Hz
V_3 = Max of 135 Hz and 15 Hz at min 15 Hz
V_4 = Min 135 and 15 Hz at min 15 Hz

4. Markers (75MHz).

Marker Width

$$W_{ft} = \frac{(TAS)(T_{av})}{0{,}592} \quad \text{or}$$

$$W_{ft} = \frac{(G_s)(T)}{0.592} \quad \text{or}$$

$$W_{nm} = \frac{(TAS)(T_{av})}{3600}$$

Where:
G_s = Ground Speed (knots)
W_{ft} = Width (ft)
W_{nm} = Width (nm)
T = Time (sec)
TAS = True Airspeed (knots)
T_{av} = Time Average (sec)

5. Radar.

Blind Speed using Non-Staggered or Uniform Pulse

$$V = \frac{291(PRF)}{F}$$

Where:
V = Groundspeed (knots)
PRF = Pulse Repetition Frequency (pulses/sec)
F = Transmitter Frequency (Mhz)

6. Localizer.

a. Course Width.

$$W = \frac{0.0159(ETAS)(T_{av})}{D}$$

Where:
W = Width (degrees)
ETAS = Effective True Airspeed (knots)
T_{av} = Time Average for course crossing (sec)
D = Distance from the localizer antenna to the point where the aircraft cross the localizer course (nm to the nearest thousandth)

Computed true airspeed (TAS) may be used if correction for crosswind component is applied from Figure 3 in Appendix C.

b. Determining Localizer Tailored Width.

$$W = 2\left(\arctan\left(\frac{350}{D}\right)\right)$$

Where:
W = Tailored Width (degrees)
D = Distance from the localizer antenna to the runway threshold (ft)

c. Dual Frequency Localizer Power Ratio.

$$dB = 20\left[\log \frac{E_1}{E_2}\right]$$

Where:
dB = Power ratio (dB)
E_1 = Signal Strength of course transmitter as read from the AGC Meter (µvolts)
E_2 = Signal Strength of clearance transmitter as read from the AGC Meter (µvolts)

7. Glide Slope.

a. Glidepath Width or Angles.

$$\theta = \arc\tan \frac{A}{D \pm F}$$

Where:
θ = Angle (degrees)
A = Absolute (Tapeline) altitude (ft) above the glide slope antenna
D = Geodetic distance (ft) from the glide slope antenna to the outer marker (or checkpoint)

$$F = 6076.1 \left(\frac{V}{3600}\right)T$$

Note: F is a factor. The value and sign (plus or minus) is determined by the location of the computation point on the recording.

- Assign a minus value to F if T occurs between the outer marker (or checkpoint) and the facility
- Assign a plus value to F if T occurs prior to the outer marker (or checkpoint)

V = Ground speed (knots)
T = Time to computation point (e.g., 75µA, 150HZ, 0µA, 75µA 90Hz for path width, and angle)

b. Glideslope distance – Threshold to Point C calculation. See FAA Order 8240.36, Appendix 22, Paragraphs 59, 60, and 63.

8. Precision Approach.

a. Level Run Glidepath Angel (using paper units).

(1) $$\theta = \frac{A(0.00943)}{D}$$

Where:
θ = Glidepath Angle (degrees)
A = Absolute (Tapeline) altitude (ft) above the glide slope antenna
D = Distance from the Runway Point of Intercept (RPI) to the point where the glidepath is crossed (nm to the nearest thousandth)

(2) $$\theta = \frac{A(I_1)}{106(D)(I_2)}$$

Where:
θ = Glidepath Angle (degrees)
A = Absolute (Tapeline) altitude (ft) above the glide slope antenna
I_1 = Inches or units of recording paper from surveyed checkpoint to RPI
I_2 = Inches or units of recording paper from RPI to the point where the glidepath is crossed
D = Distance from the Runway Point of Intercept (RPI) to the point where the glidepath is crossed (nm to the nearest thousandth)

b. Altimetry Method.

$$\text{Measured Angle} = \frac{A1}{106 \times D}$$

Where:
A1 = Tapeline altitude in feet
D = Distance in nautical miles from RPI

9. Procedures.

Gradient and Climb Rates

$$\frac{Cfd}{60} : \frac{Gr}{1} : \frac{Cr}{Gs}$$

Where:
Cfd = Climb rate (ft/nm)
Gr = Gradient (in percent/100)
Cr = Rate of Climb (ft/min)
Gs = Ground Speed (knots)

This formula is expressed as a ratio which can be solved directly on a pilot's computer (e.g., Jeppesen CR-3)

10. MLS PFE/PFN.CMN Angular Tolerances.

$$\theta = \arctan \frac{Tf}{D}$$

Where:
θ = Angular Tolerance at measure point.
Tf = PFE/PFN/CMN Tolerance in feet
D = Distance in feet from Azimuth antenna to Tolerance reference Point (ARD or MAP)

11. FMS Waypoint DME Evaluation Obit/ARC Radius.

R = 0.0125D +0.25NM + XTRK

Where:

R = Radius in nm of orbit or arc
D = Distance in nm from the DME station farthest from the waypoint.
XTRK = Waypoint design criteria from Order 8260.40

Note: The XTRK value is .6 nm for Initial Approach, Intermediate, Final Approach, Missed Approach, and missed approach holding waypoints, 2.0 nm for feeder waypoints, and 3.0 nm for en route waypoints.

Appendix C. Working Graphs and Charts

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Figure C-1. Radio Line of Sight Chart.

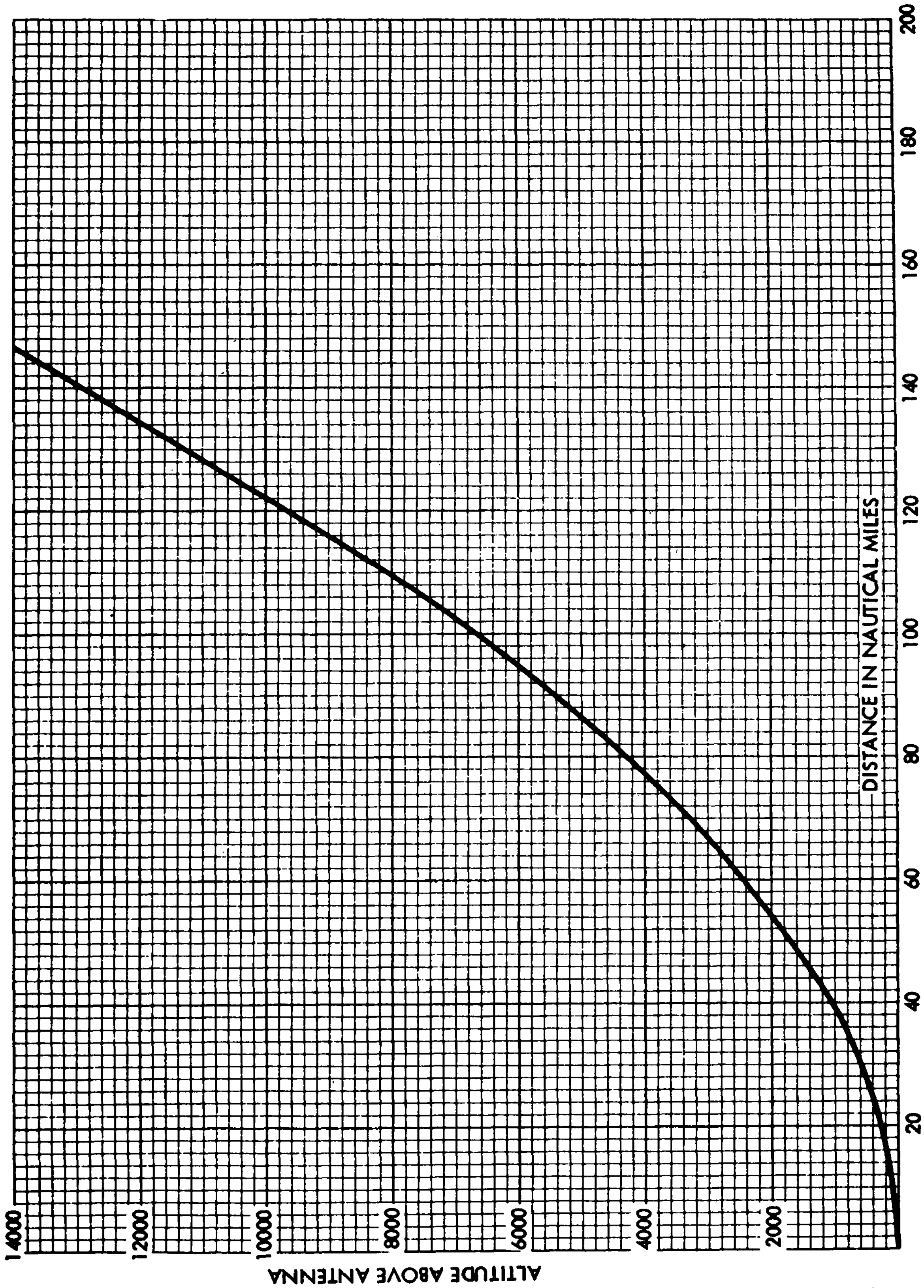


Figure C-2. Correction for Earth Curvature.

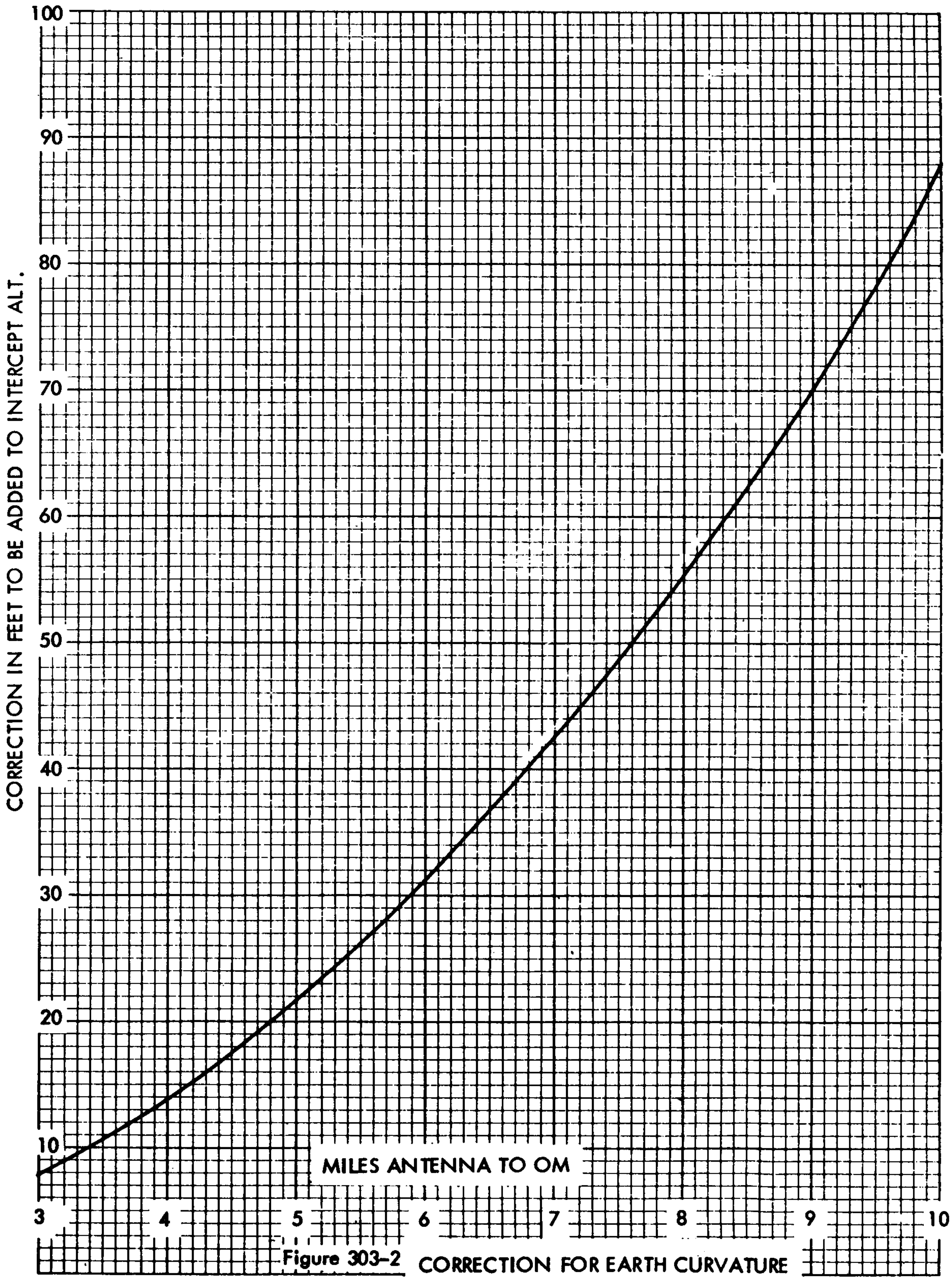


Figure C-3. Tailored Localizer Course Width.

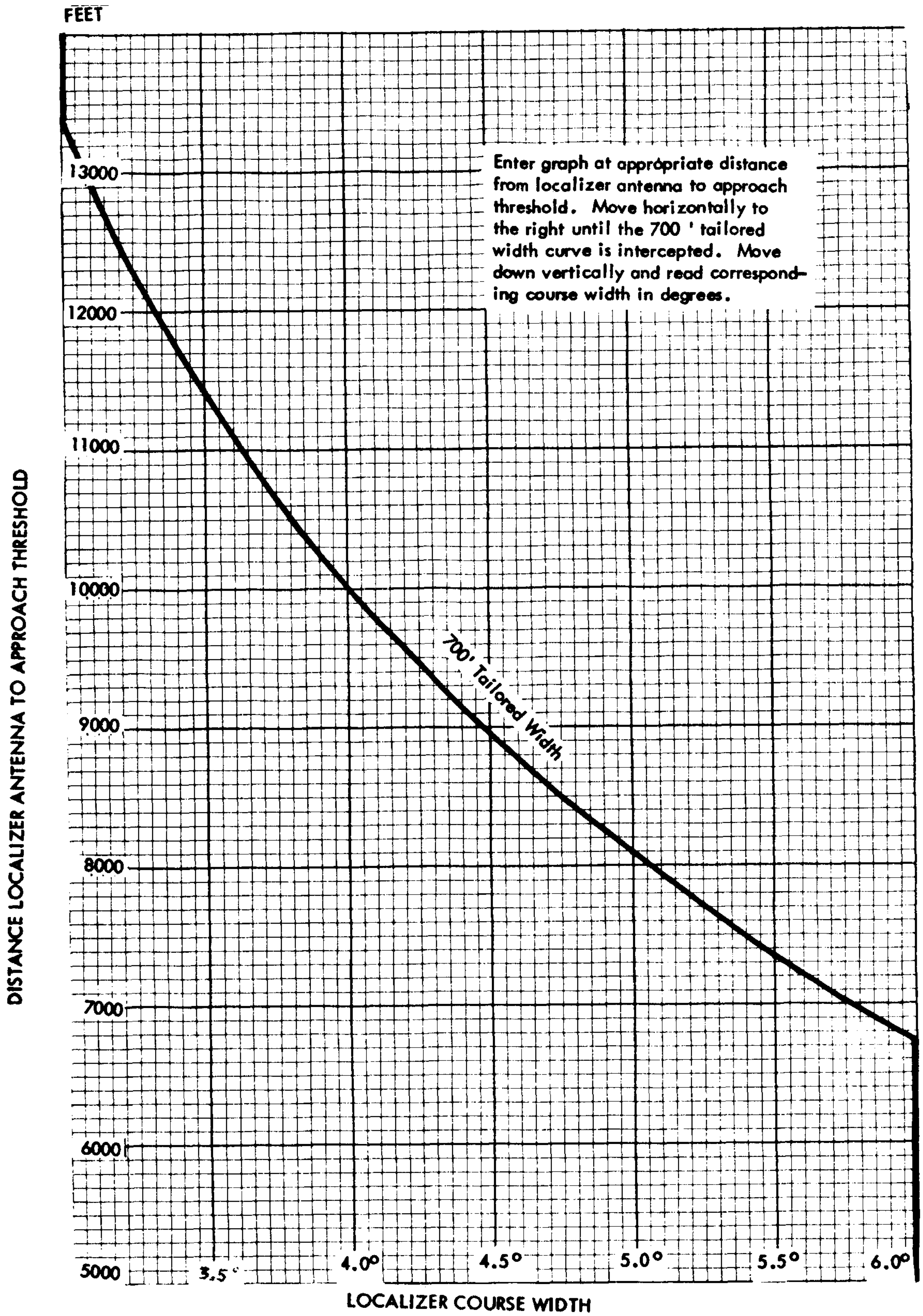


Figure C-4A. ILS Structure Tolerances.

LOCALIZER

CAT I — Coverage Limits to PtA = 30 uA
Pt. A to Pt. B = 15 uA + (D-0.58) 4.39
Pt. B to Pt. C = 15 uA

CAT II, III — Coverage Limits to Pt. A = 30 uA
Pt. A to Pt. B = 5 uA + (D-0.58) 7.31
Pt. B to Pt. D = 5 uA
Pt. D to Pt. E = 5 uA + $(\frac{t}{T} 5)$

GLIDESLOPE

CAT I — Coverage Limits to Pt. C = 30 uA
CAT II, III — Coverage Limits to Pt. A = 30 uA
Pt. A to Pt. B = 20 uA + (D-0.58) 2.92
Pt. B to Threshold = 20 uA

D = Distance in nautical miles.
T = Distance in feet between Pt. D and Pt. E.
t = Distance in feet between Pt. D and the point at which the tolerance is being computed.

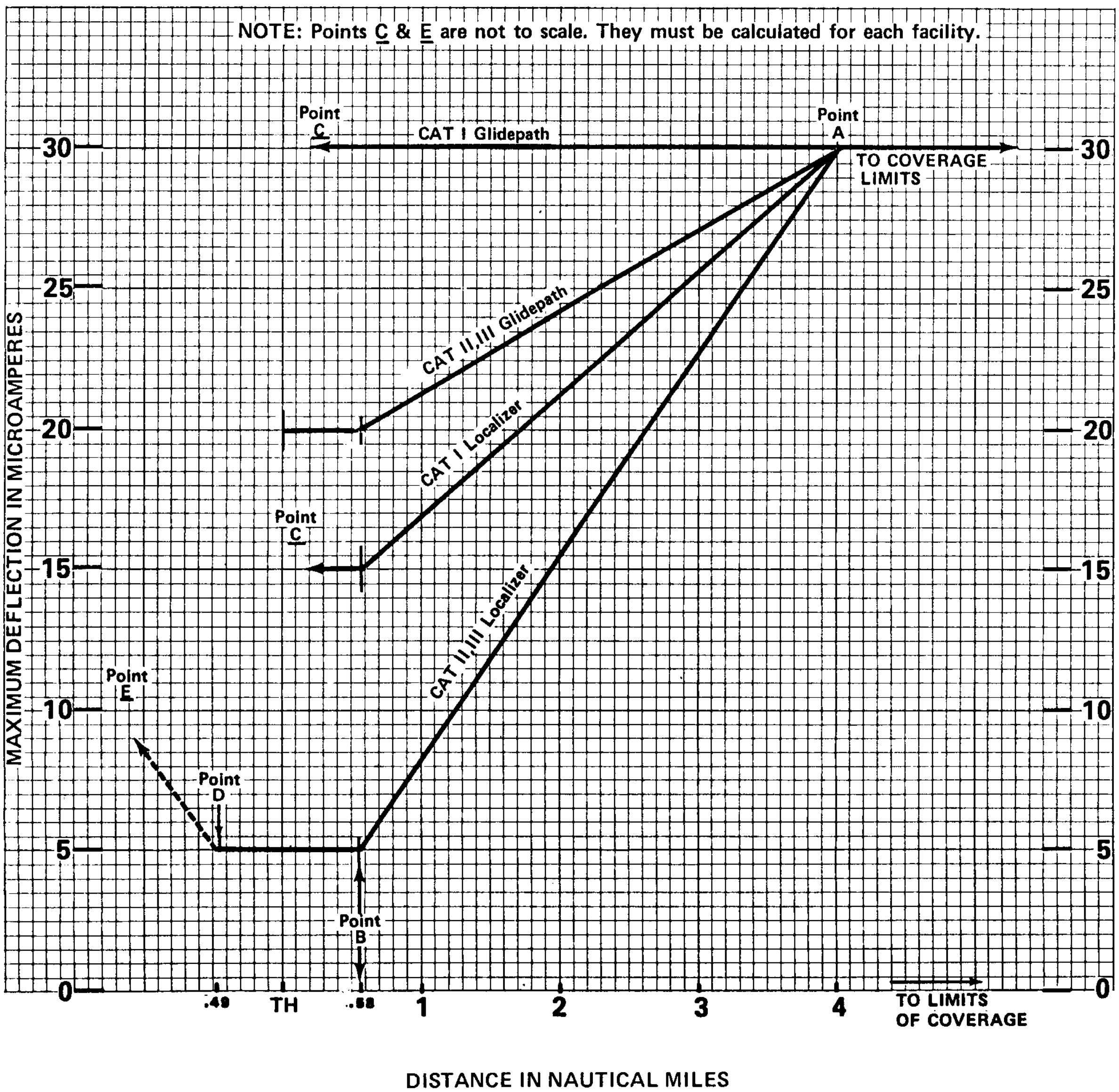
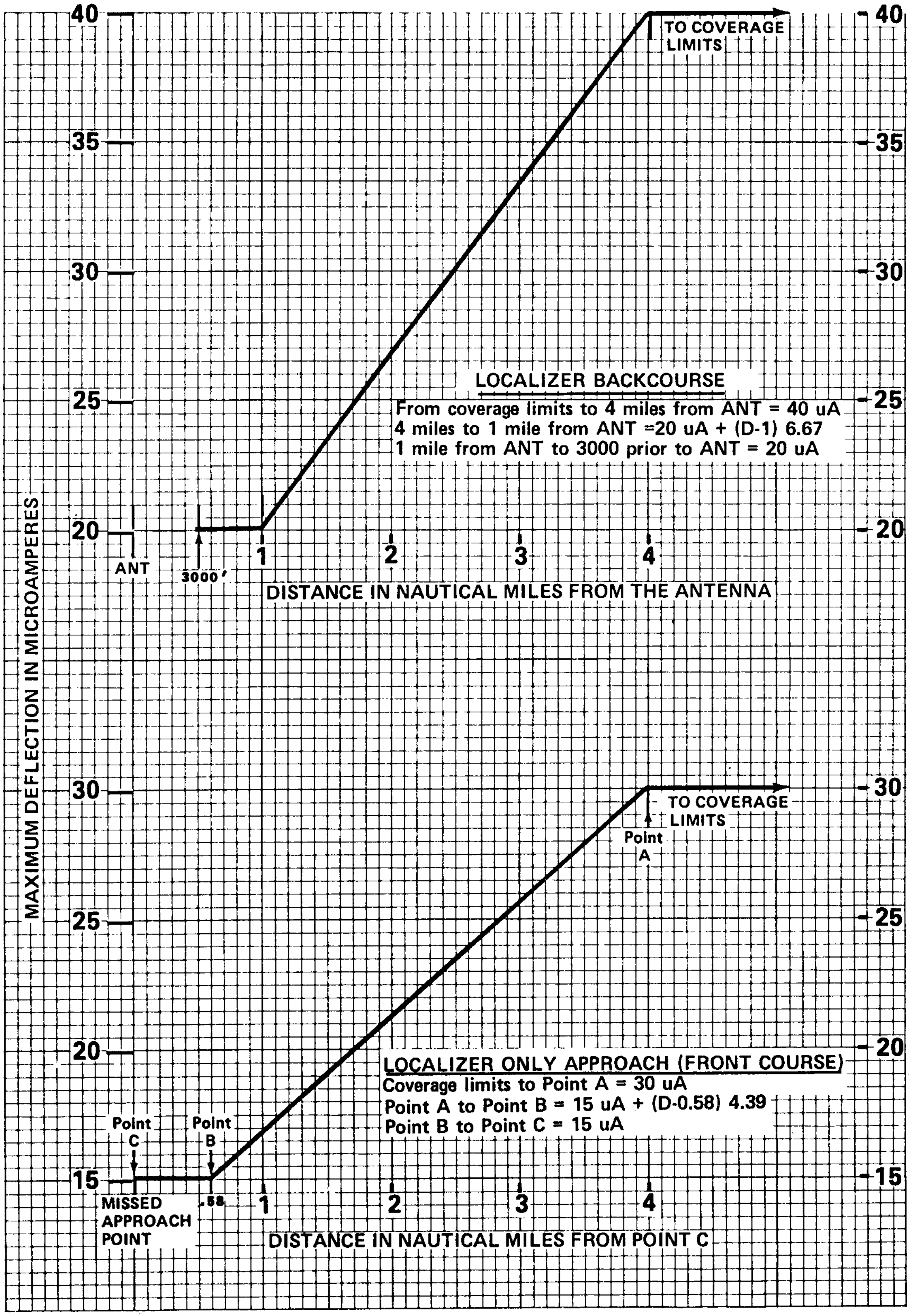


Figure C-4B. Back Course and Localizer Only Structure Tolerances.



1. NAVAID Service Volumes. Most air navigation radio aids, which provide positive course guidance, have a designated standard service volume (SSV).

a. VOR/ DME/ TACAN Standard Service Volumes are illustrated in Figures 3-5A-F.

b. All elevations shown are with respect to the station's site elevation (AGL). Coverage is not available in a cone of airspace directly above the facility.

Figure C-5A. Standard High Altitude Service Volume.

(See Figure C-5F for altitudes below 1,000 ft.)

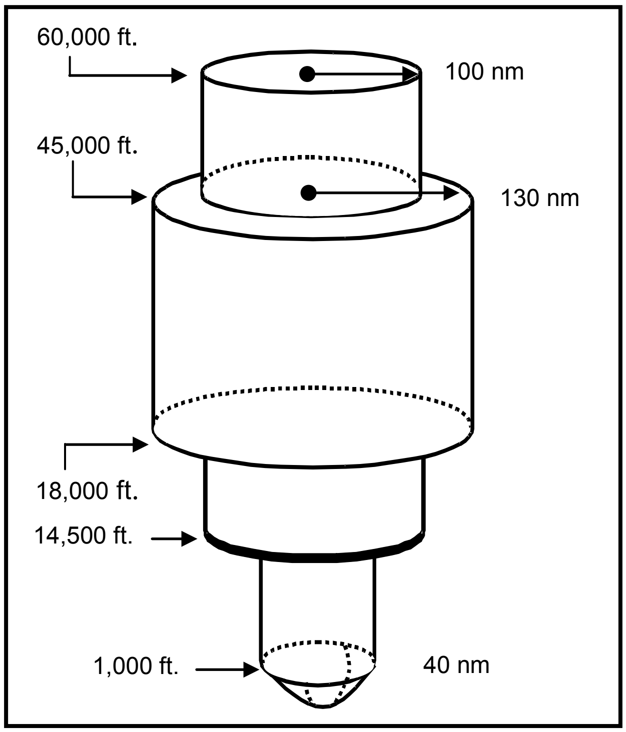


Figure C-5B. Standard Low Altitude Service Volume.

(See Figure C-5F for altitudes below 1,000 ft.)

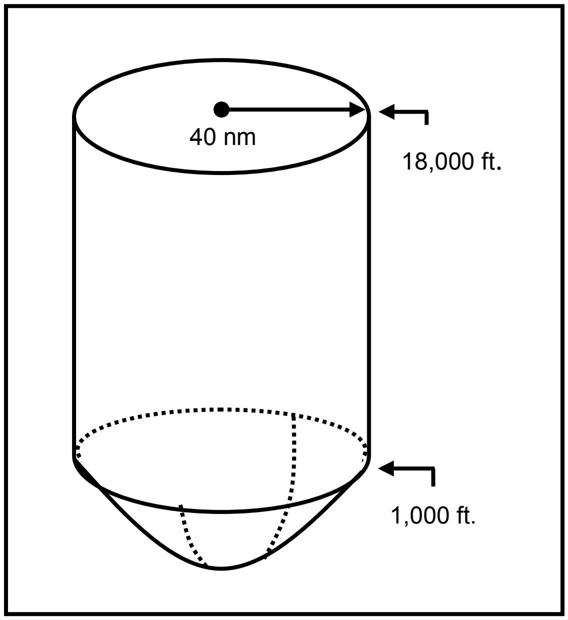


Figure C-5C. Standard Terminal Service Volume.

(See Figure C-5E for altitudes below 1,000 ft.)

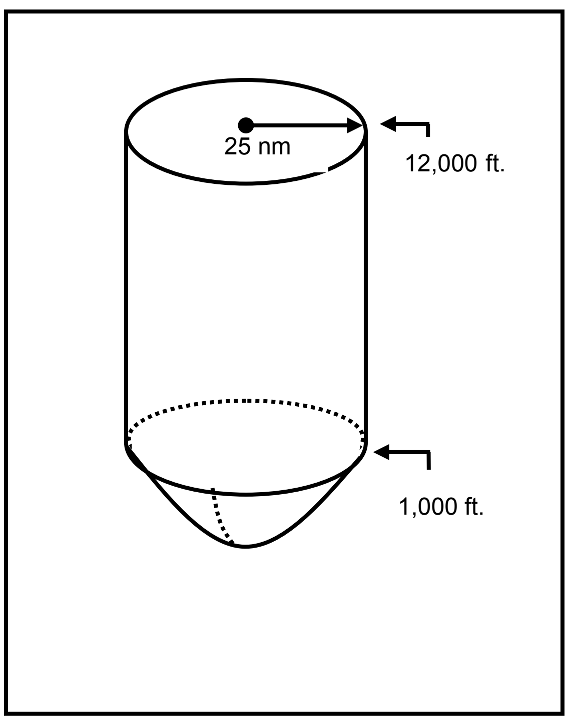


Figure C-5D. VOR/DME/TACAN Standard Service Volume.

SSV Class Designator	Altitude and Range Boundaries
T (Terminal)	From 1,000 ft above ground level (AGL) up to and including 12,000 ft AGL at radial distances out to 25 nm.
L (Low Altitude)	From 1,000 ft AGL up to and including 18,000 ft AGL at radial distances out to 40 nm.
H (High Altitude)	From 1,000 ft AGL up to and including 14,500 ft AGL at radial distances out to 40 nm. From 14,500 ft AGL up to and including 60,000 ft at radial distances out to 100 nm. From 18,000 ft AGL up to and including 45,000 ft AGL at radial distances out to 130 nm.

Figure C-5E. Service Volume Lower Edge Terminal.

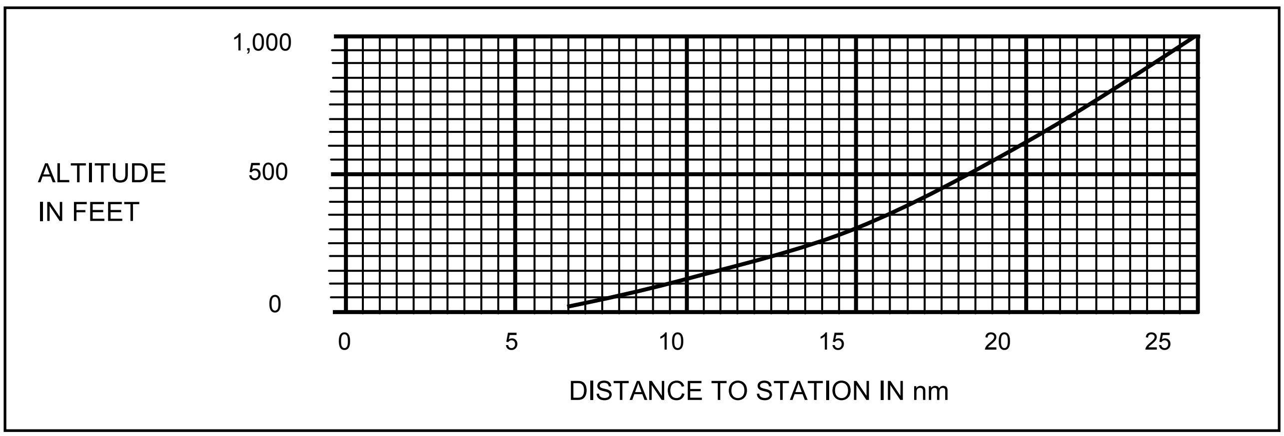


Figure C-5F. Service Volume Lower Edge Standard High and Low.

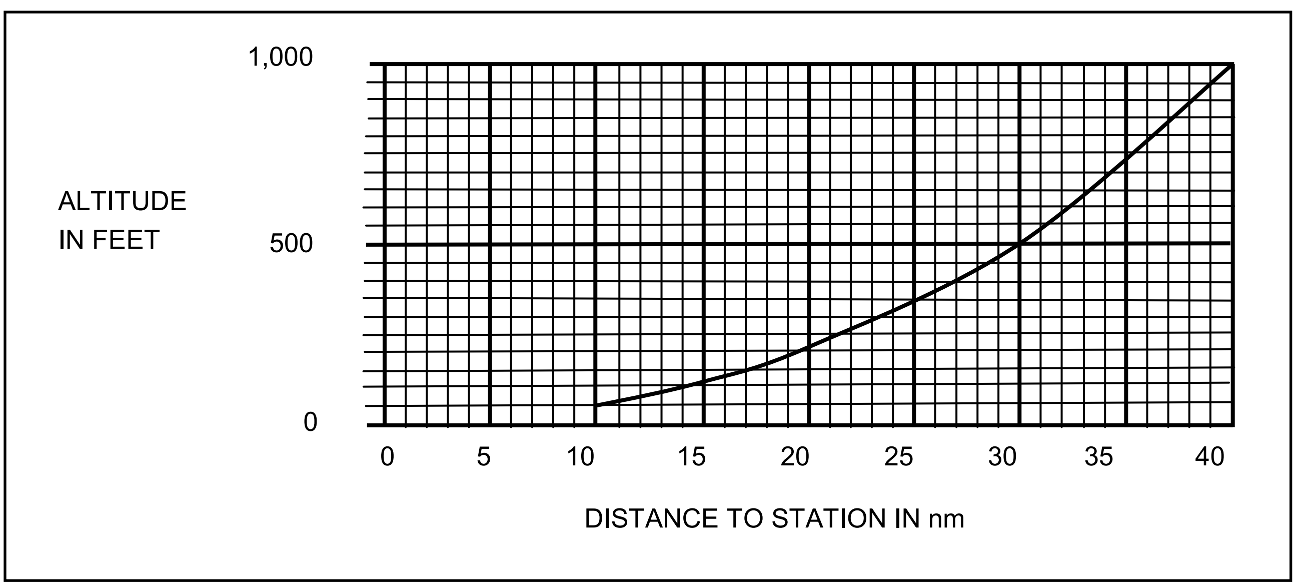


Figure C-6A. VOR Sensing and Rotation

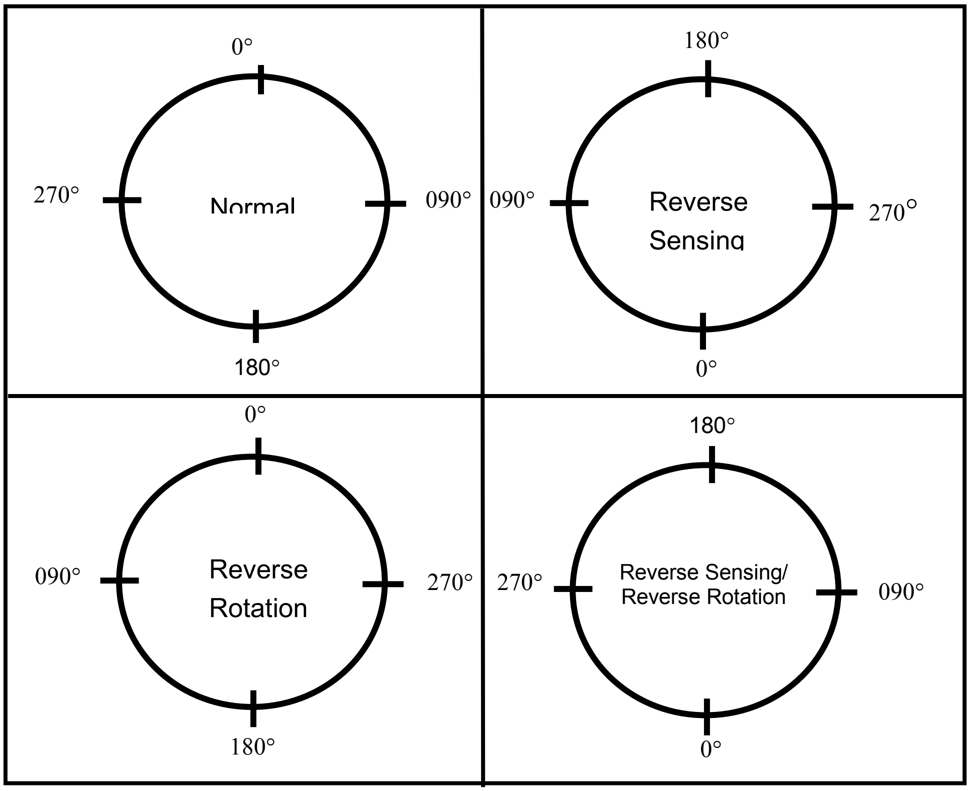


Figure C-6B. TACAN Sensing and Rotation

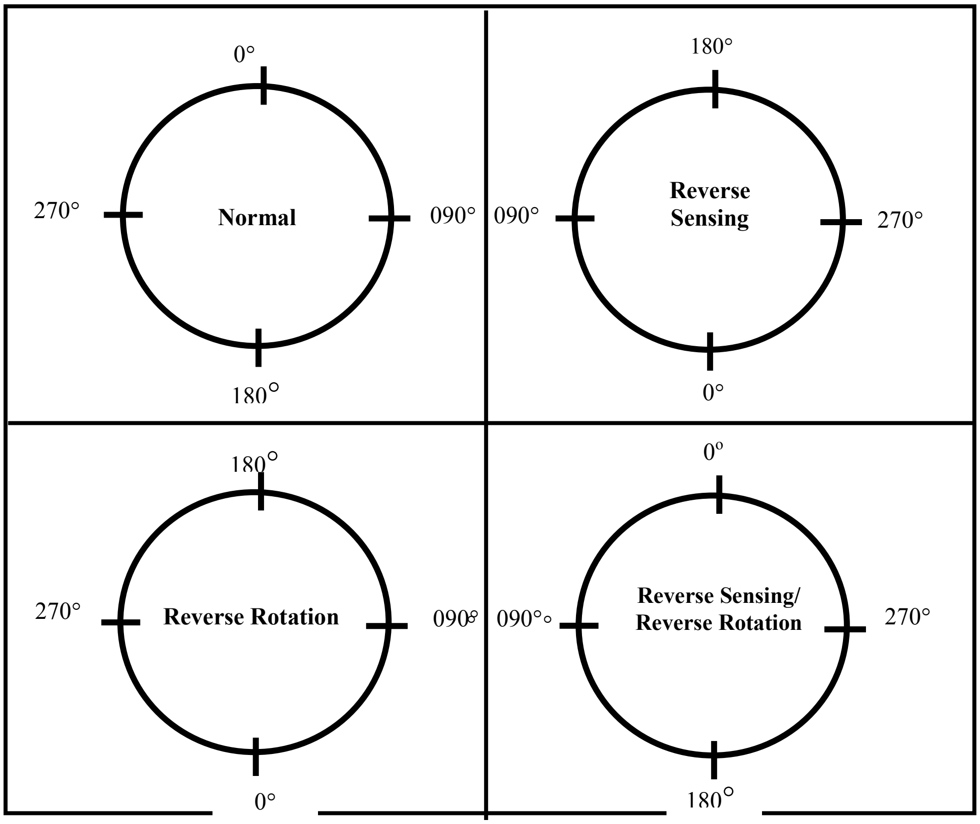


Figure C-7. Intersections (Coverage).

Primary radials = 4 nm or 4.5°, whichever is greater

Dis. From fac in nm	Deg. Off course = to 4 nm	NDB's	Crossing Radial (not primary)
5	38.7	± 5°	± 3.6°
6	33.7	± 5°	± 3.6°
7	29.7	± 5°	± 3.6°
8	26.6	± 5°	± 3.6°
9	24.0	± 5°	± 3.6°
10	21.8	± 5°	± 3.6°
11	20.0	± 5°	± 3.6°
12	18.4	± 5°	± 3.6°
13	17.1	± 5°	± 3.6°
14	15.9	± 5°	± 3.6°
15	14.9	± 5°	± 3.6°
16	14.0	± 5°	± 3.6°
17	13.2	± 5°	± 3.6°
18	12.5	± 5°	± 3.6°
19	11.9	± 5°	± 3.6°
20	11.3	± 5°	± 3.6°
21	10.8	± 5°	± 3.6°
22	10.3	± 5°	± 3.6°
23	9.9	± 5°	± 3.6°
24	9.5	± 5°	± 3.6°
25	9.1	± 5°	± 3.6°
26	8.7	± 5°	± 3.6°
27	8.4	± 5°	± 3.6°
28	8.1	± 5°	± 3.6°
29	7.9	± 5°	± 3.6°
30	7.6	± 5°	± 3.6°

Dis. From fac in nm	Deg. Off course = to 4 nm	NDB's	Crossing Radial (not primary)
31	7.4	± 5°	± 3.6°
32	7.1	± 5°	± 3.6°
33	6.9	± 5°	± 3.6°
34	6.7	± 5°	± 3.6°
35	6.5	± 5°	± 3.6°
36	6.3	± 5°	± 3.6°
37	6.2	± 5°	± 3.6°
38	6.0	± 5°	± 3.6°
39	5.9	± 5°	± 3.6°
40	5.7	± 5°	± 3.6°
41	5.6	± 5°	± 3.6°
42	5.4	± 5°	± 3.6°
43	5.3	± 5°	± 3.6°
44	5.2	± 5°	± 3.6°
45	5.1	± 5°	± 3.6°
46	5.0	± 5°	± 3.6°
47	4.9	± 5°	± 3.6°
48	4.8	± 5°	± 3.6°
49	4.7	± 5°	± 3.6°
50.8	4.5	± 5°	± 3.6°
52	4.09	± 5°	± 3.6°
53	4.17	± 5°	± 3.6°
54	4.25	± 5°	± 3.6°
55	4.33	± 5°	± 3.6°
56	4.41	± 5°	± 3.6°
57	4.49	± 5°	± 3.6°
58	4.56	± 5°	± 3.6°
59	4.64	± 5°	± 3.6°

Dis. From fac in nm	**Deg. Off course = to 4 nm**	**NDB's**	**Crossing Radial (not primary)**
60	4.72	± 5°	± 3.6°
61	4.80	± 5°	± 3.6°
62	4.88	± 5°	± 3.6°
63	4.96	± 5°	± 3.6°
64	5.04	± 5°	± 3.6°
65	5.12	± 5°	± 3.6°
66	5.19	± 5°	± 3.6°
67	5.27	± 5°	± 3.6°
68	5.35	± 5°	± 3.6°
69	5.43	± 5°	± 3.6°
70	5.51	± 5°	± 3.6°
71	5.59	± 5°	± 3.6°
72	5.67	± 5°	± 3.6°
73	5.75	± 5°	± 3.6°
74	5.82	± 5°	± 3.6°
75	5.90	± 5°	± 3.6°
76	5.98	± 5°	± 3.6°
77	6.06	± 5°	± 3.6°
78	6.14	± 5°	± 3.6°
79	6.22	± 5°	± 3.6°
80	6.30	± 5°	± 3.6°
81	6.37	± 5°	± 3.6°
82	6.45	± 5°	± 3.6°
83	6.53	± 5°	± 3.6°
84	6.61	± 5°	± 3.6°
85	6.69	± 5°	± 3.6°
86	6.77	± 5°	± 3.6°
87	6.85	± 5°	± 3.6°

Dis. From fac in nm	Deg. Off course = to 4 nm	NDB's	Crossing Radial (not primary)
88	6.93	± 5°	± 3.6°
89	7.00	± 5°	± 3.6°
90	7.08	± 5°	± 3.6°
91	7.16	± 5°	± 3.6°
92	7.24	± 5°	± 3.6°
93	7.32	± 5°	± 3.6°
94	7.40	± 5°	± 3.6°
95	7.48	± 5°	± 3.6°
96	7.56	± 5°	± 3.6°
97	7.63	± 5°	± 3.6°
98	7.71	± 5°	± 3.6°
99	7.79	± 5°	± 3.6°
100	7.87	± 5°	± 3.6°
101	7.95	± 5°	± 3.6°
102	8.03	± 5°	± 3.6°
103	8.11	± 5°	± 3.6°
104	8.18	± 5°	± 3.6°
105	8.26	± 5°	± 3.6°
106	8.34	± 5°	± 3.6°
107	8.42	± 5°	± 3.6°
108	8.50	± 5°	± 3.6°
109	8.58	± 5°	± 3.6°
110	8.66	± 5°	± 3.6°
111	8.74	± 5°	± 3.6°
112	8.81	± 5°	± 3.6°
113	8.89	± 5°	± 3.6°
114	8.97	± 5°	± 3.6°
115	9.05	± 5°	± 3.6°

Dis. From fac in nm	**Deg. Off course = to 4 nm**	**NDB's**	**Crossing Radial (not primary)**
116	9.13	± 5°	± 3.6°
117	9.21	± 5°	± 3.6°
118	9.29	± 5°	± 3.6°
119	9.37	± 5°	± 3.6°
120	9.44	± 5°	± 3.6°
121	9.52	± 5°	± 3.6°
122	9.60	± 5°	± 3.6°
123	9.68	± 5°	± 3.6°
124	9.76	± 5°	± 3.6°
125	9.84	± 5°	± 3.6°
126	9.92	± 5°	± 3.6°
127	10.00	± 5°	± 3.6°
128	10.07	± 5°	± 3.6°
129	10.15	± 5°	± 3.6°
130	10.23	± 5°	± 3.6°
131	10.31	± 5°	± 3.6°
132	10.39	± 5°	± 3.6°
133	10.47	± 5°	± 3.6°
134	10.55	± 5°	± 3.6°
135	10.62	± 5°	± 3.6°
136	10.70	± 5°	± 3.6°
137	10.78	± 5°	± 3.6°
138	10.86	± 5°	± 3.6°
139	10.94	± 5°	± 3.6°
140	11.02	± 5°	± 3.6°
141	11.10	± 5°	± 3.6°
142	11.18	± 5°	± 3.6°
143	11.25	± 5°	± 3.6°

Dis. From fac in nm	Deg. Off course = to 4 nm	NDB's	Crossing Radial (not primary)
144	11.33	± 5°	± 3.6°
145	11.41	± 5°	± 3.6°
146	11.49	± 5°	± 3.6°
147	11.57	± 5°	± 3.6°
148	11.65	± 5°	± 3.6°
149	11.73	± 5°	± 3.6°
150	11.81	± 5°	± 3.6°
151	11.88	± 5°	± 3.6°
152	11.96	± 5°	± 3.6°
153	12.04	± 5°	± 3.6°
154	12.12	± 5°	± 3.6°
155	12.20	± 5°	± 3.6°
156	12.28	± 5°	± 3.6°
157	12.36	± 5°	± 3.6°
158	12.43	± 5°	± 3.6°
159	12.51	± 5°	± 3.6°
160	12.59	± 5°	± 3.6°
161	12.67	± 5°	± 3.6°
162	12.75	± 5°	± 3.6°
163	12.83	± 5°	± 3.6°
164	12.91	± 5°	± 3.6°
165	12.99	± 5°	± 3.6°
166	13.06	± 5°	± 3.6°
167	13.14	± 5°	± 3.6°
168	13.22	± 5°	± 3.6°
169	13.30	± 5°	± 3.6°
170	13.38	± 5°	± 3.6°
171	13.46	± 5°	± 3.6°

Dis. From fac in nm	**Deg. Off course = to 4 nm**	**NDB's**	**Crossing Radial (not primary)**
172	13.54	± 5°	± 3.6°
173	13.62	± 5°	± 3.6°
174	13.69	± 5°	± 3.6°
175	13.77	± 5°	± 3.6°
176	13.85	± 5°	± 3.6°
177	13.93	± 5°	± 3.6°
178	14.01	± 5°	± 3.6°
179	14.09	± 5°	± 3.6°
180	14.17	± 5°	± 3.6°
181	14.25	± 5°	± 3.6°
182	14.32	± 5°	± 3.6°
183	14.40	± 5°	± 3.6°
184	14.48	± 5°	± 3.6°
185	14.56	± 5°	± 3.6°
186	14.64	± 5°	± 3.6°
187	14.72	± 5°	± 3.6°
188	14.80	± 5°	± 3.6°
189	14.87	± 5°	± 3.6°
190	14.95	± 5°	± 3.6°
191	15.03	± 5°	± 3.6°
192	15.11	± 5°	± 3.6°
193	15.19	± 5°	± 3.6°
194	15.27	± 5°	± 3.6°
195	15.35	± 5°	± 3.6°
196	15.43	± 5°	± 3.6°
197	15.50	± 5°	± 3.6°
198	15.58	± 5°	± 3.6°
199	15.66	± 5°	± 3.6°

Dis. From fac in nm	Deg. Off course = to 4 nm	NDB's	Crossing Radial (not primary)
200	15.74	± 5°	± 3.6°

Appendix D. Frequency Spectrum

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Appendix D. Frequency Spectrum

1. Frequency Allocation

The following is a tabulation of frequencies available for use in the aeronautical, broadcast, and mobile bands. This tabulation may be used as an aid for identifying potential sources of interference. Also included is the VHF/UHF NAVAID Frequency Channeling and Pairing Chart which covers the X and Y channels for TACAN, 50 kHz spacing for VOR and LOC, and 150 kHz GS spacing. The Frequency Management Office can provide additional information regarding users of specific frequencies or bands of frequencies.

Frequency	Service
200-415 kHz	L/ MF radio beacons, ranges, and tower voice (285-325 kHz and 405-415 kHz shared with maritime navigational aids).
1605 kHz-24 mHz	MF/ HF Communications (shared with all services and Government/ non-Government users).
90 -110 kHz	Loran-C
75m Hz	VHF Marker Beacons
108-118 mHz	ILS Localizer & VOR
118-136 mHz	VHF Communications
162-174 mHz	Relay/ Control of VORTAC
225-328.6 mHz	UHF Communications
328.6-335.4 mHz	ILS Glide Slope
335.4-400 mHz	UHF Communications
406-420 mHz	Relay/ Control of VORTAC
420-460 mHz	Radio Altimeter
960-1215 mHz	TACAN and DME
1030 mHz and 1090 mHz	ATC Radar Beacon
1215-1400 mHz	Long Range Surveillance Radar
1227.6 mHz	L2 GPS
1435-1535 mHz	Aeronautical Telemetering (Flight Tests)
1535-1542.5 mHz	Maritime Mobile-Satellite
1542.5-1543.5 mHz	Aeronautical Mobile-Satellite (R) and Maritime Mobile-Satellite
1543.5-1558.5 mHz	Aeronautical Mobile-Satellite (R)
1558.5-1636.5 mHz	Aeronautical Radio Navigation

Frequency	Service
1575.42mHz	L2 Global Positioning System
1636.5-1644 mHz	Maritime Mobile-Satellite
1644-1645 mHz	Aeronautical Mobile-Satellite (R) and Maritime Mobile Satellite
1645-1660 mHz	Aeronautical Mobile Satellite (R)
2700-2900 mHz	Airport Surveillance Radar (shared with meteorological radar).
4200-4400 mHz	Radar Altimeter
5000-5250 mHz	Reserved for Aeronautical Radio Navigation and Space Radio Communication
5031 –5090.7 MHz	Microwave Landing System (MLS)
5350-5470 mHz	Airborne Weather Radar
7125-8400 mHz	Microwave Link for Long Range Radar Relay
8800 mHz	Airborne Doppler Radar
9000-9200 mHz	Precision Approach Radar (PAR)
9300-9500 mHz	Airborne Weather Radar
13.25-13.4 gHz	Doppler Navigation Aids
15.4-15.7 gHz	Reserved for Aeronautical Radio Navigation and Space Radio Communications
24.25-24.47 gHz	Airport Surface Detect Radar (ASDE)
540-1600 kHz	Standard USA
2300-2495 kHz	Tropical Zone only
2500 kHz	WWV Standard Frequency
3200-3400 kHz	Tropical Zone only
3900-4000 kHz	International (Region 3 only)
3950-4000 kHz	International (Region 1 only)
4750-4995 kHz	Tropical Zone only
5000 kHz	WWV Standard Frequency
5005-5060 kHz	Tropical Zone only
5950-6200 kHz	International
9500-9775 kHz	International
10 mHz	WWV Standard Frequency
11.7-11.975 mHz	International

Frequency	Service
15 mHz	WWV Standard Frequency
15.1-15.45 mHz	International
17.7-17.9 mHz	International
20 mHz	WWV Standard Frequency
21.45-21.75 mHz	International
25 mHz	WWV Standard Frequency
25.6-26.1 mHz	International
54-72 mHz	Television, VHF
76-88 mHz	Television, VHF
88-108 mHz	FM
174-216 mHz	Television, VHF
470-890 mHz	Television, UHF

2. Nomenclature of Frequency Bands

a. International**.**

VLF	Very Low Frequency	0 - 30 kHz
LF	Low Frequency	30 - 300 kHz
MF	Medium Frequency	300 - 3,000 kHz
HF	High Frequency	3,000 - 30,000 kHz
VHF	Very High Frequency	30,000 kHz - 300 mHz
UHF	Ultra High Frequency	300 - 3,000 mHz
SHF	Super High Frequency	3,000 - 30,000 mHz
EHF	Extremely High Frequency	30,000 - 300,000 mHz

The shaded frequencies are, for AFIS use, paired communications frequencies that correspond to the indicated TACAN channel.

b. VHF/ UHF NAVAID Frequency Channeling and Pairing.

DME Channel Number	Frequency				MLS Channel Number	DME Airborne Interrogate				DME GND Reply	
							Pulse Code				
							Normal	P/ DME			
	LOC	GS	VHF/ VOR	MLS		Freq	DME us	IA us	FA us	DME Freq	PC us
1X	-	-	134.40	-	-	1025	12	--	--	962	12
1Y	-	-	134.45	-	-	1025	36	--	--	1088	30
2X	-	-	134.50	-	-	1026	12	--	--	963	12
2Y	-	-	134.55	-	-	1026	36	--	--	1089	30
3X	-	-	134.60	-	-	1027	12	--	--	964	12
3Y	-	-	134.65	-	-	1027	36	--	--	1090	30
4X	-	-	134.70	-	-	1028	12	--	--	965	12
4Y	-	-	134.75	-	-	1028	36	--	--	1091	30
5X	-	-	134.80	-	-	1029	12	--	--	966	12
5Y	-	-	134.85	-	-	1029	36	-	-	1092	30
6X	-	-	134.90	-	-	1030	12	-	-	967	12
6Y	-	-	134.95	-	-	1030	36	-	-	1093	30
7X	-	-	135.00	-	-	1031	12	-	-	968	12
7Y	-	-	135.05	-	-	1031	36	-	-	1094	30
8X	-	-	135.10	-	-	1032	12	-	-	969	12
8Y	-	-	135.15	-	-	1032	36	-	-	1095	30
9X	-	-	135.20	-	-	1033	12	-	-	970	12
9Y	-	-	135.25	-	-	1033	36	-	-	1096	30
10X	-	-	135.30	-	-	1034	12	-	-	971	12
10Y	-	-	135.35	-	-	1034	36	-	-	1097	30
11X	-	-	135.40	-	-	1035	12	-	-	972	12
11Y	-	-	135.45	-	-	1035	36	-	-	1098	30
12X	-	-	135.50	-	-	1036	12	-	-	973	12
12Y	-	-	135.55	-	-	1036	36	-	-	1099	30

DME Channel Number	Frequency				MLS Channel Number	DME Airborne Interrogate				DME GND Reply	
							Pulse Code				
							Normal	P/ DME			
	LOC	GS	VHF/ VOR	MLS		Freq	DME us	IA us	FA us	DME Freq	PC us
13X	-	-	135.60	-	-	1037	12	-	-	974	12
13Y	-	-	135.65	-	-	1037	36	-	-	1100	30
14X	-	-	135.70	-	-	1038	12	-	-	975	12
14Y	-	-	135.75	-	-	1038	36	-	-	1101	30
15X	-	-	135.80	-	-	1039	12	-	-	976	12
15Y	-	-	135.85	-	-	1039	36	-	-	1102	30
16X	-	-	135.90	-	-	1040	12	-	-	977	12
16Y	-	-	135.95	-	-	1040	36	-	-	1103	30
17X	-	-	108.00	-	-	1041	12	-	-	978	12
17Y	-	-	108.05	5043.0	540	1041	36	36	42	1104	30
18X	108.10	334.70		5031.0	500	1042	12	12	18	979	12
18Y	108.15	334.55		5043.6	542	1042	36	36	42	1105	30
19X	-	-	108.20	-	-	1043	12	-	-	980	12
19Y	-	-	108.25	-	-	1043	36	36	42	1106	30
20X	108.30	334.10		5031.6	502	1044	12	12	18	981	12
20Y	108.35	333.95		5044.8	546	1044	36	36	42	1107	30
21X	-	-	108.40	-	-	1045	12	-	-	982	12
21Y	-	-	108.45	5045.4	548	1045	36	36	42	1108	30
22X	108.50	329.90		5032.2	504	1046	12	12	18	983	12
22Y	108.55	329.75		5046.0	550	1046	36	36	42	1109	30
23X	-	-	108.60	-	-	1047	12	-	-	984	12
23Y	-	-	108.65	5046.6	552	1047	36	36	42	1110	30
24X	108.70	330.50		5032.8	506	1048	12	12	18	985	12
24Y	108.75	330.35		5047.2	554	1048	36	36	42	1111	30
25X	-	-	108.80	-	-	1049	12	-	-	986	12
25Y	-	-	108.85	5047.8	556	1049	36	36	42	1112	30

DME Channel Number	Frequency LOC	GS	VHF/ VOR	MLS	MLS Channel Number	DME Airborne Interrogate Freq	Pulse Code Normal DME us	P/ DME IA us	FA us	DME GND Reply DME Freq	PC us
26X	108.90	329.30		5033.4	508	1050	12	12	18	987	12
26Y	108.95	329.15		5048.4	558	1050	36	36	42	1113	30
27X	-	-	109.00	-	-	1051	12	-	-	988	12
27Y	-	-	109.05	5049.0	560	1051	36	36	42	1114	30
28X	109.10	331.40		5034.0	510	1052	12	12	18	989	12
28Y	109.15	331.25		5049.6	562	1052	36	36	42	1115	30
29X	-	-	109.20	-	-	1053	12	-	-	990	12
29Y	-	-	109.25	5050.2	564	1053	36	36	42	1116	30
30X	109.30	332.00		5034.6	512	1054	12	12	18	991	12
30Y	109.35	331.85		5050.8	556	1054	36	36	42	1117	30
31X	-	-	109.40	-	-	1055	12	-	-	992	12
31Y	-	-	109.45	5051.4	568	1055	36	36	42	1118	30
32X	109.50	332.60		5035.2	514	1056	12	12	18	993	12
32Y	109.55	332.45		5052.0	570	1056	36	36	42	1119	30
33X	-	-	109.60	-	-	1057	12	-	-	994	12
33Y	-	-	109.65	5052.6	572	1057	36	36	42	1120	30
34X	109.70	333.20	-	5035.8	516	1058	12	12	18	995	12
34Y	109.75	333.05	-	5035.2	574	1058	36	36	42	1121	30
35X	-	-	109.80	-	-	1059	12	-	-	996	12
35Y	-	-	109.85	5053.8	576	1059	36	36	42	1122	30
36X	109.90	333.80		5036.4	518	1060	12	12	18	997	12
36Y	109.95	333.65		5054.4	578	1060	36	36	42	1123	30
37X	-	-	110.00	-	-	1061	12	-	-	998	12
37Y	-	-	110.05	5055.0	580	1061	36	36	42	1124	30
38X	110.10	334.40		5037.0	520	1062	12	12	18	999	12
38Y	110.15	334.25									

						DME Airborne Interrogate				DME GND Reply	
							Pulse Code				
							Normal	P/ DME			
DME Channel Number	Frequency				MLS Channel Number	Freq	DME us	IA us	FA us	DME Freq	PC us
	LOC	GS	VHF/ VOR	MLS							
39X	-	-	110.20	-	-	1063	12	-	-	1000	12
39Y	-	-	110.25	5056.2	584	1063	36	36	42	1126	30
40X	110.30	335.00		5037.6	522	1064	12	12	18	1001	12
40Y	110.35	334.85		5056.8	586	1064	36	36	42	1127	30
41X	-	-	110.40	-	-	1065	12	-	-	1002	12
41Y	-	-	110.45	5057.4	588	1065	36	36	42	1128	30
42X	110.50	329.60		5038.2	524	1066	12	12	18	1003	12
42Y	110.55	329.45		5058.0	590	1066	36	36	42	1129	30
43X	-	-	110.60	-	-	1067	12	-	-	1004	12
43Y	-	-	110.65	5058.6	592	1067	36	36	42	1130	30
44X	110.70	330.20		5038.8	526	1068	12	12	18	1005	12
44Y	110.75	330.05		5059.2	594	1068	36	36	42	1131	30
45X	-	-	110.80	-	-	1069	12	-	-	1006	12
45Y	-	-	110.85	5059.8	596	1069	36	36	42	1132	30
46X	110.90	330.80		5039.4	528	1070	12	12	18	1007	12
46Y	110.95	330.65		5060.4	598	1070	36	36	42	1133	30
47X	-	-	111.00	-	-	1071	12	-	-	1008	12
47Y	-	-	111.05	5061.0	600	1071	36	36	42	1134	30
48X	111.10	331.70		5040.0	530	1072	12	12	18	1009	12
48Y	111.15	331.55		5061.6	602	1072	36	36	42	1135	30
49X	-	-	111.20	-	-	1073	12	-	-	1010	12
49Y	-	-	111.25	6062.2	604	1073	36	36	42	1136	30
50X	111.30	332.30		5040.6	532	1074	12	12	18	1011	12
50Y	111.35	332.15		5062.8	606	1074	36	36	42	1137	30
51X	-	-	111.40	-	-	1075	12	-	-	1012	12
51Y	-	-	111.45	5063.4	608	1075	36	36	42	1136	30

DME Channel Number	Frequency LOC	GS	VHF/ VOR	MLS	MLS Channel Number	DME Airborne Interrogate Freq	Pulse Code Normal DME us	P/ DME IA us	FA us	DME GND Reply DME Freq	PC us
52X	111.50	332.90		5041.2	534	1076	12	12	18	1013	12
52Y	111.55	332.75		5064.0	610	1076	36	36	42	1139	30
53X	-	-	111.60	-	-	1077	12	-	-	1014	12
53Y	-	-	111.65	5064.4	612	1077	36	36	42	1140	30
54X	111.70	333.50		5041.8	536	1078	12	12	18	1015	12
54Y	111.75	333.35		5065.2	614	1078	36	36	42	1141	30
55X	-	-	111.80	-	-	1079	12	-	-	1016	12
55Y	-	-	111.85	5065.8	616	1079	36	36	42	1142	30
56X	111.90	331.10		5042.4	538	1080	12	12	18	1017	12
56Y	111.95	330.95		5066.4	618	1080	36	36	42	1143	30
57X	-	-	112.00	-	-	1081	12	-	-	1018	12
57Y	-	-	112.05	-	-	1081	36	-	-	1144	30
58X	-	-	112.10	-	-	1082	12	-	-	1019	12
58Y	-	-	112.15	-	-	1082	36	-	-	1145	30
59X	-	-	112.20	-	-	1083	12	-	-	1020	12
59Y	-	-	112.25	-	-	1083	36	-	-	1146	30
60X	-	-	133.30	-	-	1084	12	-	-	1021	12
60Y	-	-	133.35	-	-	1084	36	-	-	1147	30
61X	-	-	133.40	-	-	1085	12	-	-	1022	12
61Y	-	-	133.45	-	-	1085	36	-	-	1148	30
62X	-	-	133.50	-	-	1086	12	-	-	1023	12
62Y	-	-	133.55	-	-	1086	36	-	-	1149	30
63X	-	-	133.60	-	-	1087	12	-	-	1024	12
63Y	-	-	133.65	-	-	1087	36	-	-	1150	30
64X	-	-	133.70	-	-	1088	12	-	-	1151	12
64Y	-	-	133.75	-	-	1088	36	-	-	1025	30

DME Channel Number	Frequency				MLS Channel Number	DME Airborne Interrogate				DME GND Reply	
							Pulse Code				
							Normal	P/ DME			
	LOC	GS	VHF/ VOR	MLS		Freq	DME us	IA us	FA us	DME Freq	PC us
65X	-	-	133.80	-	-	1089	12	-	-	1152	12
65Y	-	-	133.85	-	-	1089	36	-	-	1026	30
66X	-	-	133.90	-	-	1090	12	-	-	1153	12
66Y	-	-	133.95	-	-	1090	36	-	-	1027	30
67X	-	-	134.00	-	-	1091	12	-	-	1154	12
67Y	-	-	134.05	-	-	1091	36	-	-	1028	30
68X	-	-	134.10	-	-	1092	12	-	-	1155	12
68Y	-	-	134.15	-	-	1092	36	-	-	1029	30
69X	-	-	134.20	-	-	1093	12	-	-	1156	12
69Y	-	-	134.25	-	-	1093	36	-	-	1030	30
70X	-	-	112.30	-	-	1094	12	-	-	1157	12
70Y	-	-	112.35	-	-	1094	36	-	-	1031	30
71X	-	-	112.40	-	-	1095	12	-	-	1158	12
71Y	-	-	112.45	-	-	1095	36	-	-	1032	30
72X	-	-	112.50	-	-	1096	12	-	-	1159	12
72Y	-	-	112.55	-	-	1096	36	-	-	1033	30
73X	-	-	112.60	-	-	1097	12	-	-	1160	12
73Y	-	-	112.65	-	-	1097	36	-	-	1034	30
74X	-	-	112.70	-	-	1098	12	-	-	1161	12
74Y	-	-	112.75	-	-	1098	36	-	-	1035	30
75X	-	-	112.80	-	-	1099	12	-	-	1162	12
75Y	-	-	112.85	-	-	1099	36	-	-	1036	30
76X	-	-	112.90	-	-	1100	12	-	-	1163	12
76Y	-	-	112.95	-	-	1100	36	-	-	1037	30
77X	-	-	113.00	-	-	1101	12	-	-	1164	12
77Y	-	-	113.05	-	-	1101	36	-	-	1038	30

DME Channel Number	Frequency LOC	GS	VHF/ VOR	MLS	MLS Channel Number	DME Airborne Interrogate Freq	Pulse Code Normal DME us	P/ DME IA us	FA us	DME GND Reply DME Freq	PC us
78X	-	-	113.10	-	-	1102	12	-	-	1165	12
78Y	-	-	113.15	-	-	1102	36	-	-	1039	30
79X	-	-	113.20	-	-	1103	12	-	-	1166	12
79Y	-	-	113.25	-	-	1103	36	-	-	1040	30
80X	-	-	113.30	-	-	1104	12	-	-	1167	12
80Y	-	-	113.35	5067.0	620	1104	36	36	42	1041	30
81X	-	-	113.40	-	-	1105	12	-	-	1168	12
81Y	-	-	113.45	5067.6	622	1105	36	36	42	1042	30
82X	-	-	113.50	-	-	1106	12	-	-	1169	12
82Y	-	-	113.55	5068.2	624	1106	36	36	42	1043	30
83X	-	-	113.60	-	-	1107	12	-	-	1170	12
83Y	-	-	113.65	5068.8	626	1107	36	36	42	1044	30
84X	-	-	113.70	-	-	1108	12	-	-	1171	12
84Y	-	-	113.75	5069.4	628	1108	36	36	42	1045	30
85X	-	-	113.80	-	-	1109	12	-	-	1172	12
85Y	-	-	113.85	5070.0	630	1109	36	36	42	1046	30
86X	-	-	113.90	-	-	1110	12	-	-	1173	12
86Y	-	-	113.95	5070.6	632	1110	36	36	42	1047	30
87X	-	-	114.00	-	-	1111	12	-	-	1174	12
87Y	-	-	114.05	5071.2	634	1111	36	36	42	1048	30
88X	-	-	114.10	-	-	1112	12	-	-	1175	12
88Y	-	-	114.15	5071.8	636	1112	36	36	42	1049	30
89X	-	-	114.20	-	-	1113	12	-	-	1176	12
89Y	-	-	114.25	5072.4	638	1113	36	36	42	1050	30
90X	-	-	114.30	-	-	1114	12	-	-	1177	12
90Y	-	-	114.35	5073.0	640	1114	36	36	42	1051	30

DME Channel Number	Frequency				MLS Channel Number	DME Airborne Interrogate				DME GND Reply	
							Pulse Code				
							Normal	P/ DME			
	LOC	GS	VHF/ VOR	MLS		Freq	DME us	IA us	FA us	DME Freq	PC us
91X	-	-	114.40	-	-	1115	12	-	-	1178	12
91Y	-	-	114.45	5073.6	642	1115	36	36	42	1052	30
92X	-	-	114.50	-	-	1116	12	-	-	1179	12
92Y	-	-	114.55	5074.2	644	1116	36	36	42	1053	30
93X	-	-	114.60	-	-	1117	12	-	-	1180	12
93Y	-	-	114.65	5074.8	646	1117	36	36	42	1054	30
94X	-	-	114.70	-	-	1118	12	-	-	1181	12
94Y	-	-	114.75	5075.4	648	1118	36	36	42	1055	30
95X	-	-	114.80	-	-	1119	12	-	-	1182	12
95Y	-	-	114.85	5076.0	650	1119	36	36	42	1056	30
96X	-	-	114.90	-	-	1120	12	-	-	1183	12
96Y	-	-	114.95	5076.6	652	1120	36	36	42	1057	30
97X	-	-	115.00	-	-	1121	12	-	-	1184	12
97Y	-	-	115.05	5077.2	654	1121	36	36	42	1058	30
98X	-	-	115.10	-	-	1122	12	-	-	1185	12
98Y	-	-	115.15	5077.8	656	1122	36	36	42	1059	30
99X	-	-	115.20	-	-	1123	12	-	-	1186	12
99Y	-	-	115.25	5078.4	658	1123	36	36	42	1060	30
100X	-	-	115.30	-	-	1124	12	-	-	1187	12
100Y	-	-	115.35	5079.0	660	1124	36	36	42	1061	30
101X	-	-	115.40	-	-	1125	12	-	-	1188	12
101Y	-	-	115.45	5079.6	662	1125	36	36	42	1062	30

DME Channel Number	Frequency LOC	GS	VHF/ VOR	MLS	MLS Channel Number	DME Airborne Interrogate Freq	Pulse Code Normal DME us	P/ DME IA us	FA us	DME GND Reply DME Freq	PC us
102X	-	-	115.50	-	-	1126	12	-	-	1189	12
102Y	-	-	115.55	5050.2	664	1126	36	36	42	1063	30
103X	-	-	115.60	-	-	1127	12	-	-	1190	12
103Y	-	-	115.65	5080.8	666	1127	36	36	42	1064	30
104X	-	-	115.70	-	-	1128	12	-	-	1191	12
104Y	-	-	115.75	5081.4	668	1128	36	36	42	1065	30
105X	-	-	115.80	-	-	1129	12	-	-	1192	12
105Y	-	-	115.85	5082.0	670	1129	36	36	42	1066	30
106X	-	-	115.90	-	-	1130	12	-	-	1193	12
106Y	-	-	115.95	5082.6	672	1130	36	36	42	1067	30
107X	-	-	116.00	-	-	1131	12	-	-	1194	12
107Y	-	-	116.05	5083.2	674	1131	36	36	42	1068	30
108X	-	-	116.10	-	-	1132	12	-	-	1195	12
108Y	-	-	116.15	5083.8	676	1132	36	36	42	1069	30
109X	-	-	116.20	-	-	1133	12	-	-	1196	12
109Y	-	-	116.25	5084.4	678	1133	36	36	42	1070	30
110X	-	-	116.30	-	-	1134	12	-	-	1197	12
110Y	-	-	116.35	5085.0	680	1134	36	36	42	1071	30
111X	-	-	116.40	-	-	1135	12	-	-	1198	12
111Y	-	-	116.45	5085.6	682	1135	36	36	42	1072	30

DME Channel Number	Frequency LOC	Frequency GS	Frequency VHF/ VOR	Frequency MLS	MLS Channel Number	DME Airborne Interrogate Freq	Pulse Code Normal DME us	Pulse Code P/ DME IA us	Pulse Code P/ DME FA us	DME GND Reply DME Freq	DME GND Reply PC us
112X	-	-	116.50	-	-	1136	12	-	-	1199	12
112Y	-	-	116.55	5086.2	684	1136	36	36	42	1073	30
113X	-	-	116.60	-	-	1137	12	-	-	1200	12
113Y	-	-	116.65	5086.8	686	1137	36	36	42	1074	30
114X	-	-	116.70	-	-	1138	12	-	-	1201	12
114Y	-	-	116.75	5087.4	688	1138	36	36	42	1075	30
115X	-	-	116.80	-	-	1139	12	-	-	1202	12
115Y	-	-	116.85	5088.0	690	1139	36	36	42	1076	30
116X	-	-	116.90	-	-	1140	12	-	-	1203	12
116Y	-	-	116.95	5088.6	692	1140	36	36	42	1077	30
117X	-	-	117.00	-	-	1141	12	-	-	1204	12
117Y	-	-	117.05	5089.2	694	1141	36	36	42	1078	30
118X	-	-	117.10	-	-	1142	12	-	-	1205	12
118Y	-	-	117.15	5089.8	696	1142	36	36	42	1079	30
119X	-	-	117.20	-	-	1143	12	-	-	1206	12
119Y	-	-	117.25	5090.4	698	1143	36	36	42	1080	30
120X	-	-	117.30	-	-	1144	12	-	-	1207	12
120Y	-	-	117.35	-	-	1144	36	-	-	1081	30
121X	-	-	117.40	-	-	1145	12	-	-	1208	12
121Y	-	-	117.45	-	-	1145	36	-	-	1082	30

DME Channel Number	Frequency LOC	GS	VHF/ VOR	MLS	MLS Channel Number	DME Airborne Interrogate Freq	Pulse Code Normal DME us	P/ DME IA us	FA us	DME GND Reply DME Freq	PC us
122X	-	-	117.50	-	-	1146	12	-	-	1209	12
122Y	-	-	117.55	-	-	1146	36	-	-	1083	30
123X	-	-	117.60	-	-	1147	12	-	-	1210	12
123Y	-	-	117.65	-	-	1147	36	-	-	1084	30
124X	-	-	117.70	-	-	1148	12	-	-	1211	12
124Y	-	-	117.75	-	-	1148	36	-	-	1085	30
125X	-	-	117.80	-	-	1149	12	-	-	1212	12
125Y	-	-	117.85	-	-	1149	36	-	-	1086	30
126X	-	-	117.90	-	-	1150	12	-	-	1213	12
126Y	-	-	117.95	-	-	1150	36	-	-	1087	30

Appendix E. Map Interpretation.

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Appendix E. Map Interpretation.

1. Introduction.

a. Aeronautical charts normally used for checkpoint orbit checks have substantial effect on the data processing center. Through the cooperation of the United States Coast and Geodetic Survey, certain information concerning aeronautical charts has been collected. Coast and Geodetic Survey personnel have accompanied flight crews on orbit type checks. Outlined here is information considered helpful in improving the accuracy of flight inspection results, with particular reference to chart construction, design, and preparation for flight inspection use, checkpoint selection, etc.

b. The use of state highway maps or county maps is not recommended if aeronautical charts are available, as there is considerable variation in the accuracy of the maps among various states and counties.

c. It has been determined, however, that the Defense Mapping Agency Series 1501, Joint Operations Graphics, although not aeronautical charts, are satisfactory for flight inspection use. Due to the scale of these maps (1 to 250,000), greater detail is available than that displayed by the sectional charts; consequently more definable checkpoints can be utilized.

d. The positions of many facility sites have been determined by first-order triangulation or photogrammetric methods with a high degree of accuracy. Before recommending that coordinates of a facility be changed, the Coast and Geodetic Survey should be contacted for verification of such a change.

2. Aeronautical Chart Preparation.

a. In congested areas of the Nation, checkpoints are plentiful, and it is possible to select only the most desirable. In sparsely settled areas, it may be necessary to use every feature appearing on the chart in order to obtain a maximum of 8 or 10 checkpoints. For these reasons, it is helpful to have an understanding of the manner in which final drawings for aeronautical charts are made.

b. The preparation of final drawings for charts using three separate colors is made as follows:

(1) Black. Includes railroads, roads (these are sketched in black, but photograph gray on final chart), city and town symbols, boundaries, dots showing the location of spot heights, landmark symbols, etc.

(2) Blue. Drainage.

(3) Brown. Contours.

c. In order to provide satisfactory clearances between various features, it is often necessary to shift some away from their correct geographic positions. This shift does not usually amount to more than 1/32 of an inch on the printed chart, but it is often required for increased clarity and legibility of the chart. In shifting, two general conditions are to be met:

(1) All possible detail in the relative position of the features is retained as closely as possible.

(2) The geographic position of the combination of features is retained as closely as possible.

d. For example, in case of a road paralleling a railroad for a short distance, the railroad is drawn in its true geographic position, and the road is displaced enough to provide the required clearance. If both were displaced by equal amounts, as first might be suspected, a curve that is nonexistent in fact would have to be introduced into the railroad or the railroad would have to be displaced for some little distance on either side, with consequent displacement of towns and other features along the railroad.

e. Similarly, if a road parallels the railroad for a short distance, then crosses and again parallels the railroad on the other side, the railroad should be shown in its correct position and the road displaced as before.

f. Further, there are conditions where a road may parallel a railroad for a short distance, and both may be displaced by an amount equal to one-half the required clearance.

g. In general, it has been found that a railroad should be held in its correct position first, a road second, and stream last. That is, between a railroad and a highway or stream, the latter are usually shifted; between a road and a stream, the stream is displaced.

h. If a stream flows between a road and a railroad, or between two railroads, the stream retains its true position and other features are displaced. As a rule, all town and city symbols are affixed in their correct positions. Since railroads and towns are usually held in their correct positions, other features are adjusted to them. Landmarks such as oil derricks, race-tracks, etc., should be used only as a last resort.

i. Since each color on a printed chart is a separate sheet, the registration of the colors may be checked at the "neat line" at each corner of the chart. The color which is not correct can be identified by the color tick. If a color is too far from correct registration, several charts should be examined and an effort made to obtain one that is more accurate.

3. Preparation of Charts for Flight Inspection Use. In preparing a chart for a flight inspection, the following procedure is outlined.

a. The *exact* latitude and longitude of the facility should be plotted on the chart as follows:

(1) Plot the longitude on parallels, which are subdivided into 1-minute intervals, north and south of the station, then draw a fine line connecting these two points and extend the line far enough in both directions to fit a large protractor. This will be the true north reference. The latitude should be scaled, using hairspring dividers, from the parallel below the site along the nearest meridian, subdivided into 1-minute -intervals, and then be transferred to the true north reference where it intersects the same parallel. Because of curvature in the parallels, this procedure will be far more accurate than measuring the latitude on each side of the site and then drawing a line between the two points of latitude.

(2) If two or more charts must be joined together, such as Kansas City and Des Moines for the St. Joseph VOR, it is suggested that the following method be used: Select one of the charts which will be used to plot the correct position of the VOR and use it as the overlay chart. For example, the correct position of the STJ VOR is to be plotted on the Kansas City chart. Place a straight edge on the intersection of north lat. 40° 05'00" and 94° 00'00" west long. Draw a straight line between these two points. The use of a razor blade for cutting along a straight edge is preferred. This chart will be mounted on the Des Moines chart by correctly aligning the central meridian of 95° 00'00" and placing the two points mentioned above in their correct position. The slight difference in the size of the two charts will fall away from the central meridian and allow the minimum error near the station. If it is necessary to join four charts together, it is suggested that the two north charts be mounted on the two south charts to form the east and west half, then the east and west sections may be mounted along a meridian such as 96° 00'00", making sure that the 40° parallel is in correct alignment and that the 96th meridian is in a straight line.

(3) The magnetic north reference may not be plotted from the facility location with magnetic variation interpolated from the lines of magnetic variation shown on the chart. The determination of the correct magnetic variation is extremely important. Whenever possible, the magnetic variation should be obtained from the latest information available through the Coast and Geodetic Survey. If the available information is not up to date, the annual rate of change in variation should be applied. It is conceivable that errors as great as 0.5° may occur if proper determination of magnetic variation is not made through use of the latest and most accurate source of this information.

(4) After the magnitude of magnetic variation has been determined, it is suggested that this be plotted on the chart using at least a 6-inch circular protractor and marking it from the true north reference, both north and south of the site and connecting the two points with a fine line which passes directly through the site. The 90° to 270° magnetic lines may be marked by resetting the protractor on the magnetic north reference.

4. Use of the Chart.

a. In the selection of checkpoints, black should be used first, gray second, and blue (drainage) last. Only in rare cases will the facility site be accurately located. Consequently, the facility location should always be plotted as outlined above.

b. One good checkpoint each 30° provides more repeatable results (provided constant radius is maintained) than large numbers of checkpoints using all types of map information.

c. If the same chart is used over an extended period of time, it may be necessary to realign the magnetic north reference line due to annual change in the variation. This is particularly true in some areas where the annual rate of change is extraordinary.

Appendix F. UHF Homing Beacons.

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Appendix F. UHF Homing Beacons.

1. Introduction.

a. The UHF Homing Beacon (AN/ URN-12) ground station transmits a continuous carrier in the frequency range of 275 to 287 megacycles, modulated with a 1,020-cycle tone for identification purposes. The power output is approximately 15 watts.

b. The pilot of an aircraft equipped with the AN/ARA-25 or similar equipment can determine the relative bearing of, and "home" on, the Facilities Maintenance equipment. The airborne equipment extracts the information from signals received by the AN/ARC-27 or similar UHF communications receiver. The relative bearing of the signal source is indicated on a course indicator. Best results are obtained under straight and level flight conditions.

2. Preflight Requirements.

a. Facilities Maintenance personnel should prepare for flight inspection in accordance with procedures outlined in Paragraph 4.7.a.

b. Air. The flight inspector will prepare for the flight inspection in accordance with procedures outlined in Paragraph 4.7.b. In addition to the above preparations, the flight inspector will:

(1) Be sure that an approved type of airborne equipment is installed and has been calibrated and aligned in accordance with current FAA directives. Wide Area Multilateration (WAM) System.

(2) For commissioning, use a suitable chart, scale 1:500,000 or greater, to plot the exact location of the facility. Plot a series of checkpoints spaced approximately 45° apart at a radius between 20 and 30 nm from the station. Determine the primary air routes that are served by the facility and plot the routes on the chart. Select two courses for a long-distance check.

> Note: These two courses may be extensions of the primary air routes previously selected, but should be at least 45° apart.

3. Flight Inspection Procedures. The primary object of the flight inspection is to determine the coverage and quality of the transmitted signal; therefore, it is necessary that the aircraft be flown through normal usage patterns and procedures to determine the usability of the facility and to ensure that the homing beacon meets the operational requirements for which it was installed.

a. Checklists.

Type Check	**Reference Paragraph**	**C**	**P**
Station identification	A6.3.b(1)	X	X
Bearing accuracy	A6.3.b(2)	X	X
Voice	A6.3.b(3)	X	X
Coverage	A6.3.b(4)	X	X
Long distance	A6.3.b(5)	X	
Low approach	A6.3.b(6)	X	X
Station passage	A6.3.b(7)	X	X
Standby equipment	A6.3.b(8)	X	X
Standby power	4.17.c	X	

b. Detailed Procedures.

(1) Station Identification. Select the proper frequency and check for correct identification and tone of the signal. Any discrepancies noted should be reported to maintenance personnel for corrective action before continuing the flight inspection. Note any frequency interference from other stations.

(2) Bearing Accuracy. Check bearing accuracy against AFIS, GPS, or map reference at least at one point in the service volume, preferably on a published procedure. Fly at minimum instrument altitudes or at an altitude to ensure adequate signal strength.

(3) Voice. If the facility is equipped with voice feature, this feature should be checked at maximum usable distance. It will be noted that most types of airborne equipment will require the receiver function selector to be placed in the RECEIVE position to receive voice transmissions. Request a long voice transmission and note the voice quality, modulation, and freedom from interference. In the event voice transmissions do not reach the maximum usable range, return inbound until they can be received satisfactorily. Record this distance on the flight inspection report.

(4) Coverage.

(a) Proceed outbound along one of the primary air routes at minimum instrument altitude until reaching 45 nm or until any out-of-tolerance condition is observed. This position will be the usable distance. Upon completion of the investigation of the first route, proceed to the remaining routes and repeat the above procedures.

(b) During the check, observe the surrounding terrain and note the location of terrain, or other obstructions that may prevent line-of-sight transmissions to an area beyond the obstructions. Reflections of radio signals, or shadow effect, caused by the intervening terrain, or other obstacles, may result in bearing errors or loss of usable signal.

(c) If areas of weak signal are encountered or if terrain obstructions exist, investigate the areas in question and record the areas checked, location of apparent obstructions, and the minimum altitude and distance at which a usable signal can be received.

(d) For periodic inspections, check coverage from 45 nm at minimum en route altitude until intercepting the approach procedure.

(5) Long-Distance Check. Proceed outbound along one of the air routes or courses selected to a distance of 100 nm at an altitude of 10,000 ft. Observe and record the extent of the pilot's direction indicator needle oscillation, AGC, and the station identification. Then proceed to the other air route or selected course at the 100-mile range and fly inbound along this route to the facility site, again noting the identification, AGC, and needle oscillation.

(6) Standard Instrument Approach Procedure (SIAP). If this facility is to be used as a low approach aid, a low approach will be made for each of the proposed or approved procedures. Check each approach procedure for flyability. Unusual conditions noted will be further investigated. The flight inspector must follow the procedures for inspection of SIAP(s) contained in Chapter 6. Altitudes flown shall be the minimum proposed or published for the segment evaluated, except that the final segment must be flown to 100 ft below the lowest published MDA. The flight inspector must check to ensure compliance with tolerances in Paragraph A6.5.

(a) Commissioning Inspection of SIAP. The flight inspector must evaluate all segments of the proposed procedure.

(b) For a periodic inspection, evaluate the final approach segment of the SIAP.

(7) Station Passage. Fly over the antenna site and note the position where station passage is indicated. The station passage should be indicated by a sharp positive reversal of the pilot's direction indicator needle. No specific tolerances are established for station passage; however, it should be encountered approximately over the facility. Any area where the needle has a tendency to reverse itself before actually passing over the station should be plotted on the chart and reported on the flight inspection report.

(8) Standby Equipment. Standby equipment will be spot-checked to ascertain that it meets the same tolerances as the primary equipment.

4. Analysis.

a. From the data obtained during the flight inspection, the flight inspector must determine if there are any areas where the facility fails to meet the coverage and/or bearing tolerance. If such areas were noted during the flight inspection, he should analyze all data to determine if such effects are caused by terrain or equipment. Normally this facility cannot be expected to give reliable information at ranges and altitudes which are below line of sight.

b. The airborne ADF equipment (AN/ ARA-25) is an attachment applied to the UHF transceiver to enable it to take bearings on a transmitted signal. While in the ADF position, the ADF antenna seeks a null in the process of presenting a bearing. Under these conditions, very little signal from the transmitter is applied to the UHF transceiver, and tone identification cannot be heard at distances greater than 70 nm, line of sight, but may be heard at shorter distances depending upon the ambient electrical noise level of the airborne ADF system. (The antenna drive mechanism develops a 100-cycle signal that is great enough to blanket the tone identification except at close range to the transmitter.) Continuous switching from the RECEIVE to ADF position must be accomplished in order to monitor both the identification and the ADF indications.

c. The bearing indicator normally hunts plus or minus a few degrees of the received bearing when the transmitter is operating satisfactorily. In the absence of a carrier, the bearing indicator usually rotates slowly and continuously over 360° of azimuth, or remains stationary. For this reason, the station must be monitored intermittently in the RECEIVE and ADF position.

5. Tolerances. All UHF Homers will meet these tolerances for an UNRESTRICTED classification. Classification of the facility based on flight inspection results is the responsibility of the flight inspector.

a. Identification. Station Identification will be correct, clear, and intelligible.

b. Bearing Error.

(1) Maximum bearing error will not exceed ± 5°

(2) ADF needle oscillation will not exceed ± 5°

c. Voice. If provided, will be clear and readable at distances equal to or greater than two-thirds of the maximum usable distance of the facility..

d. Coverage. Usable distance will not be less than 45 nm at minimum instrument altitude.

e. Station Passage. At all altitudes, the needle reversal must occur approximately over the ground facility. (Any condition of false reversal attributable to the ground facility requires a notice to airmen.)

f. Standby Equipment. Standby equipment will meet the same tolerances as specified for the primary equipment.

Appendix G. Administrative Information.

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Appendix G. Administrative Information.

1. Distribution. All distribution is done electronically.

2. Background.

a. U.S. Policy. International Group on International Aviation (IGIA) 777/4.6G specifies that the FAA will provide flight inspection of the common air navigation system, U.S. military aids worldwide, reimbursable services to other countries, and encourage other countries to establish their own flight inspection capability.

The VFR Flight Inspection Program (VFR FIP) is a support activity of the FAA/ Flight Inspection Services (AJW-3)/ National Aeronautical Charting Office (NACO). In keeping with the statutory responsibilities of the Federal Aviation Act of 1958, NACO is responsible for maintaining the standards of accuracy, completeness, and currency of all air cartographic materials that will meet the minimum standards approved by the FAA and/or the Inter-Agency Air Cartographic Committee's U.S. Government Chart Specifications.

To supplement office review and ensure the accuracy, completeness, and overall adequacy of these charts, the FAA conducts a systematic program of chart verification by visual flight inspection.

b. Program Objectives. The following objectives reflect FAA philosophy. Current and future planning should be aligned to these objectives.

(1) Adequate site survey and analysis of ground and inflight data.

(2) Correlated ground and flight measurements at the time of facility commissionings.

(3) System reliability to meet justified user needs.

(4) Maximum reliance on ground measurements supported by inflight measurements of those facility parameters which cannot satisfactorily be measured by other means.

(5) Through continued inflight surveillance of the National Airspace System (NAS), determine system adequacy, isolate discrepancies, and provide feedback for system improvement.

(6) To review, verify, and edit topographic, cultural, and obstruction data (roads, railroads, antennas, towers, power lines, rivers, urban areas, etc.) depicted on FAA VFR Aeronautical Charts for accuracy and navigational usefulness.

c. The Interface with Agency Rules. Instrument flight procedures and ATC services require periodic flight surveillance of the air navigation system and dictate strict enforcement of the performance standards adopted for each aid.

d. Flight inspection programs were unified under the FAA by Executive Order 11047, August 28, 1962, subject to the provisions of Executive Order 11161, July 7, 1964. The programs are based on joint DOD/FAA standards, procedures, techniques, and criteria.

e. The design standards for air navigation services are documented in Annex 10 to the Convention on International Civil Aviation Organization (ICAO) and in various FAA standards and directives.

f. This order implements the applicable provisions of the North Atlantic Treaty Organization (NATO) Standardization Agreement (STANAG) 3374.AS.

g. Quality Assurance. 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.

3. Authority to Change This Order. The Administrator, in coordination with the DOD, reserves the authority to approve changes which establish policy, delegate authority, or assign responsibility. The Director of Flight Inspection Services may issue changes as necessary to implement policy and standardize procedures and techniques for the flight inspection of air navigation services to ensure accomplishment of the U.S. Flight Inspection Program.

4. Definitions. This order contains policy statements and guidance material. Directive verbs are used as follows:

a. Use *MUST* when an action is mandatory.

b. Use *WILL* when it is understood the action will be taken.

c. Use *SHOULD* when an action is desirable but not mandatory.

d. Use *MAY* when an action is permissible.

5. Unit of Measurement. Unless otherwise stated, the following references are used throughout this manual:

Term(s)	**Referenced to**
Mile	Nautical Miles
Airspeeds and Ground Speeds	Knots
Bearings, Headings, Azimuths, Radials Direction Information and Instructions	Magnetic North
RNAV Tracks	True North
Altitudes	Absolute True

6. Identifying Changes in the Text of This Manual. A vertical bar is used to highlight substantive changes in the text. The bar will be inserted in the left margin of each column to identify the changes. This paragraph is used as a typical example. Vertical bars are not used in complete rewrites of the Basic Order.

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