CHANGE

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

6750.49A
CHG 1

12/19/2001

SUBJ: MAINTENANCE OF INSTRUMENT LANDING SYSTEM (ILS) FACILITIES

1. PURPOSE. This change will correct identified errors, omissions, and incorporate other required changes in 6750.49A. This directive implements Configuration Control Decision (CCD) No. N 22910, Update Maintenance Technical Handbook Order 6750.49A.

2. DISTRIBUTION.

a. This directive is distributed to selected offices and services within Washington headquarters, the William J. Hughes Technical Center, the Mike Monroney Aeronautical Center, regional Airway Facilities divisions, and Airway Facilities field offices having the following facilities/equipment: GS, LOC, LDA, IM, MM, OM.

b. An electronic version and distribution report of this directive is available on an Intranet site located at **http://aos-ext.jccbi.gov/** under the "Technical Documentation" heading.

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Program Director for Operational Support

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CHAPTER 1. GENERAL INFORMATION AND REQUIREMENTS

1-1. OBJECTIVE. This handbook provides the necessary guidance to be used, in conjunction with information available in instruction books and other handbooks, for the proper maintenance of all instrument landing system (ILS) facilities (localizer, localizer-type directional aid (LDA)), glide slope, and ILS associated markers.

1-2. MAINTENANCE CONCEPT.

a. General. The ILS maintenance concept is that the characteristics and limits of the radiated signal, rather than the monitored signal, shall be measured, documented, flight tested, and protected by monitors.

b. Test Equipment.

(1) General. The latest edition of Order 6200.4, Test Equipment Management Handbook, requires that all test equipment used to maintain National Airspace System (NAS) equipment shall be calibrated. Exceptions are made for older test equipment or those used for maintaining reference readings only, not absolute measurements. Newer ILS facilities are being procured that include built-in test equipment (BITE) which has been calibrated at the factory by the manufacturer. The BITE is designed to be of sufficient accuracy and reliability for the ILS specialist to document, maintain, and troubleshoot the ILS equipment in lieu of external test equipment. However, when the BITE * is used for this purpose, a certified ILS specialist must verify the proper operation and accuracy of the BITE. * Verification of the BITE shall be made upon installation, upon replacement of equipment modules that contain BITE circuitry, and on a periodic basis. When properly maintained and verified by a certified ILS specialist, the BITE is the preferred method to document, troubleshoot, and maintain the ILS equipment.

(2) External Test Equipment. External test equipment shall be used to document, troubleshoot, and maintain the ILS when BITE is not available. This equipment includes the portable ILS receiver (PIR), the FA-9438 modulation meter, power meters, voltmeters, etc., and/or other equivalent test equipment as required. The PIR is the primary ILS test instrument, and therefore shall be maintained, calibrated, and used by a certified ILS specialist. This order provides calibration procedures for the PIR.

(3) Built-In Test Equipment (BITE). ILS BITE, when available, is the preferred method to document, troubleshoot, and maintain the ILS equipment. This is largely due to the fact that the ILS BITE measurements may be accessed at the facility or at a remote location by a maintenance data terminal (MDT). The BITE in conjunction with the MDT eliminates the necessity for the ILS specialist to have available at all times many different pieces of test equipment, and for the specialist to be on-site to ascertain proper operation. Future plans may include an electronic method of recording periodic maintenance checks to floppy disks via the MDT, eliminating the necessity for handwritten forms. However, for the BITE to be utilized for this purpose, the following conditions shall be met:

(a) The BITE shall be verified for proper operation and accuracy with calibrated test equipment and/or calibration standards traceable to the National Institute of Standards and Technology (NIST), by a certified ILS specialist in accordance with the standards and tolerances, and periodicity specified in this order.

(b) In the case of repair or replacement of an equipment module and/or its software, containing BITE sensors, measurement circuits, etc., calibration of that portion of the BITE must be verified for proper operation and accuracy at the time of the repair or replacement.

(4) Facilities with a Remote Maintenance Monitor (RMM). Many facilities containing BITE measurement capability and those that only remote the monitor measurements have the capability of transmitting that data via modems over Federal Aviation Administration (FAA) or Telco circuits to a remote location. The remote location may be the local Airport Traffic Control Tower (ATCT), and/or an Air Route Traffic Control Center (ARTCC), and the associated maintenance control center (MCC). This handbook will strive to follow the maintenance concept of paragraph 1-2a, above. That is, the ILS radiated signal measurements, not the monitored signal, will be measured, documented, and maintained. For those facilities that contain BITE which is properly maintained, and has its data remoted via modems, remote maintenance monitoring system (RMMS), and RMM, that data may be substituted for an actual site visit for certification purposes. RMM facilities which only remote the monitor readings may not be used for remote certification purposes. To remotely certify facilities equipped with BITE, the following conditions must be met:

(a) In all but the most unusual cases, the remoting of the ILS BITE measurement data and/or monitor data should not fail in a manner that would result in erroneous data being presented to the ILS specialist or operator at a remote facility. The remoting system would be expected to either fail completely or present data that would be instantly recognized as garbled data. However, to ensure that the data being transferred (via RMS/ RMMS systems, remote control panels, modems, etc.) over FAA or Telco circuits/links is valid, the accuracy of the data transferred must be verified by a ILS certified specialist in accordance with the standards and tolerances, and periodicity specified in this order.

(b) In the case of repair or replacement of an equipment module and/or its software, which performs data multiplexing, encoding/decoding of data, or otherwise involved with the transfer of data to a remote location, the accuracy of data transfer must be verified at the time of repair or replacement.

1-3. REMOTE MONITORING SUBSYSTEM (RMS).

a. Background. The purpose of instrument landing system (ILS) RMS is to automate and add remote capabilities to the maintenance operations required for ILS equipment. Remote maintenance monitoring does not replace the ILS executive monitor (the monitor which causes equipment shutdown), the remote status indicator normally used by air traffic personnel, or the notification requirements for shutdown and restoration of the ILS equipment.

b. Policy. ILS equipment with airport remote monitoring systems (ARMS) installed or ILS equipment designed with RMS capability shall be maintained in accordance with the appropriate RMS related paragraphs of this handbook. All prescribed maintenance activities must be accomplished whether RMS capability is installed or not. Remote data collection is an acceptable method of reading and recording facility parameters provided the remote readings accurately correlate with onsite readings.

1-4. ILS FACILITY OPERATION. After a facility has been accepted for operation and placed into service, the system specialist is responsible for ensuring continued operation by performing the maintenance tasks prescribed in this order, equipment instruction books and other applicable agency orders. The system specialist assigned to maintain ILS facilities must review all operational requirements and be familiar with all maintenance aspects of these facilities. This includes the technical standards and procedures in this order, equipment instruction books, facility reference data on file, meter readings, recorded data on technical performance records, past or current flight inspection report information, and the condition of test equipment. The system specialist is expected to keep his/her supervisor advised of all abnormal or unusual conditions.

1-5. STAND-ALONE OPERATION OF GLIDE SLOPE FACILITIES. A glide slope facility is normally installed with an associated localizer facility (i.e., no known permanent stand-alone operation of glide slope facilities exist). Whenever a localizer facility must be removed from service, and has an associated glide slope facility, the glide slope facility should continue in operation. Glide slopes installed on opposite ends of the same runway need not be interlocked; they may operate simultaneously provided that they are on different operating radio frequencies (rf) and that no rf interference problem exists between them.

* **1-6. Hazardously Misleading Information (HMI).** Certain facility maintenance practices (e.g., phasing navigation signals) may require intentionally radiating HMI. Such occurrences shall be minimized in both number and duration when practical. Methods to accomplish this include using more than one specialist to eliminate access time to far-field measurement areas, and using additional or specialized test equipment and procedures as a substitute for radiating HMI. Risk Management techniques shall be used to mitigate the remaining risk. *

1-7. MAINTENANCE. For maintenance purposes, all localizer facilities, whether conventional, offset, or localizer-type directional aid (LDA), are treated identically unless provided for otherwise within this order.

1-8. CERTIFICATION. Refer to Order 6000.15 for general guidance on the certification of systems, subsystems, and equipment. Refer to appendix 1 of this handbook for the specific certification requirements of the ILS. When the direct measurement of certification parameters method is used, the certification parameters must be measured using the handbook procedures referenced in the standards and tolerances table for that parameter. Follow the guidance of Order 6000.15 for other certification methods.

1-20. AIRPORT SAFETY AREAS.

a. Frangibility Requirements for ILS Components. The requirements governing frangibility of ILS components are in the Federal Air Regulations (FAR), part 139, paragraph 139.45(a)(2). This paragraph states, "The applicant for an airport operating certificate must show that on its airport, no object is located in any safety area, except objects that must be maintained because of their function or that are constructed on frangible mounted supporting structures of minimum practical height." The enforcement and interpretation of this regulation is the responsibility of the Airports Division. The size and location of the safety areas are defined in Advisory Circular AC 150/5300-4, Utility Airports Air Access to National Airports.

b. Safety Areas. The glide slope is usually outside the airport safety area, which usually extends 250 ft (76 m) each side of runway centerline. The localizer antenna array may or may not be in the runway safety area, which usually extends 1000 ft (300 m) past the stop end of the runway. Antenna systems mounted inside the safety area should be of frangible construction. The actual size of a particular airport safety area is unique to that airport, and no conclusion should be made concerning a specific airport based upon the general statements made in this paragraph.

c. Frangible Antenna Arrays. The log-periodic, traveling wave antenna (TWA), and end-fire antenna arrays are classified as frangible. The V-ring antenna systems have been retrofitted with frangible antenna masts at many locations. The frangibility issue is addressed at the initial installation of an ILS on any airport by the engineer responsible for the siting of the ILS. After installation and facility commissioning it is the responsibility of the FAA system specialist to promptly report any non-frangible structures associated with the ILS that are installed within the airport safety areas.

1-21. AIRCRAFT ACCIDENT.

a. General. The responsibilities of Airway Facilities (AF) personnel following an aircraft accident or incident are defined in Order 8020.11, Aircraft Accident and Incident Notification, Investigation, and Reporting. For each accident or incident for which AF notification is required, the regional Airway Facilities Aircraft Accident Representative (AFAAR) determines which facilities require certification and data archiving, and/or removal from service for more thorough investigative work. Facilities removed from service may be restored via certification, flight inspection, or both depending upon AFAAR decisions. The AFAAR will communicate these decisions to field personnel through the appropriate Control Center.

b. Activities. An ATSS responsible for post-accident/incident activities for an ILS should perform only those actions requested by the AFAAR. If an ILS subsystem is removed from service at AFAAR direction, the responding Specialist shall comply explicitly with the Facility Restoral Checklist in Order 8020.11. Although many periodic facility certifications can be effected remotely, a site visit may be necessary for a post-accident/incident certification, depending on the circumstances of the accident, and will be specifically requested by the AFAAR when deemed appropriate. If a flight inspection and subsequent facility certification are requested by the AFAAR, no adjustments shall be made to any facility awaiting post-accident flight inspection. In addition to performing the requested activities, the Specialist shall also comply with all interruption reporting, logging, and record-keeping requirements of Orders 6040.15, 6000.15 and 8020.11, respectively.

c. Multiple ILS Airports. If more than one localizer or glide slope at an airport were operating simultaneously at the time of the accident/incident, they must continue to operate throughout the course of the post accident/incident flight inspection activities.

1-22. FLIGHT INSPECTION POLICY.

a. General.

(1) Special flight inspections are useful in evaluating or validating parameters that cannot be otherwise verified by ground measurements. A flight inspection evaluation does not certify that equipment operation is optimal or acceptable following corrective maintenance. This is the system specialist's responsibility. Reference readings, on file at the site, should enable maintenance personnel to ascertain proper equipment performance and permit restoration of service approval following most corrective maintenance actions.

(2) Occasionally, nonscheduled flight inspections are needed to evaluate localizer, glide slope, or marker beacon signal-in-space characteristics. Certain properties of the radiated signal (such as course/path structure and coverage) preclude ground level assessment. When unscheduled activities or events occur that alter or impact these type properties, a special flight inspection evaluation is required.

NOTE: All requests for special flight inspections require prior coordination and approval at the regional Airway Facilities (AF) division level (or higher).

(3) Several well-studied facts provide the basis for decisions as to whether a special flight inspection is needed for a given concern-causing event. *

(a) Changes in areas beyond 30 glide slope (GS) or 35 localizer (LOC) azimuthal degrees from the course or path line rarely affect ILS user indications.

(b) Metallic structures and power lines produce the greatest effect on course/path structure when erected parallel to the runway centerline azimuth.

(c) Objects erected beyond 1200 ft (360 m) and less than 0.5° in elevation have little effect on the glide slope guidance information.

(d) Changes in ground contour of 1 ft (30 cm) or more within the defined critical areas of the localizer and image-type glide slopes are of concern, more so if within 500 ft (150 m) of the glide slope antenna or 1000 ft (300 m) of the localizer antenna arrays.

* **b. Activities Requiring a Special Flight Inspection.** *

(1) Changes in obstructions, buildings, power lines, electromagnetic environment, etc., that may affect the radiated signal or service provided.

(2) Construction work, runway repairs, etc., being performed in the general area of the localizer or glide slope and there is doubt about the impact upon the as-published service.

(3) A change in the facility's assigned operating frequency.

(4) Repositioning (change in height or offset) of an antenna within a glide slope, localizer, or marker radiating array.

c. Activities Requiring Special Approval to Restore Service.

(1) Following corrective maintenance involving certain critical elements and circuit components, engineering personnel (regional level or higher) must approve the restoration of service. Verbal approvals to restore must be followed by a timely letter or facsimile from the regional AF engineering division formally documenting the authorization. Such documents of authorization and related records of performance must be retained until such time as log entries covering these activities are purged.

* (2) The ILS engineer or system specialist may request additional checks of system performance as a precondition for approving the return of a given facility to service. Special technical documentation requirements typically include before-and-after readings of parameters affected by the specific maintenance activity and which support a conclusion that normal equipment operation is restored. Some special procedures and/or records may be requested to support anticipated future troubleshooting activities. *

(3) Critical corrective maintenance activities include:

* (a) Replacement of any transmit rf components, such as coaxial lines and antenna elements, bridges, power dividers, modulators, and transmitter units that contain these components. (Typical post-repair activities include measurement of signal amplitudes and phase relationships potentially affected during the repair, measurement of monitor input signals, system phasing, etc.) *

(b) Repair, replacement, or reinstallation of a localizer antenna element within the array. (Typical post-repair activities include pair null checks, a system phase check, a ground check, measurement of monitor input signals, etc.)

(c) Repair, replacement, or reinstallation of a glide slope antenna. (Typical post-repair activities include measurements of signal amplitudes and phase in individual antenna elements with a proximity probe and/or vector voltmeter, measurements of monitor input signal characteristics, etc.)

d. Other Activities. All other maintenance activities that meet the requirements of this handbook do not require special documentation or a flight inspection evaluation.

e. Retention of Flight Inspection Data. ILS facilities operating parameters reference values are established by flight inspection personnel using airborne measurement and evaluation. These include operating rf power levels and adjustment deviation limits for monitored parameters. When a reference value is established during a given flight inspection, a copy of the associated flight inspection report and data worksheet(s) (if available) shall be retained in the facility records until such time as that reference value is superseded. This requirement applies to all ILS facilities (including markers). At all facilities, established parameter reference values shall be traceable to the appropriate flight inspection report through facility documentation maintained in the Facility Reference Data File.

1-23. RESTRICTIONS TO REDUCE INTERFERENCE.

a. Obstruction Criteria. Airway facilities personnel are to monitor all construction activities or natural growths for possible violation of obstruction criteria and possible effects to the radiated characteristics of the facility. Full precautionary measures must be taken to avoid possible interference with localizer or glide slope radiation patterns during maintenance activities. If there is any doubt of the accuracy of the radiated signal, the facility shall be shut down until accuracy is verified by Flight Inspection. Similar action is required following reports of localizer or glide slope interference caused by aircraft or vehicles. Criteria for determining obstructions to air navigation can be found in 0Federal Air Regulation (FAR) Part 77, Objects Affecting Navigable Airspace.

b. RF Interference. Rf interference is the result of undesirable signals that deteriorate the radiated or received characteristics of the ILS facility signals. Rf interference problems that cannot be corrected should be reported through official channels to the regional Frequency Management staff, and their assistance should be requested. It may be necessary to request assistance from Flight Inspection.

1-24. ILS CRITICAL AREAS.

a. Definition. The facility system specialist must be aware that disturbance to the localizer or glide slope signals may occur when other aircraft or surface vehicles operate near the localizer or glide slope antennas. These areas, which are to be protected from vehicular or aircraft traffic, are called the ILS critical areas. Airway facilities ILS specialists should consider conformance to critical area marking standards when certifying a facility.

The critical areas and additional data concerning hold lines, signs, etc., are defined in the latest edition of Order 6750.16, Siting Criteria for Instrument Landing Systems, and the latest editions of Advisory Circular * 150/5340-1, Marking of Paved Areas of Airports, and Advisory Circular 150/5340-18, Standards for Airport Sign Systems.

b. Protection of Areas. Air Traffic procedures require that the tower personnel control airport surface traffic so localizer and glide slope critical areas are protected whenever reported weather is poorer than prescribed minima. When the weather conditions are better than the prescribed minima, or when no tower is in operation, ILS critical area protection is not provided other than by self-policing of airport areas. For this reason, proper marking of the ILS critical areas is essential.

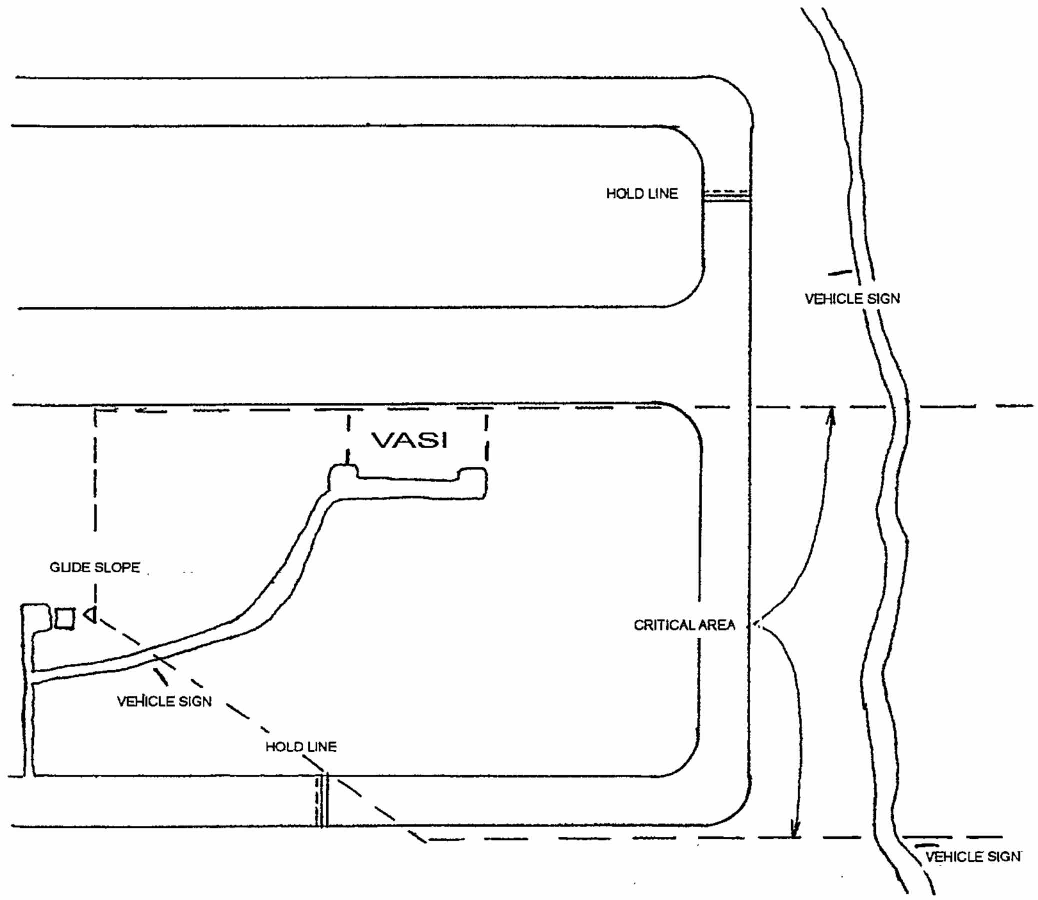
c. Actions Required.

(1) Airway facilities personnel are responsible for advising airport management authorities of critical area criteria, and for requesting that they provide and maintain the necessary signs, holding lines, and other markings delineating the restricted areas.

(2) Airway facilities personnel are responsible for unlighted critical area warning signs, to prevent unauthorized vehicular traffic in the localizer and glide slope critical areas. At a minimum, signs shall be installed where each road enters/leaves the critical area. The signs should be approximately 1 ft by 2 ft (30 by 60 cm) in size, and preferably constructed of nonmetallic material. Suggested wording is ILS CRITICAL AREA KEEP OUT. See figure 1-2 for typical placement.

(3) Vegetation in the critical areas shall be kept below 12 inches (30 cm). Except for cutting and removal of vegetation, all farming activities are forbidden in the ILS critical areas. *

FIGURE 1-2. TYPICAL CRITICAL AREA WARNING SIGN PLACEMENT



* **1-25. MISALIGNMENT DETECTORS (MAD).** Required only on localizer antennas with single masts. *

1-26. thru 1-99. RESERVED.

CHAPTER 2. TECHNICAL CHARACTERISTICS AND THEORY OF OPERATION

2-1. GENERAL. This chapter presents technical characteristics and theory of operation for the instrument landing system (ILS), which includes the localizer (LOC), glide slope (GS), and marker beacons ((MB) – inner, middle, or outer). Detailed hardware information, circuit descriptions, and theory of operation are left to the individual manufacturer's instruction book.

2-2. THE GROUND-BASED SYSTEM.

a. Radiating System. Ground equipment for an ILS consists of electronic equipment to generate signals with the proper characteristics, a radiating antenna array, and monitoring hardware to ensure the integrity of the radiated signals. Since ILS technology, installation, testing, and performance are largely the science of antennas, the substantive differences between various systems and installations are usually associated with the antenna array in use.

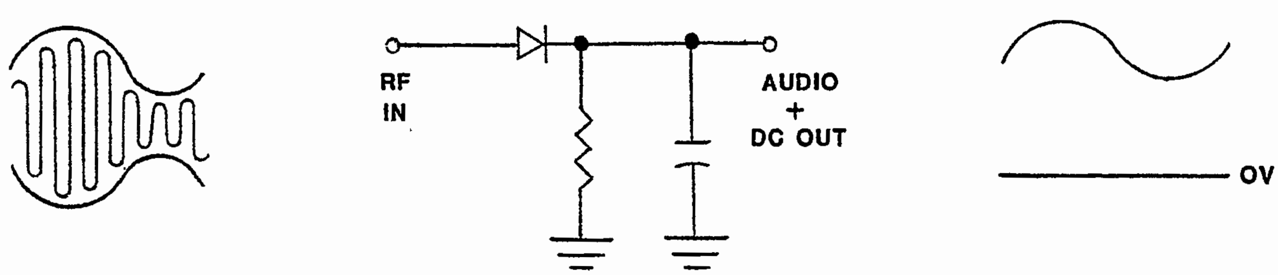
b. Diagrams. Electronic equipment provided with the various antenna systems is usually derived from a generic block diagram, differing only by a particular manufacturer's choice of circuitry and technology. Thus, considerable antenna theory of technical characteristics will be presented here, with only a brief description of the electronic circuits.

2-3. THE AIRBORNE SYSTEM.

a. Receiver Operation. Since all ILS radiated signals are amplitude modulated (am) carriers, the fundamental common characteristic of the airborne receiving equipment is the linear envelope detector – the standard am detector using a diode and resistor-capacitor (RC) time constant circuitry, shown in figure 2-1. Newer versions of this circuit include direct current (dc) pre-biasing of the diode to provide a quiescent operating point which is in the more linear range of the diode's voltage-current (V-I) curve, reducing distortion and improving operation over temperature variations.

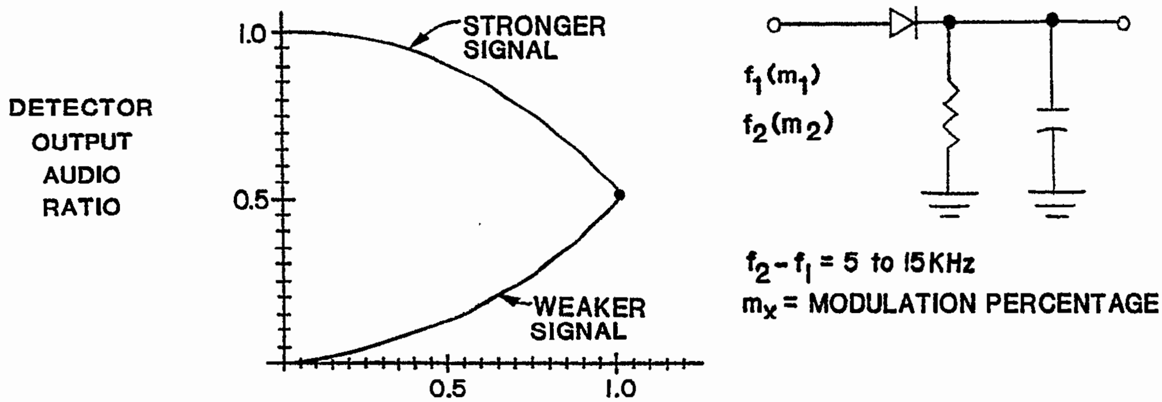
b. Capture-Effect Defined. A linear envelope detector exhibits a capture-effect, when presented with two or more am signals of slightly different frequency. This effect is different than the "capture ratio" of frequency modulation (fm) receivers with their discriminator circuitry, which captures the receiver on the stronger of two co-channel signals.

FIGURE 2-1. STANDARD AM DETECTOR



c. Explanation of Capture Effect. The capture effect of an am linear envelope detector is encountered when two am signals of differing frequencies are introduced at the input of the detector. As long as the frequency difference is slight (approximately 5 to 15 kHz), and the amplitude difference of the two signals sufficiently large (10 dB for an ideal diode, 15 dB for typical diodes), the output of the detector will be largely due only to the modulation on the stronger of the two input signals. Figure 2-2 is a graph of this "acoustic ratio", the ratio of the output modulating signals versus the ratio of the input signal amplitudes of an am detector. This capture-effect characteristic of the linear envelope detector is put to good use in "capture-effect" localizers and glide slopes, and is detailed in the following sections.

FIGURE 2-2. ACOUSTIC RATIO, PROPERTY OF AM DETECTOR



* **RF AMPLITUDE RATIO – DETECTOR INPUT** *

2-4. MAINTENANCE AND MONITORING PHILOSOPHY.

a. Changing Emphasis. The FAA's maintenance philosophy provides that the characteristics and limits of the radiated signal, rather than the monitored signal, shall be measured, documented, flight tested, and protected by monitors.

b. Types of Monitoring.

(1) Field Monitoring. This technique offered monitor input signals that were an accurate representation of the signal in space at specific sampling points. However, such field monitors were subject to environmental conditions, such as weather, effects of overflights, animals, and automobiles. For that reason, most field monitoring type systems have been replaced by more reliable integral monitored systems. Field monitoring today is reserved for specialized and/or critical areas such as CAT II/III far-field monitoring (FFM) or end-fire array glide slopes.

(2) Integral Monitoring. Improved hardware designs implemented integral monitors, which sampled signals in the close proximity of the radiating elements of the antennas. The use of integral monitors provided immunity to most changes in environmental conditions and offered much-improved equipment availability. This improvement was partially offset, however, by the relatively small addition of physical integrity monitors, such as snow depth monitors and coaxial-cable continuity circuits.

c. Recombination Circuits. In contrast to field monitors, today's integral monitors require recombination circuits of some type, to provide amplitude and phase conditioning of the signals from several antennas (which would have been combined in space for field monitors.) This extra circuitry is capable of providing monitor input signals whose navigation characteristics can simulate nearly any point in space. While this is highly desirable and convenient, the technique also allows the manipulation or degradation of the recovered or monitored signals in such a way that the monitor may be happy or in alarm for nearly any condition of the radiated signal.

SECTION 1. LOCALIZERS (Continued)

that represents the signal in the far field at specific azimuth angles from the runway centerline. While this technique can accurately represent changes in the signal due to changes in electronics and antennas, it does not consider errors in the signal due to physical distortion of the array or variations in the propagation medium.

b. Additional Sensors. To counter these deficiencies, a variety of physical integrity and far-field monitors have been implemented to augment the integral monitors. These include misalignment detectors on single pedestal antenna element structures, dc currents on the center conductors of coaxial cables for fault monitoring, and complete receivers at the opposite end of the runway (primarily for Categories II and III). For such combinations, the integral monitors generally have very short or no time delays for sensing of changes in the signal, while the field monitors provide delays of up to several minutes before actuation of control circuitry, since changes in received signals might be due to taxiing or overflying aircraft.

2-19. LDA AND OFFSET LOCALIZERS. At some runways, terrain may prevent the localizer antennas from being positioned on the runway centerline extended. Where this occurs, the localizer antenna array may be offset so that the course does not lie along the runway centerline. If the * offset angle is 3° or less, the facility will be classified as an offset localizer. If the offset angle is greater than 3°, the facility will be classified as a localizer-type directional aid (LDA). *

2-20. thru 2-29. RESERVED.

SECTION 2. GLIDE SLOPES

2-30. GENERAL CONCEPTS, IMAGE AND END-FIRE.

a. Description. An ILS glide slope furnishes vertical guidance to aircraft on an approach to the runway. The glide slope transmits in the 328 to 336 MHz ultrahigh frequency (uhf) portion of the electromagnetic spectrum, and uses amplitude modulation to encode information on the radio frequency (rf) carrier. Guidance from the glide slope is generated by radiating a complex combination of uhf signals, each modulated with two tones, 90 and 150 Hz. (An exception is the clearance signal from the capture-effect glide slope, which is modulated only by a 150 Hz tone, as described in paragraph 2-70e.)

b. Airborne Equipment. In the aircraft, a standard superheterodyne uhf receiver detects the glide slope signal. Filtering circuits separate the fly-up (150 Hz) and fly-down (90 Hz) signals and apply them to a differential meter (zero-center crosspointer). A small flag near the edge of the indicator is normally out of view, but will appear whenever the radiated signal from the glide slope does not meet minimum requirements, or the aircraft receiver has failed.

c. Ground Equipment. The glide slope consists of an equipment shelter, transmitting equipment, a horizontally polarized antenna system, monitoring equipment, and control equipment. The antenna system is usually located approximately 1000 ft (300 m) beyond the approach end of the runway (toward the stop end), and 250 to 650 ft (75 to 200 m) offset from the runway centerline.

d. General Types. Glide slope antenna systems belong to one of two fundamental types – image and end-fire.

(1) Image Glide Slope Antenna System.

(a) An image glide slope antenna system generates a vertical radiation pattern by reflecting signals off a carefully controlled and prepared area of ground in front of the antennas. This reflected signal is combined with a directly radiated signal in the user's antenna. The phase and amplitude relationships between these two signals determine the resultant vertical rf radiation pattern of the antenna system. ILS fly-up and fly-down information is obtained from several overlapping vertical patterns.

(b) For analysis and mathematical convenience purposes, this signal generation method is identical to one in which the reflecting plane and reflected signals are replaced by an image antenna system, symmetrically located below the imaginary reflecting plane the same distance as the actual antennas are located above it. Figure 2-16 contrasts the two methods of visualizing and analyzing the antenna system. (Consult standard physics and optics texts for a more detailed presentation of these concepts.)

(2) End-Fire Glide Slope Antenna System.

(a) An end-fire glide slope antenna system is one whose fly-up and fly-down information is derived solely from the phase relationship between two point sources: radiators that are located close to the ground, in contrast to the image system, whose antennas are positioned on a tower. To provide a fairly broad usable horizontal pattern, many point sources are positioned along a curve so that the phase relationship between two antenna elements remains independent of aircraft azimuth for small angles from the runway centerline. Figure 2-17 shows the physics of determining, in the vertical plane, the difference in arrival phase of two end-fire antenna elements at an aircraft antenna.

(b) End-fire glide slope antennas are mounted close to the ground, (i.e., typically between 2 to 6 ft (0.6 to 1.8 m) in height) and do not require a large controlled reflecting plane. Although the close proximity of the radiating elements to the ground raises the vertical radiation pattern substantially higher than an image type antenna system, this does not present a problem since the fly-up and fly-down information is determined mainly by the difference in relative phase of the signals radiated by the front and rear main antennas. In theory, the received signals are not affected by the nature or height of the ground in close proximity to the radiating elements. However, in practice, snow and ice build up, on and in proximity to the radiating elements and monitor antennas, have resulted in facility shutdowns and unsatisfactory flight checks. As with image systems, the near-field monitoring system (i.e., M1, M2 and M3) is more sensitive to the snow and ice build up than is the actual far-field, as measured by flight inspections. As a general guideline, after approximately six to eight inches of snow build up, an area of ten to twenty feet around the radiating and monitor elements should be cleared to prevent problems with the system.

2-31. CHOOSING A TYPE OF GLIDE SLOPE ANTENNA SYSTEM.

a. Types Available. FAA has five standard glide slope antenna systems. They are the null-reference (NR), sideband-reference (SBR) and capture-effect (CE) image systems, and the basic and upslope end-fire systems. The proper choice of antenna system for a given runway environment depends primarily on two considerations, the available amount and required cost of preparing a reflecting plane, and the nature of far-field (off-airport property) terrain. Refer to the latest edition of Order 6750.16, Siting Criteria for Instrument Landing Systems, for further reference.

b. Antenna Mounting Heights. The three image systems require varying amounts of reflecting or ground plane. For horizontally polarized antenna elements, the mounting height above a flat (level or tilted) reflecting plane determines the vertical angle of nulls and maxima in the radiation pattern. Figure 2-18 shows that for an approximate 30-ft (9 m) mounting height, an image glide slope antenna produces a first vertical null of 3°, with maxima at 1.5°, 4.5°, and higher angles. Higher mounting heights require correspondingly larger amounts of controlled ground plane and illuminate more far-field sources of reflections.

c. Ground Plane Requirements. Figure 2-19 depicts general siting requirements for the three image systems. The length and required smoothness of the reflecting plane are shown, along with the maximum height of significant reflecting surfaces beyond the reflecting planes. The NR glide slope is used at sites with low far-field reflectors and large, smooth ground planes. The SBR glide slope is used at sites with short ground planes, although they can also be used in place of NR systems for small improvements in performance in the presence of far-field reflectors. The CE glide slope is used at sites with challenging (high vertical angle) far-field reflectors. In some cases, the SBR and CE systems may be used at sites where there is sufficient ground plane area available for NR operation, but the cost of achieving the ground plane smoothness exceeds the penalties of the more complex SBR and CE equipment.

SECTION 2. GLIDE SLOPES (Continued)

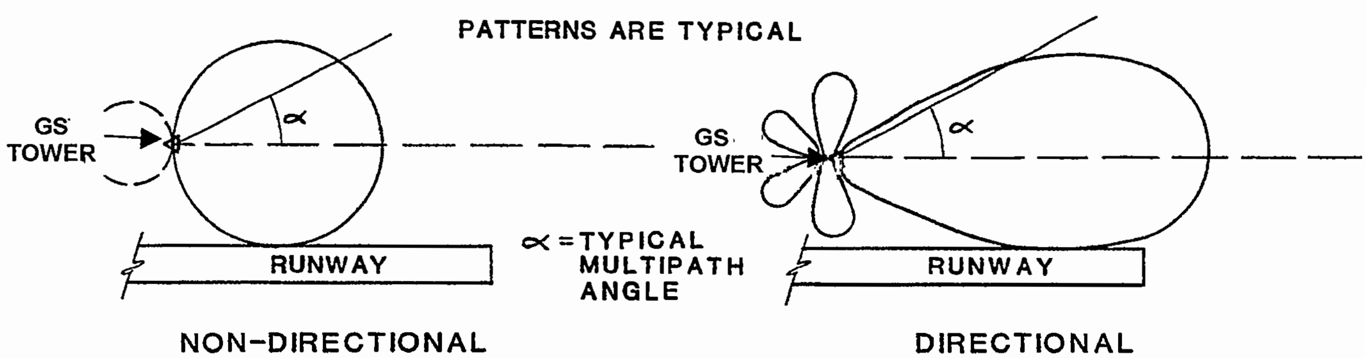
2-32. GLIDE SLOPE REFLECTING PLANE CONSIDERATIONS (IMAGE TYPES ONLY). Since image arrays require a reflecting plane to form the vertical radiation pattern structure, and therefore the structure of the vertical aircraft guidance, they require more attention than end-fire systems. Upon installation, the area may require costly grading to achieve sufficient smoothness and lateral and longitudinal slopes within published criteria. Vehicular and aircraft traffic must be controlled during instrument approaches, and certain structures cannot be in the ground plane area. A covering of snow and ice or drifts may also affect the guidance signal. For SBR systems, even large ruts from vehicle operation at certain locations in front of the antenna system can also cause the vertical guidance structure to vary.

2-33. GLIDE SLOPE COVERAGE.

a. Usable Coverage. Glide slopes are required to provide usable signals horizontally to an azimuth of 8° on either side of the localizer course, to a distance of typically 10 nmi (18.5 km). Earlier glide slope designs used simple dipole antennas, which were only slightly directional. Since the horizontal aperture of the antennas was small, reflecting objects at wide angles away from the direction of the approaching aircraft were illuminated, causing multipath conditions, which often derogated the quality of the vertical guidance. Figure 2-20 shows the horizontal rf pattern (plan view) of antennas typically used with first generation solid-state electronics.

b. Directive Antennas. Modern antenna systems achieve greater gain and horizontal directivity using wider aperture antennas, each of which may consist of several independent radiating elements to generate the proper horizontal antenna pattern. Figure 2-20 also shows a horizontal rf pattern typical of these antennas, whose aperture is approximately 6 ft (1.8 m). The greater directivity allows the construction and placement of larger reflecting surfaces nearer the glide slope without significantly affecting the vertical structure of the glide slope guidance.

FIGURE 2-20. HORIZONTAL ANTENNA RADIATION PATTERN



SECTION 2. GLIDE SLOPES (*Continued*)

2-34. GLIDE SLOPE COURSE STRUCTURE.

a. Path Angle. Glide slope signals from the antenna system are arranged so that in the vertical plane, the amplitudes of the detected and 90 and 150 Hz tones are equal at an angle above the horizontal called the path angle. Since the tones are applied to a differential cockpit meter or CDI, a centered needle occurs at the glide path angle, typically 3°. The stability, accuracy, and smoothness along the approach of the path angle are the primary characteristics of the glide slope.

b. Path Width. As an aircraft descends below the path angle, the cockpit indicator must smoothly increase its fly-up (150 Hz) signal proportional to the angular deviation from the path, until the half path width angle, or edge of path, is encountered. At angles above the path angle, the amount of fly-down (90 Hz) signal must increase proportionally to the top-half path-width angle, or top edge of path. The angular difference between the top and bottom half path width angles or edges of path is called the glide slope path width, and is standardized to be 1.4°. Thus full scale fly-up and fly-down deflections of the cockpit indicator occur at 2.3° and 3.7° for a path angle of 3°. Flight inspection reported path width is half of the total path width, thus flight inspection reports 0.70 as optimum. This is due to the non-linearity of the glide slope width beyond half-scale deflection. The path width is one of the primary characteristics of the glide slope signal.

c. Clearances. At angles lower than the bottom edge of path, the indicator must remain pegged to provide a full scale fly-up signal at all obstacle heights. This angular sector between obstructions and the bottom edge of path is called the clearance area, and the fly-up signals in this area are called the clearances. Glide slope clearances are one of the primary characteristics of the glide slope signal.

2-35. GLIDE SLOPE RADIATION PATTERNS (IMAGE ARRAY, GENERIC).

a. Signals. Glide slope transmitting equipment generates two amplitude modulated signals, a carrier plus sidebands (CSB) signal and a sidebands-only (SBO) signal. Each of the signals is modulated by two tones, 90 and 150 Hz. The audio phase of the 90 Hz signal is equal between the CSB and SBO signals, while the phase of the 150 Hz signal is opposite. The amplitude equality of the tones on the signals is carefully controlled.

b. Antenna Height. The signals are applied to a vertically mounted array of horizontally polarized antennas. (More than one antenna may be used to generate the CSB or SBO signals in space, depending upon the type of image array used.) The mounting height of a horizontally polarized antenna above the reflecting surface determines the vertical angles at which signal strength nulls and maxima occur. Doubling the mounting height of an antenna will halve the vertical angles for these characteristics. The rf phase of the signal on one side of a null is opposite or 180 electrical degrees different from the phase on the other side of the null. Refer to figure 2-18 where the plus and minus symbols represent rf phase reversals of 180°.

c. Proper Antenna Height. The antenna heights for image arrays are chosen so that the resultant SBO signal in space has zero signal strength at the desired aircraft descent angle, or path angle, while the CSB signal has a maximum or near-maximum value at the path angle. Since the equality of the 90 and 150 Hz tones is carefully controlled on the CSB signal, an aircraft receiver whose antenna is positioned in the vertical null of the SBO signal will detect equal amounts of 90 and 150 Hz signals. (This is termed zero DDM or zero difference in depth of modulation.) As the receiving antenna is moved above or below the path angle, non-zero amounts of SBO signal will be received in addition to the CSB signal. Above the path angle, the audio phase relationships of the tones modulating the CSB and SBO signals causes the resultant 150 Hz signals to be smaller than the resultant 90 Hz signals, and the cockpit differential meter displays a fly-down indication. Below the path angle, the 150 Hz signals predominate, causing a fly-up indication. For small angular displacements from the path angle, the variation in the DDM or predominance of the 90 or 150 Hz tones is linear with respect to the angular displacement.

d. Similarities of Image Array Types. The three types of image arrays differ only in the shape of their vertical patterns for the CSB and SBO signals. Each has an SBO signal null at the path angle, and each has a maximum or near-maximum CSB signal at the path angle. However, the sideband reference and capture-effect arrays do not have symmetrical patterns around the path angle. Nevertheless, the resultant DDM pattern is identical for each of the arrays neglecting multipath conditions and the clearance signals for the capture-effect array. Refer to figure 2-21.

SECTION 2. GLIDE SLOPES (Continued)

SUBSECTION 3. CAPTURE-EFFECT (CE) GLIDE SLOPE (Continued)

FIGURE 2-26. CAPTURE-EFFECT SBO PATTERNS

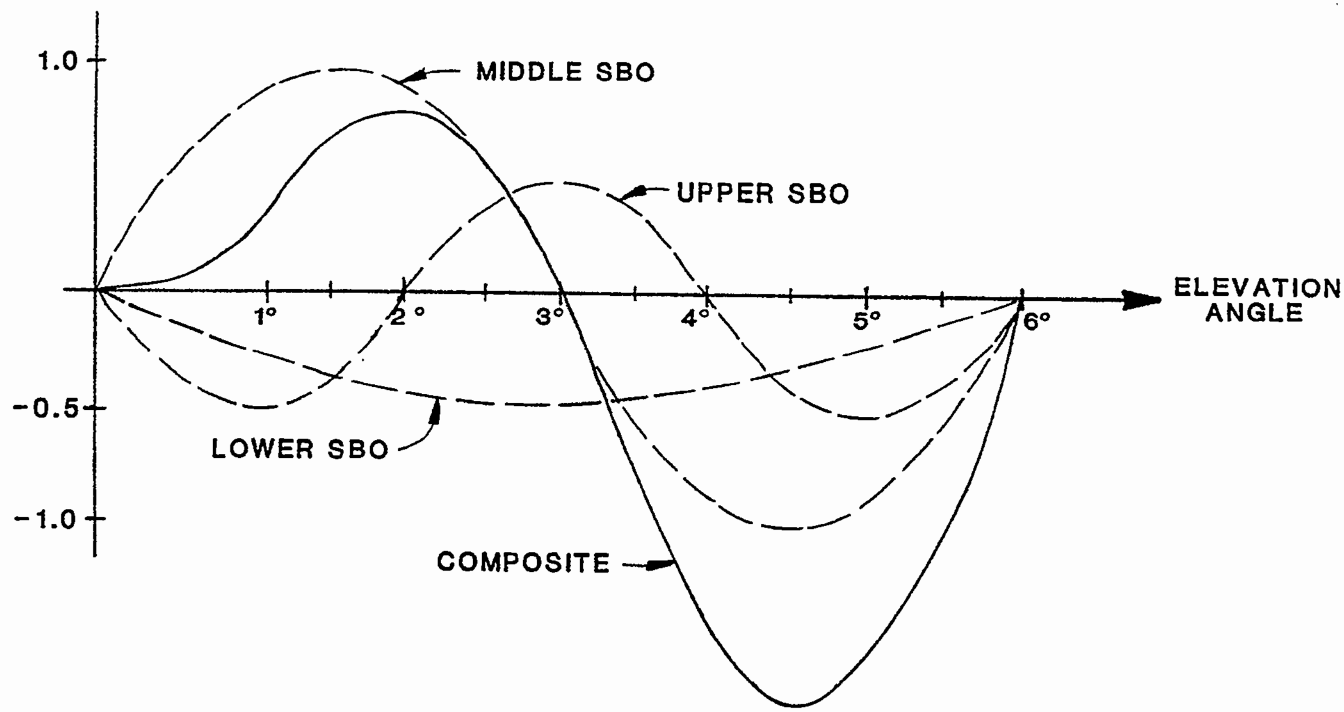
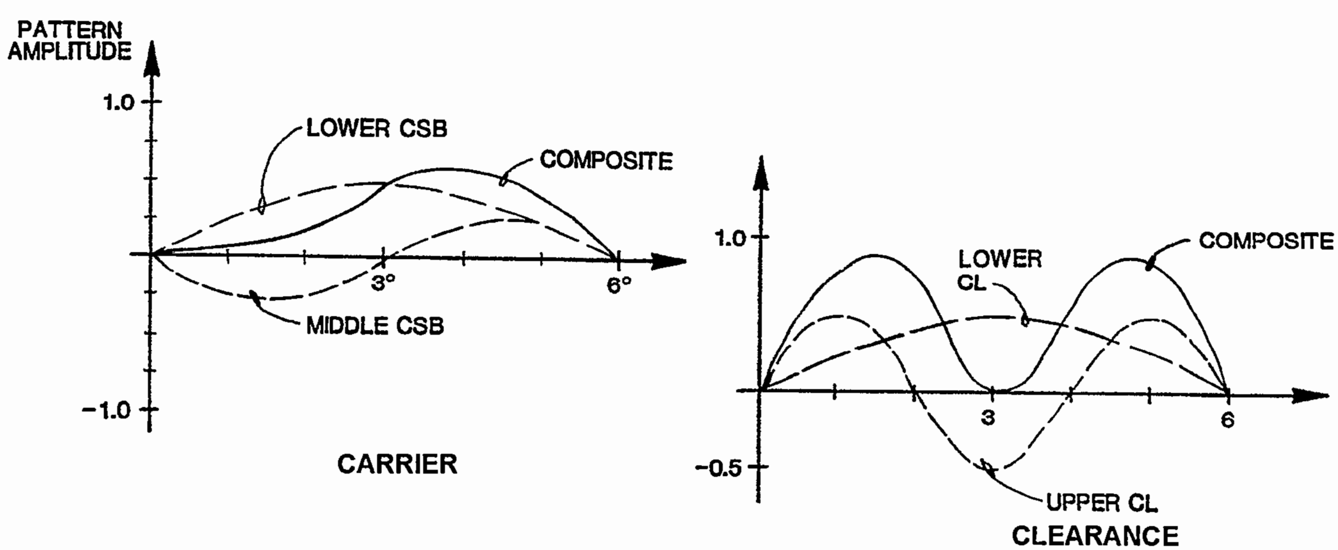


FIGURE 2-27. CARRIER AND CLEARANCE PATTERNS



SECTION 2. GLIDE SLOPES (Continued)

SUBSECTION 3. CAPTURE-EFFECT (CE) GLIDE SLOPE (Continued)

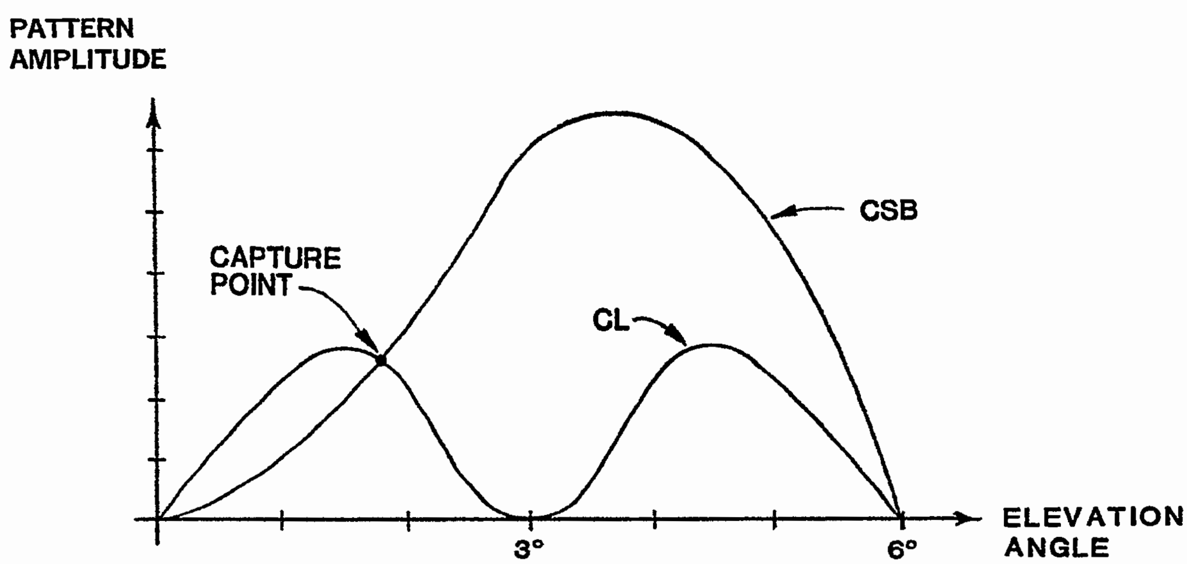
e. Clearance Signal. Although a precisely aligned CEGS system without a clearance transmitter can provide sufficient fly-up DDM signals at low elevation angles, the signal strength of those fly-up signals is weak. Figure 2-27 also plots the clearance pattern derived by radiating in-phase clearance transmitter energy from the upper and lower antennas. This pattern is relatively strong at low and high angles, with a broad null or minimum at the path angle. Thus, the clearance transmitter normally has no affect on the received signals between the top and bottom edges of the path width. By adjusting the ratio of the signal strengths of the course and clearance transmitters properly, the clearance signal will predominate by more than 10 dB at low angles, and the course signal will predominate by more than 10 dB at angles near the path. Figure 2-28 shows the course CSB and clearance patterns superimposed with correct relative amplitudes. Note that the upper clearance lobe, above 3°, is very weak with respect to the course signal, so that above the path angle as well as near the path angle, the course transmitter provides all guidance information. Equal CSB and clearance powers exist at the capture-effect point, which is typically 1.7° in elevation.

2-72. CEGS DISTRIBUTION AND MONITORING.

a. RF Distribution. The CEGS is the most complex of the image glide slopes and requires a distribution circuit to provide the amplitude and phase control to feed the three antennas properly. Figure 2-29 shows a typical CEGS amplitude and phase control unit (APCU) block diagram used * to mix the CSB, SBO, and clearance signals. CSB signals are * fed to the lower and middle antennas, SBO signals to each of the antennas, and clearance signals to the lower and upper antenna. Power dividers are provided to adjust the amplitude ratios, and several phase shifters are normally used for convenient adjustment of feedline lengths.

b. Monitoring. All CEGS systems use fully-integral monitoring of path, width, and clearance signals by simulating the amplitude and phase relationships normally occurring at three specific vertical angles in space, in addition to a field path monitor. Figure 2-30 illustrates typical recombination circuits used for the integral monitors. Typical DDM outputs are 0.000, 0.175, and 0.300 for the path, width, and clearance integral monitors, respectively.

FIGURE 2-28. CEGS COURSE AND CLEARANCE VOLTAGE PATTERNS



CHAPTER 3. STANDARDS AND TOLERANCES

3-1. GENERAL. This chapter prescribes the standards and tolerances for the ILS as defined and described in the latest edition of Order 6000.15, General Maintenance Handbook for Airway Facilities. All key performance parameters and/or key inspection elements are identified by an arrow (→) placed to the left of the applicable item. This chapter is divided into five sections: Section 1, Localizers, paragraphs 3-5 thru 3-34); Section 2, Glide Slopes, paragraphs 3-35 thru 3-64; Section 3, 75 MHz ILS Markers, paragraphs 3-65 thru 3-84; Section 4, Built-In Test Equipment (BITE), paragraphs 3-85 thru 3-94; Section 5, Remote Maintenance Monitor (RMM), paragraph 3-95 thru 3-104.

* **3-2. PHILOSOPHY.**

a. General. The International Civil Aviation Organization (ICAO) establishes worldwide requirements for ILS signal parameters and monitor limits in its Annex 10 document. The General Maintenance Handbook for Airway Facilities, Order 6000.15, defines generic FAA implementation philosophy and policy for parameter tolerances/limits on any facility type, while implementation policy specific to ILS equipment is defined in (this) Order 6750.49. Portions of Order 6000.15's paragraph 302, Standards and Tolerances/Limits, are summarized here. Due to ICAO requirements and the closed-loop nature of integral ILS monitors (with the resulting need to establish a known correlation between the monitored signal and the user's received signal), two types of tolerances and three types of parameters are defined.

b. Types of Tolerances. Tolerances applied to signal characteristics with the equipment adjusted to its "normal" operating state are often referred to as "adjust and maintain" tolerances. Tolerances applied to signal characteristics with the equipment intentionally adjusted to its monitor shutdown points are often referred to as "not to exceed", alarm, or alarm limit tolerances. The "adjust and maintain" tolerances are typically much more demanding (tighter) than monitor alarm point tolerances, and are considered quality control (QC) tolerances. Continued operation beyond these QC tolerances is not considered unsafe to the user. However, continued operation beyond the alarm limits is not allowed, since such conditions may be unsafe to the user.

c. Types of Parameters. Most of the tolerances in this chapter for localizers and glide slopes apply to three types of parameters: *

* **(1) Transmitter Parameters.** These parameters describe the signal-generation electronics equipment, exclusive of the antenna system, and are found in Subsection 1, excluding paragraphs 3-15 and 3-45. Since transmitter parameters are independent of the antenna system or external environmental factors, their tolerances are usually quite tight. These tight tolerances are QC or "adjust and maintain" type tolerances, and apply any time the parameters are observed with the transmitting equipment in its "normal" condition (i.e., not intentionally adjusted to alarm or monitor shutdown limits conditions).

(2) Executive Monitor Parameters. These parameters define the "not to exceed" or shutdown or alarm points for monitored parameters. Tolerances for the monitor alarm points are those beyond which operation must cease, because continued operation outside these limits may be unsafe to the user. These tolerances are found in Subsection 2, paragraphs 3-20 and 3-50, and assume absolute monitor system stability. For a typical facility, the actual monitor alarm point will be adjusted intentionally to a value slightly tighter than these tolerances, to allow for the calibration precision of applicable test equipment, variations in a repeated measurement over time, and small day-to-day changes in parameter values.

(3) Reference Parameters (Radiated Signal or Far-Field Parameters). These parameters define the characteristics of the radiated signal as seen by an ILS receiver in the far field of the antenna systems. The measurements are made either in the air via a flight inspection aircraft or on the ground using a Portable ILS Receiver (PIR). Both "adjust and maintain" (normal) and "not to exceed" (alarm limit) tolerances are defined. Because these parameters are affected by both the transmitter and radiating antenna system, as well as the receiver, their tolerances include allowances for the typical uncertainty of far-field measurements caused by antenna positioning and calibration uncertainties, as well as environmental effects such as multipath reflections and temperature changes on coaxial cables. The initial and operating limits for measurements by a flight inspection aircraft (paragraphs 3-30 and 3-60) have several unique characteristics:

(a) Whenever reference values for subsequent ground maintenance activities are being established, airborne measurements must meet the initial tolerances/limits. The initial tolerance is an Airway Facilities tolerance on a flight inspection measurement. It *

★ is substantially tighter than required by the U.S. Standard Flight Inspection Manual, Order OA P 8200.1, so that the ground references are taken with the ILS equipment adjusted to near-optimum conditions.

(b) The operating tolerance/limit for an airborne measurement is identical to the limits found in the Flight Inspection Manual.

(c) The difference between the initial and operating tolerances/limits for a parameter measured by the flight inspection aircraft is at least as large as the typical uncertainty of the airborne measurement.

d. Example. Consider the course alignment parameter for a Category III ILS localizer.

(1) The transmitter parameter corresponding to a localizer's course alignment is Modulation Equality. Tolerances for this parameter are found in paragraph 3-11c, and apply when the transmitting equipment is operating normally as the user would find it. For quality control purposes, the tolerances are quite tight (maximum change of 0.002 DDM or approximately 2 uA from that established by flight inspection) because error contributions from the antenna and monitor subsystems are not included.

(2) Course alignment is measured in the antenna system's far field by a flight inspection aircraft, and by an ILS specialist using a portable ILS receiver.

(a) Tolerances for airborne measurements are found in paragraph 3-30c(1) for the transmitter adjusted to its normal condition, and in paragraph 3-30c(4) for the transmitter shifted clockwise and counterclockwise. If the purpose of the airborne measurement is to establish not-to-exceed reference values for the monitor's course shift alarm points, the Initial tolerance (AF's quality control tolerance) in paragraph 3-30c(4) must be met. If the purpose of the airborne measurement is to validate the continued validity of previously-established alarm limit reference values, only the Operating tolerance in paragraph 3-30c(4) must be met. For this parameter, the difference between the Initial and Operating alarm limits (difference ★ ★ of 0.002 DDM or approximately 2 uA) is the typical airborne measurement uncertainty, as described in subparagraph c(2)(c) above.

(b) Tolerances for ground measurements of localizer alignment adjusted for normal or non-alarm conditions are found in paragraph 3-31a(3). The operating limits (e.g., within 0.004 DDM or approximately 4 uA for Category III) are larger than the corresponding transmitting equipment tolerance (within 0.002 DDM or approximately 2 uA), to account for uncertainties contributed by the antenna system and the measurement environment.

(3) The executive monitor's parameters corresponding to course alignment are the Course Shift Alarms found in paragraph 3-20a(1). The Standard values are derived from a flight inspection (airborne) measurement, as defined in subparagraph d(2)(a) above. These tolerances apply when the course is intentionally rotated to the monitor shutdown point, as required by Periodic Maintenance activities found in Chapter 4.

3-3. CATEGORY IIIA OPERATION WITH CATEGORY II EQUIPMENT. When Category II equipment is used for a Category IIIa approach, Category III standards and tolerances apply.

3-4. CATEGORY II OPERATIONS USING CATEGORY I FACILITIES. When Category I facilities are used for Category II operations, Category II standards and toleranes apply. Reference Order 8400.13.

3-5. GENERAL. This section prescribes the standards and tolerances for all localizer facilities as defined and described in Order 6000.15, General Maintenance Handbook for Airway Facilities.

3-6 thru 3-9. RESERVED. ★

SUBSECTION 1. NORMAL TRANSMITTER PARAMETERS

Parameter	Reference Paragraph	Standard	Tolerance/Limit	
			Initial	Operating
3-10. RF POWER LEVELS	5-10			
a. One-Frequency System Carrier Power		As established by flight inspection	98 to 102 percent of standard	60 to 120 percent of standard
b. Two-Frequency System Carrier Power.				
(1) Course and Clearance		As established by flight inspection	98 to 102 percent of standard	80 to 120 percent of standard
(2) Centerline capture ratio............................	5-176	≥10 dB	Same as standard	Same as standard
3-11. MODULATION LEVELS.				
a. 90 Hz	5-14	20 percent	19 to 21 percent	18 to 22 percent
b. 150 Hz	5-14	20 percent	19 to 21 percent	18 to 22 percent
c. Modulation Equality	5-10	As established by flight inspection	≤0.003 DDM of standard	≤0.013 DDM of standard
d. 1020 Hz	5-15	8 percent	7 to 9 percent	6 to 10 percent

SECTION 1. LOCALIZERS (Continued)

SUBSECTION 1. NORMAL TRANSMITTER PARAMETERS (Continued)

Parameter	Reference Paragraph	Standard	Tolerance/Limit Initial	Tolerance/Limit Operating
3-12. **AUDIO PHASING.** All two-frequency systems, course to clearance tones phase relationship.	5-19	In phase	Within 185 µs (10° of 150 Hz cycle)	Same as initial
3-13. **FREQUENCY**	5-18			
→ a. **Carrier, Single-Frequency**		Authorized (add offset if applicable)	Standard ±0.002 percent	Same as initial
→ b. **Carrier, Two-Frequency (8.0 kHz).**[1]				
(1) Course transmitter		Authorized +4.0 kHz	Standard ±0.002 percent	Same as initial
(2) Clearance		Authorized –4.0 kHz	Standard ±0.002 percent	Same as initial
(3) Carrier frequency separation		8.0 kHz	Standard ±5.0 percent	Standard ±10.0 percent
→ c. **Carrier, Two-Frequency (9.0 kHz).**[1]				
(1) Course transmitter		Authorized +4.5 kHz	Standard ±0.002 percent	Same as initial
(2) Clearance		Authorized –4.5 kHz	Standard ±0.002 percent	Same as initial
(3) Carrier frequency separation		9.0 kHz	Standard ±5.0 percent	Standard ±10 percent
* → d. **Carrier, Two-Frequency (9.5 kHz).**[1]				
(1) Course transmitter		Authorized +4.75 kHz	Standard ±0.002 percent	Same as initial
(2) Clearance		Authorized –4.75 kHz	Standard ±0.002 percent	Same as initial
(3) Carrier frequency separation		9.5 Khz	Standard ±5.0 percent	Standard ±10 percent

[1] These three tolerances must be met concurrently.

SECTION 1. LOCALIZERS (Continued)

SUBSECTION 1. NORMAL TRANSMITTER PARAMETERS (Continued)

Parameter	Reference Paragraph	Standard	Tolerance/Limit Initial	Tolerance/Limit Operating
e. Modulation Tones.				
(1) Identification		1020 Hz	970 to 1070 Hz	Same as initial
(2) 90 Hz		90 Hz	89.1 to 90.9 Hz	Same as initial
(3) 150 Hz		150 Hz	148.5 to 151.5 Hz	Same as initial
3-14. SYSTEM PHASING.				
a. Antenna Systems	5-16	Optimum	≤5° from optimum	≤10° from optimum
b. Monitor System	5-17	Optimum	≤5° from optimum	≤10° from optimum
3-15 ANTENNA SYSTEMS.				
a. Insulation Resistance	5-132	Infinity	>50 megohms	>20 megohms
b. DC Resistance	5-133	Baseline measurement	≤ Standard +5 Ω	Same as initial
c. Voltage Standing-Wave Ratio (vswr)	5-121, 5-123	1.0:1	≤1.25:1	≤1.40:1
3-16. thru 3-19. RESERVED.				

SUBSECTION 2. EXECUTIVE MONITOR PARAMETERS

Parameter	Reference Paragraph	Standard	Tolerance/Limit Initial	Tolerance/Limit Operating
3-20. MONITOR ALARM POINTS.				
a. Course Shift Alarm	5-13			
(1) Clockwise and Counterclockwise		As derived from airborne alignment value	Alarms when course shift ≤ standard	Same as initial
(2) Clearance (two-frequency only)		≤0.015 DDM	≤0.018 DDM	≤0.020 DDM
b. Course Width Alarm	5-13			
(1) Wide		As established by flight inspection	Alarms when sideband power ≥ standard	Same as initial
(2) Narrow		As established by flight inspection	Alarms when sideband power ≤ standard	Same as initial
c. Clearance Width Alarm (Wide) (Two-Frequency Only).	5-13	As established by flight inspection	Alarms when sideband power ≥ standard	Same as initial

SECTION 1. LOCALIZERS (Continued)

★ **SUBSECTION 2. EXECUTIVE MONITOR PARAMETERS** ★

Parameter	Reference Paragraph	Standard	Tolerance/Limit Initial	Tolerance/Limit Operating
★ **d. Rf Power Alarm**[1]	5-13			
(1) Single-frequency		60 percent of normal	As established by flight inspection but ≥50 percent of normal	Same as initial
(2) Two-frequency		85 percent of normal	As established by flight inspection but ≥80 percent of normal	Same as initial
e. Modulation Level Alarm	5-13			
★ **(1) Course and Clearance Monitors.**[2]				
(a) Low		SDM = 36 percent	SDM ≥34 percent	Same as initial
(b) High		SDM = 44 percent	SDM ≤46 percent	Same as initial
(2) Identification Tone (if equipped)		Alarms with loss of tone and continuous tone	Same as standard	Same as standard
f. Far-Field Monitor Alarm	5-13			
(1) Course Shift (cw and ccw).				
★ (a) Category II		≤0.011 DDM	Same as standard	Same as standard
(b) Category III		≤0.009 DDM	Same as standard	Same as standard ★
(2) Rf Level		Alarms with loss of rf	Same as standard	Same as standard
g. Remote Monitor Receiver Alarm	5-11	Appropriate indication for facility shutdown	Same as standard	Same as standard

[1] The standard value may be increased by flight inspection requirements. In these instances, the initial and operating tolerances shall equal or exceed the standard.

[2] Sum of depth of modulations (SDM) is the sum of the 90 and 150 Hz modulation components.

SECTION 1. LOCALIZERS (Continued)

SUBSECTION 2. EXECUTIVE MONITOR PARAMETERS (Continued)

Parameter	Reference Paragraph	Standard	Tolerance/Limit	
			Initial	Operating
3-21. MONITOR TIME DELAYS.				
a. Category I and LDA.[1]				
(1) Shutdown delay	5-20	10 seconds	≤10 seconds	Same as initial
(2) Auto-restart delay after shutdown (single equipment).	5-21	≥20 seconds	Same as standard	Same as standard
(3) Auto-reset delay (single equipment)	5-21	≥4.5 minutes	Same as standard	Same as standard
b. Category II.				
(1) Shutdown delay[1]	5-20	≤5 seconds	Same as standard	Same as standard
(2) Cold standby equipment auto-restart delay after main equipment shutdown.	5-21	≥20 seconds	Same as standard	Same as standard
(3) Manual restore delay		>20 seconds	Same as standard	Same as standard
(4) Far-field monitor total shutdown delay	5-20	90 seconds	80 to 100 seconds	70 to 110 seconds
(5) Far-field monitor status indicator display delay.	5-20	25 seconds	22 to 28 seconds	18 to 32 seconds
c. Category III.				
(1) Shutdown delay	5-20	≤2 seconds	Same as standard	Same as standard
(2) Manual-restore delay	5-20	>20 seconds	Same as standard	Same as standard
(3) Far-field monitor total shutdown delay	5-20	90 seconds	80 to 100 seconds	Same as initial
(4) Far-field monitor status indicator display delay.	5-20	3 seconds	2.5 to 3.5 seconds	2.2 to 4.4 seconds
3-22. thru 3-29. RESERVED.				

[1] At cold standby facilities, this is the time for the main equipment to shut down without a transfer after a monitor alarm. The standby equipment should not energize before the period specified in subparagraph 3-21b(2).

SECTION 1. LOCALIZERS (Continued)

SUBSECTION 3. REFERENCE PARAMETERS

Parameter	Reference Paragraph	Standard	Tolerance/Limit Initial	Tolerance/Limit Operating
* **3-30. AIRBORNE MEASUREMENTS.**[1, 2]	6-5			
a. Flight Inspection Course Width.				
(1) Width Normal.				
(a) Category I, II		Commissioned course width	≤5 percent of standard	≤17 percent of standard
(b) Category III		Commissioned course width	≤5 percent of standard	≤10 percent of standard
* (2) **Width Alarm** (Wide and Narrow)		≤10 percent of commissioned course width	≤14 percent of commissioned course width	≤17 percent of commissioned course width *
b. Flight Inspection Low Clearance.				
(1) Normal		≥175 µA	≥165 µA	≥150 µA
* (2) Wide and Narrow alarm		≥160 µA	≥150 µA	≥135 µA *
c. Flight Inspection Course Alignment.				
(1) Normal Front Course.				
(a) Category I		0 µA	≤3 µA	≤15 µA
(b) Category II		0 µA	≤3 µA	≤11 µA
* (c) Category III		0 µA	≤3 µA	≤9 µA *
(2) **Backcourse** (independently monitored).		0 µA	≤10 µA	≤20 µA
(3) **Backcourse** (facilities subordinate to front course).		0 µA	≤65 µA	Same as initial
(4) Course Shift.				
(a) Category I		10 µA	≤13 µA	≤15 µA
(b) Category II		6 µA	≤9 µA	≤11 µA
(c) Category III		4 µA	≤7 µA	≤9 µA

[1] The operating tolerances in paragraph 3-30 agree with flight inspection tolerance/limits.
[2] The initial tolerance in paragraph 3-30 shall be met anytime reference values are established.

SECTION 1. LOCALIZERS (Continued)

SUBSECTION 3. REFERENCE PARAMETERS (Continued)

Parameter	Reference Paragraph	Standard	Tolerance/Limit Initial	Tolerance/Limit Operating
(5) **Course Shift** (backcourse LDA, offset, simplified directional facility (SDF), and two-frequency localizer with monitored commissioned backcourse).		15 µA	≤ standard	≤20 µA
3-31. GROUND CHECK.				
→ a. **Normal**	5-12			
(1) **Course Width.**				
(a) Category I, LDA, and offset		DDM established during reference ground check	Same as standard	Initial ±0.015 DDM
(b) Category II and III		DDM established during reference ground check	Same as standard	Initial ±0.010 DDM
(2) **Off Course Clearance**		DDM established during reference ground check	Same as standard	≥90 percent of standard
(3) **Course Position.**				
* (a) Category I, LDA, and offset		0 DDM	DDM established during reference ground check	Initial ±0.008 DDM *
(b) Category II		0 DDM	DDM established during reference ground check	Initial ±0.006 DDM
(c) Category III		0 DDM	DDM established during reference ground check	Initial ±0.004 DDM
b. **Composite Sideband Null Position**	5-22	Centerline	≤10 inches from centerline per 1000 ft from array or ≤25 centimeters from centerline per 300 meters from array	≤20 inches from centerline per 1000 ft from array Or ≤50 centimeters from centerline per 300 meters from array
3-32. thru 3-34. RESERVED.				

SECTION 2. GLIDE SLOPES

3-35. GENERAL. This section prescribes the standards and tolerances for all glide slope facilities, as defined and described in Order 6000.15, General Maintenance Handbook for Airway Facilities.

3-36. thru 3-39. RESERVED.

*

SUBSECTION 1. NORMAL TRANSMITTER PARAMETERS

*

Parameter	*Reference Paragraph*	*Standard*	*Tolerance/Limit*	
			Initial	*Operating*
→ **3-40. RF POWER LEVELS.**				
* **a. Null Reference**. Carrier Power	5-40	As established by flight inspection	98 to 102 percent of standard	60 to 120 percent of standard
b. Sideband Reference.				
(1) Carrier power	5-40	As established by flight inspection	98 to 102 percent of standard	60 to 120 percent of standard
(2) Sideband power ratio (lower to upper antenna).	5-125	1:1	Same as standard	0.95:1 to 1.05:1
c. Capture Effect.				
(1) Transmitter Carrier Power Output (Course and Clearance)	5-40	As established by flight inspection	98 to 102 percent of standard	80 to 120 percent of standard
(2) Antenna Power Ratios.[1]	5-126			
(a) Clearance power in upper antenna to course power in middle antenna.		0.15:1 (0.387:1) [1]	As established by flight inspection, but not to exceed 0.25:1 (0.5:1) [1]	90 to 120 percent of initial but not to exceed 0.30:1 (0.548:1) [1] *
(b) Sideband power.				
1 Lower to upper antenna		1:1 (1:1) [1]	As established by flight inspection, but between 0.95:1 to 1.05:1 (.975:1 to 1.025:1) [1]	Initial ±5 percent

[1] Values enclosed in parentheses are voltage ratios.

SECTION 2. GLIDE SLOPES (Continued)

* SUBSECTION 1. NORMAL TRANSMITTER PARAMETERS (Continued) *

Parameter	Reference Paragraph	Standard	Tolerance/Limit	
			Initial	Operating
2 Middle to upper antenna (or lower antenna).		4:1 (2:1) [1]	As established by flight inspection, but between 3:1 to 5:1 (1.73:1 to 2.25:1) [1]	Initial ±5 percent
(c) Carrier power, lower to middle antenna.		4:1 (2:1) [1]	As established by flight inspection, but between 3:1 to 5:1 (1.73:1 to 2.25:1) [1]	Initial ±5 percent
d. End-Fire Glide Slope.				
* (1) **Transmitter Carrier Power Output (Course and Clearance)**	5-40	As established by flight inspection	98 to 102 percent of standard	80 to 120 percent of standard
(2) **Antenna Power Ratios.** [1]				
(a) Course array (rear to front antenna).		1.46:1 (1.21:1) [1]	Less than 1.6:1 (1.26:1) [1]	Same as initial
(b) Clearance array (front to rear antenna).		1:1 (1:1) [1]	Less than 1.2:1 (1.1:1) [1]	Same as initial
→3-41. MODULATION LEVELS.				
a. Course Transmitter.				
(1) 90 Hz	5-47	40 percent	39 to 41 percent	38 to 42 percent
(2) 150 Hz	5-47	40 percent	39 to 41 percent	38 to 42 percent
(3) Modulation equality[2]	5-40	0 DDM	Same as standard	≤0.010 DDM *

[1] Values enclosed in parenthesis are voltage ratios.

[2] The standard for EFGS is 0 DDM with the SBO dummy loaded or the reference DDM in the carrier feedline after the dummy is removed. Refer to paragraph 5-40.

SECTION 2. GLIDE SLOPES (Continued)

* **SUBSECTION 1. NORMAL TRANSMITTER PARAMETERS (Continued)** *

Parameter	*Reference Paragraph*	*Standard*	*Tolerance/Limit*	
			Initial	*Operating*
b. Clearance Transmitter (CEGS and EFGS Only).	5-47	80 percent	76 to 84 percent	Same as initial
3-42. **AUDIO PHASING.** Course to clearance tones, phase relationship (CEGS and EFGS only).	5-58	In phase	Within 185 µs (10° of 150 Hz cycle)	Same as initial
3-43. **FREQUENCY**	5-57			
→ **a. Carrier, Single-Frequency**		Authorized (add offset if applicable	Standard ±0.002 percent	Same as initial
→ **b. Carrier, Two-Frequency.** [1]				
(1) Course transmitter		Authorized +4 kHz	Standard ±0.002 percent	Same as initial
(2) Clearance transmitter		Authorized –4 kHz	Standard ±0.002 percent	Same as initial
(3) Carrier frequency separation		8 Khz	Standard ±5.0 percent	Standard ±10.0 percent
c. Modulation Tones.				
(1) 90 Hz		90 Hz	89.1 to 90.9 Hz	Same as initial
* (2) 150 Hz		150 Hz	148.5 to 151.5 Hz	Same as initial
→ 3-44. **RF PHASING.**				
a. NRGS Phasing	5-48			
(1) Transmitter radiated CSB to SBO		Optimum	±5° of standard	Same as initial
(2) Integral monitor network	5-49	Optimum	±5° of standard	Same as initial
b. SBRGS Phasing	5-50			
(1) Transmitter.				
(a) CSB to SBO in lower antenna		Optimum	±5° of standard	Same as initial *

[1] These three tolerances must be met concurrently.

SECTION 2. GLIDE SLOPES (Continued)

SUBSECTION 1. NORMAL TRANSMITTER PARAMETERS (Continued)

Parameter	*Reference Paragraph*	*Standard*	*Tolerance/Limit*	
			Initial	*Operating*
(b) Upper to lower antenna		Optimum	±5° of standard	Same as initial
(2) Integral monitor network	5-51	Optimum	±5° of standard	Same as initial
c. CEGS Phasing	5-52			
(1) CSB/SBO Phasing				
(a) Middle antenna		Optimum	±5° of standard	Same as initial
(b) Lower antenna		Optimum	±5° of standard	Same as initial
(2) Antenna Phasing [1]				
(a) Antenna #1		Optimum	±5° of standard	Same as initial
(b) Antenna #2		Optimum	±5° of standard	Same as initial
(3) Integral Monitor Network	5-53	Optimum	±5° of standard	Same as initial
d. EFGS Phasing				
(1) Clearance array (Dual only)	5-55	Minimum detected clearance on monitor M2	±5° of standard	Same as initial
(2) CSB to SBO phasing, course array	5-54	90°	±3° of standard	Same as initial
(3) Integral path monitor phasing	5-56	0°	±3° of standard	Same as initial
3-45. ANTENNA SYSTEMS.				
a. Insulation Resistance	5-132	Infinity	>50 megohms	>20 megohms
b. DC Resistance	5-133	Baseline measurement	≤ Standard +5 Ω	Same as initial
c. VSWR	5-121, 5-124	1.0:1	≤1.25:1	≤1.40:1

[1] Two antennas phased with respect to the third 'reference' antenna (common to both pairs).

SECTION 2. GLIDE SLOPES (Continued)

* SUBSECTION 1. NORMAL TRANSMITTER PARAMETERS (Continued) *

Parameter	Reference Paragraph	Standard	Tolerance/Limit Initial	Tolerance/Limit Operating
d. VSWR (EFGS Only). Feedlines clearance and monitor antennas (antennas connected).	5-121, 5-123	1.0:1	≤1.90:1	≤2.0:1
e. EFGS CLEARANCE MONITOR ANTENNA.	5-122	Equal signal from both clearance transmitting antennas	Front antenna signal equals rear antenna signal ±10 percent	Same as initial
3-46. thru 3-49. RESERVED.				

* SUBSECTION 2. EXECUTIVE MONITOR PARAMETERS *

Parameter	Reference Paragraph	Standard	Tolerance/Limit Initial	Tolerance/Limit Operating
3-50. MONITOR ALARM POINTS.				
a. Path or Phase Channel Alarm.				
(1) Single and Parallel Integral Path Monitor.				
(a) NRGS, CEGS	3-60, 5-43, 5-45	Alarms when modulation balance DDM is shifted 0.025 DDM	≤0.030 DDM	Same as initial
(b) SBRGS	3-60, 5-44			
1 High angle		Alarms when path is shifted +0.3° from established angle	Alarms when upper antenna power is increased to value established for high angle alarm by flight inspection	Upper antenna power ≤ initial value

SECTION 2. GLIDE SLOPES (Continued)

*

SUBSECTION 2. EXECUTIVE MONITOR PARAMETERS (Continued)

*

Parameter	Reference Paragraph	Standard	Tolerance/Limit Initial	Tolerance/Limit Operating
2 Low angle		Alarms when path is shifted –0.2° from established angle	Alarms when upper antenna power is decreased to value established for low angle alarm by flight inspection	Upper antenna power ≥ initial value
3 Path (phasing)		Alarms when upper antenna is advanced and retarded 19° from normal	As established by flight inspection but not to exceed ±30°	Same as initial
(2) Both Field and Integral Path Monitors, EFGS.	3-60, 5-46			
(a) Snap Down.				
1 High angle		Alarms when path is shifted +0.3° from established angle	Alarms when path shift ≤ standard	Same as initial
2 Low angle		Alarms when path is shifted –0.2° from established angle	Alarms when path shift ≤ standard	Same as initial
(b) Integral.				
1 High angle		Alarms when path is shifted +0.3° from established angle	Alarms when path shift ≤ standard	Same as initial
2 Low angle		Alarms when path is shifted –0.2° from established angle	Alarms when path shift ≤ standard	Same as initial

*

SECTION 2. GLIDE SLOPES (Continued)

SUBSECTION 2. EXECUTIVE MONITOR PARAMETERS (Continued)

Parameter	Reference Paragraph	Standard	Tolerance/Limit	
			Initial	*Operating*
b. Width or Amplitude Channel Alarm............	5-43, 5-44, 5-45, 5-46			
(1) Wide..		As established by flight inspection	Alarms when sideband power ≥ standard	Same as initial
(2) Narrow		As established by flight inspection	Alarms when sideband power ≤ standard	Same as initial
c. Rf Power Alarm[1]	5-43, 5-44, 5-45, 5-46			
(1) One-frequency..		60 percent of normal	As established by flight inspection but ≥50 percent of normal	Same as initial
(2) Two-frequency (CEGS & EFGS)		85 percent of normal	As established by flight inspection but ≥80 percent of normal	Same as initial
d. Modulation Level Alarm..............................	5-43, 5-44, 5-45, 5-46			
(1) Course monitor......................................				
(a) Low		SDM = 76 percent	SDM ≥72 percent	Same as initial
(b) High		SDM = 84 percent	SDM ≤86 percent	Same as initial

[1] The standard value may be increased by flight inspection requirements. In these instances the initial and operating tolerances shall equal or exceed the standard. Where there are both near-field and integral rf monitors, these tolerances apply to integral monitors.

SECTION 2. GLIDE SLOPES (Continued)

* **SUBSECTION 2. EXECUTIVE MONITOR PARAMETERS (Continued)** *

Parameter	Reference Paragraph	Standard	Tolerance/Limit	
			Initial	Operating
(2) Clearance monitor				
(a) Low		76 percent	≥68 percent	Same as initial
(b) Withdrawn CHG 1				
e. Antenna Signal Attenuation Alarm .... (CEGS Only).	3-60, 5-45			
(1) Upper antenna		5.0 dB	As established by flight inspection but not to exceed 5.0 dB	Same as initial
(2) Middle antenna		1.5 dB	As established by flight inspection but not to exceed 2.0 dB	Same as initial
f. Middle Antenna Dephasing Alarm .... (CEGS Only).	3-60, 5-45	15° advanced and retarded from normal	As established by flight inspection but not to exceed 20°	Same as initial
g. Main SBO Dephasing Alarm	5-43, 5-44, 5-45, 5-46			
(1) NRGS		30° advanced and retarded from normal	As established by flight inspection but not to exceed 30°	≤ initial value
(2) EFGS		15° advanced and retarded from normal	Alarms when path shift ≤ standard	Same as initial
h. Remote Monitor Receiver Alarm	5-41	Appropriate indication for facility shutdown	Same as standard	Same as standard

SECTION 2. GLIDE SLOPES (Continued)

*

SUBSECTION 2. EXECUTIVE MONITOR PARAMETERS (Continued)

*

Parameter	Reference Paragraph	Standard	Tolerance/Limit Initial	Tolerance/Limit Operating
3-51. MONITOR TIME DELAYS.				
a. Category I. [1,2]				
(1) Shutdown delay..	5-59	5 seconds	≤6 seconds	Same as initial
(2) Auto-restart delay (single equipment).........................	5-60	≥20 seconds	Same as standard	Same as standard
(3) Auto-reset delay (single equipment)...........................	5-60	≥4.5 minutes	Same as standard	Same as standard
b. Category II, III.[3]				
(1) Shutdown delay[2]......................................	5-59	≤2 seconds	Same as standard	Same as standard
* (2) Cold standby equipment auto-restart delay after main equipment shutdown.	5-60	≥20 seconds	Same as standard	Same as standard
(3) Manual restore delay................................		≥20 seconds	Same as standard	Same as standard *
3-52. thru 3-59. RESERVED.				

[1] For the end-fire glide slope, the time delay is measured from the time the glide slope station monitor senses an out-of-tolerance condition from its monitored parameter or senses an alarm condition from the snap-down monitor.

[2] The parameters specified in this paragraph are maximum times allowed for the category. For specific adjustment procedures, refer to the applicable instruction book.

[3] At GRN-29 facilities, this is the time for the main equipment to shut down without a transfer after a monitor alarm. The standby equipment should not energize before the period specified in paragraph 3-51.

SECTION 2. GLIDE SLOPES (Continued)

SUBSECTION 3. REFERENCE PARAMETERS

Parameter	Reference Paragraph	Standard	Tolerance/Limit	
			Initial	Operating
3-60. AIRBORNE MEASUREMENTS [1]	6-5			
a. Flight Inspection Path Angle.				
(1) Normal		Commissioned angle (CA)	CA ±0.05°	CA +10.0, –7.5 percent
(2) High-angle alarm[2]		CA +0.05°	CA +0.25°	CA +10.0 percent
(3) Low-angle alarm[2]		CA –0.05°	CA –0.15°	CA –7.5 percent
b. Flight Inspection Path Width.				
(1) Normal		0.70°	0.65° to 0.75°	0.50° to 0.90°
(2) Wide alarm		0.80°	0.75° to 0.87°	≤0.90°
(3) Narrow alarm		0.60°	0.53° to 0.65°	≥0.50°
c. Flight Inspection Structure Below Path (Angle for 190 μA).		≥75 percent of CA	≥50 percent of CA	≥30 percent of CA
d. Path Symmetry (in normal).				
(1) Cat I		50 percent	60 to 40 percent	67 to 33 percent
(2) Cat II, III		50 percent	55 to 45 percent	58 to 42 percent

[1] The operating tolerances in paragraph 3-60 are the flight inspection tolerance/limits. The initial tolerance in paragraph 3-60 shall be met any time reference values are established or are being re-established.

[2] Tolerances are only applicable to SBRGS & EFGS.

SECTION 2. GLIDE SLOPES (Continued)

SUBSECTION 3. REFERENCE PARAMETERS (Continued)

Parameter	Reference Paragraph	Standard	Tolerance/Limit	
			Initial	Operating
* **e. System Dephasing (Advance and Retard).** [1,2,3]	5-192			
(1) Main sidebands (NRGS, CE, and SBR)		≤30°	19°to 30°	Same as initial
(2) Middle antenna (CEGS)		≤20°	10° to 20°	Same as initial
(3) Upper antenna (SBRGS)		≤30°	19° to 30°	Same as initial
f. Attenuation (CEGS). [1,2]				
(1) Middle antenna		1.5 dB	≤2 dB	Same as initial
(2) Upper antenna		5 dB	≤5 dB	Same as initial
3-61. GROUND CHECKS (EFGS)	5-42			
a. Snap-Down Points 1, 2, and 3		As established during reference ground check	±0.025 DDM of standard	±0.040 DDM of standard
b. Normal.				
(1) Points 1, 2, and 3		As established during reference ground check	±0.025 DDM	±0.040 DDM of standard
(2) Points 4 and 5		>0.500 DDM	>0.300 DDM	Same as initial
3-62. thru 3-64. RESERVED.				

* [1] The standard values for system dephasing and attenuation are greater than initial values because a properly optimized system will withstand larger changes in these parameters.

[2] During dephasing and attenuation checks, the system must remain within the operating tolerances of paragraph 3-60a, b, and c.

[3] System dephasing tolerances do not apply to end-fire glide slopes.

SECTION 3. 75 MHZ ILS MARKERS

3-65. GENERAL. This section prescribes the standards and tolerances for all 75 MHz ILS marker facilities as defined and described in Order 6000.15, General Maintenance Handbook for Airway Facilities.

3-66. thru 3-69. RESERVED.

*

SUBSECTION 1. NORMAL TRANSMITTER PARAMETERS

*

Parameter	Reference Paragraph	Standard	Tolerance/Limit	
			Initial	Operating
→ **3-70. RF CARRIER POWER LEVEL**	5-70	As established by flight inspection	98 to 102 percent of standard	60 to 120 percent of standard
→ **3-71. MODULATION LEVEL**	5-71	95 percent	93 to 97 percent	85 to 99 percent
→ **3-72. FREQUENCY**	5-75			
a. Carrier.				
(1) Conventional		75.000 MHz	±2250 Hz of standard	±3750 Hz of standard
(2) Offset frequency operation		75.004 MHz and 74.996 MHz	±1500 Hz of standard	Same as initial
b. Modulation Tones.				
(1) Outer marker		400 Hz	399 to 401 Hz	396 to 404 Hz
(2) Middle marker		1300 Hz	1297 to 1303 Hz	1287 to 1313 Hz
(3) Inner marker		3000 Hz	2992 to 3008 Hz	2970 to 3030 Hz
3-73. ANTENNA SYSTEMS.				
→ **a. Reflected power level (vswr)**	5-121, 5-124	1.0:1	≤1.67:1	≤1.75:1
b. Insulation resistance	5-132	Infinity	≥50 megohms	≥20 megohms
c. DC Resistance	5-133	Baseline measurement	≤ Standard +5 Ω	Same as initial
→ **3-74. ANTENNA SYSTEM (COLLINEAR ARRAY).**				
a. Antenna Current Balance Ratio	5-211	1.0:1	≤1.05:1	≤1.1:1
b. Electrical Length of Phasing Sections (Collinear Dual Dipoles).	5-210	Y section equal to X section plus 180°	±2° of standard	±4° of standard
3-75. thru 3-79. RESERVED.				

SECTION 3. 75-MHZ ILS MARKERS (Continued)

SUBSECTION 2. EXECUTIVE MONITOR PARAMETERS

Parameter	Reference Paragraph	Standard	Tolerance/Limit	
			Initial	Operating
3-80. MONITOR ALARM POINTS	5-72			
a. Carrier Power[1]		60 percent of normal	≥50 percent of normal	Same as initial
b. Modulation.				
(1) Non-Measured System.				
(a) Loss of tone		Alarms	Same as standard	Same as standard
(b) Continuous tone		Alarms	Same as standard	Same as standard
(2) Measured System.				
(a) Low modulation		85 percent	≥80 percent	Same as initial
(b) High modulation		99 percent	≤100 percent	Same as initial
c. Vswr (for systems with vswr monitoring).		2.5:1	≤3.0:1	Same as initial
3-81. AUTOMATIC TRANSFER AND/OR SHUTDOWN.	5-73	15 seconds	≤30 seconds	≤30 seconds
3-82. thru 3-84. RESERVED.				

[1] This is not a parameter that needs to be checked by flight inspection.

SECTION 4. BUILT-IN TEST EQUIPMENT (BITE)

3-85. GENERAL. This section prescribes the standards and tolerances for built-in test equipment (BITE) as defined and described in Order 6000.15, General Maintenance Handbook for Airway Facilities.

3-86. thru 3-89. RESERVED.

Parameter	*Reference Paragraph*	*Standard*	*Tolerance/Limit*	
			Initial	*Operating*
→ **3-90. VERIFICATION OF BUILT-IN TEST EQUIPMENT (BITE).**				
* **a. Power Output Verification**............................	5-81	Same as reference	≤2.0 percent difference	Same as initial
b. VSWR Verification..	5-81	2.0:1	1.8 to 2.2:1	Same as initial
c. Modulation Verification................................	5-82	Same as reference	≤1.5 percent difference	Same as initial
d. Difference in Depth of Modulation (DDM) Verification.	5-83	Same as reference	≤0.002 DDM difference	Same as initial
e. Frequency Separation Verification............	5-84	Same as reference	±50.0 Hz	Same as initial *
3-91. thru 3-94. RESERVED.				

SECTION 5. REMOTE MAINTENANCE MONITOR (RMM)

3-95. GENERAL. This section prescribes the standards and tolerances for all remote maintenance monitor (RMM) (both analog and digital RMM) for ILS facilities as defined and described in Order 6000.15, General Maintenance Handbook for Airway Facilities.

3-96. thru 3-99. RESERVED.

Parameter	*Reference Paragraph*	*Standard*	*Tolerance/Limit*	
			Initial	*Operating*
* **3-100. ANALOG SYSTEMS** (e.g., ARMS, RMS)...... *	5-90			
a. DDM Indications..		Indication on data terminal same as local indication	±0.002 DDM	±0.002 DDM
b. Other Indications Required For................ Certification.		Indication on data terminal same as local indication	±3 percent of local reading	±5 percent of local reading
c. Other Indications Not Required For .... Certification.		Indication on data terminal same as local indication	Standard ±8 percent	Standard ±10 percent
3-101. DIGITAL SYSTEMS (e.g., Mark 20).............	5-91			
a. Digital Indications......................................		Indication on data terminal same as local indication	±1 least significant digit (LSD)	Same as initial
b. Parameters Locally Measured By Meters Or External Test Equipment.				
(1) DDM indications		Indication on data terminal same as local indication	±0.002 DDM	Same as initial
(2) Other indications...................................		Indication on data terminal	±3 percent of local reading	±5 percent of local reading
3-102. thru 3-104. RESERVED.				

CHAPTER 4. PERIODIC MAINTENANCE

4-1. GENERAL.

a. Description. This chapter establishes the maintenance activities that are required for ILS facilities on a periodic basis and provides the schedules for their accomplishment. The chapter is divided into two sections. The first section identifies the performance checks (i.e., tests, measurements, and observations) of normal operating controls and functions which are necessary to determine whether operation is within established tolerances/limits. The second section identifies other maintenance tasks which are necessary to prevent deterioration and/or ensure reliable operation. Refer to Order 6000.15, General Maintenance Handbook for Airway Facilities, for additional guidance.

b. Application. These schedules apply to all ILS facilities. When a conflict exists between this handbook and other handbooks or equipment instruction books, this handbook takes precedence.

* **c. Reference Paragraphs.** The reference paragraphs in the maintenance procedure columns are listed to show only the basic paragraphs wherein the specific procedures are found. Only the subparagraph(s) directly applicable to the item(s) being checked apply. *

4-2 thru 4-9. RESERVED.

SECTION 1. PERFORMANCE CHECKS

SUBSECTION 1. LOCALIZERS

Performance Checks	*Reference Paragraph*	
	Standards and Tolerances	*Maintenance Procedures*
4-10. MONTHLY.		
a. Complete a line entry of normal equipment parameters for each set of equipment installed.	--	5-10
b. Check monitor shutdown function of each set of equipment installed.	--	5-11
4-11. QUARTERLY.		
a. Perform normal (both equipments if dual) ground check	3-31	5-12
* **b.** Check monitor alarm points	3-20	5-13 *
4-12. SEMIANNUALLY.		
a. Check modulations	3-11	5-14, 5-15
b. Check system and integral monitor rf phasing	3-14	5-16, 5-17

SUBSECTION 1. LOCALIZERS - (Continued)

Performance Checks	Reference Paragraph: Standards and Tolerances	Reference Paragraph: Maintenance Procedures
4-13. ANNUALLY.		
a. Measure frequencies	3-13	5-18
b. Check audio phasing	3-12	5-19
c. Check time delays	3-21	5-20
d. Check auto-reset/restart	3-21	5-21
e. Check sideband null	3-31	5-22
4-14. AS REQUIRED.		
* **a.** Immediately preceding monitor flight inspection:[1] *		
(1) Check modulations	3-11	5-14, 5-15
(2) Check air-to-ground (a-g) transceiver operation	Order 6600.21, Maintenance of Communication Transceivers	5-221
(3) Perform normal ground check	3-31	5-12
b. Immediately following monitor flight inspection (that established new reference values), perform reference ground check.[2] *	3-31	5-175
4-15. thru 4-19. RESERVED.		

* [1] Reference 6-31 & 6-32 for additional information. *

[2] Reference 6-37 for additional information.

SUBSECTION 2. GLIDE SLOPES

Performance Checks	Reference Paragraph: Standards and Tolerances	Reference Paragraph: Maintenance Procedures
4-20. MONTHLY.		
a. Complete a line entry of normal equipment parameters for each set of equipment installed.	--	5-40
b. Check monitor shutdown function of each set of equipment installed.	--	5-41
4-21. QUARTERLY.		

SUBSECTION 2. GLIDE SLOPES – (Continued)

Performance Checks	Reference Paragraph	
	Standards and Tolerances	Maintenance Procedures
a. Perform ground check (end-fire only; both equipments if dual)	3-61	5-42
b. Check monitor alarm points	3-50	5-43 thru 5-46
4-22. SEMIANNUALLY.		
* a. Check modulations	3-41	5-47 *
b. Check system and integral monitor rf phasing	3-44	5-48 thru 5-56
4-23. ANNUALLY.		
a. Measure frequencies	3-43	5-57
b. Check audio phasing	3-42	5-58
c. Check time delays	3-51	5-59
d. Check auto-reset/restart	3-51	5-60
*		*
4-24. AS REQUIRED.		
a. Immediately preceding monitor flight inspection: [1]		
(1) Check modulations	3-41	5-47
(2) Check a-g transceiver operation	Order 6600.21, Maintenance of Communication Transceivers	5-221
(3) Perform ground check (end-fire only)	3-61	5-42
b. Immediately following monitor flight inspection (that established new reference values): [2]		
* (1) Perform reference ground check (end-fire only)	3-61	5-42 *
(2) Update monitor references (if needed)	--	5-62
4-25. thru 4-29. RESERVED.		

* [1] Reference 6-31 & 6-32 for additional information. *

[2] Reference 6-37 for additional information.

SUBSECTION 3. 75-MHZ ILS MARKERS

Performance Checks	*Reference Paragraph*	
	Standards and Tolerances	*Maintenance Procedures*
4-30. SEMIANNUALLY.		
a. Check rf power	3-70	5-70
b. Check modulation	3-71	5-71
c. Check monitor alarm points	3-80	5-72
d. Check automatic transfer/shutdown	3-81	5-73
e. Check alternate equipment (dual systems)	--	5-74
4-31. ANNUALLY. Measure frequencies	3-72	5-75
4-32. thru 4-39. RESERVED.		

SUBSECTION 4. BUILT-IN TEST EQUIPMENT (BITE)

Performance Checks	*Reference Paragraph*	
	Standards and Tolerances	*Maintenance Procedures*
4-40. ANNUALLY.[1]		
* **a.** Power output	3-90a	5-81
b. Vswr measurement	3-90b	5-81
c. Modulation percentage	3-90c	5-82
d. Difference in depth of modulation	3-90d	5-83
e. Frequency separation	3-90e	5-84
4-41. AS REQUIRED.		
a. Initial installation	3-90	5-80 thru 5-84
b. Replacement of module containing BITE circuitry	3-90	5-80 thru 5-84 *
4-42. thru 4-49. RESERVED.		

[1] A line entry shall be made on a Form 6000-8 recording the five BITE portable maintenance data terminal (PMDT) readings vs. the external standard test equipment measurements and the final adjusted measurement(s) if made. A separate Form 6000-8 shall be utilized for each set of equipment (i.e., No:1 and No:2 GS equipment).

SUBSECTION 5. REMOTE MAINTENANCE MONITOR (RMM)

Performance Checks	*Reference Paragraph*	
	Standards and Tolerances	*Maintenance Procedures*
4-50. SEMIANNUALLY. Verify remote maintenance monitor data (analog system).	3-100	5-90
4-51. ANNUALLY. Verify remote maintenance monitor data (digital system).	3-101	5-91
4-52. thru 4-59. RESERVED.		

SECTION 2. OTHER MAINTENANCE TASKS

SUBSECTION 1. ILS FACILITIES

Maintenance Tasks	*Reference Paragraph*	
	Standards and Tolerances	*Maintenance Procedures*
4-60. MONTHLY. Perform equipment time update for facilities with remote set capability.	--	5-112
* **4-61. QUARTERLY.**		
a. Check all warning and critical area signs	--	5-110
b. Check vegetation control	--	5-110
c. Environmental Encroachment	--	5-114 *
* **4-62. SEMIANNUALLY.**		*
a. Check equipment air filters	--	5-110
b. Perform PIR audio calibration	--	5-111
c. Perform equipment time update	--	5-112
* **4-63. ANNUALLY.**		
a. Clean/inspect all equipment	--	5-110
b. Check/perform PIR rf/audio calibration (PIR's capable of field rf calibration).	--	5-111
c. Perform backup power (battery) check	--	5-113
4-64. AS REQUIRED.[1] Check test equipment calibration due dates as noted on calibration labels and forward for calibration as needed.		
4-65. thru 4-69. RESERVED.		*

[1] Certain PIR models, manufactured by NAVAIDS, THALES ATM, and ASII, have or are being modified for extended calibration cycles (i.e. four years).,

SUBSECTION 2. ILS ANTENNAS

Maintenance Tasks	*Reference Paragraph*	
	Standards and Tolerances	*Maintenance Procedures*
4-70. ANNUALLY.		
a. Measure vswr at transmitter	3-15, 3-45, 3-73	5-121
b. Check EFGS clearance monitor antenna location	3-45	5-122
c. Check EFGS air system integrity	--	5-123
4-71. BIENNIAL. [1]		
a. Measure vswr at antenna feed lines	3-15, 3-45, 3-73	5-124
b. Check antenna rf power distribution	3-40	5-125, 5-126
4-72. thru 4-79. RESERVED.		

SUBSECTION 3. ILS TRANSMISSION LINES

Maintenance Tasks	*Reference Paragraph*	
	Standards and Tolerances	*Maintenance Procedures*
4-80. ANNUALLY. Inspect rf cables	--	5-131
* **4-81. BIENNIAL.** [1]		
a. Measure rf cable insulation resistance	3-15, 3-45, 3-73	5-132
b. Measure rf cable dc resistance (Except V-Ring)	3-15, 3-45, 3-73	5-133 *
4-82. thru 4-89. RESERVED.		

[1] Once every two years.

SECTION 1. PERFORMANCE CHECK PROCEDURES (Continued)

TABLE 5-1. ILS TECHNICAL PERFORMANCE RECORD FORMS (Continued)

FAA FORM NUMBERS	*TITLE*	*APPLICATION*
6750-28	Sideband-Reference Glide Slope Monitor Reference Data	All sideband-reference glide slopes
6750-29	Capture-Effect Glide Slope Monitor Reference Data	All capture-effect glide slopes
6750-30	End-Fire Glide Slope Ground Check	All end-fire glide slopes
6750-31	End-Fire Glide Slope Monitor Reference Data	All end-fire glide slopes
6750-32	Localizer & Glide Slope - Modulation/Frequencies	All localizers/glide slopes
6770-4	ILS 75 MHz Marker	All 75 MHz markers

5-7. GROUND CHECKS.

a. General. The information presented in this paragraph applies to all localizer facilities.

(1) Ground checks of localizer radiated signals, using a portable ILS receiver (PIR), provide a useful method of evaluating overall system performance. They are required on a periodic basis to ensure that the radiated signal has not changed due to changes of the localizer antenna array, the environment around the array, or the localizer equipment. Reference ground check data establishes the reference data base that is used by the systems specialist to ensure that the localizer radiated signal is maintained within flight inspection tolerances. With a few exceptions, this will also allow the specialist to restore a facility without a confirming flight inspection.

(2) Three types of ground checks may be used in the maintenance of ILS localizers. They are normal, monitors, and reference ground checks.

(a) A normal ground check is the taking of data at the established check points with the transmitting equipment operating normally. The parameters measured are course position, course width and clearance.

(b) A monitors ground check includes all the data taken by a normal ground check plus course position and width data with the facility in the alarm conditions. The * monitors ground check may be used to ensure that the monitor alarms at or before the radiated signal reaches the alarm limits established during flight inspection. *

(c) The reference ground check includes all normal * ground check data. Reference ground check data provides a * means of correlating current conditions to those at the time of the last reference ground check (when initial airborne tolerances were met).

b. When Ground Checks Are Required. Ground checks are required under any of the following conditions:

(1) Reference Ground Checks. This check shall be completed within 8 hours of flight inspection and shall be completed before returning the facility to service.

(a) Upon completion of flight inspection for purposes of commissioning a new facility.

(b) Upon completion of any monitors flight inspection that requires a change to the facility reference values. This will result whenever a flight inspection

SECTION 1. PERFORMANCE CHECK PROCEDURES (Continued)

discrepancy occurs, or when new radiated signal or monitor parameters are necessary. These parameters include carrier power, sideband power, modulation balance, etc. Only changes required during flight inspection need be updated on the reference ground check. However, changes that the specialist makes to establish new, tighter reference operating limits, if past flight check indicated this action to be prudent, do not require a new reference ground check.

* **(2) Monitor Ground Checks. (Optional)**

(a) May be used in troubleshooting efforts.

(b) Refer to paragraph 5-13 for a procedure to determine if the localizer monitor alarm points are within the reference values established during the reference flight inspection. *

(3) Normal Ground Checks.

(a) Periodically, as required by chapter 4.

(b) After an aircraft accident.

(c) Before a scheduled monitor flight inspection. This may be accomplished up to 5 days before the monitors flight inspection.

(d) After a monitors flight inspection, if a normal ground check was not performed prior to the inspection.

* (e) When, in the judgment of the specialist, it is required to confirm facility operation. *

5-8. thru 5-9. RESERVED

SUBSECTION 1. LOCALIZERS

5-10. LINE ENTRY OF NORMAL READINGS.

a. Object. This procedure provides a method to complete a line entry of the normal parameters on FAA Form 6750-24, with the equipment in normal configuration.

b. Discussion. A line entry of the localizer normal parameters is required before a normal ground check and periodically as required in chapter 4. This check is made without adjustment to the equipment and can be performed from a remote maintenance monitor (RMM). Computer generated data reports may be used in lieu of FAA form.

c. Test Equipment Required.

(1) A portable ILS receiver (PIR).

(2) A digital voltmeter (dvm) (optional).

(3) The facility rf wattmeter and/or built-in test equipment (BITE).

NOTE: Chapter 1, Paragraph 1-2b, Test Equipment, discusses external test equipment and BITE, and their proper use in the NAS. Particular attention must be paid to the proper use and maintenance of test equipment to ensure accurate evaluations of equipment operation. For instance, when using a BIRD wattmeter for power measurements, the same set of rf bodies, wattmeter, and elements must be utilized due to the variability of the wattmeter components. For BITE, proper calibration and verification of measurements are required.

d. Conditions. The facility is operating normally. For facilities that are equipped with standby equipment, switch standby equipment on-line to take readings.

e. Detailed Procedure. At the local site or RMM location, perform the following steps.

(1) Measure and record the normal carrier power on FAA Form 6750-24. Confirm that the power is within the established tolerance value. If not within tolerance, corrective action is required.

SECTION 1. PERFORMANCE CHECK PROCEDURES (Continued)

SUBSECTION 1. LOCALIZERS (Continued)

(2) Measure and record the normal sideband power on FAA Form 6750-24.

(3) Measure and record the monitor width DDM, the monitor course DDM, and the modulation equality (carrier feedline DDM) on FAA Form 6750-24.

* **NOTE:** Carrier feedline DDM measurements may differ from audio measurements. This is likely due to the sideband energy coming back down the CSB feedline. *

(4) Check the quality of the identification and voice for clarity and correct information. If acceptable, record a check mark under the appropriate column. This check may be omitted when completing the line entry from the RMM.

(5) At two-frequency localizers, complete the steps above for the clearance transmitter.

(6) To obtain a computer generated data report of normal readings for the Mark 20 ILS; log onto the facility to be recorded, check that the transmitter to be recorded is "On Antenna"; from the "Commands" menu depress the key sequence <D E O> for transmitter one; or <D E T> for transmitter two. Hot keys, Alt F5 or Alt F6, may also be used. The report may be printed by depressing the "Print Screen" key and then selecting "P" for print. If desired the report may also be saved to disk by depressing the "D" key.

(7) At all dual equipment facilities complete a normal line entry for each set of equipment.

5-11. LOCAL AND REMOTE MONITOR SHUTDOWN OPERATION.

a. Object. This procedure provides a method to determine that a shutdown is properly sensed at the local and/or remote control points.

b. Discussion. Certain alarms in the ILS equipment shall result in an equipment transfer and/or shutdown. Also, if remotely monitored, an indication that the facility is shut down shall be received at the remote monitor location. This check confirms that the shutdown occurs and that the remote control point is properly notified. This check can also be initiated and monitored from a remote maintenance monitor (RMM) location.

* **c. Conditions.** A facility shutdown is required for this check. *

d. Detailed Procedure.

(1) Simulate a continuous alarm, or from the RMM perform a station integrity check.

(2) Allow a shutdown to occur.

(3) Determine that the proper remote and local alarm indications occurred.

(4) If remote restore capability is installed, restore the facility from the remote control point or allow the auto-restart circuit to restore the facility.

(5) Make an entry in the facility log that this check was completed.

5-12. NORMAL GROUND CHECK.

a. Object. This procedure provides a method to determine that the localizer course alignment, width, and clearance are within tolerance.

b. Discussion. Navigational information provided by the localizer is a complex function of the localizer system. It is affected by the airport geometry, antenna system phase and current distribution, and other equipment parameters. The normal ground check provides a system check that is representative of the user's view.

c. Test Equipment Required.

(1) A portable ILS receiver (PIR).

(2) An appropriate antenna.

d. Conditions. The facility is operating normally, and approval has been obtained from air traffic personnel to operate on the ILS runway when required.

e. Detailed Procedure.

(1) Complete a line entry on FAA Form 6750-24 in accordance with paragraph 5-10.

(2) At the edge of course, centerline, and low clearance ground check points on each side of the array, measure the DDM value and record data on FAA Form 6750-23.

SECTION 1. PERFORMANCE CHECK PROCEDURES (Continued)

SUBSECTION 1. LOCALIZERS (Continued)

(3) Compare the data recorded with the limits established by the reference ground check.

(4) At two-frequency localizers with a commissioned backcourse, complete the steps above, using separate forms for the backcourse. Clearance ground check points are not required when ground checking the backcourse.

5-13. LOCALIZER MONITOR.

a. Object. This procedure provides a method to determine if the localizer monitor alarm points are within the reference values established during the reference flight inspection.

b. Discussion.

(1) The localizer monitor is used to ensure the integrity of the localizer system by permitting the localizer to operate only if certain system parameters are within the limits established during the reference flight inspection. This performance check is accomplished by adjusting the transmitting equipment to cause an executive monitor alarm and then verifying that the radiated parameters are within established reference values. If a radiated parameter is found outside the established reference values, it must be determined if the condition is due to monitor drift. If so, the monitor alarm points must be tightened to ensure that for day-to-day monitor drift, the monitor will alarm whenever the radiated signal parameters are at or beyond the established reference values.

(2) The reference data must be measured carefully. Power measurements must always be accomplished with the same meter and elements. The elements shall be clearly marked. In addition to the rf wattmeter readings, it is recommended that a digital voltmeter (dvm) be used to obtain reference readings for carrier and sideband power in normal, wide, and narrow alarms. These reference readings can be made with greater repeatability using the dvm than by using the analog wattmeter. This is done by connecting a digital voltmeter, set to measure dc voltage, to the detector element output in place of the normal meter. Improved consistency in dvm readings will result if the dvm input is shunted with a 1400 Ω ±1 percent resistor. This resistor presents the same load to the detector elements as the normal analog meter. If the reference readings are made with the load resistor in place, all future measurements must be made in this configuration. When using BITE, proper calibration and verification of measurements are required.

(3) The monitor DDM values are the monitor input values measured with the PIR or monitor digital readout values. No tolerance exists for the DDM values. They are used to detect trends such as system or monitor drift.

(4) This performance check requires a line entry on FAA Form 6750-24. The reference data line contains the reference data used to perform a monitor performance check. The reference data line and reference ground check
* can be updated only in accordance with paragraph 5-175. *

c. Test Equipment Required.

(1) A portable ILS receiver (PIR) and/or BITE.

(2) The facility rf wattmeter or BITE.

(3) An optional digital voltmeter (dvm).

(4) The FA-9438 modulation meter, BITE, or equivalent.

NOTE: Chapter 1, Paragraph 1-2b, Test Equipment, discusses external test equipment and BITE, and their proper use in the NAS. Particular attention must be paid to the proper use and maintenance of test equipment to ensure accurate evaluations of equipment operation. For instance, when using a BIRD wattmeter for power measurements, the same set of rf bodies, wattmeter, and elements must be utilized due to the variability of the wattmeter components.

d. Conditions. A facility shutdown is required for this check.

e. Detailed Procedure.

(1) Preliminary actions.

(a) Refer to FAA Form 6750-24 for the applicable reference values.

SECTION 1. PERFORMANCE CHECK PROCEDURES (Continued)

SUBSECTION 1. LOCALIZERS (Continued)

* (b) Verify that the SDM and DDM are set to reference values. Check carrier power and if required, adjust to the reference value as established on FAA Form 6750-24. Adjustments should be made as accurately as possible, as they will affect the subsequent path width alarm points. The facility and monitor combining network (if applicable) must be properly phased.

(c) Bypass the monitor to prevent shutdown.

(2) Width alarms.

(a) Verify that the rf carrier power level is at the power established during the reference flight inspection. Reduce the sideband power until the monitor width channel is in wide alarm. Record the sideband power on FAA Form 6750-24.

(b) Confirm that the sideband power is greater than, or equal to, the operating tolerance. If it is not within tolerance, corrective action is required.

(c) Measure and record the width monitor DDM on FAA Form 6750-24. Note that no tolerance exists on this entry. It is used to detect trends.

(d) Increase the sideband power until the monitor width channel is in narrow alarm. Record the sideband power on FAA Form 6750-24.

(e) Confirm that the sideband power is less than or equal to, the operating tolerance. If not within tolerance, corrective action is required.

(f) Measure and record the width monitor DDM on FAA Form 6750-24. Note that no tolerance is established on this entry. It is used only to detect trends.

(g) Return the sideband power to normal.

(3) Course position alarms.

(a) Connect the PIR to measure DDM in the carrier feedline or reference the BITE radiated signal DDM measurement.

(b) Using the modulation balance control or MDT, shift the course clockwise (150 > 90 Hz) until the monitor course position channel is in alarm. Measure and record the * carrier feedline DDM value on FAA Form 6750-24. Confirm that the carrier feedline DDM is not more than established reference value. If not within tolerance, corrective action is required.

(c) Measure and record the course monitor DDM on FAA Form 6750-24. Note that no tolerance is established for this entry. It is used only to detect trends.

(d) Repeat the procedure in steps (b) and (c) with the modulation balance control adjusted to shift the course counterclockwise (90 > 150 Hz).

(e) Restore the modulation balance control or the MDT settings to normal.

(4) Modulation level alarms.

(a) Reduce the composite carrier modulation (90 + 150 Hz) until the monitor is in low modulation percent alarm. Measure the carrier modulation, using the modulation meter or MDT. Confirm that the modulation percentages are not below the operating tolerance stated in chapter 3.

(b) On equipment that monitors high modulation percent, repeat step (a) for high modulation percent alarm. Confirm that the modulation percentages are not above the operating tolerance in chapter 3. On some equipment, verification of modulation alarms by adjusting the transmitting equipment is not possible. In this case, verify the modulation alarm(s) by using the monitor test dial or reducing the monitor input as appropriate. The tolerance for this type of equipment is stated as a percent of full scale monitor indication.

* (c) Record the results of the modulation alarm point checks. The readings are to be recorded on FAA Form 6750-32. The entries can be made in either the remarks column or can be added using the additional empty column.

(d) Restore the carrier modulation to normal. *

(5) Rf level alarms.

(a) Reduce the carrier power until the monitor is in rf low-level alarm. Measure and record the carrier power. Determine if the carrier power is within the operating tolerance in chapter 3.

(b) For those systems that monitor high power (e.g., the Mark 20) increase the carrier power until the monitor is in rf high-level alarm. Measure and record the carrier power.

SECTION 1. PERFORMANCE CHECK PROCEDURES (Continued)

SUBSECTION 1. LOCALIZERS (Continued)

Determine if the carrier power is within the operating tolerance in chapter 3. Note that no tolerance is established for high RF level alarm.

(c) Restore the carrier rf power to normal.

(6) **Dual frequency systems.** For dual frequency localizers, repeat the above applicable procedures for the clearance equipment.

(7) **Identification alarms.**

(a) If the facility is equipped with identification tone monitoring, continue with the following steps. Otherwise, omit this check.

(b) Using the 1020 Hz identification keying switch or a MDT, set the identification tone to CONSTANT. Confirm that an identification alarm occurs.

(c) Set the 1020 Hz identification to OFF using the keying switch or the MDT. Confirm that an identification alarm occurs.

(d) Restore the 1020 Hz identification tone to normal.

(8) **Far-field monitor alarms.** This procedure must be performed during periods of low activity to avoid reflections that can cause inaccurate results. This procedure requires a person at the localizer and at the far-field monitor.

(a) Connect the PIR or an MDT, and setup to read modulation equality of the radiated signal. Note the DDM reading for reference.

(b) Adjust the modulation balance in one direction until all far-field monitors are in alarm.

(c) Calculate the difference in DDM between the reference DDM and the DDM in alarm. Determine if the difference is within the operating tolerance of paragraph 3-20f.

(d) Repeat steps (b) and (c) adjusting the modulation balance in the opposite direction.

(e) Adjust the modulation balance to the reference reading obtained in step (a).

(f) Momentarily disconnect the antenna from each far-field monitor receiver. Confirm that the far-field monitor alarms.

(g) Return the equipment to normal.

5-14. 90 AND 150 HZ MODULATION PERCENTAGES.

a. Object. This procedure provides a method to determine the amplitude modulation percentages of the 90 and 150 Hz navigational tones.

b. Discussion.

(1) The FA-9438 modulation meter (or equivalent) is the primary standard for the measurement of modulation percentage. Other equivalent pieces of test equipment could include a portable ILS receiver (PIR) capable of measuring modulation directly or built-in test equipment (BITE). These may be substituted for the FA-9438 when properly calibrated and/or verified for accuracy. The oscilloscope method is a backup method that uses the detected composite carrier envelope for determining the approximate percentage. The oscilloscope reference values should be noted when flight inspection or FA-9348 modulation meter have been used to measure modulation.

(2) If flight inspection reports the modulation out of tolerance, reconfirm your measurement. If the measurement is within the FA-9438 or BITE that has been verified with the FA-9438, before adjusting the transmitter modulation percentage to meet flight inspection tolerances, advise flight inspection personnel of your situation. If possible, ask them to verify their system calibration and check for radio-frequency interference (rfi). Factors that may cause a difference in modulation percentage readings are:

(a) Excessive carrier component distortion.

(b) FA-9438 calibration correction factor or front panel calibration.

SECTION 1. PERFORMANCE CHECK PROCEDURES (Continued)

SUBSECTION 1. LOCALIZERS (Continued)

(c) BITE malfunction. With standby equipment, a quick check might be made by transferring to the standby to check for the same indication.

(d) Transmitter output spectrum and frequency and the 90 and 150 Hz frequencies.

(e) Stray rf pickup by the cable connecting the FA-9438 to the rf wattmeter body coupler may cause erroneous or inconsistent readings. Double-shielded coaxial cable, such as RG-223/U will minimize stray rf pickup by the cable.

c. Test Equipment Required.

(1) The FA-9438 modulation meter (or equivalent) and associated rf wattmeter body coupler.

(2) BITE/MDT.

(3) Oscilloscope, if the alternate procedure is used.

d. Conditions. The facility is operating normally.

e. Procedures. Refer to Instruction Book TI 6750.141, Installation, Operation, and Maintenance Instructions for Meter, ILS Modulation, Type FA-9438, section 3, for complete front panel calibration and operational instructions. The following steps are a digest of those instructions. Steps (1) through (5) are the front panel calibration steps. The alternate procedure (paragraph g) uses the oscilloscope to determine the approximate modulation percentage.

(1) Turn the FA-9438 ac power switch ON and allow a 10-minute warmup.

(2) Place the function selector switch to RF ZERO, and adjust the RF ZERO control for 00.0 on the PERCENT MODULATION indication.

(3) Place the function selector switch to DISPLAY ZERO, and adjust the DISPLAY_ZERO control for 00.0 on the PERCENT MODULATION indicator.

(4) Place the function selector switch to CAL 150 Hz, and adjust the CAL 150 Hz control for 42.5 on the PERCENT MODULATION indicator.

(5) Place the function selector switch to CAL 90 Hz, and adjust the CAL 90 Hz control for 42.5 on the PERCENT MODULATION INDICATOR.

NOTE: It may be necessary to repeat steps (2) through (5) occasionally as the FA-9438 warms up.

(6) Insert the FA-9438 wattmeter coupler into the carrier feedline wattmeter body and rotate the coupler for maximum pickup. *

(7) Use a double-shielded coaxial cable and connect the coupler to the RF INPUT jack of the modulation meter. *

(8) Place the function selector switch to LOCALIZER or GLIDE SLOPE, as appropriate, and read the 90 Hz and 150 Hz modulation percentages on the PERCENT MODULATION indicator.

(9) Record the percentages on FAA Form 6750-32, and determine if they are in tolerance.

(10) At two-frequency facilities, complete the steps above for the clearance transmitter on a different FAA Form 6750-32.

(11) Restore the equipment to normal.

f. BITE/MDT Procedure. Refer to the facility technical instruction book, section 3, for operation of the BITE/MDT.

(1) Proceed to the transmitter data screen of the selected transmitter and record the percentages on FAA Form 6750-32 and determine if they are in tolerance.

(2) At two-frequency facilities, complete the steps above for the clearance transmitter on a separate FAA Form 6750-32.

(3) For facilities with standby equipment, bring the standby equipment up and complete steps (1) and (2) and record on separate FAA Form(s) 6750.32.

SECTION 1. PERFORMANCE CHECK PROCEDURES (Continued)

SUBSECTION 1. LOCALIZERS (Continued)

g. Alternate Procedure. This procedure is not as accurate as the above procedure and shall be used only as a standby procedure.

(1) Set the oscilloscope vertical amplifiers for dc operation and verify that the dc balance is correct. The baseline will not move when the vertical gain is varied.

(2) Connect the detected signal jack on the carrier feedline rf body to the vertical input of the oscilloscope.

(3) Insert the wattmeter element into the rf body as if to read forward power.

(4) Adjust the sweep and sync (or trigger) controls for a stable display of the composite waveform.

(5) Disconnect the signal to the oscilloscope and position the sweep along the bottom horizontal graticule.

(6) Reconnect the signal to the oscilloscope and adjust the vertical gain until the peak of the large audio lobe is displayed tangent to the top horizontal graticule (E_{max}).

(7) Repeat steps (5) and (6) as necessary.

(8) Determine the number of E_{min} and E_{max} divisions and compute the 90 Hz plus 150 Hz composite modulation percentage:

$$\% \text{mod} = \frac{E_{max} - E_{min}}{E_{max} + E_{min}} \ x \ .54$$

(9) Record the percentages on FAA Form 6750-32 and determine if they are within tolerance.

(10) Restore the equipment to normal operation.

5-15. IDENTIFICATION TONE MODULATION PERCENTAGE.

a. Object. This procedure provides various methods to determine the modulation percentage of the localizer identification tone.

b. Discussion.

(1) Built-in test equipment (BITE) measurement of the identification tone modulation is the preferred method when available and its calibration has been verified.

(2) Other methods rely on the fact that the amplitude of the 1020 Hz audio signal detected from the carrier feedline is proportional to the percent of carrier modulation. The detected audio contains 90 and 150 Hz components with amplitudes proportional to the 90 and 150 Hz modulation percentages. By comparing the relative amplitudes of the 1020 Hz with the 90 and 150 Hz components, the relative identification modulation percentage can be determined.

c. Test Equipment Required.

(1) BITE/MDT.

(2) Audio wave analyzer with wattmeter element and suitable audio cable for connection to an rf body.

(3) A digital voltmeter (dvm).

d. Conditions. Use of the BITE/MDT requires only the hook up of the MDT. If the audio analyzer is used, permission shall be obtained from air traffic personnel to briefly interrupt the identification keying. When using the digital voltmeter method, a facility shutdown is required.

e. BITE/MDT Detailed Procedure. Refer to the facility technical instruction book, section 3, for operation of the BITE/MDT.

(1) Proceed to the transmitter data screen of the selected transmitter and record the percentages on FAA Form 6750-32 and determine if they are in tolerance.

(2) At two-frequency facilities, complete the step above for the clearance transmitter on a separate FAA Form 6750-32.

SECTION 1. PERFORMANCE CHECK PROCEDURES (Continued)

SUBSECTION 1. LOCALIZERS (Continued)

d. Conditions. A facility shutdown is required for both far-field and in-line checks.

e. Far-Field Quadrature Phasing, Detailed Procedure.

(1) Dummy-load the sideband output. At two-frequency localizers, disable the clearance system.

(2) Position the PIR at the established far-field phasing point, and note the reference DDM reading. The far-field phasing point shall be established per paragraph 5-173.

(3) Remove the dummy load and insert the 90° phasing section in the sideband feedline.

(4) Adjust the sideband phaser until the reference DDM is obtained at the phasing point.

(5) Remove the 90° phasing section and reconnect the sideband feedline.

(6) At two-frequency localizers, restore the clearance system to normal and disable the course system. Dummy-load the clearance system sideband output, and repeat steps (2) through (5).

(7) Restore the facility to service.

f. In-Line Phasing, Detailed Procedure.

(1) Connect the PIR to the signal sampler. If a V-ring hang-on probe is used, it should be attached to one of the two outermost antennas. The same antenna should be used for all subsequent checks.

(2) Dummy-load the sideband output. At two-frequency localizers, disable the clearance system.

(3) Note the reference DDM reading on the PIR.

(4) Remove the dummy load and restore the sideband energy. Note the initial phaser setting.

(5) Adjust the sideband phaser for reference DDM. The difference between the phaser settings should be less than ±10°.

(6) At two-frequency localizers, restore the clearance system to normal and disable the course system. Dummy-load the clearance system sideband output, and repeat steps (2) through (5).

(7) Restore the facility to service.

5-17. MONITOR PHASING AND AMPLITUDE.

a. Object. This procedure provides a method to determine the monitor carrier to sideband-only phase and amplitude relationship and to correct, if necessary.

b. Discussion. To ensure that the monitor will properly sense system dephasing and sideband amplitude changes, the monitor phasing and amplitude adjustment should be near optimum. This procedure measures the monitoring system sideband phase and amplitude, not the radiated signal sideband and amplitude. Before this measurement, the localizer system phasing and course width must be adjusted to optimum.

c. Test Equipment Required.

(1) A portable ILS receiver (PIR).

(2) BITE/MDT.

(3) The facility 90° phasing section.

d. Conditions. A facility shutdown is required for this check.

e. Detailed Procedure.

(1) Ensure that the localizer course width and phasing are adjusted to optimum in accordance with paragraphs 5-16 and 5-171.

(2) Dummy load the transmitter sideband-only (SBO) output port and the SBO feedline input. With the PIR or MDT, take a reference DDM reading at the width monitor input from the monitor recombining network, or with the MDT take a width reading. The reference reading should be near 0 DDM.

SECTION 1. PERFORMANCE CHECK PROCEDURES (Continued)

SUBSECTION 1. LOCALIZERS (Continued)

(3) Remove the dummy load and insert the 90° section in the sideband feedline. Restore the sideband energy and note the DDM reading now obtained.

(4) For systems other than the Mark 20, note the position of the integral monitor phaser and then adjust the phaser to the reference value obtained in step (2). * For the Mark 20 localizer, a length of cable was installed instead of an adjustable phaser. *

(5) For systems other than the Mark 20, the difference between the original phaser position and the new position is the error that existed before this procedure was accomplished. This error should be within the operating tolerance listed in chapter 3. For the Mark 20 localizer, note the difference between the reference DDM in step (2) and the value obtain in step (3). Compare this to the operating tolerance listed in chapter 3. If out of operating tolerance, cable A2W49, SBO IN to SBO OUT, on the monitor recombiner unit must be changed or recut. In this case, the phasing must be brought to within initial tolerance.

(6) Remove the 90° section and restore the sideband energy to the sideband feedline.

(7) If required, adjust the width level attenuator in the monitor recombining network to the established DDM level. A typical value is 0.155 DDM.

(8) Restore the facility to service.

5-18. AUDIO AND RF FREQUENCIES.

a. Object. This procedure provides a method to measure the ILS facility audio and carrier frequencies.

b. Discussion. The operating frequencies of an ILS facility must remain within specified limits of the authorized values. The rf body installed in the carrier or an antenna feedline is a convenient point to obtain a sample for the rf measurement. The navigational audio frequencies are essential for establishing the course and width, while the identification tone is a necessary indication of facility availability and identification. Navigation audio signals may be sampled via an rf wattmeter body with a suitable element installed, or an equipment test point(s) depending on the facility type.

c. Test Equipment Required.

(1) A frequency counter with 0.0001 percent (1 part per million (ppm)) or better accuracy.

(2) An rf wattmeter body coupler.

(3) An optional wave analyzer.

d. Conditions. For sampled measurements, i.e., those taken without disturbing the radiated signal, the facility may remain in operation. For measurements taken where a frequency must be removed or switched to continuous, the facility must be removed from service.

e. Detailed Procedure. For the following test connections consult the applicable TI for an appropriate test point or jack, or use an rf wattmeter body and element. For the Mark 20 Localizer/Glide Slope, a convenient point is located on the AC/DC Switch Module Assembly 1A2/1A4.

(1) Measure the modulation frequencies (90, 150, 1020 Hz, etc.) using an equipment test point, jack, or detected output from an rf wattmeter body. If no jack is provided on the equipment which accesses the 90 and 150 Hz tones individually, they may be measured by using a wave analyzer to separate the 90 and 150 Hz tones. The input of the wave analyzer is connected to the audio output of the carrier rf body with an appropriate size element inserted.

(a) Connect the frequency counter to the output of the wave analyzer. Adjust the wave analyzer first to 90 and then to 150 Hz and read the navigational tone frequencies on the counter.

(b) The 1020 Hz or any other identification tone frequency may be measured directly at the oscillator or by using the wave analyzer with the keyer set for constant tone.

(2) Measure the rf frequency of the transmitter(s) by * connecting the counter to an rf wattmeter body coupler. The * transmitter must be operating for at least 15 minutes before measuring rf frequency. The audio modulation may have to be removed to obtain a constant counter readout.

(3) Record the results obtained in steps (1) and (2) on the appropriate form. If any frequency or the frequency separation at two-frequency facilities is out of tolerance, corrective action shall be taken.

(4) If the rf frequency is adjustable, the transmitter should be adjusted as close to the authorized frequency as

SECTION 1. PERFORMANCE CHECK PROCEDURES (Continued)

SUBSECTION 1. LOCALIZERS (Continued)

possible, and shall be adjusted to within the initial tolerances specified in chapter 3. Following rf frequency adjustment, the final measurement should be performed at least 5 minutes after the last adjustment is made. This is to allow the oscillator sufficient time to settle to its final operating frequency.

5-19. AUDIO PHASING.

a. Object. This procedure provides a method to determine that the audio phase relationship between the 90 Hz and 150 Hz modulation tones of the course and clearance transmitters are in phase. *

b. Discussion. The audio phase relationship between the course and clearance signals must be in phase to ensure that these signals always add to and not subtract from each other. This is true for both localizers and glide slopes. When an aircraft is in transition between a predominance of signal from the course, and clearance transmitter, these signals may be approximately equal. When this occurs, a false course or path could be produced if the audio phasing is out of phase. Navigation audio signals may be sampled via an rf wattmeter only with a suitable element installed, or an equipment test point(s) depending on the facility type.

c. Test Equipment Required.

(1) An oscilloscope with an accurately calibrated time base.

(2) An rf wattmeter body with suitable wattmeter element.

d. Conditions. For sampled measurements, i.e., those taken without disturbing the radiated signal, the facility may remain in operation. For measurements taken where a frequency is removed or switched to continuous the facility must be removed from service.

e. Detailed Procedure.

NOTE: For the following test connections consult the applicable TI for an appropriate test point or jack, or use an wattmeter body and element. For the Mark 20 Localizer/Glide Slope, a convenient point is located on the AC/DC Switch Module Assemble 1A2/1A4.

(1) Connect the oscilloscope Y INPUT to observe the course (or path) transmitter 150 Hz output.

(2) Connect the oscilloscope TRIGGERING INPUT to the course (or path) transmitter 150 Hz output, or an external scope sync output..

(3) Adjust the triggering so that the waveform crosses the zero axis at the center of the oscilloscope display.

(4) Connect the oscilloscope Y INPUT to observe the clearance transmitter 150 Hz output. DO NOT ADJUST ANY CONTROLS.

(5) Confirm that the positive and negative peaks are in the same position on the oscilloscope as the course transmitter.

(6) Measure the time (in microseconds) between the center of the oscilloscope and the scope trace.

(7) Confirm that the time measured is within the operating tolerance of chapter 3.

(8) Restore the equipment to normal operation.

5-20. SHUTDOWN AND FAR-FIELD MONITOR TIME DELAYS.

a. Object. This procedure provides a method to determine the times of the shutdown and far-field monitor (FFM) time delays.

b. Discussion. The time that a facility is permitted to radiate outside monitor alarm limits must be short. This is to protect aircraft in the final stages of approach from prolonged exposure to possible signal error. The different time delays are defined below.

(1) Shutdown delay. This delay is the total time a facility is allowed to radiate with a continuous monitor alarm. For dual equipment, this delay includes the transfers from main to standby to shutdown except at GRN-29 facilities. At GRN-29 facilities, this is the time for the main equipment to shut down without a transfer after a monitor alarm.

(2) Far-field monitor delay. This time delay applies to localizers that have a far-field monitor(s) and

SECTION 1. PERFORMANCE CHECK PROCEDURES (Continued)

SUBSECTION 1. LOCALIZERS (Continued)

is the total time between the initiation of a continuous far-field monitor alarm and a localizer shutdown or to CAT I downgrade. This time delay is relatively long, as the far-field monitor experiences numerous momentary alarms due to multipath from taxiing and overflying aircraft.

c. Test Equipment Required. A device suitable for measuring elapsed time. For Mark 20; the PMDT.

NOTE: Mark 20 facilities: The transfer and shutdown timing test have been included in the localizer/glide slope test menu..

d. Conditions. A facility shutdown is required for this check.

e. Detailed Procedure.

(1) Shutdown delay (non-Mark 20 system).

(a) Initiate a continuous monitor alarm and measure the time between initiation of the alarm condition(s) and localizer shutdown.

(b) Compare this measurement with the standard and tolerance contained in paragraph 3-21, and correct, if necessary. Record shutdown delay on the appropriate form.

(c) Return facility to service.

(2) Shutdown delay (Mark 20 system).

(a) Connect the Mark 20 PMDT serial communications cable to the equipment serial communications port. Set the PMDT power switch to ON and log onto the equipment.

(b) From the commands menu proceed to the "Tests" menu and perform the "Shutdown time test" (i.e., from the "Commands" menu; execute the following sequence of keys <T H>. The total shutdown time (including transfer for dual equipment) will be displayed via a pop-up shutdown/transfer test screen; labeled "Shutdown time:"

(c) Compare this measurement with the standard and tolerance contained in paragraph 3-21 and correct, if necessary. Record the shutdown or downgrade delay on the appropriate form.

(d) Log off the equipment, set the PMDT power switch to OFF and disconnect the PMDT serial communications cable from the equipment. Return the facility to service.

(3) Far-field monitor delay. Initiate a continuous alarm at the far-field monitor(s). This may be accomplished by removing one of the navigation tones at the localizer, or by causing an alarm at the far-field monitor itself.

NOTE: Mark 20 facilities: Due to the difficulty of performing this check at Mark 20 facilities, the far-field monitor delay measurement will not be performed at this time. Procedures for this check are being evaluated for inclusion into this handbook at a later date.

(a) Measure the time between initiation of the alarm condition(s) and localizer shutdown. If the system contains more than one timer for far-field monitor shutdown delay, the tolerance applies only to the total delay and not to any individual timers.

(b) Measure the time between the initial start of the far-field monitor status unit (FA-10039) countdown and the aural alarm.

(c) Confirm that the times measured are within the operating tolerances of chapter 3.

(d) Restore the facility to service operations.

5-21. AUTOMATIC RESTART AND RESET (SINGLE * AND COLD STANDBY EQUIPMENT). *

a. Object. This procedure provides a method of determining if the automatic restart and reset circuits function properly and are within the established limits.

b. Discussion. The function of the auto-restart is to * attempt to return a single-equipment or a cold standby, * dual-equipment facility to service shortly after it has shut down due to an alarm condition. If the auto-restart is successful and the equipment remains in service for a predetermined length of time, the auto-reset function will clear the auto-restart circuit and restore it to normal operation. When an alarm occurs, a short delay takes place before the facility shuts down. This delay is called the shutdown delay. The equipment will remain off the air until a longer delay, called the auto-restart delay, occurs. After the auto-restart delay, the equipment will attempt to return itself to service. If the alarm still

SECTION 1. PERFORMANCE CHECK PROCEDURES (Continued)

SUBSECTION 1. LOCALIZERS (Continued)

persists, a number of other restart attempts with varying auto-restart delay times may occur depending on the equipment type. If the equipment restarts and remains in service for a predetermined period of time, an auto-reset circuit resets the auto-restart function to its normal status. If all auto-restart attempts are exhausted and the equipment does not stay in service, the restart/reset circuits must be manually reset at the facility.

c. Test Equipment Required. A device suitable for measuring elapsed time.

d. Conditions. A facility shutdown is required for this check.

e. Detailed Procedure.

(1) Initiate a monitor alarm and allow the equipment to shut down.

(2) Measure the time elapsed between shutdown and the time when the automatic restart attempts to return the facility to service. Record the time on the appropriate form. Determine if the auto-restart time is within the established limits.

(3) Repeat steps (1) and (2) for each available auto-restart. Determine if the auto-restart time(s) is within the established limits, and record the shortest time on the appropriate form.

(4) After the final auto-restart attempt, ascertain that if the alarm is still present the equipment shuts down and a manual reset is required to restart it. *

(5) Initiate a monitor alarm and allow the equipment to shut down. Remove the alarm condition and allow the auto-restart to return the equipment to service. If the equipment has auto-reset capabilities, ascertain that the auto-reset circuits are reset after an elapsed time of 4.5 minutes or greater, measured from the time the alarm was initiated. For specific times refer to the equipment instruction book.

(6) Restore the facility to service.

5-22. SIDEBAND NULL.

a. Object. This procedure provides a method to determine the position of the sideband null relative to course centerline.

b. Discussion. The location of the sideband null and its coincidence with the course centerline affords optimum structure of the localizer course. A null in the sideband radiation pattern occurs when sideband energy from one-half of the localizer array is received concurrently with an equal amount of opposite phased energy from the other half. If an amplitude inequality occurs between the two halves, the resulting energy difference converts the former null into a sideband intensity minimum. Altering the 180° sideband phase relationship between the two halves shifts the null (or minimum) toward the side with the greater delay (lagging phase). Reflections also modify the null depth and position. Rotating the array moves the null position degree for degree.

c. Test Equipment Required.

(1) A portable ILS receiver (PIR).

(2) An audio meter.

(3) A directional antenna, such as a Yagi designed for localizer frequencies, is highly recommended.

d. Conditions. A facility shutdown is required for this check.

e. Detailed Procedure.

(1) Feed a maximum of 5 watts carrier, modulated by a continuous 1020 Hz tone, into the sideband input to the antenna array. *

(2) Position the PIR on the course centerline. The distance to the array should be as far as possible while still maintaining a sharp null indication. A directional antenna should be used with the PIR if available.

(3) Locate the rf null as indicated by minimum audio or rf level from the PIR.

(4) Measure the null displacement from the course (centerline).

SECTION 1. PERFORMANCE CHECK PROCEDURES (Continued)

SUBSECTION 1. LOCALIZERS (Continued)

(5) Using English units: Divide the measured displacement in inches by the distance to the array in 1000's of feet. For example: the sideband null is measured 1500 feet from the array and found at 17 inches from course centerline.

$$\frac{17\text{ inches}}{1.5} = 11.33\text{ inches per 1000 feet}$$

OR;

Using metric units: Divide the measured displacement in centimeters by the distance to the array in 300's of meters. For example: the sideband null is measured 450 meters from the array and found at 45 centimeters from course centerline.

$$\frac{45\text{ cm}}{1.5} = 30\text{ centimeters per 300 meters}$$

(6) Record the results of step (5) on FAA Form 6750-22. If the results are not within tolerance, take appropriate action.

(7) To determine if site effects are compromising the measurement, repeat steps (1) through (5) at alternate distances.

(8) Restore the facility to service.

5-23. thru 5-39. RESERVED.

SECTION 1. PERFORMANCE CHECK PROCEDURES (Continued

SUBSECTION 2. GLIDE SLOPES

5-40. LINE ENTRY OF NORMAL READINGS.

a. Object. This procedure provides a method to complete a line entry of the normal parameters on FAA Form 6750-26, with the equipment in normal configuration.

b. Discussion. A line entry of the glide slope normal parameters is required after equipment transfer, before a normal end-fire glide slope ground check, and periodically as required in chapter 4. This check is made without adjustment to the equipment and can be performed from a remote maintenance monitor (RMM). Computer generated data reports may be used in lieu of FAA forms.

c. Test Equipment Required.

(1) A portable ILS receiver (PIR).

(2) A dvm (optional).

(3) The facility rf wattmeter and/or built-in test equipment (BITE).

NOTE: Chapter 1, Paragraph 1-2b, Test Equipment, discusses external test equipment and BITE, and their proper use in the NAS. Particular attention must be paid to the proper use and maintenance of test equipment to ensure accurate evaluations of equipment operation. For instance, when using a BIRD wattmeter for power measurements, the same set of rf bodies, wattmeter, and elements must be utilized due to the variability of the wattmeter components. For BITE, proper calibration and verification of measurements are required.

d. Conditions. The facility is operating normally. For facilities that are equipped with standby equipment, switch standby equipment on-line to take readings.

e. Detailed Procedure. At the local site or RMM location, perform the following steps.

(1) Measure and record the normal carrier power and clearance power (if applicable) on FAA Form 6750-26. Confirm that the power(s) are within the established reference value. If not within tolerance, corrective action is required.

(2) Measure and record the normal sideband power and carrier feedline DDM (modulation equality) on FAA * Form 6750-26. Glide slope modulation equality should always be 0 DDM. Refer to paragraph 5-62b(4) and 5-62c(2)(a)3 for EFGS. *

(3) Measure and record the monitor width DDM, the monitor course DDM, if applicable on FAA Form 6750-26. Note that no tolerance is established for these entries. They are used only to detect trends and for troubleshooting.

* (4) To obtain a computer generated data report of normal readings for the Mark 20 ILS; log onto the facility to be recorded, check that the transmitter to be recorded is "On Antenna"; from the "Commands" menu depress the key sequence <D E O> for transmitter one; or <D E T> for transmitter two. Hot keys Alt F5 or Alt F6 may also be used. The report may be printed by depressing the "Print Screen" key and then selecting "P" for print. If desired the report may also be saved to disk by depressing the "D" key. *

* (5) At all dual equipment facilities complete a normal line entry for each set of equipment. *

5-41. LOCAL AND REMOTE MONITOR SHUTDOWN OPERATION.

a. Object. This procedure provides a method to determine that a shutdown is properly sensed at the local and/or remote control points.

b. Discussion. Certain alarms in the ILS equipment shall result in an equipment transfer and/or shutdown. Also, if remotely monitored, an indication that the facility is shut down shall be received at the remote monitor location. This check confirms that the shutdown occurs and that the remote control point is properly notified. This check can also be initiated and monitored from a remote maintenance monitor (RMM) location.

SECTION 1. PERFORMANCE CHECK PROCEDURES (Continued)

SUBSECTION 2. GLIDE SLOPES (Continued)

* **c. Conditions.** A facility shutdown is required for this check. *

d. Detailed Procedure.

(1) Simulate a continuous alarm, or from the RMM perform a station integrity check.

(2) Allow a shutdown to occur.

(3) Determine that the proper remote and local alarm indications occurred.

(4) If remote restore capability is installed, restore the facility from the remote control point or allow the auto-restart circuit to restore the facility.

(5) Make an entry in the facility log that this check was completed.

5-42. END-FIRE GROUND CHECK.

a. Object. This procedure provides a method to check the path angle of the transverse structure.

b. Discussion. The rf phase relationship between the front and rear course antenna determines the glide slope path angle. By inserting a known phase delay in the front antenna feedline, the path angle can be lowered to ground level. This is accomplished with a switch on the end-fire interface unit. The DDM at ground level is checked at various locations in the glide slope transverse structure with the path normal and snapped down. The location of the ground check points is defined in paragraph 5-197.

c. Test Equipment Required. A portable ILS receiver (PIR).

d. Conditions. A facility shutdown is required for this check.

e. Detailed Procedure.

(1) With the facility normal, complete a line entry on FAA Form 6750-26.

(2) With the facility normal (at each ground check point), measure the DDM with the PIR and record the value on FAA Form 6750-30.

(3) Place the mode switch on the end-fire interface unit to the DOWN position.

(4) At ground check points 1, 2, and 3, measure the DDM with the PIR, and record the value on FAA Form 6750-30.

(5) Confirm that the values measured in steps (2) and (4) are within the established reference values. If not within tolerance, corrective action is required.

(6) Return the mode switch to the OPERATE position.

(7) Restore the facility to service.

5-43. NULL-REFERENCE MONITOR.

a. Object. This procedure provides a method to determine whether the glide slope monitor alarm points are within the reference values established during a flight inspection that established reference values.

b. Discussion.

(1) The glide slope monitor is used to ensure the integrity of the glide slope system by permitting the glide slope to operate only if certain system parameters are within the limits established during the reference flight inspection. This performance check is accomplished by adjusting the transmitting equipment to cause a monitor alarm and then verifying that the radiated parameters are within established reference values. If a radiated parameter is found outside the established reference values, it must be determined if the condition is due to monitor drift. If so, the monitor alarm points must be tightened to ensure that for day-to-day monitor drift, the monitor will alarm whenever the radiated signal parameters are at or beyond the established reference values.

* **(2)** The reference data must be measured very carefully. Power measurements must always be accomplished with the same meter and elements. The elements shall be clearly marked. In addition to the rf wattmeter readings, it is recommended that a digital voltmeter (dvm) be used to obtain reference readings for carrier and sideband power in normal, wide, and narrow alarm. These reference readings *

SECTION 1. PERFORMANCE CHECK PROCEDURES (Continued

SUBSECTION 2. GLIDE SLOPES (Continued)

can be made with greater repeatability by using the dvm than by using the analog wattmeter. This is done by connecting a dvm, set to measure dc voltage, to the detector element output in place of the normal meter. Improved consistency * in dvm readings will result if the dvm input is shunted with a 1400-Ω ±1 percent resistor. This resistor presents the same load to the detector elements as the normal analog meter. If the reference readings are made with the load resistor in place, all future measurements must be made in this configuration. *

* (3) The monitor DDM values are the monitor input values measured with the PIR or monitor digital readout values. No tolerance exists for the DDM values. They are used to detect trends such as system or monitor drift. *

* (4) This performance check requires a line entry on FAA Form 6750-27. The reference data line contains the reference data used to perform a monitor performance check. The reference data line can be updated only in accordance with paragraph 5-62. *

c. Test Equipment Required.

(1) A portable ILS receiver (PIR).

(2) An rf wattmeter.

(3) A dvm (optional).

(4) The FA-9438 modulation meter or equivalent.

d. Conditions. A facility shutdown is required for this check.

e. Detailed Procedure.

(1) Preliminary actions.

(a) Refer to FAA Form 6750-27 for the reference values specified during the monitor performance check.

(b) Verify that modulation is 40 percent for each tone. If required, adjust carrier power to the reference value as established on FAA Form 6750-26. The carrier power must be correct because the width (and width alarm) is a function of the carrier/sideband ratio. The facility and monitor combining network (if applicable) must be properly phased.

(c) Connect the PIR to the carrier rf body, and ensure that modulation equality (0 DDM) exists.

(2) Width alarms.

(a) Reduce the sideband power until the monitor width channel is in wide alarm. Record the sideband power on FAA Form 6750-27.

(b) Confirm that the sideband power is not less than the established reference value. If not within tolerance, corrective action is required.

(c) Measure and record the width monitor DDM on FAA Form 6750-27. Note that no tolerance is established on this entry. It is used only to detect trends.

(d) Raise the sideband power until the monitor width channel is in narrow alarm. Record the sideband power on FAA Form 6750-27.

(e) Confirm that the sideband power is not more than the established reference value. If not within tolerance, take corrective action.

(f) Measure and record the width monitor DDM on FAA Form 6750-27. Note that no tolerance is established on this entry. The entry is used only to detect trends.

(g) Return the sideband power to normal.

(3) Path angle alarms (integral). For monitors with parallel path channels, perform steps (a) thru (d) for both channels.

(a) Connect the PIR to measure DDM in the carrier feedline.

(b) Adjust the modulation balance control until the integral monitor path channel is in high path angle alarm (150 > 90 Hz). Measure and record the carrier rf body and monitor DDM values on FAA Form 6750-27. Determine if the rf body DDM is within the operating tolerances in chapter 3. If the carrier DDM is out of tolerance, corrective action is required. Compare the monitor input DDM to previous readings. Note that no tolerance is established for this entry. The entry is used only to detect trends.

(c) Repeat step (b) for the modulation balance control adjusted for 90 > 150 Hz.

(d) Adjust the modulation balance control for 0 DDM.

SECTION 1. PERFORMANCE CHECK PROCEDURES (Continued)

SUBSECTION 2. GLIDE SLOPES (Continued)

(4) **SBO dephasing alarms.**

(a) Note the position of the main sideband (SBO) phaser.

(b) Advance the main (SBO) phaser until the * monitor width channel alarms. A preferred alternate method is to add a predetermined line length (type N or BNC elbows, or equivalent) to the carrier feedline. Determine if * the phaser change is within established reference values. Record the change in degrees on FAA Form 6750-27.

(c) Repeat the procedure in step (b) with the SBO phaser retarded.

(d) Return the main (SBO) phaser to the normal position noted in step (a).

(5) **Modulation level alarms.**

(a) Reduce the composite carrier modulation (90 + 150 Hz) until the monitor is in low modulation percent alarm. Measure the carrier modulation, using the modulation meter. Confirm that the modulation percentages are not below the operating tolerance in chapter 3.

* (b) Record the results of the modulation alarm point checks. The readings are to be recorded on FAA Form 6750-32. The entries can be made in either the remarks column or can be added using the additional empty column. *

(c) Restore the carrier modulation to normal.

(6) **Rf level alarms.**

(a) Reduce the carrier power until the monitor is in rf low-level alarm. Measure and record the carrier power. Determine if the carrier power is within the operating tolerance in chapter 3. Note that no tolerance is established for high rf level alarm.

(b) Restore the carrier rf power to normal.

5-44. SIDEBAND-REFERENCE MONITOR.

a. Object. This procedure provides a method to determine whether the glide slope monitor alarm points are within the reference values established during the reference flight inspection.

b. Discussion.

(1) The glide slope monitor is used to ensure the integrity of the glide slope system by permitting the glide slope to operate only if certain system parameters are within the limits established during the reference flight inspection. This performance check is accomplished by adjusting the transmitting equipment to cause a monitor alarm and then verifying that the radiated parameters are within established reference values. If a radiated parameter is found outside the established reference values, it must be determined if the condition is due to monitor drift. If so, the monitor alarm points must be tightened to ensure that for day-to-day monitor drift, the monitor will alarm whenever the radiated signal parameters are at or beyond the established reference values.

(2) The reference data must be measured very carefully. Power measurements must always be accomplished with the same meter and elements. The elements shall be clearly marked. In addition to the rf wattmeter readings, it is recommended that a digital voltmeter (dvm) be used to obtain reference readings for carrier and sideband power in normal, wide, and narrow alarm. These reference readings can be made with greater repeatability by using the dvm than by using the analog wattmeter. This is done by connecting a dvm, set to measure dc voltage, to the detector element output in place of the normal meter. Improved consistency in dvm readings will result if the dvm input is shunted with a 1400-Ω ±1 percent resistor. This resistor presents the same load to the detector elements as the normal analog meter. If the reference readings are made with the load resistor in place, all future measurements must be made in this configuration.

SECTION 1. PERFORMANCE CHECK PROCEDURES (Continued

SUBSECTION 2. GLIDE SLOPES (Continued)

(3) The monitor DDM values are the monitor input values measured with the PIR or monitor digital readout values. No tolerance exists for the DDM values. They are used to detect trends such as system or monitor drift.

(4) This performance check requires a line entry on FAA Form 6750-28. The reference data line contains the reference data used to perform a monitor performance check. The nominal data line can only be updated in accordance * with paragraph 5-62. *

c. Test Equipment Required.

(1) A portable ILS receiver (PIR).

(2) An rf wattmeter.

(3) A dvm (optional).

(4) The FA-9438 modulation meter or equivalent.

d. Conditions. A facility shutdown is required for this check.

e. Detailed Procedure.

(1) Preliminary actions.

(a) Refer to FAA Forms 6750-28 for the reference values specified during the monitor performance check.

(b) Verify that modulation is 40 percent for each tone. If required, adjust carrier power to the reference value as established on FAA Form 6750-26. The carrier power must be correct because the width (and width alarm) is a function of the carrier/sideband ratio. The facility and monitor combining network (if applicable) must be properly phased.

(c) Connect the PIR to the carrier rf body and ensure that modulation equality (0 DDM) exists.

(2) Width alarms.

(a) Reduce the sideband power until the monitor width channel is in wide alarm. Record the sideband power on FAA Form 6750-28.

(b) Confirm that the sideband-to-carrier power ratio is not less than the established reference value. If not within tolerance, corrective action is required.

(c) Measure and record the width monitor DDM on FAA Form 6750-28. Note that no tolerance is established on this entry. It is used only to detect trends.

(d) Raise the sideband power until the monitor width channel is in narrow alarm. Record the sideband power on FAA Form 6750-28.

(e) Confirm that the sideband power is not more than the established reference value. If not within tolerance, corrective action is required.

(f) Measure and record the width monitor DDM on FAA Form 6750-28. Note that no tolerance is established on this entry. It is used only to detect trends.

(g) Return the sideband power to normal.

(3) Path angle alarms.

(a) Adjust the power divider on the amplitude and phase control unit (APCU) until the integral monitor path channel alarms (upper antenna power increases).

(b) Measure and record the upper antenna power in the angle high integral column on FAA Form 6750-28. Confirm that upper antenna power is not more than the established reference value. If not within tolerance, corrective action is required.

(c) Measure and record the integral path monitor DDM in the angle high integral column on FAA Form 6750-28. Note that no tolerance is established on this entry. It is used only to detect trends.

(d) Repeat the steps of this check with the APCU power divider adjusted for low angle alarm (upper antenna power decreases).

(e) Return the APCU power divider to normal. * Refer to paragraph 5-125 for a procedure on adjusting the sideband power between upper and lower antennas. *

SECTION 1. PERFORMANCE CHECK PROCEDURES (Continued)

SUBSECTION 2. GLIDE SLOPES (Continued)

* **(4) SBO dephasing alarms. (Optional)**

(a) Note the position of the main sideband (SBO) phaser.

(b) Advance the main SBO phaser until the monitor width channel alarms. A preferred alternate method is to add a predetermined line length (type N or BNC elbows, or equivalent) to the carrier feedline. Determine if the phaser change is within established reference values. Record the change in degrees in the main SBO dephasing column on FAA Form 6750-28. *

(c) Repeat the above step with the SBO phaser retarded.

(d) Return the main (SBO) phaser to the normal position noted in step (a).

(5) Upper antenna dephasing alarms.

* (a) Advance the APCU upper antenna phaser until a monitor alarm occurs. A preferred alternate method is to add a predetermined line length (type N or BNC elbows, or equivalent) to the lower antenna feedline.

(b) Record the change in degrees in the upper antenna dephasing column on FAA Form 6750-28. Confirm that the value is within established reference value. If not within tolerance, corrective action is required.

(c) Repeat the steps of this check with the upper antenna phaser retarded. A preferred alternate method is to add a predetermined line length (type N or BNC elbows, or equivalent) to the upper antenna feedline.

(d) Restore the upper antenna phaser to normal.

(6) Modulation level alarms.

(a) Reduce the composite carrier modulation (90 + 150 Hz) until the monitor is in low modulation percent alarm. Measure the carrier modulation using the modulation meter. Confirm that the modulation percentages are not below the operating tolerance in chapter 3.

(b) Record the results of the modulation alarm point checks. The readings are to be recorded on FAA Form * 6750-32. The entries can be made in either the remarks column or can be added using the additional empty column.

(c) Restore the carrier modulation to normal. *

(7) Rf level alarms.

(a) Reduce the carrier power until the monitor is in rf low level alarm. Measure and record the carrier power. Determine that the carrier power is within the operating tolerance in chapter 3. Note that no tolerance is established for high rf level alarm.

(b) Restore the carrier rf power to normal.

(8) Restore the facility to service.

5-45. CAPTURE-EFFECT MONITOR.

a. Object. This procedure provides a method to determine whether the glide slope monitor alarm points are within the reference values established during the reference flight inspection.

b. Discussion.

(1) The glide slope monitor is used to ensure the integrity of the glide slope system by permitting the glide slope to operate only if certain system parameters are within the limits established during the reference flight inspection. This performance check is accomplished by adjusting the transmitting equipment to cause a monitor alarm and then verifying that the radiated parameters are within established reference values. If a radiated parameter is found outside the established reference values, it must be determined if the condition is due to monitor drift. If so, the monitor alarm points must be tightened to ensure that for day-to-day monitor drift, the monitor will alarm whenever the radiated signal parameters are at or beyond the established reference values.

(2) The reference data must be measured carefully. Rf power measurements using the Bird Wattmeter must always be accomplished with the same meter and elements. The elements shall be clearly marked. In addition to the rf wattmeter readings, it is recommended that a digital voltmeter (dvm) be used to obtain reference readings for carrier and sideband power in normal, wide, and narrow alarm. These reference readings can be made with greater repeatability by using the dvm than by using the analog

SECTION 1. PERFORMANCE CHECK PROCEDURES (Continued

SUBSECTION 2. GLIDE SLOPES (Continued)

wattmeter. This is done by connecting a dvm, set to measure dc voltage, to the detector element output in place of the normal meter. Improved consistency in dvm readings will result if the dvm input is shunted with a 1400-Ω ±1 percent resistor. This resistor presents the same load to the detector elements as the normal analog meter. If the reference readings are made with the load resistor in place, all future measurements must be made in this configuration.

(3) Measurements taken with built in test equipment (BITE) (i.e., power, DDM, modulation, etc.) must be verified for accuracy with external test equipment as outlined in this handbook. This is to ensure that repeatable results are obtained and maintained in the case of internal equipment failure and/or replacement of modules that effect BITE measurements.

(4) For equipment with pre and hard alarms, in all cases where a procedure instructs an adjustment to a monitor alarm, reference is to the hard alarm.

(5) For equipment that uses a maintenance data terminal (MDT), when adjusting the phase of a signal, the number of degrees adjusted may need to be determined from a reference index number. This may be accomplished via a table or conversion chart, usually found in the equipment TI. For this reason, the alternate methods described in the procedures (i.e., the addition and removal of line lengths, elbows, etc.) is recommended.

(6) The monitor DDM values are the monitor input values as measured with a PIR or the digital readout values of the monitor or as measured with BITE/MDT. No tolerance is established for the DDM values. They are used to detect trends such as system or monitor drift.

(7) This performance check requires a line entry on FAA Form 6750-29. The reference data line contains the reference data used to perform a monitor performance check. The reference data line can only be updated in * accordance with paragraph 5-62. *

c. Test Equipment Required.

(1) A portable ILS receiver (PIR).

(2) BITE/MDT

(3) Rf wattmeter.

(4) A dvm (optional).

(5) The FA-9438 modulation meter or equivalent.

d. Conditions. A facility shutdown is required for this check.

e. Detailed Procedure.

(1) Preliminary actions.

(a) Refer to FAA Form 6750-29 for the reference values specified during the monitor performance check.

(b) Verify that modulation is 40 percent for each tone. If required, adjust carrier power to the reference value as established on FAA Form 6750-26. The carrier power must be correct because the width (and width alarm) is a function of the carrier/sideband ratio. The facility and monitor combining network (if applicable) must be properly phased.

(c) Set up the PIR, BITE/MDT, or equivalent to measure DDM in the carrier feedline and ensure that modulation equality (0 DDM) exists.

(d) Bypass the equipment monitor(s).

(2) Width alarms.

(a) Reduce the sideband power until the monitor width channel is in wide alarm. Record the sideband power on FAA Form 6750-29.

(b) Confirm that the sideband power is not less than the established reference value. If not within tolerance, corrective action is required.

(c) Measure and record the width monitor DDM on FAA Form 6750-29. Note that no tolerance is established on this entry. It is used only to detect trends.

SECTION 1. PERFORMANCE CHECK PROCEDURES (Continued)

SUBSECTION 2. GLIDE SLOPES (Continued)

(d) Raise the sideband power until the monitor width channel is in narrow alarm. Record the sideband power on FAA Form 6750-29.

(e) Confirm that the sideband power is not more than the established reference value. If not within tolerance, corrective action is required.

(f) Measure and record the width monitor DDM on FAA Form 6750-29. Note that no tolerance is established on this entry. It is used only to detect trends.

(g) Return the sideband power to normal.

(3) Path angle alarms (integral). For monitors with parallel path channels, perform steps (a) through (d) for both channels.

(a) Set up the PIR, BITE/MDT, or equivalent to measure DDM in the carrier feedline.

(b) Adjust the modulation balance until the integral monitor path channel is in high path angle alarm (150 > 90 Hz). Measure and record the carrier feedline and monitor DDM values on FAA Form 6750-29. Determine if the DDM is within the operating tolerances in chapter 3. If the carrier feedline DDM is out of tolerance, corrective action is required. Compare the monitor input DDM to previous readings. Note that no tolerance is established for this entry. It is used only to detect trends.

(c) Follow the procedure in step (b) for the modulation balance adjusted for 90 > 150 Hz.

(d) Readjust the modulation balance for 0 DDM.

* **(4) SBO dephasing alarms. (Optional)** *

(a) Note the position of the main sideband (SBO) phaser or the MDT SBO phase setting.

(b) Advance the main (SBO) phase or insert and adjust the test kit phaser until the monitor width channel alarms. A preferred alternate method is to add a predetermined line length (type N or BNC elbows, or equivalent) to the carrier feedline. Confirm that the phase change is within the operating tolerances in chapter 3. If not within tolerance, corrective action is required.

(c) Repeat the procedure in step (b) with the SBO phase retarded.

(d) Return the main (SBO) phase to the normal position noted in step (a) or remove the added line lengths.

(5) Middle antenna dephasing alarms.

(a) Advance the APCU middle antenna phase (or insert and adjust the test kit phaser in the middle antenna feedline) until the width monitor alarms. If the test kit phaser is used, it should be the same as used for the reference flight check that established the FAA Form 6750-29 values. Also, the test phaser should have been previously checked with a vector voltmeter to ensure accuracy. A preferred alternate method is to add the same predetermined line length (type N or BNC elbows, or equivalent) to both the lower and upper antenna outputs of the APCU.

(b) Record the change in degrees in the middle antenna dephasing column on FAA Form 6750-29. Confirm that the value is within established reference value. If not within tolerance, corrective action is required.

(c) Repeat the procedure in the above steps with the middle antenna phase retarded (the same line length added to the middle antenna output).

(d) Restore the middle antenna phase to normal, or remove the test phaser or lines.

(6) Attenuate upper antenna alarm.

(a) Insert the capture-effect test kit attenuator into the upper antenna feedline. This attenuator should have been previously checked with a vector voltmeter to ensure that the total insertion phase delay equals 360° ±5°. Also, the accuracy of the dial calibration of the attenuator should be verified. Refer to paragraph 5-155 for this procedure.

(b) Adjust the test attenuator until the path monitor alarms.

SECTION 1. PERFORMANCE CHECK PROCEDURES (Continued

SUBSECTION 2. GLIDE SLOPES (Continued)

(c) Record the attenuation value in the upper antenna attenuation column on FAA Form 6750-29. Confirm that the attenuation is less than, or equal to, the established reference value. If not within tolerance, corrective action is required.

(d) Remove the test attenuator from the upper antenna feedline.

(7) Attenuate middle antenna alarm.

(a) Insert the capture-effect test kit attenuator into the middle antenna feedline.

(b) Adjust the test attenuator until the width monitor alarms.

(c) Record the attenuation value in the middle antenna attenuation column on FAA Form 6750-29. Confirm that the attenuation is less than, or equal to, the established reference value. If not within tolerance, corrective action is required.

(d) Remove the test attenuator from the middle antenna feedline.

(8) Modulation level alarms.

(a) Reduce the carrier modulation until the monitor is in low modulation percent alarm. Measure the carrier modulation using BITE/MDT, the FA-9438 modulation meter, or equivalent. Confirm that the modulation percentages are not below the operating tolerance in chapter 3.

* (b) Record the results of the modulation alarm point checks. The readings are to be recorded on FAA Form 6750-32. The entries can be made in either the remarks column or can be added using the additional empty column. *

(c) Restore the carrier modulation to normal.

(9) Rf level alarms.

(a) Reduce the carrier power until the monitor is in rf low level alarm. Measure and record the carrier power. Determine whether the carrier power is within the operating * tolerance in chapter 3. Note that no tolerance is established for high rf level alarm. *

(b) Restore the carrier rf power to normal.

(10) Clearance transmitter. Repeat steps (8) and (9).

NOTE: The FA-9438 modulation meter may not accurately measure the high 150 Hz modulation percentage. In this case, use the alternate procedure explained in paragraph 5-47.

(11) Restore the facility to service.

5-46. END-FIRE MONITOR.

a. Object. This procedure provides a method to determine whether the glide slope monitor alarm points are within the reference values established during the reference flight inspection.

b. Discussion.

(1) The glide slope monitor is used to ensure the integrity of the glide slope system by permitting the glide slope to operate only if certain parameters are within the limits established during the reference flight inspection. This performance check is accomplished by adjusting the transmitting equipment to cause a monitor alarm and then verifying that the radiated parameters are within established reference values. If a radiated parameter is found outside reference values, it must be determined if the condition is due to monitor drift. If so, the monitor alarm points must be tightened to ensure that for day-to-day monitor drift, the

SECTION 1. PERFORMANCE CHECK PROCEDURES (Continued)

SUBSECTION 2. GLIDE SLOPES (Continued)

monitor will alarm whenever the radiated signal parameters are at or beyond the established reference values.

(2) The reference data must be measured very carefully. Power measurements must always be accomplished with the same meter and elements. The elements shall be clearly marked. In addition to the rf wattmeter readings, it is recommended that a digital voltmeter (dvm) be used to obtain reference readings for carrier and sideband power in normal, wide, and narrow alarm. These reference readings can be made with greater repeatability using the dvm than by using the analog wattmeter. This is done by connecting a dvm, set to measure dc voltage, to the detector element output in place of the normal meter. Improved consistency in dvm readings will result if the dvm input is shunted with a 1400 Ω percent resistor. This resistor presents the same load to the detector elements as the normal analog meter. If the reference readings are made with the load resistor in place, all future measurements must be made in this configuration.

(3) The monitor DDM values are the monitor input values measured with the dvm or monitor digital readout values. No tolerance exists for the DDM values. They are used to detect trends such as system or monitor drift.

(4) This performance check requires a line entry on FAA Form 6750-31. The reference data line contains the reference data used to perform a monitor performance check. The reference data line and reference ground check can only
* be updated in accordance with paragraph 5-62. *

c. Test Equipment Required.

(1) A portable ILS receiver (PIR).

(2) An rf wattmeter.

(3) A dvm (optional)

(4) The FA-9438 modulation meter or equivalent.

d. Conditions. A facility shutdown is required for this check.

e. Detailed Procedure.

(1) Preliminary actions.

(a) Refer to FAA Form 6750-31 for the reference values specified during the monitor performance check.

(b) Verify that modulation is 40 percent for each tone. If required, adjust carrier power to the reference value as established on FAA Form 6750-31. The carrier power must be correct because the width (and width alarm) is a function of the carrier/sideband ratio. The facility and monitor combining network (if applicable) must be properly phased.

(c) Connect the PIR to the carrier rf body, and ensure that modulation equality (0 DDM) exists. Refer to
* paragraphs 5-62b(4), and 5-62c(2)(a)3 for EFGS. *

(d) Disable autophaser (if present).

(2) Width alarms.

(a) Reduce the sideband power until the monitor width channel is in wide alarm. Record the sideband power on FAA Form 6750-31.

(b) Confirm that the sideband power is not less than the established reference value. If not within tolerance, corrective action is required.

(c) Measure and record the width monitor DDM on FAA Form 6750-31. Note that no tolerance is established on this entry. It is used only to detect trends.

(d) Raise the sideband power until the monitor width channel is in narrow alarm. Record the sideband power on FAA Form 6750-31.

(e) Confirm that the sideband power is not more than the established reference value. If not within tolerance, corrective action is required.

SECTION 1. PERFORMANCE CHECK PROCEDURES (Continued

SUBSECTION 2. GLIDE SLOPES (Continued)

(f) Measure and record the width monitor DDM on FAA Form 6750-31. Note that no tolerance is established on this entry. It is used only to detect trends.

(g) Return the sideband power to normal.

(3) Path angle alarm (integral path monitor).

(a) Disable autophaser (if present).

(b) Note the position of the rear course antenna phaser.

(c) Retard the rear course antenna phaser until the monitor integral path channel is in alarm. Measure and record the change in degrees and the monitor DDM values on FAA Form 6750-31. Confirm that the change in degrees does not exceed the established reference value. If not within tolerance, corrective action is required.

(d) Repeat the above step with the rear course antenna phaser advanced.

(e) Restore the rear course antenna phaser to normal position noted in step (a).

(f) Enable autophaser.

(4) Path angle alarm (field snap down).

(a) Disable autophaser (if present).

(b) Note the position of the rear course antenna phaser.

(c) Retard the rear course antenna phaser until the snap down monitor M2 is in alarm. Record the change in degrees in the angle high snap down column on FAA Form 6750-31. Confirm that the change in degrees does not exceed the established reference value. If not within tolerance, corrective action is required.

(d) Repeat the above step with the rear course antenna phaser advanced.

(e) Repeat steps (c) and (d) for snap down monitors M1 and M3.

(f) Restore the rear course antenna phaser to the normal position noted in step (b).

(g) Enable autophaser.

(5) SBO dephasing alarm.

(a) Note the position of the main sideband (SBO) phaser.

(b) Advance the main SBO phaser until the monitor near field path channel alarms. Measure and record the change in degrees in the SBO dephase column on FAA Form 6750-31. Confirm that the change in degrees is within the operating tolerances in chapter 3. If not within tolerance, corrective action is required.

(c) Repeat the above step with the SBO phaser retarded.

(d) Return the main SBO phaser to the normal position noted in step (a).

(6) Modulation level alarms.

(a) Reduce the carrier modulation until the monitor is in low modulation percent alarm. Measure the carrier modulation using the modulation meter. Confirm that the modulation percentage is not below the operating tolerance * in chapter 3.

(b) Record the results of the modulation alarm point checks. The readings are to be recorded on FAA Form 6750-32. The entries can be made in either the remarks column or can be added using the additional empty column.

(c) Restore the carrier modulation to normal. *

(7) Rf level alarms.

(a) Reduce the carrier power until the monitor is in rf low level alarm. Measure and record the carrier power. Determine whether the carrier power is within the operating tolerance in chapter 3. Note that no tolerance is established for high rf level alarm.

(b) Restore the carrier rf power to normal.

(8) Clearance transmitter. Repeat checks (6) and (7), above. The FA-9438 modulation meter may not accurately measure the high 150 Hz modulation

SECTION 1. PERFORMANCE CHECK PROCEDURES (Continued)

SUBSECTION 2. GLIDE SLOPES (Continued)

percentage. In this case, use the alternate procedure explained in paragraph 5-47g.

(9) Restore the facility to service.

5-47. 90 AND 150 Hz MODULATION PERCENTAGES.

a. Object. This procedure provides a method to determine the amplitude modulation percentages of the 90 and 150 Hz navigational tones.

b. Discussion.

(1) The FA-9438 modulation meter (or equivalent) is the primary standard for the measurement of modulation percentage. Other equivalent pieces of test equipment could include a portable ILS receiver (PIR) capable of measuring modulation directly or built-in test equipment (BITE). These may be substituted for the FA-9438 when properly calibrated and/or verified for accuracy. The oscilloscope method is a backup method that uses the detected composite carrier envelope for determining the approximate percentage. The oscilloscope reference values should be noted when flight inspection or FA-9348 modulation meter have been used to measure modulation.

(2) If flight inspection reports the modulation out of tolerance, reconfirm your measurement. If the measurement is within the FA-9438 or BITE that has been verified with the FA-9438, before adjusting the transmitter modulation percentage to meet flight inspection tolerances, advise flight inspection personnel of your situation. If possible, ask them to verify their system calibration and check for radio-frequency interference (rfi). Factors that may cause a difference in modulation percentage readings are:

(a) Excessive carrier component distortion.

(b) FA-9438 calibration correction factor or front panel calibration.

(c) BITE malfunction. With standby equipment, a quick check might be made by transferring to the standby to check for the same indication.

(d) Transmitter output spectrum and frequency and the 90 and 150 frequencies.

(e) Stray rf pickup by the cable connecting the FA-9438 to the rf wattmeter body coupler may cause erroneous or inconsistent readings. Double-shielded coaxial cable, such as RG-223/U will minimize stray rf pickup by the cable.

c. Test Equipment Required.

(1) The FA-9438 modulation meter (or equivalent) and associated rf wattmeter body coupler.

(2) BITE/MDT.

(3) Oscilloscope, if the alternate procedure is used.

d. Conditions. The facility is operating normally.

e. Procedures. Refer to Instruction Book TI 6750.141, Installation, Operation, and Maintenance Instructions for Meter, ILS Modulation, Type FA-9438, section 3, for complete front panel calibration and operational instructions. The following steps are a digest of those instructions. Steps (1) through (5) are the front panel calibration steps. The alternate procedure (paragraph g) uses the oscilloscope to determine the approximate modulation percentage.

(1) Turn the FA-9438 ac power switch ON and allow a 10 minute warmup.

(2) Place the function selector switch to RF ZERO, and adjust the RF ZERO control for 00.0 on the PERCENT MODULATION indication.

(3) Place the function selector switch to DISPLAY ZERO, and adjust the DISPLAY ZERO control for 00.0 on the PERCENT MODULATION indicator.

(4) Place the function selector switch to CAL 150 Hz, and adjust the CAL 150 Hz control for 42.5 on the PERCENT MODULATION indicator.

(5) Place the function selector switch to CAL 90 Hz, and adjust the CAL 90 Hz control for 42.5 on the PERCENT MODULATION INDICATOR.

NOTE: It may be necessary to repeat steps (2) through (5) occasionally as the FA-9438 warms up.

SECTION 1. PERFORMANCE CHECK PROCEDURES (Continued

SUBSECTION 2. GLIDE SLOPES (Continued)

(3) Confirm that the modulation balance is 0 DDM. Correct to 0 DDM if necessary.

(4) Reconnect the sideband input to the APCU through the facility quadrature line section.

(5) Note the position of the integral monitor phaser. Adjust the phaser for a 0 DDM reading on the PIR.

(6) The difference between the original phaser position and the new position is the error that existed before this procedure was accomplished. This error should be within the operating tolerance listed in chapter 3.

(7) Remove the quadrature line section from the sideband line.

(8) If the DDM is substantially different, adjust the integral monitor attenuator to increase or decrease the DDM reading. Repeat steps (4) through (7) to correct any phase changes caused by changing the attenuator setting.

(9) Using the main sideband phaser, dephase the main sidebands in one direction to alarm. Fixed line lengths may be used in lieu of adjusting the main sideband phaser as described in paragraph 6-35e. Note the change from the normal phaser setting. Dephase the main sidebands in the other direction, again noting the change from the normal setting. If the monitor does not alarm with symmetrical (equal) dephasing of the main sideband phase the monitor combining unit phase that was adjusted in step (5) will require refining to provide symmetrical dephasing to alarm. If this situation occurs, the station 90° line section should be checked.

(10) Restore the facility to service.

5-50. SIDEBAND REFERENCE SYSTEM PHASING.

a. Object. This procedure provides a method to ground-phase the system such that the correct carrier, CSB, and sideband-only (SBO) phase relationships are distributed to the antennas, and to properly phase the antennas to each other.

b. Discussion. Rf phasing of the sideband reference glide slope affects both path width and path angle. Advancing or retarding the SBO signals of a properly phased sideband reference system with the main sideband phaser will symmetrically broaden the path width. Likewise, advancing or retarding the upper antenna phaser will symmetrically broaden the path width and lower the glide angle. Significant changes in ground phasing require investigation and corrective action.

c. Test Equipment Required.

(1) A portable ILS receiver (PIR).

(2) A glide slope antenna.

* **(3)** Dummy loads. *

(4) A quadrature (90°) line section.

(5) Two-way communications.

d. Conditions. A facility shutdown is required for this check. A ground-phasing reference point must have been previously established in accordance with paragraph 5-191. The SBO power distribution must be correct in accordance
* with paragraph 5-125. *

e. Detailed Procedure.

(1) Lower antenna (CSB + SBO) phasing.

(a) Disconnect and dummy load the sideband input of the amplitude and phase control unit (APCU). Also dummy-load the sideband output of the transmitter.

(b) Connect the PIR to the lower antenna wattmeter detector output. Confirm that modulation equality is 0 DDM. Correct to 0 DDM if necessary.

(c) Add the facility quadrature line section to the sideband input line removed in step (a) and reconnect it to the APCU.

SECTION 1. PERFORMANCE CHECK PROCEDURES (Continued)

SUBSECTION 2. GLIDE SLOPES (Continued)

(d) Adjust the main SBO phaser for 0 DDM in the lower antenna feedline.

(e) Remove the 90° section, and verify that there is a predominance of 90 Hz in the lower antenna feedline.

(2) Upper to lower antenna phasing.

(a) Insert the facility quadrature line section in the APCU sideband input line.

(b) Note the upper antenna phaser setting.

(c) Position the PIR at the ground-phasing point established in accordance with paragraph 5-191.

(d) Adjust the upper antenna phaser for the reference DDM reading obtained when the ground-phasing point was established. Note that this may be a non-zero DDM value.

(e) The difference between the old and new phaser setting is the phase error that existed before this procedure was accomplished.

(f) Restore the facility to service. At the ground-phasing point, verify a predominance of 150 Hz.

(g) Refer to paragraph 5-51 and check the * integral monitoring network phasing if the upper antenna * phaser required adjustment.

5-51. SIDEBAND REFERENCE MONITOR COMBINING NETWORK.

a. Object. This procedure provides a method to determine whether the sideband-reference glide slope monitor combining network is properly adjusted.

b. Discussion. The rf signals are sampled from upper and lower antenna monitor pickups. Rf phase and amplitude adjustments provide an rf phase (path) output and an rf amplitude (width) output either directly to the monitor or through an rf detector to the monitor. Readjustment of system rf phasing or APCU power to optimum requires readjustment to the monitor combining network. The monitor combining network should not be adjusted until the sideband-reference glide slope rf phasing and APCU powers are determined at optimum.

c. Test Equipment Required. A portable ILS receiver (PIR).

d. Conditions. Interruption to facility monitoring is required for this procedure.

e. Detailed Procedure.

(1) Place the monitor bypass switch in BYPASS.

(2) Confirm that the modulation balance is 0 DDM. Correct to 0 DDM if necessary.

(3) Disconnect the cable from the hybrid path output, and connect the PIR to the hybrid path output.

(4) If the PIR is not indicating 0 DDM, note the phaser setting and adjust the phaser for 0 DDM indication on the PIR. Verify that the rf phase difference of the phaser setting is within established tolerance.

(5) If the glide slope system rf phasing and powers have been optimized, leave the monitor combining network phaser adjusted for 0 DDM. If the system has not been optimized, return the phaser to the setting noted in step (4).

(6) Disconnect the PIR cable from the hybrid path output and reconnect the cable removed in step (3).

(7) Disconnect the cable from the hybrid width output, and connect the PIR to the hybrid width output. The PIR should indicate a predominate 150 Hz signal of approximately 0.240 DDM. Changes in this value from monitor reference readings require investigation of system rf power ratios and rf phasing.

(8) Remove the PIR cable from the hybrid width output, and reconnect the cable disconnected in step (7).

(9) If adjustments were made to the monitor combining network, readjust the monitor as required before unbypassing the monitor and returning the system to service.

SECTION 1. PERFORMANCE CHECK PROCEDURES (Continued

SUBSECTION 2. GLIDE SLOPES (Continued)

5-52. CAPTURE-EFFECT SYSTEM PHASING.

a. Object. This procedure provides a method to ground phase the system such that the correct carrier and sideband-only phase relationships are distributed between the three antennas, and to correctly phase the antennas to each other.

b. Discussion. System phasing affects path angle, path width, path symmetry, and below path clearances. A ground phasing point must be established in the far field in accordance with paragraph 5-191. The desired phase relationships are:

(1) The carrier sidebands (CSB's) in the lower antenna are 180° out of phase with CSB in the middle antenna.

(2) The sidebands only (SBO) in the lower antenna are 180° out of phase with the SBO in the middle antenna.

(3) The SBO's in the upper antenna are 180° out of phase with the SBO in the middle antenna.

(4) The 90 Hz SBO signal in the middle antenna is in phase with the 90 Hz CSB signal in the middle antenna, and 90 Hz predominates.

(5) The 90 Hz SBO signal in the lower antenna is in phase with the 90 Hz CSB signal in the lower antenna, and 90 Hz predominates.

(6) The clearance signal in the upper antenna is in phase with the clearance signal in the lower antenna.

* **NOTE:** If significant changes to the system are being made, such as replacing antennas or antenna cables, it is recommended that the rf method of phasing given in the latest edition of Order 6750.54, Installation Instructions for Instrument Landing System (ILS) Facilities, paragraphs 319 and 322, be used initially so that gross errors may be avoided. *

c. Test Equipment Required.

(1) A portable ILS receiver (PIR).

(2) A glide slope antenna.

(3) Dummy loads.

(4) A quadrature (90°) line section.

(5) Two-way communications.

d. Conditions. A facility shutdown is required for this check.

e. Detailed Procedure.

(1) **Method #1.**

(a) Middle antenna CSB/SBO phasing.

1 Turn off (or disconnect and dummy load) the clearance transmitter and the clearance input port of the APCU.

2 Disconnect and dummy load the APCU sideband input cable and the APCU sideband input port.

3 Connect the PIR to the middle antenna thruline body, and confirm that the modulation equality is 0 DDM. Correct if necessary.

4 Connect the facility quadrature line section to the main sideband line, and reconnect it to the APCU. With the PIR connected to the middle antenna thruline body, adjust the main sideband phaser for 0 DDM.

(b) Lower antenna CSB/SBO phasing.

* **NOTE:** Perform steps 1 and 2 only if the APCU has a lower antenna CSB/SBO phaser. *

1 Connect the PIR to the lower antenna thruline body.

2 Adjust the lower antenna APCU CSB/SBO phaser until the PIR reads 0 DDM.

SECTION 1. PERFORMANCE CHECK PROCEDURES (Continued)

SUBSECTION 2. GLIDE SLOPES (Continued)

3 Remove the quadrature line section, reconnect the sideband line, and check for proper sensing (90 Hz predominate) in the lower and middle antenna thruline bodies.

* (c) Upper/middle antenna phasing.

NOTE: The middle antenna phaser (if installed) should not be adjusted. Even though the lower antenna is the theoretical phase reference of a capture-effect glide slope, the middle antenna is treated as a reference in phasing procedures because of the middle antenna dephasing check performed on some flight inspections.

1 Replace all wattmeter elements.

2 Disconnect and dummy load the APCU lower antenna output and the lower antenna feedline.

3 Reinsert the quadrature line section in the APCU sideband input line.

4 Take the PIR to the established far-field phasing point. Observe the DDM scale, and adjust the upper antenna phaser for the reference DDM value obtained when phasing references were established. This value should be recorded on the appropriate FAA Forms 6030-16, Technical Reference Data Record Cover/ Transmittal Sheet, and 6030-17, Technical Reference Data Record. (See the latest edition of Order 6030.45, Facility Reference Data File.)

5 The difference between the phaser's original setting and the new phaser setting is the error that existed before this procedure was performed. Significant changes in ground phasing should be investigated.

(d) Lower/upper antenna phasing.

1 Remove the dummy load from the APCU lower antenna output and reconnect the lower antenna.

2 Disconnect and dummy load the middle antenna feedline and the APCU middle antenna output.

3 At the established far-field phasing point, observe the DDM scale, and adjust the lower antenna phaser for the reference DDM value that was obtained when phasing references were established. This value should be recorded on the appropriate Facility Reference * * Data Record (see Order 6030.45, Facility Reference Data File).

4 The difference between the phaser's original setting and the new phaser setting is the error that existed before this procedure was performed. Significant changes should be investigated.

5 Restore clearance energy.

6 Restore the facility to service.

7 Refer to paragraph 5-53, and check the integral width monitoring network phasing if the facility phasing was changed.

(e) Changing the DDM reference.

1 The reference values of DDM given in steps (c)4 and (d)3 are values that have been carefully established. They are values that were measured after completing a glide slope flight inspection that determined proper far-field phasing. These reference values should seldom change after they are established.

2 If it is necessary to establish new references for a facility, they shall not be changed until a flight inspection, that includes all the periodic with-monitors checks, has been completed. When the middle antenna phase is advanced and retarded, the facility must be found to be in an in-tolerance condition. The reference values can then be measured and recorded on facility reference data records per Order 6030.45 and included in the facility records after the flight inspection has been completed.

(2) Method #2. *

(a) Middle antenna CSB/SBO phasing.

1 Turn off (or disconnect and dummy load) the clearance transmitter and the clearance input port of the APCU.

2 Disconnect and dummy load the APCU sideband input cable and the APCU sideband input port.

3 Connect the PIR to the middle antenna thruline body, and confirm that the modulation equality is 0 DDM. Correct if necessary.

SECTION 1. PERFORMANCE CHECK PROCEDURES (Continued

SUBSECTION 2. GLIDE SLOPES (Continued)

4 Connect the facility quadrature line section to the main sideband line, and reconnect it to the APCU. With the PIR connected to the middle antenna thruline body, adjust the main sideband phaser for 0 DDM.

(b) Lower antenna CSB/SBO phasing.

NOTE: Perform steps 1 and 2 only if the APCU has a lower antenna CSB/SBO phaser.

1 Connect the PIR to the lower antenna thruline body.

2 Adjust the lower antenna APCU CSB/SBO phaser until the PIR reads 0 DDM.

3 Remove the quadrature line section, reconnect the sideband line, and check for proper sensing (90 Hz predominate) in the lower and middle antenna thruline bodies.

(c) Lower/middle antenna phasing. *

NOTE: The middle antenna phaser (if installed) should not be adjusted. Even though the lower antenna is the theoretical phase reference of a capture-effect glide slope, the middle antenna is treated as a reference in phasing procedures because of the middle antenna dephasing check performed on some flight inspections.

* 1 Configure the APCU so that CSB is transmitted out the lower antenna only.

2 Configure the APCU so that SBO is transmitted to the middle and upper antennas only.

3 Disconnect and dummy load the upper antenna feedline and the APCU upper antenna output.

4 Reinsert the quadrature line section in the APCU sideband input line.

5 At the established far-field phasing point, adjust the lower antenna phaser for the reference DDM value obtained when phasing references were established. This value should be recorded on the appropriate Facility Reference Data Record. (See the latest edition of Order 6030.45, Facility Reference Data File). The difference * between the phaser's original setting and the new phaser setting, is the error that existed before this procedure was performed. Significant changes in ground phasing should be investigated.

6 Remove the quadrature line section, reconnect the sideband line, and check for proper sensing in far-field (150 Hz predominate). *

(d) Lower/upper antenna phasing.

* 1 Disconnect and dummy load the middle antenna feedline and the APCU middle antenna output.

2 Remove the dummy load from the APCU upper antenna output and reconnect the upper antenna.

3 Reinsert the quadrature line section in the APCU sideband input line.

4 At the established far-field phasing point, adjust the upper antenna phaser for the reference DDM value obtained when phasing references were established. This value should be recorded on the appropriate Facility Reference Data Record. (See the latest edition of Order 6030.45, Facility Reference Data File). The difference between the phaser's original setting and the new phaser setting, is the error that existed before this procedure was performed. Significant changes in ground phasing should be investigated.

5 Remove the quadrature line section, reconnect the sideband line, and check for proper sensing in far-field (90 Hz predominate).

6 Remove the dummy load from the APCU middle antenna output and reconnect the middle antenna.

7 Restore clearance energy and check for proper sensing in far-field (150 Hz predominate).

8 Restore the facility to service.

9 Refer to paragraph 5-53, and check the integral width monitoring network phasing if the facility phasing was changed. *

(e) Changing the DDM reference.

SECTION 1. PERFORMANCE CHECK PROCEDURES (Continued)

SUBSECTION 2. GLIDE SLOPES (Continued)

1 The reference values of DDM given in steps (c)4 and (d)3 are values that have been carefully established. They are values that were measured after completing a glide slope flight inspection that determined proper far-field phasing. These reference values should seldom change after they are established.

2 If it is necessary to establish new references for a facility, they shall not be changed until a flight inspection, that includes all the periodic with-monitors checks, has been completed. When the middle antenna phase is advanced and retarded, the facility must be found to be in an in-tolerance condition. The reference values can then be measured and recorded on facility reference data records per Order 6030.45 and included in the facility records after the flight inspection has been completed.

* **(3) Method #3.** If signal strength is inadequate for this procedure, use method #2.

(a) Middle antenna CSB/SBO phasing.

1 Turn off (or disconnect and dummy load) the clearance transmitter and the clearance input port of the APCU.

2 Disconnect and dummy load the APCU upper antenna output, the APCU sideband input cable, and the APCU sideband input port.

3 Connect the PIR to the middle antenna thruline body, and confirm that the modulation equality is 0 DDM. Correct if necessary.

4 Connect the facility quadrature line section to the main sideband line, and reconnect it to the APCU. With the PIR connected to the middle antenna thruline body, adjust the main sideband phaser for 0 DDM.

(b) Lower antenna CSB/SBO phasing.

NOTE: Disregard steps 1 and 2 if a carrier-sideband phaser is not installed.

1 Connect the PIR to the lower antenna thruline body. *

* 2 Adjust the lower antenna APCU carrier-sideband phaser for the reference DDM value obtained in step (a)3.

3 Remove the quadrature line section, reconnect the sideband line, and check for proper sensing (90 Hz predominate) in the lower and middle antenna thruline bodies.

(c) Lower/middle antenna phasing.

1 Reinsert the quadrature line section in the APCU sideband input line.

2 Note the upper and lower antenna phaser settings.

3 At the established far-field phasing point, adjust the lower antenna phaser for the reference DDM value obtained when phasing references were established. This value should be recorded on the appropriate Facility Reference Data Record. (See the latest edition of Order 6030.45, Facility Reference Data File). The difference between the phaser's original setting and the new phaser setting, is the error that existed before this procedure was performed. Significant changes in ground phasing should be investigated.

NOTE: The middle antenna phaser (if installed) should not be adjusted, as it is the reference for the upper and lower antenna phaser settings.

(d) Upper/lower antenna phasing.

1 Remove the dummy load from the APCU upper antenna output and reconnect the upper antenna.

2 Disconnect and dummy load the middle antenna feedline and APCU middle antenna output.

3 At the established far-field phasing point, adjust the upper antenna phaser for the reference DDM reading when phasing references were established. This value should be recorded on the appropriate Facility Reference Data Record. (See the latest edition of Order 6030.45, Facility Reference Data File). The difference between the phaser's original setting and the new phaser setting is the error that existed before this procedure was performed. Significant changes in ground phasing should be investigated. *

SECTION 1. PERFORMANCE CHECK PROCEDURES (Continued

SUBSECTION 2. GLIDE SLOPES (Continued)

* 4 Remove the quadrature line section from the APCU input sideband line, and reconnect the middle antenna feedline.

5 Restore clearance energy.

6 Restore the facility to service.

7 Refer to paragraph 5-53, and check the integral width monitoring network phasing if the facility phasing was changed.

(e) Changing the DDM reference.

1 The reference values of DDM given in steps (c)3 and (d)3 are values that have been carefully established. They are values that were measured after completing a glide slope flight inspection that determined proper far-field phasing. These reference values should seldom change after they are established.

2 If it is necessary to establish new references for a facility, they shall not be changed until a flight inspection, that includes all the periodic with-monitors checks, has been completed. When the middle antenna phase is advanced and retarded, the facility must be found to be in an in-tolerance condition. The reference values can then be measured and recorded on facility reference data records per Order 6030.45 and included in the facility records after the flight inspection has been completed. *

5-53. CAPTURE-EFFECT INTEGRAL MONITOR.

a. Object. This procedure provides a method to determine whether the phase of the rf signals from the carrier and sideband antenna pickup loops are within prescribed tolerances at the monitor corner of the combining bridge.

b. Discussion. The rf signals from the integral width monitoring pickups must be in phase at the width monitor output of the combining bridge to provide symmetrical monitor alarm points when the facility is dephased in opposite directions. They must also be properly phased and of the correct amplitude for proper operation of the integral path monitor. Phasing at the combining bridge output should not change except for network deterioration. A change in glide slope phasing will require checking of the phase of the width monitor network.

c. Test Equipment Required.

(1) A portable ILS receiver (PIR).

* **(2)** Dummy loads. *

(3) A quadrature (90°) line section.

d. Conditions. The facility is properly phased. A shutdown is required for this check.

e. Detailed Procedure. Refer to the manufacturer's instruction book for specific procedures. The general procedure is detailed below.

(1) Disconnect and dummy load the main sideband output of the transmitter and the SBO input to the APCU.

(2) Connect the PIR to the width monitor detector or to the width monitor rf output of the recombining bridge.

(3) Confirm that the modulation balance is 0 DDM. Correct to 0 DDM if necessary.

(4) Reconnect the sideband input to the APCU through facility quadrature line section.

(5) Note the position of the monitor combining unit middle antenna phaser. Adjust the phaser for a 0 DDM reading on the PIR.

(6) The difference between the original phaser position and the new position is the phase error that existed before this procedure was accomplished. Ascertain that the phase error is within operating tolerance, and return the phaser to the position noted in step (5).

(7) Remove the quadrature line section from the sideband line.

(8) If the DDM is substantially different, adjust the attenuator in the lower antenna monitor line to increase or decrease the DDM reading. Repeat steps (4) through (7) to correct any phase changes caused by changing the attenuator setting.

(9) Restore the facility to service.

SECTION 1. PERFORMANCE CHECK PROCEDURES (Continued)

SUBSECTION 2. GLIDE SLOPES (Continued)

* **(10)** Check the clearance cancellation in accordance with paragraph 5-61. *

NOTE: Steps (11) through (18) apply only to facilities that have a pickup probe in the upper antenna.

(11) With the sideband output terminated into a dummy load, radiate only the modulated carrier.

(12) Connect the PIR to the output of the path monitor detector or to the path monitor rf output of the combining bridge.

(13) Obtain a reference (0 DDM) reading on the PIR.

(14) Reconnect the sideband output through a quadrature line section.

(15) Note the monitor combining unit upper antenna phaser position, and then adjust it for the reference value noted in step (13).

(16) Ascertain that the phase error is within operating tolerance for the capture-effect integral monitor width phasing.

(17) Return the monitor combining unit upper antenna to the position noted in step (15). Remove the quadrature line section and restore the equipment to normal.

(18) Restore the facility to service.

5-54. END-FIRE COURSE ARRAY SBO PHASING.

a. Object. This procedure provides a method to ground-phase the system to obtain the correct carrier to sideband-only phase relationship.

b. Discussion. Carrier, CSB, and sidebands, SBO, are fed in quadrature to both antennas of the course array. CSB to SBO phasing can be effectively performed on the ground by observing the DDM in the front course antenna feedline. Airborne phasing checks of CSB to SBO phase shall not be conducted on end-fire systems. The phasing of the course array should always be maintained in quadrature (0 DDM), as any value other than quadrature will derogate facility performance.

c. Test Equipment Required. A portable ILS receiver (PIR).

d. Conditions. The facility is operating normally.

e. Procedure.

(1) Note the position of the main SBO phaser.

* **(2)** Verify transmitter modulation balance. Refer to paragraphs 5-62b(4) and 5-62c(2)(a)3. *

(3) Disconnect quadrature detector from signal sampler in the front antenna, and connect PIR to the sampler output.

(4) Adjust main SBO phaser on the transmitter for 0 DDM.

(5) Confirm that the phaser change is within the operating tolerance in chapter 3.

(6) Return the main SBO phaser to the normal position noted in step (1).

(7) Restore the facility to service.

5-55. END-FIRE CLEARANCE ARRAY PHASING.

a. Object. This procedure provides a method to obtain the proper radiated rf phase between the two clearance array antennas.

b. Discussion. The end-fire array provides precision guidance in a relatively narrow sector either side of the runway centerline. The clearance array provides the user full scale fly-up outside this sector. To provide this, the two clearance antennas are fed equal power and are phased to provide minimum energy near runway centerline and two broad maxima at approximately ±20° from runway centerline.

c. Test Equipment Required. An oscilloscope.

d. Conditions. Facility operating normal.

e. Procedure.

SECTION 1. PERFORMANCE CHECK PROCEDURES (Continued

SUBSECTION 2. GLIDE SLOPES (Continued)

(1) Connect an oscilloscope to monitor the detected output of the snap-down monitor detector (midfield monitor) and note waveform of M2 during a scan. The waveform will be an audio (90/150 Hz) waveform with a higher frequency waveform superimposed on it. This higher frequency waveform is the beat frequency (approximately 8 kHz) between the course transmitter and the clearance transmitter.

(2) Note the position of the front clearance antenna phaser.

(3) While observing the oscilloscope, adjust the front clearance antenna phaser for minimum detected 8 kHz.

(4) Determine the amount of change, in degrees, from the normal phaser position noted in step (2). Compare this value with your facility reference data, as established by flight inspection, and note any difference. This difference (i.e., between the current measurement and the facility reference value) should be within the operating tolerance in chapter 3. If not within tolerance, corrective action is required.

(5) If an adjustment is made in step (4) the location of the clearance monitor antenna should be confirmed in accordance with paragraph 5-122.

(6) Return the clearance front clearance array phaser to the position noted in step (2).

(7) Restore the facility to service.

5-56. END-FIRE COURSE ARRAY MONITOR PHASING.

a. Object. This procedure provides a method to obtain the correct phase relationships between the front and rear course array integral monitor signals.

b. Discussion. A part of the energy fed to each antenna of the course array is not radiated and is available for monitoring the relative phase shifts of the signals passing through the antennas. Since the relative phase shift is directly related to the path angle, the unused energy provides an accurate means to monitor the glide slope angle. This monitor will not detect angle changes due to physical spacing, horizontal location, or physical obstructions in the array. The snap-down monitor will monitor these environmental affects.

c. Test Equipment Required.

(1) A portable ILS receiver (PIR).

(2) Two dummy loads.

d. Conditions. The facility operating normally.

e. Procedure.

* **(1)** Verify transmitter modulation balance. Refer to paragraphs 5-62b(4) and 5-62c(2)(a)3. *

(2) Verify that the CSB to SBO phasing is in accordance with paragraph 5-54.

(3) Verify that the rf power levels from the front and rear monitor feedlines are within the power ratio as listed in the standards and tolerances in chapter 3. This is accomplished by dummy loading one of the monitor feedlines and its associated monitor bridge input and noting the integral monitor rf level. Repeat this step for the other monitor feedline.

(4) Reconnect both feedlines to the course integral monitor bridge.

(5) Disconnect the course detector from the output of the monitor bridge and connect the PIR to the bridge.

(6) Note the position of the course monitor rear feedline phaser.

(7) Adjust the phaser in the rear course monitor feedline until the PIR reads the reference DDM and that the path rf level shows a maximum. Confirm that the change is within the operating tolerance in chapter 3.

(8) Return the course monitor rear feedline phaser to the position noted in step (6).

(9) Return the facility to service.

SECTION 1. PERFORMANCE CHECK PROCEDURES (Continued)

SUBSECTION 2. GLIDE SLOPES (Continued)

5-57. AUDIO AND RF FREQUENCIES.

a. Object. This procedure provides a method to measure the ILS facility audio and carrier frequencies.

b. Discussion. The operating frequencies of an ILS facility must remain within specified limits of the authorized values. The rf body installed in the carrier or an antenna feedline is a convenient point to obtain a sample for the rf measurement. The navigational audio frequencies are essential for establishing the course and width, while the identification tone is a necessary indication of facility availability and identification. Navigation audio signals may be sampled via an rf wattmeter body with a suitable element installed, or an equipment test point(s) depending on the facility type.

c. Test Equipment Required.

(1) A frequency counter with 0.0001 percent (1 part per million (ppm)) or better accuracy.

(2) An rf wattmeter body coupler.

(3) An optional wave analyzer.

d. Conditions. For sampled measurements, i.e., those taken without disturbing the radiated signal, the facility may remain in operation. For measurements taken where a frequency must be removed or switched to continuous, the facility must be removed from service.

e. Detailed Procedure. For the following test connections consult the applicable TI for an appropriate test point or jack, or use an rf wattmeter body and element. For the Mark 20 Localizer/Glide Slope, a convenient point is located on the AC/DC Switch Module Assemble 1A2/1A4.

(1) Measure the modulation frequencies (90, 150, 1020 Hz, etc.) using an equipment test point, jack, or detected output from an rf wattmeter body. If no jack is provided on the equipment which accesses the 90 and 150 Hz tones individually, they may be measured by using a wave analyzer to separate the 90 and 150 Hz tones. The input of the wave analyzer is connected to the audio output of the carrier rf body with an appropriate size element inserted.

(a) Connect the frequency counter to the output of the wave analyzer. Adjust the wave analyzer first to 90 Hz and then to 150 Hz and read the navigational tone frequencies on the counter.

(b) The 1020 Hz or any other identification tone frequency may be measured directly at the oscillator or by using the wave analyzer with the keyer set for constant tone.

(2) Measure the rf frequency of the transmitter(s) by connecting the counter to an rf wattmeter body coupler. If the only available rf wattmeter body happens to be in a glide slope antenna feedline, other signals may need to be turned off (i.e. an clearance transmitter) to obtain the measurement. The transmitter must be operating for at least 15 minutes before measuring rf frequency. The audio modulation may have to be removed to obtain a constant counter readout.

(3) Record the results obtained in steps (1) and (2) on the appropriate form. If any frequency or the frequency separation at two-frequency facilities is out of tolerance, corrective action shall be taken.

(4) If the rf frequency is adjustable, the transmitter should be adjusted as close to the authorized frequency as possible, and shall be adjusted to within the initial tolerances specified in chapter 3. Following rf frequency adjustment, the final measurement should be performed at least 5 minutes after the last adjustment is made. This is to allow the oscillator sufficient time to settle to its final operating frequency.

5-58. AUDIO PHASING.

a. Object. This procedure provides a method to determine that the audio phase relationship between the 150 Hz modulation tones of the path and clearance transmitters (for glide slope) or the 90 Hz and 150 Hz modulation tones of the course and clearance transmitters (for localizer) are in phase.

b. Discussion. The audio phase relationship between the course and clearance signals must be in phase to ensure that these signals always add to and not subtract from each other. This is true for both localizers and glide slopes. When an aircraft is in transition between a predominance of signal from the course, and clearance transmitter, these signals may be approximately equal. When this occurs, a false course or path could be produced if the audio phasing

SECTION 1. PERFORMANCE CHECK PROCEDURES (Continued

SUBSECTION 2. GLIDE SLOPES (Continued)

is out of phase. Navigation audio signals may be sampled via an rf wattmeter body with a suitable element installed, or an equipment test point(s) depending on the facility type.

c. Test Equipment Required.

(1) An oscilloscope with an accurately calibrated time base.

(2) An rf wattmeter body with suitable wattmeter element.

d. Conditions. For sampled measurements, i.e., those taken without disturbing the radiated signal, the facility may remain in operation. For measurements taken where a frequency is removed or switched to continuous the facility must be removed from service.

e. Detailed Procedure.

NOTE: For the following test connections consult the applicable TI for an appropriate test point or jack, or use an rf wattmeter body and element. For the Mark 20 Localizer/Glide Slope, a convenient point is located on the AC-DC Switch Module Assemble 1A2/1A4.

(1) Connect the oscilloscope Y INPUT to observe the course (or path) transmitter 150 Hz output.

(2) Connect the oscilloscope TRIGGERING INPUT to the course (or path) transmitter 150 Hz output or an external scope sync output.

(3) Adjust the triggering such that the waveform crosses the zero axis at the center of the oscilloscope display.

(4) Connect the oscilloscope Y INPUT to observe the clearance transmitter 150 Hz output. DO NOT ADJUST ANY CONTROLS.

(5) Confirm that the positive and negative peaks are in the same position on the oscilloscope as the course transmitter.

(6) Measure the time (in microseconds) between the center of the oscilloscope and the scope trace.

(7) Confirm that the time measured is within the operating tolerance of chapter 3.

(8) Restore the equipment to normal operation.

5-59. SHUTDOWN AND MONITOR TIME DELAY.

a. Object. This procedure provides a method to determine the time of the shutdown and monitor time delay.

b. Discussion. The time that a facility is permitted to radiate outside monitor alarm limits must be short. This is to protect aircraft in the final stages of approach from prolonged exposure to possible signal error. Shutdown delay is the total time a facility is allowed to radiate with a continuous monitor alarm. For dual equipment, this delay includes the transfers from main to standby to shutdown except at GRN-29 facilities. At GRN-29 facilities, this is the time for the main equipment to shut down without a transfer after a monitor alarm.

c. Test Equipment Required. A device suitable for measuring elapsed time. For Mark 20; the portable maintenance data terminal (PMDT).

NOTE: Mark 20 facilities: The transfer and shutdown timing test have been included in the Localizer/Glide Slope Test menu.

d. Conditions. A facility shutdown is required for this check.

e. Detailed Procedure.

(1) Shutdown delay (non-Mark 20 system).

(a) Initiate a continuous monitor alarm and measure the time required for the facility to shutdown. Record the shut down delay on the appropriate form.

(b) Compare this measurement with the standard and tolerance contained in paragraph 3-51 and correct, if necessary. Record shutdown delay on the appropriate form.

(c) Return facility to service.

(2) Shutdown delay (Mark 20 system).

(a) Connect the Mark 20 PMDT serial communications cable to the equipment serial communications port.

SECTION 1. PERFORMANCE CHECK PROCEDURES (Continued)

SUBSECTION 2. GLIDE SLOPES (Continued)

Set the PMDT power switch to ON and log onto the equipment.

(b) From the commands menu proceed to the "Tests" menu and perform the "Shutdown time test" (i.e., from the "Commands" menu; execute the following sequence of keys <T H>. The total shutdown time (including transfer for dual equipment) will be displayed via a pop-up shutdown/transfer test screen; labeled "Shutdown time".

(c) Compare this measurement with the standard and tolerance contained in paragraph 3-51 and correct, if necessary. Record the shutdown delay on the appropriate form.

(d) Log off the equipment, set the PMDT power switch to OFF and disconnect the PMDT serial communications cable from the equipment. Return the facility to service.

5-60. AUTOMATIC RESTART AND RESET (SINGLE * AND COLD STANDBY EQUIPMENT). *

a. Object. This procedure provides a method of determining if the automatic restart and reset circuits function properly and are within the established limits.

b. Discussion. The function of the auto-restart is to * attempt to return a single-equipment or a cold standby, dual- * equipment facility to service shortly after it has shut down due to an alarm condition. If the auto-restart is successful and the equipment remains in service for a predetermined length of time, the auto-reset function will clear the auto-restart circuit and restore it to normal operation. When an alarm occurs, a short delay takes place before the facility shuts down. This delay is called the shutdown delay. The equipment will remain off the air until a longer delay, called the auto-restart delay, occurs. After the auto-restart delay, the equipment will attempt to return itself to service. If the alarm still persists, a number of other restart attempts with varying auto-restart delay times may occur depending on the equipment type. If the equipment restarts and remains in service for a predetermined period of time, an auto-reset circuit resets the auto-restart function to its normal status. If all auto-restart attempts are exhausted and the equipment does not stay in service, the restart/reset circuits must be manually reset at the facility.

c. Test Equipment Required. A device suitable for measuring elapsed time.

d. Conditions. A facility shutdown is required for this check.

e. Detailed Procedure.

(1) Initiate a monitor alarm and allow the equipment to shut down.

(2) Measure the time elapsed between shutdown and the time when the automatic restart attempts to return the facility to service. Record the time on the appropriate form. Determine if the auto-restart time is within the established limits.

(3) Repeat steps (1) and (2) for each available auto-restart. Determine if the auto-restart time(s) is within the established limits, and record the shortest time on the appropriate form.

(4) After the final auto-restart attempt, ascertain that if the alarm is still present the equipment shuts down and a manual reset is required to restart it.

(5) Initiate a monitor alarm and allow the equipment to shut down. Remove the alarm condition and allow the auto-restart to return the equipment to service. If the equipment has auto-reset capabilities, ascertain that the auto-reset circuits are reset after an elapsed time of 4.5 minutes or greater, measured from the time the alarm was initiated. For specific times refer to the equipment instruction book.

(6) Restore the facility to service.

5-61. CAPTURE-EFFECT MONITOR CLEARANCE * CANCELLATION (GRN-29 EQUIPMENT). *

a. Object. This procedure provides a method to prevent the clearance signal in the lower antenna from entering the monitor width channel via the integral monitor network.

b. Discussion. Clearance 150 Hz, if allowed to enter the monitor width channel, could add to, or subtract from, the course system 150 Hz, thereby producing incorrect path width DDM indications. To prevent this, a clearance

SECTION 1. PERFORMANCE CHECK PROCEDURES (Continued

SUBSECTION 2. GLIDE SLOPES (Continued)

signal of equal amplitude and 180° out of phase to that of the lower antenna is taken from the APCU or upper antenna pickup probe and used to cancel the clearance from the lower antenna before it enters the monitor width channel.

c. Test Equipment Required. An oscilloscope.

d. Conditions. A facility shutdown is required for this check.

e. Detailed Procedure.

(1) Turn the clearance transmitter on and radiate all signals normal.

(2) Connect an oscilloscope to the monitor width (clearance) channel test jack, and observe the predominant 150 Hz signal.

(3) Adjust the clearance cancellation phase and amplitude for minimum 8 kHz. Lock the controls in position.

(4) With the monitor properly adjusted and both course and clearance transmitters energized, observe the 150 Hz indication on the monitor width meter as the clearance transmitter is turned on and off. If clearance cancellation adjustments were correctly made, there should be either no change in the 150 Hz level or only a slight flicker of the meter.

(5) Restore the facility feedlines to normal.

(6) Adjust the monitor to alarm at or before the wide alarm sideband-to-carrier power ratio established by flight inspection. Restore the sideband power to normal.

(7) Restore the facility to service.

5-62. REFERENCE DATA, FAA FORMS 6750-26 TO -29 AND -31.

a. Object. This procedure establishes the reference values and operating limits that all subsequent glide slope performance checks must meet.

b. Discussion.

(1) Facility reference data is prepared at facility commissioning or any subsequent flight inspection that requires the establishment of new radiated reference parameters for normal or alarm points. New reference values would typically be required if a flight inspection measurement was out of tolerance or a recommissioning was required, such as antenna change, angle change, etc. Whenever the initial or subsequent reference values are established, the initial airborne tolerances of paragraph 3-60 shall be met. The operating tolerances are based on the reference values for both the normal and the alarm conditions. The tolerances are applied to the radiating portion of the system, NOT the monitor. The monitor is adjusted to ensure that the system transfers or shuts down before the radiating system exceeds the reference value. The systems specialist should establish tighter monitor operating limits if past flight inspections or monitor drift indicates this to be prudent. For example, if flight inspections subsequent to the establishment of reference values indicate that the facility is close to being out of tolerance, new, tighter, radiated reference values may be established and the monitor alarm points moved accordingly. This will ensure that later flight inspections will be in tolerance.

(2) Monitor input DDM is recorded for trend analysis and troubleshooting purposes only. There are no tolerances placed on monitor input DDM values.

(3) The reference data must be measured very carefully. Power measurements must always be accomplished with the same meter and elements. The elements shall be clearly marked. In addition to the rf wattmeter readings, it is recommended that a digital voltmeter (dvm) be used to obtain reference readings for carrier and sideband power in normal, and in wide and narrow alarm. These reference readings can be made with greater repeatability using the dvm than by using the analog wattmeter. This is done by connecting a dvm, set to measure dc voltage, to the detector element output in place of the normal meter. Improved consistency in dvm readings will result if the dvm input is shunted with a 1400 Ω ±1 percent resistor. This resistor presents the same load to the detector elements as the normal analog meter. If the reference readings are made with the load resistor in place, all future measurements must be made in this configuration.

(4) At end-fire glide slopes the sideband-only (SBO) and carrier-plus sideband (CSB) combining hybrid present an impedance unbalance to the two inputs which results in an erroneous modulation balance indication at the carrier feedline rf body. Therefore, the SBO must be terminated

SECTION 1. PERFORMANCE CHECK PROCEDURES (Continued)

SUBSECTION 2. GLIDE SLOPES (Continued)

in a dummy load before adjusting the modulation balance to 0 DDM. After the modulation balance is adjusted for 0 DDM, the SBO dummy load should be removed and a reference DDM measured at the carrier rf body and recorded on FAA Form 6750-26. The FA-9438 wattmeter coupler is the preferred coupler for measuring the carrier feedline DDM in the carrier rf body.

c. Detailed Procedure.

(1) Reference values. The reference values from both normal and alarm conditions entered on FAA Forms 6750-26 through -29 and -31 are derived from the FAA Form 6750-4, Glide Slope Flight Inspection Data Work Sheet. This form is completed during the reference flight ⋆ inspection. Parameters not subject to flight inspection are ⋆ derived from the standards and tolerances in chapter 3.

(2) Operating tolerance values.

(a) FAA Form 6750-26, All Glide Slopes Normal Radiated Parameters.

1 Carrier power: For both the lower and upper tolerances enter your facilities reference values (i.e., for a single frequency facility with a normal reference value of 3.0 watt; lower standard would be 60% or 1.8 watts; upper standard would be 120% or 3.6 watts).

2 Clearance power: Same as for carrier power.

3 Carrier feedline DDM: Enter the modulation equality operating tolerances on the lower and upper tolerance lines; e.g., ≤0.010 DDM of reference value.

NOTE: At EFGS, the SBO must be dummy loaded at the SBO rf body Z12 before adjusting for 0 DDM in the carrier rf body Z13. The carrier feedline DDM with the dummy removed becomes the reference value.

(b) FAA Form 6750-27, Null-Reference Glide Slope Monitor Reference Data.

1 Wide sideband power: Enter ≥ the reference value for wide alarm.

2 Narrow sideband power: Enter ≤ the reference value for narrow alarm.

3 Angle high and low, integral carrier feedline DDM: Enter ≤ the operating tolerance DDM.

4 Dephasing main SBO: Enter ≤ the reference dephasing values for advance and retard to wide alarm.

(c) FAA Form 6750-28, Sideband Reference Glide Slope Monitor Reference Data.

1 Wide sideband power: Enter ≥ the reference value for wide alarm.

2 Narrow sideband power: Enter ≤ the reference value for narrow alarm.

3 Angle high, integral and field upper antenna power: Enter ≤ the reference upper antenna power for high angle alarm.

4 Angle low, integral and field upper antenna power: Enter ≥ the reference upper antenna power for low angle alarm.

5 Dephasing main SBO: Enter the reference dephasing values for advance and retard to wide alarm.

6 Dephasing upper antenna: Enter ≤ the reference dephasing values for advance and retard to path alarm.

(d) FAA Form 6750-29, Capture-Effect Glide Slope Monitor Reference Data.

1 Wide sideband power: Enter ≥ the reference value for wide alarm.

2 Narrow sideband power: Enter ≤ the reference value for narrow alarm.

3 Angle high and low, integral carrier feedline DDM: Enter ≤ the operating tolerance DDM.

4 Dephasing middle antenna: Enter ≤ the reference dephasing values for advance and retard to width alarm.

SECTION 1. PERFORMANCE CHECK PROCEDURES (Continued

SUBSECTION 2. GLIDE SLOPES (Continued)

5 Attenuation upper antenna: Enter ≤ the reference upper antenna attenuation to alarm.

6 Attenuation middle antenna: Enter ≤ the reference middle antenna attenuation to wide alarm, whichever occurs first.

7 Dephasing upper antenna: Enter ≤ the reference dephasing values for advance and retard to path alarm.

(e) FAA Form 6750-31, End-Fire Glide Slope Monitor Reference Data.

1 Sideband power-wide: Enter ≥ the reference value for wide alarm.

2 Sideband power-narrow: Enter ≤ the reference value for narrow alarm.

3 Angle high or low, integral: Enter ≤ the reference value for rear antenna degrees.

4 Angle high or low, field: Enter ≤ the reference value of main array advance and retard degrees for angle alarm.

5 Angle high or low, snap down: Enter ≤ the reference value of main array advance and retard degrees for snap down (width) alarm.

6 Dephasing clearance: Enter ≤ the reference values clearance array advance and retard to clearance alarm.

5-63. thru 5-69. RESERVED.

SECTION 1. PERFORMANCE CHECK PROCEDURES (Continued)

SUBSECTION 4. BUILT-IN TEST EQUIPMENT (BITE) (Continued)

(1) Place the meter in close proximity to the equipment to be verified. Connect the HP 8482B power sensor via its sensor cable to the meter, and connect to ac power. Depress the POWER switch to ON and allow a 30 minute warm up before proceeding.

(2) The HP E4418A performs an internal self test when first turned on, and if satisfactory, comes up with the same control settings it had before line power was last removed. If this is not desired, to start at a known point depress the PRESET/LOCAL key and then press Confirm.

(3) Disconnect the HP 8482B power sensor from its companion attenuator. Connect the power sensor to the 1.00 mW, 50 MHz, POWER REF output connector on the front panel of the HP E4418A. If the power sensor has a thick protective plastic washer on it, the flat indention on the inside of the washer must be aligned with the flat bottom portion of the connector for connection.

(4) Depress the following sequence of keys: System Inputs, Tables, Sensor Cal Tables, scroll down to the HP 8482B table, and depress Table On. If you have not already done so, load your sensor's data table at this time by depressing the Edit Table key. The data table is found on the power sensor itself. Follow the steps outlined in the Power Meter User's Guide, Chapter 2, Editing Sensor Calibration Tables. It is suggested that you use data table 2, since it should already contain factory data which closely matches your sensor and will require minimal changes.

(5) Calibrate the HP E4418A by first depressing the Zero/Cal key. Check that the displayed ref. cal factor is the value for your power sensor. Wait for it to zero and then depress the CAL key. In a few seconds calibration of the meter is concluded.

(6) Disconnect the power sensor from the power ref. connector and attach back to its companion attenuator. Press the Frequency/Cal Fac key and confirm the setting of the frequency to be measured, modify with the arrow keys, if necessary. From the initial time of turn on, allow at least 30 minutes to elapse before proceeding with the BITE power verification.

(7) Configuration of all other settings such as units of measurement, resolution, digital vs. analog display, and etc., are all covered in chapter 2 of the user's manual. Most settings are selected via the instruments menus, with menu maps covered in chapter 3 of the user's manual. The HP E4418A has more capabilities than the HP 437b and can be somewhat confusing. As such, familiarization with the meter is recommended before use, perhaps with known power levels and practice readings.

NOTE: It is recommended that an rf test cable be used between the PA rf output connector and the power sensor to reduce stress on the connector, and to allow for additional room in the equipment rack. If an rf test cable is used, measure its loss in dB with a vector voltmeter at the facility frequency. Enter this loss in the offset function of the HP E4418. Reference Chapter 2 of the Power Meter User's Guide for setting the offsets. The offset allows for the HP E4418A to compensate for the rf test cable loss, and provides for a direct reading of the measured power.

g. Detailed Procedure for the Mark 20 ILS Glide Slope or Localizer Facilities.

(1) Connect the PMDT serial communications cable to the equipment serial communications port. Set the PMDT power switch to ON and log onto the equipment.

(2) From the Commands menu execute the following sequence of keys <T C P>. Select one of the equipment power amplifier's (PA) for verification.

(3) Follow the instructions per the PMDT software routine, paying particular attention to all warning and message screens. Compare the two power measurements (i.e., the HP 437B and the BITE) and the vswr measurement and verify that they are within the operating tolerances of Chapter 3, Standards and Tolerances. If out of tolerance, make the necessary adjustments per instructions in the software procedure.

(4) Complete steps (2) through (3) for each PA rf power output and vswr measurement to be verified.

(5) Log off the equipment, set the PMDT power switch to OFF and disconnect the PMDT serial communications cable from the equipment.

SECTION 1. PERFORMANCE CHECK PROCEDURES (Continued)

SUBSECTION 4. BUILT-IN TEST EQUIPMENT (BITE) (Continued)

NOTE: Comparisons between power measurements with the HP 437B and the Mark 20 BITE equipment will differ with modulation on or off. SBO modulation cannot be turned off except during the calibration procedure when a calibration voltage is automatically programmed to the SBO. Power measurements may also differ with the BIRD wattmeter, both because of modulation being on or off and differences in instrument accuracy. If desired, the BIRD wattmeter (with elements kept in the same locations) may be used for checking and maintaining day to day measurements (i.e., checking for repeatable performance).

h. Detailed Procedure for Mark 20 ILS Marker Beacon Facility.

(1) Connect the Mark 20 PMDT serial communications cable to the equipment serial communications port. Set the PMDT power switch to ON and log onto the equipment.

(2) Bypass the monitor and set the marker beacon identification tone to OFF by executing the following sequence of keys from the Commands menu; <C T I O>.

(3) Turn OFF the transmitter and disconnect the rf output cable at the PA rf output connector, A2J3. Attach the HP 437B power sensor to this point.

(4) Turn ON the transmitter and note the rf output power as measured with the HP 437B. (If using an rf test cable and its loss in dB has not been entered into the HP 437B offset function, a correction must be made to the displayed power measurement to obtain the true rf output power.)

(5) On the Mark 20 PMDT, select the transmitter data screen for the PA being verified (from the Commands menu select; <D T>) and note the forward power reading as measured by the Mark 20 BITE.

(6) Compare the two power measurements (i.e., the HP 437B and the BITE) and verify that they are within the operating tolerances of Chapter 3, Standards and Tolerances. If out of tolerance, troubleshoot and replace the faulty module(s).

(7) Connect two 50 Ω, 10 watt dummy loads, attached to a tee (for a total impedance of 25 Ω) to the output of the marker beacon PA.

(8) On the Mark 20 MDT, note the vswr reading as measured by the Mark 20 BITE (from the Commands menu select <D M>).

(9) Compare the Mark 20 vswr measurement with the standard and tolerance for vswr listed in Chapter 3, Standards and Tolerances. If out of tolerance, troubleshoot and replace the faulty module(s).

(10) Reconnect the rf output cable, reset identification tone to Keyed, and return the monitor to normal.

(11) Log off the equipment, set the PMDT power switch to OFF and disconnect the PMDT serial communications cable from the equipment.

5-82 BITE MODULATION PERCENTAGE VERIFICATION.

a. Object. This procedure provides a method to verify the calibration of the Mark 20 BITE modulation percentage measurements.

b. Discussion.

(1) The modulation percentage directly affects the performance of the ILS facilities. Verifying and maintaining the BITE calibration to known standards will greatly enhance the specialists ability to accurately maintain reference settings, to check for changes in circuits affecting modulation, to make repairs and replace modules, and to reset to known modulation values.

(2) Several different methods of measuring modulation is possible depending on the test equipment used. Basically, a sample of the transmitter rf is taken and the modulation percentage is either read directly or calculated and then compared to the BITE/PMDT measurement. The Glide Slope and Localizer procedure describes the use of the FA-9438 modulation meter. The Marker Beacon procedure describes the use of an rf sampler. Refer to your particular test equipment technical instruction manual for different methods of setup for measuring modulation percentage.

SECTION 1. PERFORMANCE CHECK PROCEDURES (Continued)

SUBSECTION 4. BUILT-IN TEST EQUIPMENT (BITE) (Continued)

c. Test Equipment Required. The Mark 20 PMDT and one or more of the following items is required depending on the facility and test equipment used.

(1) An FA-9438 Modulation Meter with rf wattmeter body coupler (sniffer), or HP 8920 rf communications radio test set, or equivalent.

(2) A Wilcox model FA-10592 or NavAids model 89-GR Portable ILS Receiver.

(3) A vhf oscilloscope capable of displaying the particular equipment modulation envelope, or an audio oscilloscope with a modulation monitor.

(4) An optional rf wattmeter body and coupler (sniffer), or an in-line rf sampler, and a 50 Ω dummy load of sufficient wattage rating for the transmitter equipment under test.

(5) Rf test cables as required. Suggest using double shielded cables of RG-223 or RG-400.

d. Conditions. For sampled measurements (i.e., those taken without disturbing the radiated signal) the facility may remain in operation. For measurements taken where a frequency must be removed or switched to continuous, the facility must be removed from service.

e. FA-9438 Modulation Meter Set-Up.

(1) Prepare the FA-9438 modulation meter for modulation measurement. Refer to instruction book TI 6750.141, Installation, Operation, and Maintenance Instruction Book for Meter, ILS Modulation, Type FA-9438, section 3, for complete front panel calibration and operational instructions. The following is a digest of those instructions. Steps (a) through (e) are the front panel calibration steps.

(a) Turn the FA-9438 ac power switch on and allow a 10-minute warmup before proceeding.

(b) Place the function selector switch to RF ZERO, and adjust the RF ZERO control for 00.0 on the PERCENT MODULATION indication.

(c) Place the function selector switch to DISPLAY ZERO, and adjust the DISPLAY ZERO control for 00.0 on the PERCENT MODULATION indicator.

(d) Place the function selector switch to CAL 150 Hz, and adjust the CAL 150 Hz control for 42.5 on the PERCENT MODULATION indicator.

(e) Place the function selector switch to CAL 90 Hz, and adjust the CAL 90 Hz control for 42.5 on the PERCENT MODULATION indicator.

NOTE: It may be necessary to repeat steps (a) through (e) occasionally as the FA-9438 warms up. Allow a total warm up period of at least 30 minutes before proceeding with the BITE modulation percentage verification.

f. Detailed Procedure for the Mark 20 ILS Glide Slope or Localizer Facilities.

(1) Insert the FA-9438 wattmeter rf coupler into the carrier feedline wattmeter body and rotate the coupler for maximum pickup.

NOTE: For the Mark 20 Glide Slope, the lower antenna rf wattmeter body will have to be used. Turn off the SBO and clearance signals.

(2) Use a double-shielded coaxial cable and connect the coupler to the RF INPUT jack of the modulation meter.

(3) Place the function selector switch to LOCALIZER or GLIDE SLOPE, as appropriate, and read the 90 Hz and 150 Hz modulation percentages on the PERCENT MODULATION indicator.

(4) On the Mark 20 MDT, select the transmitter data screen for the transmitter modulation being verified, and note the 90 Hz and 150 Hz modulation percentages as measured by the Mark 20 BITE.

* (5) Take the difference between the two modulation measurements (i.e., from the FA-9438 and the BITE) and verify that it is within the operating tolerances of Chapter 3, Standards and Tolerances. If out of tolerance, *

SECTION 1. PERFORMANCE CHECK PROCEDURES (Continued)

SUBSECTION 4. BUILT-IN TEST EQUIPMENT (BITE) (Continued)

* troubleshoot and replace the faulty module. *

(6) Complete steps (1) through (5) for each transmitter being verified.

(7) Restore the equipment to normal.

g. Detailed Procedure for Mark 20 ILS Marker Beacon Facility.

(1) Connect the Mark 20 PMDT serial communications cable to the equipment serial communications port. Set the PMDT power switch to ON and log onto the equipment.

(2) Bypass the monitor and switch OFF the transmitter with the front control panel toggle switches.

(3) Using an rf cable attach a thruline wattmeter body or an in-line rf sampler terminated into a 50 Ω dummy load to the rf power amplifier output jack, A2J3.

(4) Switch the transmitter ON with the control panel toggle switch.

(5) Connect the particular piece of test equipment that you are using to a coupler probe (sniffer) and insert the probe into the thruline body or attach to the in-line sampler.

(6) If using a modulation monitor and audio oscilloscope, connect the intermediate frequency (if) output to the vertical input of the oscilloscope. For a direct reading modulation meter, refer to the instrument instructions and set for measuring modulation.

(7) On the PMDT set the modulation to continuous; i.e., from the Commands menu execute the following sequence of keys <C T I C>.

(8) Adjust the test equipment to display the modulation envelope. For a direct reading modulation meter or radio test set, note the modulation percentage.

(9) For the scope method, use the following formula to calculate the modulation percentage.

$$\%\ \text{mod} = \frac{E_{max} - E_{min}}{E_{max} + E_{min}} \times 100$$

(10) On the PMDT; from the Commands menu execute the following sequence of keys <D T>) and read the BITE modulation percentage given after 'Ident Signal'.

* (11) Take the difference between the two modulation percentages and verify that it is within the operating * tolerance of Chapter 3, Standards and Tolerances. If not, be sure to double check all equipment set ups, measurements, and calculations before replacement of any equipment circuit cards or modules.

(12) Restore the facility to normal configuration and check that the PMDT shows normal operation. Log off the equipment, disconnect the PMDT serial communication cable, switch off the PMDT, and return marker to service.

5-83. BITE DIFFERENCE IN DEPTH OF MODULATION (DDM) VERIFICATION.

a. Object. This procedure provides a method to verify the calibration of the Mark 20 BITE difference in depth of modulation (DDM) measurements.

b. Discussion.

(1) The DDM directly affects the performance of the ILS facilities. Verifying and maintaining the BITE calibration to known standards will greatly enhance the specialists ability to accurately maintain reference settings, to check for changes in circuits affecting DDM, to make repairs and replace modules and reset to known DDM values.

(2) DDM test generators can generate quite accurate DDM signals; whereas a PIR may have a tolerance specification 10 times greater than the generator. If a PIR is on the edge of its specification, and the BITE correct or slightly off in the opposite direction, the BITE may appear to be out of the operating the tolerance desired (but in fact it is reading better than the PIR). If this occurs, use a precision test generator to recheck your PIR and determine if its measurement is off, how much, and in what direction. Then use that value to correct your difference calculation between the PIR and BITE measurement before comparison to the Chapter 3, Standard and Tolerance values.

SECTION 2. OTHER MAINTENANCE TASKS PROCEDURES (Continued)

SUBSECTION 1. ILS FACILITIES (Continued)

5-113. BACKUP BATTERY POWER CHECK.

a. Object. This procedure provides a method for a basic check of facility backup battery dc power. The purpose is to identify major problems with the backup power system.

b. Discussion.

(1) To provide continuity of service in areas of poor commercial power or during times of heavy storms and subsequent power outages, backup power has been provided at almost all ILS facilities. Larger airports may have the facilities connected to a critical ac power bus (i.e., engine generators); however, almost all have some form of backup battery dc power. Battery aging, charger problems, float voltage adjustments, blown fuses, and etc. can result in a severally limited battery capacity, or no backup power at all. In general, battery backup power capability at Localizer and Glide Slope facilities have been sized to provide power for four hours or more. Marker Beacon battery backup power can sometimes be capable of powering the facility for several days.

(2) Most systems should meet the following minimum one hour check. However, if your equipment shuts down or alarms occur, check that your system is designed to meet at least a one hour backup time. If so, note battery voltage readings, check fuses, check that battery cables and connections are in good condition, check battery charger equalize and float voltages, and if all appear good; the * batteries may require replacement. Refer to Order 6980.25, Maintenance of Batteries for Standby Power. *

c. Test Equipment Required.

(1) A wrist watch or clock.

(2) For a Mark 20 or similar ILS, the PMDT.

(3) Optional; a dvm (Fluke or equivalent).

d. Conditions. The ILS facility operating normally and notification given to Air Traffic of the intended check. This procedure takes one hour to complete, and a possibility exist that an equipment shutdown or transfer to standby equipment could occur. Since the system specialist is most familiar with the facilities, it is left up to his or her judgment as to whether-or-not the facility is taken out of * service for maintenance and a Notice to Airmen (NOTAM) * is issued.

e. Procedure.

(1) At the equipment monitor, or with the ILS PMDT, note that equipment monitored parameters are normal.

(2) This step is optional; connect a dvm, or setup the ILS PMDT to display the backup battery dc voltage.

(3) Locate the ac power circuit breaker for the equipment to be checked.

(4) Using a wrist watch or clock, note the current time and switch the equipment ac circuit breaker to the OFF position.

(5) For a period of one hour; observe that all equipment monitored parameters remain within normal limits and that no alarms occur (except for a possible maintenance alert of loss of commercial power).

(6) Switch the equipment ac power circuit breaker to the ON position.

(7) At dual equipment facilities with a separate ac power circuit breaker; repeat the above procedure for the second set of equipment.

* 5-114. ENVIRONMENTAL OBSERVATION.

a. **Object.** Detect environmental changes that may cause signal degradation.

b. **Discussion.** As the airborne performance of an ILS is affected by environmental factors it is important to observe the area surrounding facilities for changes. Some of these changes may not affect ground check readings. Significant changes in signal screening and reflective characteristics may occur, primarily through building construction, between flight inspections. Additionally, some periodic flight inspection methods may not detect all low altitude localizer clearance problems caused by screening.

c. **Test Equipment required**. None required. Optional aids include airport maps, magnetic compass, binoculars, camera, etc.

d. **Conditions**. Equipment operating normally.

e. **Procedure**. While standing near the antenna, visually scan the area in front and to the sides of the approach path noting any temporary or permanent changes to vertical screening or sources of signal multipath. Type, height, distance, and angle from the runway should be noted for new construction. Environmental changes suspected to cause changes in the received signal should be discussed with engineering and/or flight inspection personnel to determine if a special flight inspection is needed.

5-115. thru 5-119. RESERVED. *

SECTION 2. OTHER MAINTENANCE TASKS (Continued)

SUBSECTION 2. ILS ANTENNAS

5-120. GENERAL. This section establishes the procedures for accomplishing the various essential maintenance activities that are required to verify that the ILS antennas are performing within specified tolerances.

5-121. ANTENNA SYSTEM VSWR AT OUTPUT OF TRANSMITTER.

a. Object. This procedure provides a method to measure the vswr of the antenna distribution circuit.

b. Discussion. Because of coaxial line loss, the vswr is not constant along a transmission line, but is greatest at the load (antenna) end. However, any change in the vswr of the antenna distribution circuit or the antenna itself will be reflected to the transmitting end. This routine check of antenna system vswr will be accomplished from the transmitting end (i.e., at the output of the transmitting equipment). Changes in the reference vswr at a particular ILS facility will require the specialist to make a more extensive check of the antenna system to identify the source of the problem.

b. Test Equipment Required. One of the following items is required.

(1) A directional rf wattmeter with appropriate elements.

(2) Mark 20 BITE and PMDT.

d. Conditions. The facility is operating normally.

e. Detailed Procedure for Non Mark 20 System.

(1) With the transmitter operating normally, measure the forward and reflected power at the thruline body, using the directional wattmeter.

(2) Compute the vswr from the values of the forward and reflected power by the use of the following formula, the vswr chart provided with the wattmeter, or the vswr chart provided in appendix 4. Record values on FAA form 6750-22.

$$Vswr = \frac{\sqrt{Power_{(forward)}} + \sqrt{Power_{(reflected)}}}{\sqrt{Power_{(forward)}} - \sqrt{Power_{(reflected)}}}$$

(3) Compare the measured vswr to the applicable tolerance and to previous measurements.

(4) Repeat the above steps for each coaxial transmission line.

f. Detailed Procedure for Mark 20 System.

(1) Connect the PMDT serial communications cable to the equipment serial communications port. Set the PMDT power switch to ON and log onto the equipment.

(2) For the Localizer or Glide Slope facility execute the following sequence of keys from the Commands menu < D T O/T C/O> (O for transmitter one and T for transmitter two; and C for the clearance transmitter and O for the on-course).

(3) Record the CSB and SBO transmitter vswr on FAA form 6750-22.

(4) Log off the equipment, set the PMDT power switch to OFF, and disconnect the PMDT serial communications cable from the equipment.

5-122. END-FIRE CLEARANCE MONITOR ANTENNA LOCATION.

a. Object. This procedure provides a method to locate the clearance monitor antenna for proper monitoring of clearance array maladjustments or faults.

b. Discussion. The clearance rf channel of the monitor is used to field monitor the radiation pattern of the two clearance antennas. The monitor antenna is positioned to detect power reduction from each of the two antennas as well as change in relative phases between the two antennas. The monitor is placed in a position where the rf energy from each antenna is in-phase (a maximum) and equal. At this location the clearance rf monitor should respond symmetrically to dephasing of the clearance antennas.

c. Test Equipment Required. None

d. Conditions. The clearance array must be properly phased in accordance with paragraph 5-55. A facility shutdown is required for this check.

SECTION 2. OTHER MAINTENANCE TASKS (Continued)

SUBSECTION 2. ILS ANTENNAS (Continued)

e. Procedure.

(1) Disconnect the front clearance antenna, and terminate the coaxial cables in dummy loads.

(2) Observe the rf level on the clearance monitor. It should be approximately 50 percent.

(3) Reconnect the front clearance antenna, and disconnect the rear clearance antenna. Terminate the open coaxial connectors with dummy loads.

(4) Observe the rf level on the clearance monitor. It should be equal to the level measured from the rear antenna, as observed in step (2), plus or minus 10 percent. If not, the clearance monitor should be reaimed toward the antenna with the lower observed rf level.

(5) Repeat steps (1) thru (4) until the levels are within 10 percent of each other.

(6) Verify the proper operation of the clearance monitor rf level if an adjustment was made in step (4).

(7) Restore the facility to service.

5-123. END-FIRE AIR SYSTEM INTEGRITY.

a. Object. This procedure provides a method to determine that air leaks do not exist in the pressurized coaxial transmission lines.

b. Discussion. Because phase stability is very important in the end-fire glide slope, the coaxial transmission lines are pressurized with dry air. An air pump drier and manifold system are used to pressurize the coaxial lines. This prevents the intrusion of moisture, which is the primary reason for phase instability of air transmission lines.

c. Conditions. The facility is operating normally.

d. Test Equipment Required. None.

e. Detailed Procedure.

(1) Check the manifold in the interface unit to ensure that all of the needle valves are fully open.

(2) Note the current manifold gauge pressure.

(3) Turn off the pump.

(4) Over a 3-hour period, occasionally check for an air pressure drop. Pressure may vary several pounds force per square inch (psi) with changes in outside temperature or sunshine.

(5) If the pressure drops more than 20 percent, locate and repair the leak.

(6) Check desiccant and replace as required.

(7) Restore the facility to service.

5-124. ANTENNA SYSTEM VSWR AT ANTENNA FEEDLINES.

a. Object. This procedure provides a method to measure the vswr of the antenna and its rf feedline. The purpose of this check is to better identify aging or damaged rf cables and/or antennas for immediate or future replacement.

> **NOTE:** This routine should be performed in conjunction with the rf cable insulation and dc resistance measurements of Subsection 3, ILS Transmission Lines.

b. Discussion. Because of coaxial line loss, the vswr is not constant along a transmission line, but is greatest at the load (antenna) end. However, any change in the vswr at the antenna will be reflected to the transmitting end. This routine check of the antenna vswr will be accomplished on each transmitting antenna with its corresponding feedline (i.e., out of the distribution network to the antenna). An out-of-tolerance condition or changes in the previous vswr measurements for a particular antenna and its feedline will require the specialist to make a more extensive vswr check of the antenna and/or feedline to identify the source of the problem.

c. Test Equipment Required. One of the following items is required.

(1) Directional wattmeter with appropriate elements.

(2) Vector Voltmeter with directional coupler.

d. Conditions. Coordinate a scheduled outage for the facility being verified with air traffic control personnel and remove from service.

e. Detailed Procedure.

(1) Configure the transmitter for an output of rf carrier only, and determine a method by which the signal may be transmitted to the point at which the antenna feedline will be disconnected.

(2) Depending on the type of test equipment to be used, adjust the transmitter rf output level to obtain stable readings of forward and reverse power (i.e., for a wattmeter, 1 watt may be selected; for a vector voltmeter (vvm) a lower output level that results in an approximate 0 dBm at the vvm may be used).

CAUTION: Do not exceed maximum input levels of the vvm test equipment. Expensive damage to the input circuits can occur. If unsure of levels; start with decreased rf power output in conjunction with a 30 dB rf attenuator attached inline to the directional coupler, gradually increase rf power or decrease attenuation until a satisfactory level is reached.

(3) One at a time, disconnect each antenna rf feedline at its distribution unit, dummy load that port, and apply the rf carrier signal to the feedline via an rf directional wattmeter. A vvm with its companion directional coupler may also be used, but the rf signal level may need to be reduced to operate normally. In either case, measure the forward and reflected power either in watts or dBm units.

(4) Compute the vswr from the values of the forward and reflected power by the use of the following formula, the vswr chart provided with the wattmeter, or the vswr chart provided in appendix 4. Record values on FAA * form 6000-8. *

$$Vswr = \frac{\sqrt{Power_{(forward)}} + \sqrt{Power_{(reflected)}}}{\sqrt{Power_{(forward)}} - \sqrt{Power_{(reflected)}}}$$

(5) Compare the measured vswr to the applicable tolerance and to previous measurements.

(6) Repeat the above steps for each antenna and its transmission feedline/tie line.

5-125. SIDEBAND-REFERENCE ANTENNA SBO AMPLITUDE EQUALITY.

a. Object. This procedure provides a method to verify, and adjust if necessary, the distribution of sideband power between the upper and lower antennas.

b. Discussion. The ratio of sideband power to the upper and lower antennas affects both the path angle and width. The following procedure should be performed before phasing the facility.

c. Test Equipment Required.

(1) A thruline wattmeter and appropriate detector elements.

(2) Two dummy loads.

d. Conditions. A facility shutdown is required for this check.

e. Detailed Procedures.

(1) Disconnect the carrier input to the APCU and terminate the carrier input connector into a dummy load.

(2) Disconnect the sideband input to the APCU and terminate the sideband line from the transmitter into a dummy load.

SECTION 2. OTHER MAINTENANCE TASKS (Continued)

SUBSECTION 2. ILS ANTENNAS (Continued)

(3) Disconnect the upper and lower antenna feedlines from the APCU and connect a dummy load to the APCU outputs.

(4) Connect the carrier output of the transmitter to the sideband input of the APCU.

(5) Using the same wattmeter detector element and meter, measure the rf power at the upper and lower antenna rf bodies. The power ratio should be within the limits prescribed in chapter 3. If necessary, adjust the power divider to equalize the powers.

(6) Restore the facility to service.

5-126. CAPTURE-EFFECT ANTENNA AMPLITUDE.

a. Object. This procedure provides a method to verify and adjust (if necessary) the carrier, sideband, and clearance power distribution to the three antennas.

b. Discussion. The rf power distribution to the antennas affects the glide angle, path width, symmetry, and below-path clearance (fly-up). Proper operation of the capture-effect glide slope can be achieved only by the use of extreme care and accuracy in amplitude and phase control unit (APCU) adjustments. It is assumed that the course transmitter modulator has been carefully adjusted for modulation equality and lobe balance and that the clearance transmitter has been adjusted for proper audio phasing and modulation percentage before proceeding with the following adjustments. The relative rf power ratios are to be established by the use of a wattmeter or a vector voltmeter. If a wattmeter is used, the same wattmeter detector element and meter movement should be inserted into the appropriate APCU thruline bodies. Due to nonuniformity between elements, the wattmeter elements used should be clearly marked to ensure that they are not unintentionally interchanged with other units. All wattmeter bodies shall be plugged with detector elements or plugs during this procedure as well as during normal facility operation. Failure to leave the wattmeter bodies in a standard configuration will affect system adjustments and stability.

NOTE: If a vector voltmeter is used for this procedure, extreme care must be taken to ensure that excessive power is not fed to the input ports. The use of in-line attenuators, directional couplers, and power samplers is strongly recommended.

c. Test Equipment Required. A wattmeter with appropriate detector elements and dummy loads. A vector voltmeter (vvm) and a directional coupler may be used in place of
* the wattmeter. A PIR that measures rf level may also be used. *

d. Conditions. A facility shutdown is required for this check.

e. Detailed Procedure.

(1) Establishment of relative carrier power levels.

(a) Deenergize the clearance transmitter.

(b) Remove the sideband input from the APCU and dummy load the cable and APCU sideband input. Remove the antenna cables and dummy load the APCU antenna outputs.

(c) Measure and note the power in the middle antenna thruline body. (With a vvm and directional coupler, measure the middle antenna output. Replace the dummy load when finished.)

(d) Move the wattmeter to the lower antenna thruline body (vvm to antenna output), and measure the power.

(e) If necessary, adjust the carrier power divider for the correct lower-to-middle carrier power ratio.

(f) Repeat steps (d) and (e) as necessary until the proper ratio is obtained.

(2) Establishment of relative sideband power ratios.

(a) Deenergize the course transmitter. Remove the dummy load from the APCU sideband input. Change the carrier cable from APCU carrier input to the APCU sideband input. Dummy load the APCU carrier input. Turn on the course transmitter.

(b) Measure and note the lower antenna power. Move the wattmeter element to the upper antenna thruline (vvm to upper antenna output).

(c) If necessary, adjust sideband power divider no. 2 for equal power in the lower and upper antennas. This also sets the correct upper-to-lower clearance power ratio.

SECTION 2. OTHER MAINTENANCE TASKS (Continued)

SUBSECTION 2. ILS ANTENNAS (Continued)

(d) Repeat steps (b) and (c) as necessary. Lock sideband power divider no. 2.

(e) Move the wattmeter element or vvm to the middle antenna. If necessary, adjust sideband power divider no. 1 for the correct middle-to-lower power ratio.

(f) Lock down sideband power divider no. 1.

(3) Establishment of course and clearance transmitter lower ratios. The vvm should not be used during this procedure. The wattmeter and normal system detector elements are to be used.

(a) Deenergize the course transmitter. Remove the dummy load from the APCU carrier input. Change the carrier cable from the APCU sideband input to the APCU carrier input. Dummy load the APCU sideband input. Turn on the course and clearance transmitters.

(b) Adjust the course transmitter for normal carrier power input to the APCU.

(c) Measure and note the middle antenna carrier power.

(d) Measure and note the upper antenna clearance power.

* (e) If necessary, adjust the power output of the clearance transmitter for the clearance power in the upper antenna specified as the initial tolerance in chapter 3. (The clearance power ratio of the upper to lower antennas was determined in step (2)(c).) *

(4) Establishment of sideband-to-carrier ratio for course signals.

(a) Remove all dummy loads, and connect all APCU input and antenna cables for normal operation.

(b) Adjust the sideband power control on the course transmitter for the carrier-to-sideband power ratio at the APCU input established by flight inspection.

(5) Corrective action.

(a) If any adjustments above were major in nature (other than fine adjustments to center a power ratio), the system must be ground-phased and the monitor alarms verified using the most recent reference data.

(b) Restore the facility to service.

5-127. thru 5-129. RESERVED.

SECTION 3. SPECIAL MAINTENANCE PROCEDURES (Continued)

SUBSECTION 2. LOCALIZERS

5-170. LOCALIZER COURSE POSITION.

a. Object. This procedure provides a method to adjust the localizer course position.

b. Discussion.

(1) The localizer course is a line extending forward from the array along which a localizer receiver finds rf modulated to equal depths by the 90 and 150 Hz components (0 DDM). Optimum course position occurs when the 0 DDM line coincides with the runway center-line and its extension. In the case of localizer-type directional aid (LDA's), optimum course position occurs when the 0 DDM line coincides with a line perpendicular to the center of the array. The course line can be moved by changing the physical orientation of the antenna array or by altering carrier modulation equality in the preradiated signal. The allowable adjustment range of the modulation balance control is limited for the latter method but it is more practical for correcting minor changes in course position. Best system performance occurs when, with carrier modulation equality, the localizer course line coincides with the principle axis of the localizer array. This ideal occurrence places the course at the radiated sideband null and produces the best course width symmetry.

(2) The course formed by energy directly from the array is modified principally by sideband-only energy arriving from reflecting surfaces. If these reflections arrive at the course line in scrambled amplitudes and phases, course roughness results. If the reflections follow a regular pattern, course scalloping or bending occurs. Reflections cause course position indications to vary with the observer's location.

c. Test Equipment Required. A portable ILS receiver (PIR).

d. Conditions. A facility shutdown is required.

e. Detailed Procedure.

(1) Multiply the desired course shift by 0.31 (which is equal to two times 0.155 DDM), and divide the results by the existing course width. (Use the same units for course shift and course width; i.e., degrees or feet, etc.) This represents the DDM change needed to produce the desired course shift.

(2) Determine the DDM in the carrier feedline.

(3) Using the modulation balance control, change the carrier feedline DDM by the amount computed in step (1).

(4) Verify the change in course position by a ground check.

(5) Return the facility to service.

5-171. LOCALIZER COURSE WIDTH.

a. Object. This procedure provides a method to adjust the localizer course width.

b. Discussion. The localizer course width is adjusted by changing the sideband-only power output of the facility. Course width varies inversely as the square root of sideband power output changes with carrier power held constant. Other parameters are also affected by sideband power adjustments. Increasing sideband power to decrease the course width causes increased course roughness. Decreasing sideband power to increase the course width reduces clearances outside the course sector. Thus, the carrier to sideband-only power ratio usually remains at the established value. Temporary sideband power changes are necessary to establish certain reference readings and to check alarm points. Permanent sideband power changes from established values are seldom needed or justified.

c. Test Equipment Required. Equipment normally used for measuring the carrier and sideband powers.

SECTION 3. SPECIAL MAINTENANCE PROCEDURES (Continued)

SUBSECTION 2. LOCALIZERS (Continued)

d. Conditions. A facility shutdown is required.

e. Detailed Procedures.

(1) Measure and record the existing carrier and sideband powers for reference.

(2) Divide the existing course width by the desired course width, square the result, then multiply by the existing sideband power.

New SB Power =

$$\frac{(\text{Existing Course Width})^2}{(\text{Desired Course Width})^2} \text{ x Existing SB Power}$$

(3) Adjust the sideband power to the result of step (2) to produce the desired course width.

(4) Verify the new course width by a ground check.

(5) Return the facility to service.

5-172. LOCATING GROUND CHECK POINTS.

a. Object. This procedure provides a method to locate permanent ground check points that provide repeatable readings.

b. Discussion. Permanently established ground check points are required for all ILS localizer, LDA, and offset facilities. Table 5-2 shows the locations of the ground check points by facility type.

c. Test Equipment Required.

(1) A portable ILS receiver (PIR).

(2) A suitable antenna, preferably one mounted on the vehicle that will be used to perform the localizer ground checks. To reduce reflection effects from fixed and moving objects and to increase signal strength, a locally procured directional antenna is highly recommended over the dipole antenna provided with the PIR. This directional antenna can be as simple as a television Yagi antenna with proper balun or a three-element Yagi cut to frequency.

d. Conditions. The facility should be operating normally and approval obtained from air traffic control personnel to operate on the ILS runway.

* **e. Detailed Procedure.** Steps (5), (8), (9), and (11) are mandatory. The goal is that ground check points provide locations where repeatable readings can be obtained. The centerline and width ground check points should be at the runway approach threshold. If repeatable measurements cannot be made at the runway threshold with a directional antenna, then the procedure listed below provides a means for locating ground check points which are closer to the array and are repeatable. *

(1) To determine the PIR rf input level, use a suitable antenna and place the PIR selector switch in the rf position. The reading obtained is converted to field strength by use of the calibration curves on the back cover of the PIR.

(2) Starting at the approach end of the runway, measure the rf level. If the rf level is less than 25 microvolts, move closer to the facility until the signal exceeds 25 microvolts.

(3) After reaching the location found in step (2) drive slowly toward the localizer on runway centerline. Ensure that the antenna is directed toward the localizer array. Observe the DDM readings on the PIR. It may be necessary to move toward the middle marker to obtain proper indications.

(4) The DDM meter should read 0 DDM or a near 0 DDM constant value as the vehicle moves along runway centerline. Oscillatory DDM meter movement is a result of reflections. If the DDM value changes slowly and is less than ±0.005 DDM, this area of the runway will probably provide a satisfactory ground check location for width and centerline. If these conditions are not met, continue along the runway until they are.

(5) [Mandatory] At the location chosen, permanently establish a course position ground check marker on the runway centerline. Spray paint on the pavement is adequate.

(6) Determine the distance between the localizer array and the course position ground check point. Absolute accuracy is not required. Analysis of airport maps is adequate to determine this distance.

SECTION 3. SPECIAL MAINTENANCE PROCEDURES (Continued)

SUBSECTION 2. LOCALIZERS (Continued)

TABLE 5-2. GROUND CHECK POINT REQUIREMENTS

Facility Type	*Runway Centerline and Course Angle*[1]	*Clearance Points*[2, 3]
All one-frequency localizers and two-frequency localizers without a commissioned backcourse.	Approach end runway threshold or closer as required, but no closer than 20 times the width of the array.	Check on front side at a distance ≥20 times the width of the clearance array (or embedded clearance portion of a two-frequency array).
Two-frequency localizer with a commissioned backcourse.	Front course: Approach end runway threshold	Check on front side at a distance ≥20 times the width of the clearance array.
	Backcourse: (1) Check on backside at a distance ≥10 times the width of the clearance array if available real estate permits. OR- (2) Check on the front side at approach end, runway threshold with course transmitter off.	Not required. Not required.
LDA or offset, one- and two-frequency localizers	Check on front side at a distance ≥20 times the width of the array.	Check on front side at a distance ≥20 times the width of the clearance array.

[1] The preferred location for the course position and width ground check points is at the runway approach threshold. However, it may be impossible to obtain repeatable data at the runway threshold due to insufficient signal strength or reflections. If this occurs, move in toward or away from the localizer antenna array as outlined in the detailed procedure. If it is necessary to locate the ground check point closer than 20 times the width of the array, written regional approval is required.

[2] Clearance ground check points are recommended at ±10°, ±20°, ±30°, ±35° and are required at the low clearance point on each side of the array. Clearance ground check points are not required outside the airport boundary.

[3] Abnormal case DDM: Some localizer antenna arrays exhibit abnormal case DDM in the clearance sectors. Abnormal case DDM will exist when the separate sideband components are greater than the carrier sidebands. When this condition occurs, space modulation is greater than transmitter modulation. This destroys the normal CSB/SBO relationship of the clearance ground check, as the DDM value measured with the PIR initially increases as the sideband power is decreased. This is caused by the method of DDM measurement within the PIR. Clearance ground check measurements are not required at azimuths where abnormal case DDM exists.

SECTION 3. SPECIAL MAINTENANCE PROCEDURES (Continued)

SUBSECTION 2. LOCALIZERS (Continued)

(7) Calculate the distance from the runway centerline to the edge of the localizer course for this distance from the localizer array using the following formula:

$$\text{Distance to Edge of Course} = \text{Distance to Localizer} \times \operatorname{Tan}\left(\frac{\text{Commissioned Course Width}}{2}\right)$$

(8) **[Mandatory]** From the runway centerline, measure and establish permanent course width ground check points at the distance calculated in step (7). Tape measure accuracy is sufficient.

(9) Using a map or drawing of the airport, pick out clearance ground check points at ±10°, ±20°, ±30°, ±35°, if used, and at the low clearance point **[Mandatory]** on each side of the array. There is more than one low clearance point by each array. Consult the manufacturer's instruction book for the antenna radiation pattern and the theoretical low clearance points.

(10) Install permanent (use posts, paint, etc.) clearance ground check markers at the locations established in step (9). As these markers are used to provide only relative readings, absolute accuracy in their placement is not required.

(11) **[Mandatory]** A map showing the ground check locations shall be displayed at the localizer facility.

5-173. LOCATING A GROUND PHASING POINT.

a. Object. This procedure provides a method to locate a suitable far-field ground-phasing point that provides optimum carrier to sideband-only phase relationship.

b. Discussion. Optimum performance of the localizer radiated signal depends upon the proper phase relationship of the carrier to sideband-only (SBO) signals. A method of verifying this phase relationship is to use the portable ILS receiver (PIR) at a point established in the far-field. The phase relationship can be determined by measuring the effects of the sideband-only signal on the carrier while in quadrature. The point at which the measurement is taken must be representative of the entire system phase relationship. This point must also be free from reflections that contribute to the inaccuracy of the measurement.

c. Test Equipment Required.

(1) A portable ILS receiver (PIR) with antenna.

(2) The facility 90° phasing section.

d. Conditions. A facility shutdown is required for this procedure.

e. Detailed Procedure.

(1) Consult the appropriate technical instruction book for the particular antenna system that is to be phased. A plot of the sideband-only radiation pattern for the array should be given. From the plot, determine where the peak of the sideband lobes occur in azimuth, relative to centerline. The relative azimuth of this sideband lobe peak is a good point to begin for locating the ground-phasing point.

(2) Position the PIR at the azimuth point of step (1) or the previously established ground check point. (See paragraph 5-172.) Ensure that this point provides line-of-sight to the localizer array.

(3) At the equipment shelter, terminate the sideband-only signal and its cable. With carrier only radiating, note the DDM reading at the far-field ground-phasing point.

(4) Insert the facility 90° phasing section in the sideband-only cable and reconnect it to its normal output port.

(5) Note the new (quadrature) DDM at the far-field ground phasing point. If the facility has been previously phased using the in-line method (per paragraph 5-16f), the reading at the far-field ground-phasing point should be near the reference DDM taken in step (3). If necessary, note the main sideband phaser setting and adjust the phaser to obtain reference DDM at the far-field ground phasing point.

(6) A test to ensure that this point is free from reflections is to observe the PIR while moving it approximately 50 feet in all directions from this point. The DDM should remain within ±0.05 DDM of reference. Large changes in DDM indicate that the readings at this point are a result of reflections. If reflections are present, a new point,

perhaps on the opposite side of centerline, should be tried. The final far-field ground phasing point selected should pass this test for reflections.

(7) A quadrature ground check, see paragraph 5-174 should be taken to ensure that the established far-field ground phasing point provides optimum results. Attention should be given to the usual low clearance points for the particular array to be phased. If flight inspection reports marginal clearances, often these clearances can be improved by far-field phasing at the reported low-clearance azimuth.

(8) Restore the facility to service.

(9) The location of the established far-field ground- * phasing point shall be clearly identified. The date, method used, and the far-field phasing values shall be identified on * the appropriate facility drawings.

5-174. QUADRATURE GROUND CHECK.

a. Object. This procedure provides a method to determine that the method used to phase a localizer antenna array produces optimum phasing in the far-field.

b. Discussion.

(1) A quadrature ground check provides a means to determine the amount of antenna array misphasing at each ground check point. A plot of this misphasing for all ground check points gives a visual indication of how well the antenna system is phased.

(2) A perfect localizer antenna array, that is perfectly phased, and which does not have structures to cause reflections, would produce zero DDM everywhere in the far-field when the sidebands are in quadrature. Any imperfection in the array, such as mutual coupling or misphasing, causes non-zero DDM readings in the far field. The amount of antenna system phase error can be calculated by:

$$\text{System phase error, in degrees} = \arctan\left(\frac{\text{quadrature DDM}}{\text{normal DDM}}\right)$$

(3) The optimum phasing of the localizer array occurs when the algebraic sum of the phase errors for each evenly spaced ground check points equals zero. When the sum of the phase errors does not equal zero, the total average phase error can be calculated by dividing the sum of the phase errors by the number of phase error data points. This procedure is valid only where phasing is checked every 5°. Optimum localizer antenna array phase can then be obtained by adjusting the carrier-to-sideband phase by the average phase error.

(4) Optimum localizer phasing does not necessarily mean that all clearances will be improved. For example, the quadrature plot of figure 5-3 shows that if the system is adjusted for optimum phase, the clearances would improve at 20° and beyond, but would get worse inside 15°. At 15° on the 150 Hz side, the clearances would be considerably lower.

c. Test Equipment Required.

(1) A portable ILS receiver (PIR).

(2) Dummy loads.

(3) The facility 90° phasing section.

d. Conditions. A facility shutdown is required for this check.

e. Detailed Procedure.

(1) Insert the 90° phasing section in the sideband feedline.

(2) Measure the DDM at each ground check point except centerline. The ground check points must be in the far field to obtain satisfactory results. For instance, a quadrature ground check at the 200-foot arc will produce unsatisfactory results due to proximity error.

(3) Calculate the phase error for each ground check point using the following formula:

$$\Phi\ (\text{phase error}) = \arctan\left(\frac{\text{quadrature DDM}}{\text{normal DDM}}\right)$$

If the quadrature DDM is not the same predominating audio frequency, the phase angle is defined to be negative.

$$\text{i.e., } \Phi = \arctan\left(\frac{.05\ (90)}{.155\ (150)}\right) = -17.9°$$

SECTION 3. SPECIAL MAINTENANCE PROCEDURES (Continued)

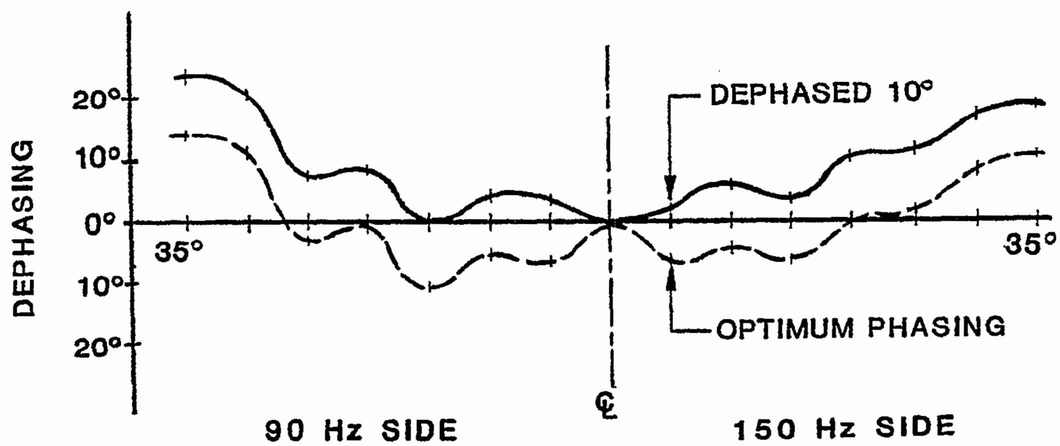
SUBSECTION 2. LOCALIZERS (Continued)

(4) Plot the amplitude of the phase error against localizer azimuth as shown in figure 5-3.

(5) With some qualifications, the best quadrature plot is one that averages zero degrees on each side of the array. Analyze the plot, and if necessary, rephase the antenna system and repeat steps (1) through (4). For small phase changes, less than 15° to 20°, a new normal ground check is not required for the purpose of calculating phase error.

(6) Restore the facility to service.

FIGURE 5-3. QUADRATURE GROUND CHECK



TYPICAL LOCALIZER QUADRATURE GROUND CHECK PLOT
OPTIMUM PHASING
VS
DEPHASED 10°

SECTION 3. SPECIAL MAINTENANCE PROCEDURES (Continued)

SUBSECTION 2. LOCALIZERS (Continued)

5-175. REFERENCE GROUND CHECK, FAA FORMS 6750-23 AND -24.

a. Object. The reference ground check establishes the * limits to which all subsequent normal ground checks are to be * compared. This reference data is to be recorded on FAA Forms 6750-23 and -24.

b. Discussion.

(1) A reference ground check is prepared after facility commissioning and after any subsequent monitor flight inspection that requires the establishment of new parameters. A reference ground check shall be completed before returning the facility to service.

(2) The system specialist should establish new, tighter reference operating limits if past flight inspections indicate this to be prudent. For instance, if previous flight inspections have found the wide alarm course width to be near the flight inspection tolerance limit, the sideband power at wide alarm may be increased. This will ensure that subsequent flight inspections will be in tolerance. Changes which loosen the reference ground check limits require a confirming flight inspection.

(3) The reference data must be measured very carefully. Power measurements must always be accomplished with the same meter and elements. The elements shall be clearly marked. In addition to the rf wattmeter readings, it is recommended that a digital voltmeter (dvm) be used to obtain reference readings for carrier and sideband power. These reference readings can be made with greater repeatability using the dvm than by using the analog wattmeter. This is done by connecting a digital voltmeter, set to measure dc voltage, to the detector element output in place of the normal meter. Improved consistency in dvm readings will result if the dvm input is shunted with a 1400 Ω ±1 percent resistor. This resistor presents the same load to the detector elements as the normal analog meter. If the reference readings are made with the load resistor in place, all future measurements must be made in this configuration.

c. Test Equipment Required.

(1) A portable ILS receiver (PIR).

(2) An appropriate antenna.

(3) A dvm (optional).

(4) The facility rf wattmeter.

d. Conditions. Ensure that the facility commissioning flight inspection or monitor flight inspection that required the establishment of new parameters met the initial tolerances of paragraph 3-30. A facility shutdown is required. The facility should be operating normally, and approval obtained from Air Traffic to operate on the ILS runway when required.

e. Detailed Procedure.

(1) Using the values established during flight inspection, enter on FAA Form 6750-24 on the reference line, values for normal carrier and sideband power, carrier feedline DDM, and monitor course and width DDM.

(2) If applicable, insert the operating tolerance for each entry completed on FAA Form 6750-24. Refer to steps (6)(a)1 through 3 of this procedure for further guidance.

(3) Confirm that the carrier feedline modulation balance is normal, as established during flight inspection.

(4) Normal.

(a) Verify that the carrier and sideband powers are at the levels established during flight inspection.

(b) At the edge of course, centerline, and low clearance ground check points, carefully measure the DDM values, and record data on FAA Form 6750-23 on the reference line.

(c) Insert the operating tolerance for each entry completed above on FAA Form 6750-23. Refer to steps (6)b)1 and 2 for further guidance.

(5) Abnormal case DDM test (only performed during reference ground check).

(a) Decrease the course transmitter sideband power to the wide alarm power established by flight inspection.

(b) At two-frequency localizers, adjust the clearance transmitter sideband and carrier power to the established wide-alarm power value.

SECTION 3. SPECIAL MAINTENANCE PROCEDURES (Continued)

SUBSECTION 2. LOCALIZERS (Continued)

(c) At each established clearance ground check point, carefully measure the DDM value.

(d) Determine if the DDM value measured has decreased from that measured in step (4)(b). If the value increased or did not change, it indicates that abnormal case DDM exists at this particular azimuth (ground check point). (Refer to paragraph 5-172 for more information on abnormal case DDM.)

(e) On FAA Form 6750-23, enter abnormal case DDM on the CENTERLINE LOWER WIDTH and CLEARANCE DDM LIMITS line for any azimuth where abnormal case DDM exists.

(f) Restore the facility to service.

(g) At facilities with dual equipment (main and standby), repeat steps (1) through (5)(f).

(6) Guidelines for determining tolerances on FAA Forms 6750-23 and -24.

(a) FAA Form 6750-24, Localizer Monitor Reference Data.

1 WIDE ALARM SIDEBAND POWER TOLERANCE: Enter the reference value.

2 NARROW ALARM SIDEBAND POWER TOLERANCE: Enter the reference value.

3 COURSE SHIFT CARRIER FEEDLINE DDM: Enter the reference value.

NOTE: Standard, reference, and tolerance values are to be carried over when new forms are established.

(b) FAA Form, 6750-23, Localizer Normal Ground Check.

1 CENTERLINE and UPPER WIDTH DDM LIMITS IN NORMAL line.

a Add the course width operating tolerance from chapter 3 to the REFERENCE, EDGE value and enter the result in each EDGE column.

b Add the course position operating tolerance from chapter 3 to the REFERENCE, CENTERLINE-value and enter the result in the CENTERLINE column.

2 CENTERLINE LOWER WIDTH, and CLEARANCE DDM LIMITS line:

a Subtract the course width operating tolerance located in chapter 3 from the REFERENCE, EDGE values, and enter the results in each EDGE column.

b Subtract the course position operating tolerance located in chapter 3 from the REFERENCE, CENTERLINE value, and enter the result in the CENTERLINE column.

c Multiply each REFERENCE clearance check point value by the off-course clearance operating tolerance located in chapter 3, and enter the result in each clearance check point column except where abnormal case DDM exists. See step (5)(e).

(c) Two-frequency localizer with commissioned backcourse. To ground-check the backcourse, repeat the procedure in steps (1) through (6)(b)3c for the backcourse, using separate forms. Clearance check points are not required.

5-176. CENTERLINE CAPTURE RATIO.

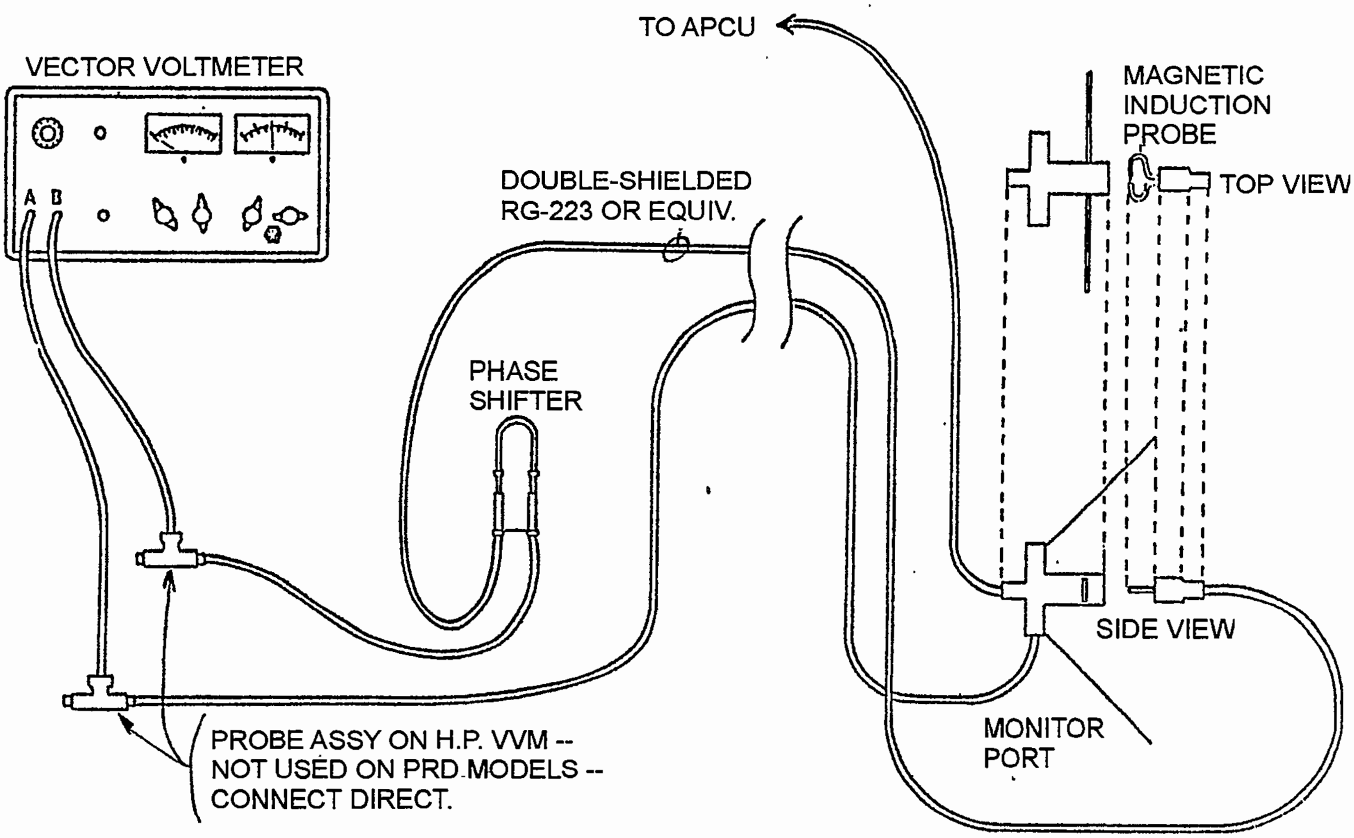
a. Object. This procedure provides a method to determine that the transmitted signal level ratio between the course and clearance transmitters is within established limits.

b. Discussion. Two-frequency localizer systems have a course and clearance transmitter separated by approximately 9 kHz. On the runway centerline, an approaching aircraft should be receiving primarily the course signal, while the clearance signal level should be significantly less than the course signal level. The ratio of these two signal levels, expressed in dB, is called the centerline capture ratio. As the ratio between the two signals increases, the aircraft receiver will respond primarily to the stronger of the two, and will be said to have been captured by the stronger signal. At a normally operating two-frequency localizer, the course signal should be at least 10 dB stronger on the runway

SECTION 3. SPECIAL MAINTENANCE PROCEDURES (Continued)

SUBSECTION 3. GLIDE SLOPES (Continued)

FIGURE 5-8. CONFIGURATION FOR MAKING PROBE MEASUREMENTS



SECTION 3. SPECIAL MAINTENANCE PROCEDURES (Continued)

SUBSECTION 3. GLIDE SLOPES (Continued)

5-191. ESTABLISHING A GROUND-PHASING REFERENCE POINT.

a. Object. This procedure provides a method to locate and permanently establish a ground-phasing point, which will be used to properly phase the signals radiated by the glide slope antennas.

b. Discussion. The initial phasing of all glide slope facilities is determined with the assistance of flight inspection. Once the facility is properly phased, a ground- phasing point is established that allows subsequent facility phasing to be accomplished without flight inspection.

c. Test Equipment Required.

(1) A portable ILS receiver (PIR).

(2) A glide slope antenna. (The localizer antenna with screw-on elements (which mounts on the PIR) should not be used.)

(3) Dummy loads.

(4) A quadrature (90°) line section.

d. Conditions. A facility shutdown is required for this check, and the facility must be properly phased and must meet the requirements of paragraph 5-192. At sideband reference and capture-effect facilities, APCU internal phase and amplitude adjustments must be correct.

e. Detailed Procedure.

(1) Selecting a ground-phasing point.

(a) The ground-phasing point should be between the runway threshold and the middle marker on the extended runway centerline or, if necessary, on the glide slope side of the runway, as close to the runway centerline as possible.

(b) There should be no significant horizontal reflectors, such as overhead power lines or fences, nor any significant terrain perturbations such as ditches, banks, hills, or mounds of dirt between the ground phasing point and the facility.

(c) All GS antennas should be line-of-sight from the phasing point.

(2) Evaluation of the proposed ground-phasing point.

(a) Ensure that the system modulation balance is 0 DDM, and the quadrature line section is 90° ±2°. Using the 90° line section, place the facility in quadrature. At CEGS facilities, disconnect and dummy load (or turn off) the clearance transmitter; disconnect and dummy load the * upper antenna and APCU upper antenna output, and configure the APCU for CSB in the lower antenna only. *

(b) At the proposed ground-phasing point, using a directional antenna held at head height (facing the facility), read and note the reference DDM. Ideally, this value should be near 0 DDM for a reflection-free site.

(c) Slowly pan the antenna from side to side approximately ±30° from the facility antennas. Changes in DDM should not exceed 0.05. If significant reflections are present at the proposed phasing point, pointing the directive antenna at the reflection source will increase its contribution to the total received signal. If the DDM changes more than, 0.05 DDM, attempt to locate a better location.

(d) Move the PIR and directional antennas to points approximately 100 ft (30 m) in front of and behind the proposed phasing point while remaining on the runway centerline (or extended centerline). At each position, aim the antenna at the facility and note the DDM at each point. Ideally, the DDM readings should be the same as at the proposed site. The difference between the proposed phasing point and each 100-ft (30 m) displaced point should not exceed 0.025 DDM for a high-quality phasing point.

(3) Establishment of reference ground-phasing values.

(a) With the facility still in the condition described in step (2)(a), measure and record the DDM value at the phasing point.

(b) At CEGS facilities only, perform the following additional steps.

1 Reconnect the upper antenna feedline to the APCU.

SECTION 3. SPECIAL MAINTENANCE PROCEDURES (Continued)

SUBSECTION 3. GLIDE SLOPES (Continued)

2 Disconnect and dummy load the middle antenna feedline and APCU middle antenna output.

3 Measure and record the DDM value at the phasing point.

(c) Restore the facility to service.

(d) On a map or drawing, mark the position of * the phasing point. The date, method used, and the far-field phasing values shall be identified on the appropriate facility drawings. Record the reference DDM reading(s) for future * reference. This data will be required whenever the system is phased.

5-192. AIRBORNE VERIFICATION OF FACILITY PHASING.

a. Object. This procedure provides a method to verify the validity of ground phasing of the glide slope facility or to properly phase the facility so that a ground phasing reference point can be established.

b. Discussion. The initial verification of facility ground phasing by flight inspection personnel is accomplished at commissioning, and subsequently, as required by current directives. The proof of valid system phasing is airborne dephasing checks. Dephasing should be done with type N elbows rather than phasers to eliminate calibration or reading errors.

c. Test Equipment Required.

(1) Identical type N elbows (which are 17 to 19 electrical degrees in length at glide slope frequencies).

(2) The flight inspection aircraft.

d. Conditions. A facility shutdown is required for this check.

e. Detailed Procedure for Null-Reference Facilities.

(1) Place two elbows in the upper antenna feedline to retard the SBO. Record the path width reported by flight inspection on FAA Form 6750-4. Remove the elbows.

(2) Place two elbows in the lower antenna feedline to advance the SBO. Record the path width reported by flight inspection personnel and compare the value with the width recorded in step (1). The path width should increase symmetrically from the optimum phase condition for each dephased condition (within flight inspection measurement accuracy and repeatability, typically 0.03° to 0.05°). If the width did not increase symmetrically, the facility is not at optimum phase. Adjust the facility phaser to correct the nonsymmetry and repeat this procedure.

(3) Restore the facility to service.

f. Detailed Procedure for Sideband-Reference Facilities.

(1) Place one elbow in the upper antenna feedline to retard the upper antenna. Record the path width, path angle, and the structure below path angle (190-µA point) reported by Flight Inspection on FAA Form 6750-4.

(2) Remove the elbow from the upper antenna feedline. Place the elbow in the lower antenna line to advance the upper antenna phase. Record the path width, path angle, and structure below path angle, and compare the values with the values obtained in step (1). The path width should symmetrically increase, and the path angle and structure angle should symmetrically lower for both dephased conditions (within flight inspection measurement accuracy and repeatability, typically 0.03° to 0.05°). If these conditions are not met, the facility is not at optimum phase. Adjust the facility phaser to correct the nonsymmetry and repeat this procedure.

(3) Restore the facility to service.

g. Detailed Procedure for Capture-Effect Facilities.

(1) Place one elbow in the middle antenna line to retard the middle antenna. Record the path width, path angle, and the structure below path angle (190-µA point) reported by Flight Inspection on FAA Form 6750-4.

(2) Remove the elbow from the middle antenna feedline. Place one elbow in the lower antenna feedline and one elbow in the upper antenna feedline simultaneously to advance the middle antenna. Record the path width, the path angle, and the structure below path angle. Compare the values with the values recorded in step (1). The path width should symmetrically widen, the path

SECTION 3. SPECIAL MAINTENANCE PROCEDURES (Continued)

SUBSECTION 3. GLIDE SLOPES (Continued)

angle should not change, and the structure angle should drop symmetrically (within Flight Inspection measurement accuracies). If these conditions are not met, the facility is not at optimum phase. Adjust the facility lower antenna phaser to correct the nonsymmetry and repeat this procedure.

(3) Remove the elbows in the lower and upper antenna feedlines. Insert three elbows into the upper antenna feedline to retard the upper antenna. Record the path angle and structure below path reported by flight inspection. (The path width is unaffected by upper antenna dephasing.)

(4) Remove the three elbows from the upper antenna feedline, and insert them into the middle antenna feedline. Insert three additional elbows into the lower antenna feedline to advance the upper antenna. Record the path angle and structure below path reported by flight inspection personnel. Compare these readings to those obtained in step (3). The path angle and structure below path for each dephased condition should be reduced symmetrically from the optimum phase condition (within flight inspection measurement accuracy and repeatability).

(5) If the conditions in step 4 are not met, adjust the upper antenna phaser and repeat steps (3) and (4) to correct the nonsymmetry.

(6) Restore the facility to service.

5-193. GLIDE SLOPE PATH WIDTH ADJUSTMENT.

a. Object. This procedure provides a method to adjust the glide slope path width.

b. Discussion. Glide slope path width is adjusted by changing the sideband-only (SBO) power output of the facility. Path width varies inversely as the square root of sideband power, with carrier power held constant. Temporary sideband power changes are necessary to establish certain reference readings or to check alarm points. Permanent changes from established references are seldom needed or justified. Do not use SBO power level adjustments to compensate for equipment faults or system changes. This adjustment procedure is intended to expedite corrections that may be required during flight inspection. Prior to adjusting path width, ascertain that the system is properly phased, and that APCU power ratios are correct.

c. Test Equipment Required. A wattmeter and detector elements.

d. Conditions. A facility shutdown is required for this check.

e. Detailed Procedure.

(1) Measure and record the existing carrier and sideband power outputs for reference.

(2) Divide the existing path width by the desired path width, square the result, and multiply by the existing sideband power.

* $$\text{SB Power}_{(New)} = \text{SB Power}_{(Exist)} \left(\frac{\text{PW (Exist)}}{\text{PW (Desired)}} \right)^2$$ *

(3) Adjust the sideband power to the result of step (2) to produce the path width desired.

(4) Verify the new path width.

(5) Restore the facility to service.

5-194. AN/GRN-27(V) CAPTURE-EFFECT SYSTEM PHASING.

a. Object. This procedure provides a method to ground phase the AN/GRN-27(V) capture-effect system so that the correct carrier and sideband-only phase relationships are distributed between the three antennas, and to correctly phase the antennas to each other.

b. Discussion. Capture-effect system phasing affects path angle, path width, path symmetry, and below path clearances. The AN/GRN-27(V) capture-effect configuration does not contain rf phasers in the antenna feedlines. Therefore, this procedure converts the capture-effect facility to a null-reference facility, without changing the phase of the lower carrier and middle sideband signals from their normal relationship in the capture-effect configuration. The main sideband phaser is used to make all phase measurements. This procedure uses quadrature DDM indications entirely, rather than rf nulls.

(h) Restore the facility to service.

* *

5-197. LOCATION OF END-FIRE GROUND CHECK POINTS.

a. Object. This procedure defines the location of the five ground check points used with the end-fire glide slope system.

b. Discussion. The end-fire glide slope angle can be ground-checked by lowering the path to ground level and then measuring the DDM at several locations in the transverse structure. This procedure establishes five ground check points, three directly in line between the field monitors and the phase center and on a line perpendicular to runway centerline, and one point on each side of the course array main beam.

c. Test Equipment Required.

(1) A tape measure.

(2) A means of permanently marking the ground check points.

d. Detailed Procedure.

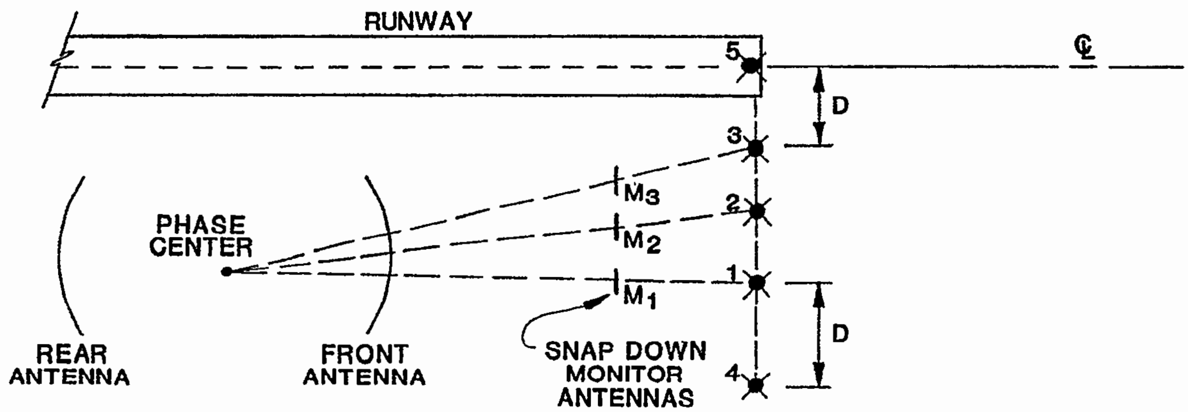
(1) Using figure 5-10, locate the ground check points 1, 2, and 3. These points are an extension of lines from the phase center through the midfield monitors M1, M2, and M3.

(2) With the clearance transmitter off and the path up, locate 0 DDM points on the edges of the main beam where DDM is in rapid transition from high 150 to high 90 Hz. These are points 4 and 5 on figure 5-10.

(3) Establish permanent ground check markers, using either spray paint or concrete markers.

(4) Restore the facility to service.

FIGURE 5-10. LOCATING GROUND CHECK MARKERS (END-FIRE GS)



5-198. END-FIRE SNAP-DOWN MONITOR ADJUSTMENT.

a. Object. This procedure adjusts the end-fire glide slope snap-down monitor assembly.

b. Discussion. The snap-down provides a field monitor of the end-fire glide slope path angle. It accomplishes this by lowering the path to ground level for 100 microseconds, approximately 60 times per second. Pin diode switches are used to add phase delay and attenuation to the front course antenna. The phase delay lowers the path to ground level, and the attenuation compensates for the difference in the distance from the field monitor antennas to the front and rear course antennas. The received signal from the front course antenna is then approximately the same amplitude as the rear course antenna signal. During the snap-down period, the clearance signal is turned off to prevent its interaction with the course signal.

c. Test Equipment Required.

(1) A digital voltmeter (dvm).

(2) An oscilloscope.

d. Condition. A facility shutdown is required for this check.

e. Detailed Procedure.

(1) Using the dvm, measure the following sync card voltages referenced to chassis ground (TP0).

(a) Check between TP3 and ground (TP0) for +15 V dc.

(b) Check between TP4 and ground (TP0) for −15Vdc.

(c) Measure between TP2 and chassis ground (TP0) for +5.00 volts. Adjust using REF R8 if necessary.

(d) Connect dvm between TP1 and chassis ground (TP0).

(e) Adjust GAIN R1 for +4.3 V dc.

(2) Connect an oscilloscope to the waveform jack on the door.

(3) Set the METER SELECTOR switch to R (rear main antenna), and observe the 90 and 150 Hz modulation pattern shown in figure 5-11(a). This pattern is not the same as CSB due to the addition of quadrature sidebands.

SECTION 3. SPECIAL MAINTENANCE PROCEDURES (Continued)

SUBSECTION 3. GLIDE SLOPES (Continued)

5-199. SNOW REMOVAL PROCEDURE.

a. Object. This procedure provides guidance to the maintenance specialist for various snow accumulation conditions.

b. Discussion.

(1) Signal samples used to analyze and control operation are obtained and processed to provide all indication of what the airborne user is receiving. Monitoring signals in lieu of actual far-field signals are obtained from integral samples. The integral monitor sample and far-field indication are essentially unaffected by small amounts of snow accumulation. When snow accumulation reaches a particular depth described in table 5-3, the action described for that snow depth shall be taken. Snow depth monitors located at selected glide slope facilities will alert the specialist when field accumulations approach prescribed limits.

TABLE 5-3. SNOW REMOVAL VERSUS SNOW DEPTH

<table>
<tr><th rowspan="2">ACTION TAKEN</th><th colspan="3">SNOW DEPTH</th></tr>
<tr><th>SBR < 6 in (15 cm) NR, CEGS < 18 in (45 cm)</th><th>SBR 6 to 8 in (15 to 20 cm) NR, CEGS 18 to 24 in (45 to 60 cm)s</th><th>SBR > 8 in (20 cm) NR, CEGS > 24 in (60 cm)</th></tr>
<tr><td>SNOW REMOVAL (See figure 1-1)</td><td>Removal not required. Restore full service and category.</td><td colspan="2">ILS Category I

Remove snow 50 feet (15 m) wide at mast widening to 200 feet (60 m) wide at 1000 feet (300 m) toward middle marker.

ILS Categories II and II

As above plus widen the area to include a line from the mast to the far edge of runway threshold.</td></tr>
<tr><td>NO SNOW REMOVAL</td><td>Restore full service and category.</td><td>All Categories

Restore to Category I service. Category D aircraft minima raised to localizer only.

Typical NOTAM text:

"Due to snow on the IXXX (appropriate identifier) glide slope, minima temporarily raised to localizer only for Category D aircraft." If applicable, "Category II NA[1]," or "Category II/III NA".</td><td>All Categories

Approach restricted to localizer only minima.

Typical NOTAM text:

"Due to snow on the IXXX (appropriate identifier) glide slope, minima temporarily raised to localizer only."</td></tr>
</table>

[1] NA (not authorized)

SECTION 3. SPECIAL MAINTENANCE PROCEDURES (Continued)

SUBSECTION 3. GLIDE SLOPES (Continued)

(2) One of the best monitoring concepts is the requirement to have specialists visually scrutinize the area of critical ground, and take action to remove any existing problem. Items which cause problems are easily spotted visually. There is no substitute for the specialist's skills in observation and analysis of the critical area for snow/ice depths, drifts, piling, obstruction to signals, etc., and exercising prudent judgments regarding requisite action.

(3) Image-type glide slope facilities with full integral monitoring are essentially insensitive to snow/ice buildup. Those facilities located in areas that have significant snow/ice accumulations require special attention as described in table 5-3.

c. Test Equipment Required. None.

d. Conditions. Refer to table 5-3 for snow conditions.

e. Detailed Procedure.

(1) Follow the guidance listed in table 5-3 for snow depths. Take appropriate action using a visual inspection, a snow depth monitor alarm, a near-field monitor alarm, or any appropriate combination of these.

(a) Visual Inspection. Refer to figure 1-1. Visually inspect the glide slope critical area. Determine the snow depth by visually averaging peaks and valleys. (Use a physical probing if necessary.) Large drifts or snow mounds must be leveled, compacted, or removed.

(b) Snow Depth Monitor Alarm. If a monitor alarms because of snow or ice conditions, remove snow or ice from the snow depth monitor. Remove, level, or compact snowbanks or drifts in the monitor area to conform to the average snow depth observed. Determine the snow depth and take action in accordance with table 5-3.

(2) The depth of snow banks along runways and taxiways in the glide slope snow clearance area (figure 1-1) must not exceed 2 ft (0.6 m). This height limitation applies only to the operation of the glide slope. At some airports, aircraft operation requirements (for example: wing-tip/ engine clearance) may dictate lower heights.

5-200. thru 5-209. RESERVED.

SUBSECTION 4. 75 MHZ ILS MARKERS

5-210. PHASING AND MATCHING TRANSMISSION LINE EQUIVALENCE OF COLLINEAR ARRAYS.

a. Object. This procedure provides a method to check the electrical length of the separate lines of the phasing and matching networks at the antenna.

b. Discussion.

(1) The line lengths in the phasing and matching sections of the collinear antenna are cut to an electrical length that will result in proper phasing and amplitude of the antenna element currents. The Y section of line is cut to equal the X section plus 180°. This has a direct relationship to the radiation pattern of the antenna. Unbalanced antenna element currents cause nonsymmetry in the radiation pattern and can result in flight inspection discrepancies. Causes of antenna element current unbalance include incorrect line lengths in the phasing and matching lines.

(2) This paragraph describes a method by which rf lines can be checked at their operating frequency.

c. Test Equipment Required. A vector voltmeter (vvm), a bidirectional coupler (Narda 3020A or equivalent), an rf signal source, and a 50 Ω dummy load.

d. Conditions. A facility shutdown is required for this check.

e. Detailed Procedure.

CAUTION: The input to the vvm must be limited to <10 mW. If the facility transmitter is used as the rf signal source, it must be attenuated properly to protect the input circuits of the vvm.

(1) Connect the vvm, bidirectional coupler, and low power signal source (an rf signal generator set to the facility frequency or the facility transmitter, properly attenuated).

CHAPTER 6. FLIGHT INSPECTION

6-1. GENERAL.

a. Contents. This chapter contains information that applies to the flight inspection of localizer, glide slope, and marker facilities. The general information regarding flight inspection of all facility types is contained in the latest edition of Orders 6000.15, General Maintenance Handbook for Airway Facilities, and 8200.1, United States Standard Flight Inspection Manual. Order 8200.1 contains special information pertaining to null-reference, sideband-reference, capture-effect, and end-fire glide slope facilities. Maintenance personnel are encouraged to familiarize themselves with the information contained in these directives, as well as this order, before participating in flight inspection activities.

b. Purpose of Flight Inspection. The purpose of the Flight Inspection program is to measure the ILS signal in space, provide correlated ground and airborne data at commissioning and on a periodic basis, and to determine system performance based on a traceable measurement standard. Flight inspection data is useful in determining facility deterioration and the necessity for facility upgrading to improve performance.

6-2. thru 6-4. RESERVED.

SECTION 1. AIRBORNE INFORMATION

6-5. AIRBORNE MEASUREMENTS.

a. General. Airborne measurements verify that the ILS signal in space meets all airborne tolerances and requirements. It is the responsibility of the system specialist to determine that the results of flight inspection personnel are adequate for facility verification via equipment or ground measurements once flight inspection personnel depart. The system specialist should consult information found in this chapter for further guidance concerning flight inspection. Airborne measurement tolerances may be found in Chapter 3, Standards and Tolerance.

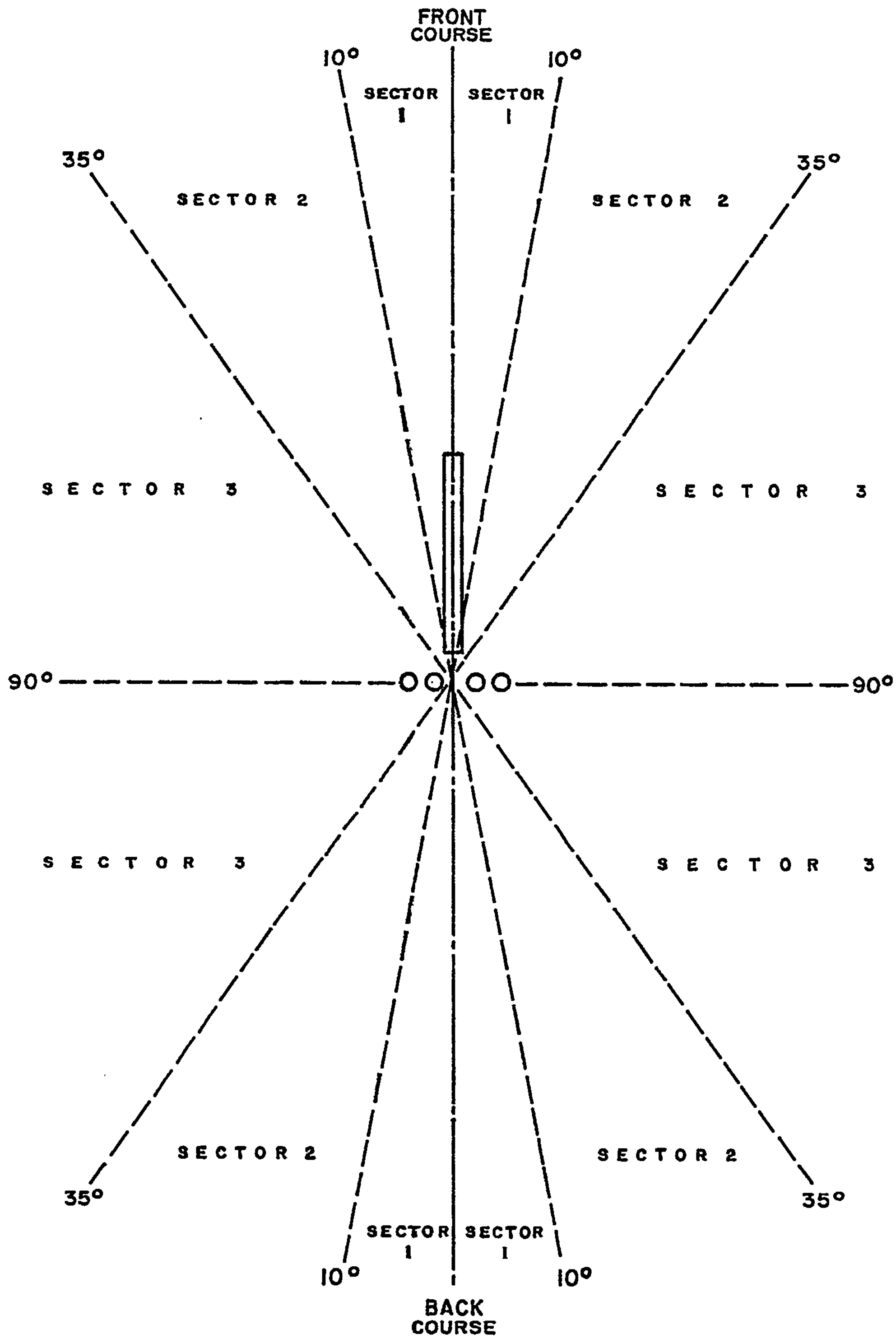
b. Initial Tolerances. Airborne measurement initial tolerances are slightly more restrictive than the flight inspection tolerances of Order 8200.1 and ARE NOT TOLERANCES IMPOSED UPON FLIGHT INSPECTION. These are Airway Facility tolerances applied ONLY when establishing facility reference values. These values are more restrictive than Order 8200.1 values to assure that the radiated signal is nearly optimum and never exceeds the published flight inspection values. This will help ensure that subsequent flight inspections (after accident, periodic, etc.) will not encounter discrepancies. During a flight inspection that establishes reference values, additional flight inspection runs shall be requested until initial tolerances are obtained. This is desirable since the reference values establish the operating limits which all subsequent monitor flight inspections and flight restorations must meet. However, due to the costs of additional flight inspection runs, optimizing the facility beyond initial tolerances should be avoided. For this purpose or with problem facilities, several types of signal-in-space evaluation packages have been developed and may be used.

c. Reference Values. When establishing reference values, the limit value furthest from the normal value and still within the range given for airborne initial tolerances should be used (e.g., for a localizer; 14 percent for wide and narrow alarm, 13 microamps for Category I course shift alarm, etc., for a Glide Slope; 0.87° for wide alarm, 0.53° for narrow alarm, etc.). This will allow for adjusting the monitors slightly tighter in normal day-to-day operation to account for expected facility drift, without setting them extremely tight, which would compromise availability.

d. Monitors Flight Inspection. Monitors flight inspections, subsequent to reference flight inspections, shall verify the reference values (radiated signal parameters) that were established during the reference flight inspection. These reference values, such as sideband power and system phasing, shall not be changed routinely in preparation for, or during, any subsequent flight inspection. All adjustments during a flight inspection shall be made to the radiated signal parameters without regard to the monitor indications. After flight inspection personnel depart, the monitor shall be adjusted for proper action when the radiated signal exceeds

SECTION 1. AIRBORNE INFORMATION (Continued)

FIGURE 6-1. LOCALIZER CLEARANCE SECTORS



the established reference values previously verified during the monitors flight inspection. If flight inspection personnel find a facility nearly out of tolerance, at the system specialist judgment, new tighter reference values may be established. When either of these occurs, a thorough investigation shall be made to determine why the reference values required changing.

6-6. FLIGHT INSPECTION SCHEDULES AND SPECIAL FLIGHT INSPECTIONS. Flight inspection is performed on a periodic basis, the period of inspection based on past facility performance. The facility monitor is checked during every other periodic inspection. Order 8200.1, section 105, list the intervals between inspections and explains the criteria for interval changes. Personnel should be aware of the inspection interval for their assigned facilities for planning purposes. When possible, facility changes requiring a flight check should be coordinated in conjunction with a scheduled periodic flight inspection.

6-7. BASIC DEFINITIONS. (Refer to figures 6-1 thru 6-3.)

a. Localizer Clearance Sector 1. From 0° to 10° each side of the localizer course.

b. Localizer Clearance Sector 2. From 10° to 35° each side of the localizer course.

c. Localizer Clearance Sector 3. From 35° to 90° each side of the localizer course.

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

e. Point A. An imaginary point on the localizer/glide slope on course located 4 nmi (7.4 km) from the runway threshold as measured along the extended runway centerline.

f. Point B. An imaginary point on the localizer/glide slope on course located 3500 ft (1065 m) from the runway threshold as measured along the extended runway centerline.

g. Point C. A point through which the downward extended straight portion of the glide slope (at commissioned angle) passes at a height of 100 ft (30.5 m) above the horizontal plane containing the runway threshold. For facilities without a glide slope, point C is the missed approach point (MAP).

h. Point D. A point 12 ft (3.66 m) above the runway centerline and 3000 ft (915 m) from the threshold toward the localizer.

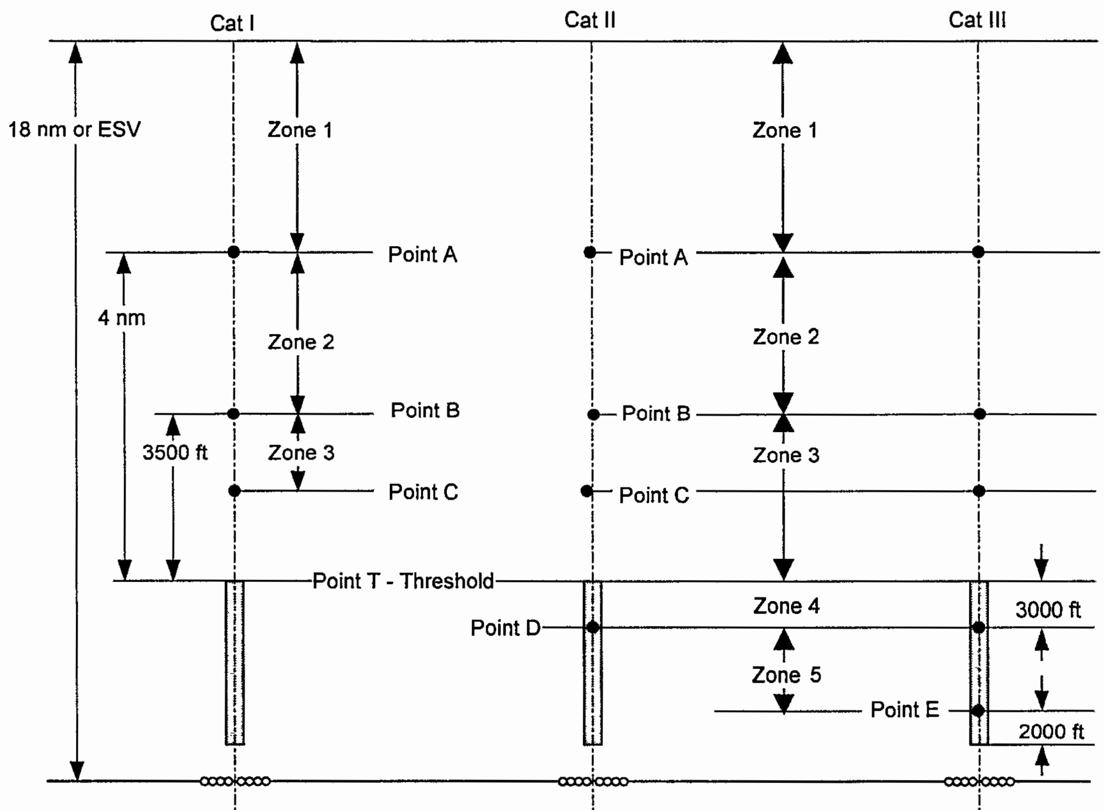
i. Point E. A point 12 ft (3.66 m) above the runway centerline and 2000 ft (610 m) from the stop end of the runway.

j. Zone 1. The distance from the coverage limit of the localizer/glide slope to point A on localizer course.

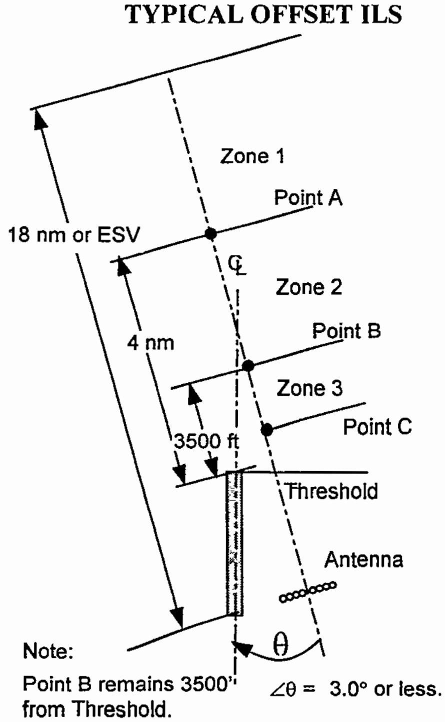
k. Zone 2. The distance from point A to point B on localizer course.

SECTION 1. AIRBORNE INFORMATION (Continued)

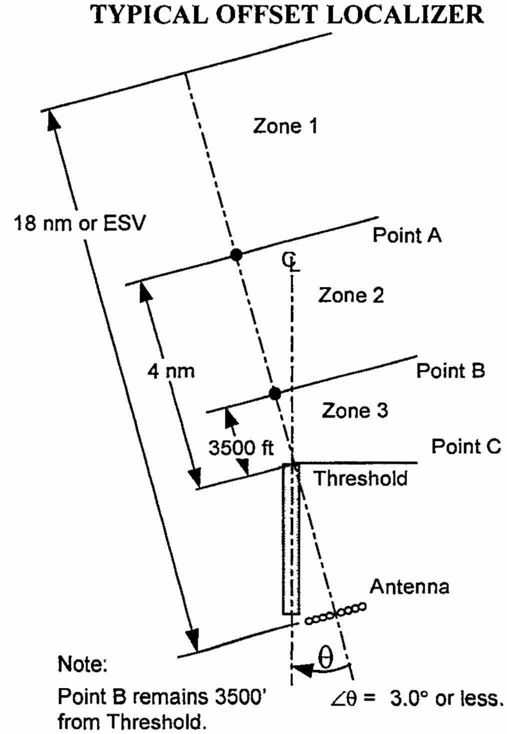
FIGURE 6-2. ILS POINTS AND ZONES



TYPICAL OFFSET ILS

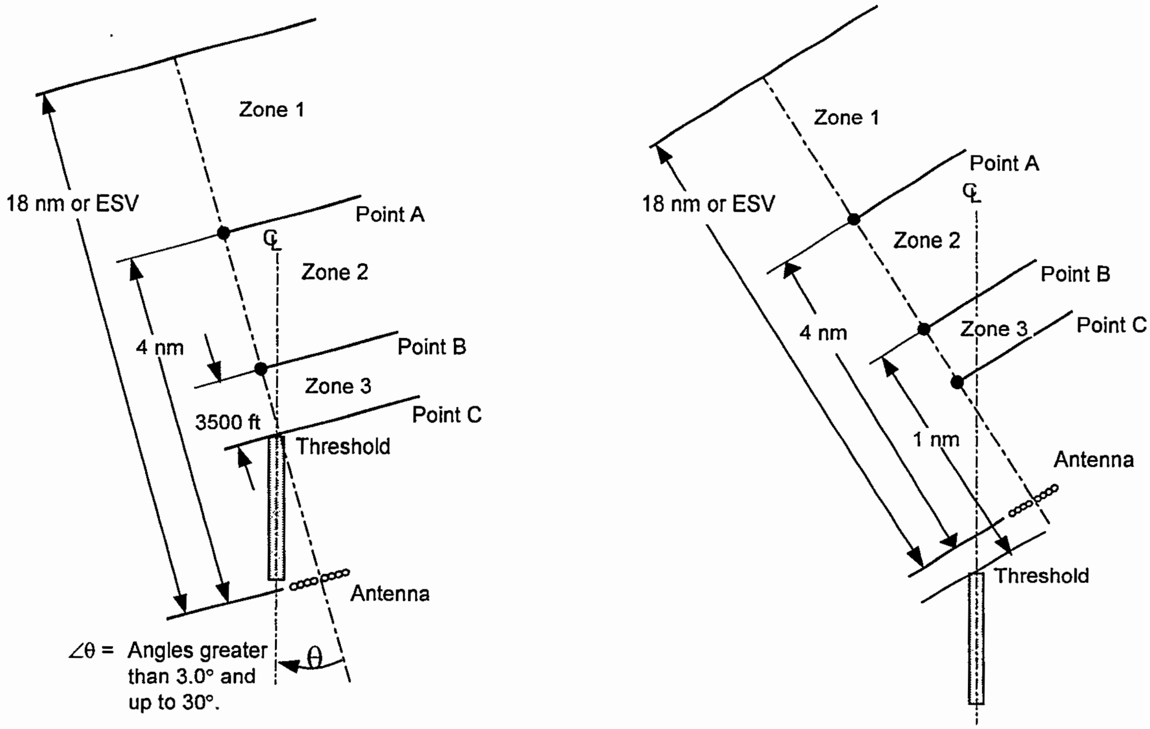


TYPICAL OFFSET LOCALIZER

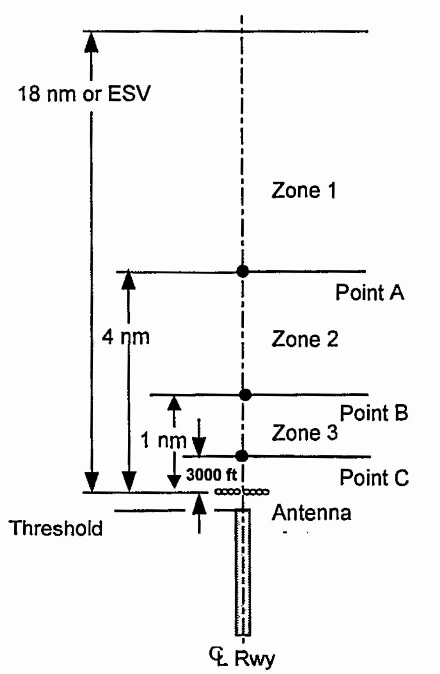


SECTION 1. AIRBORNE INFORMATION (Continued)

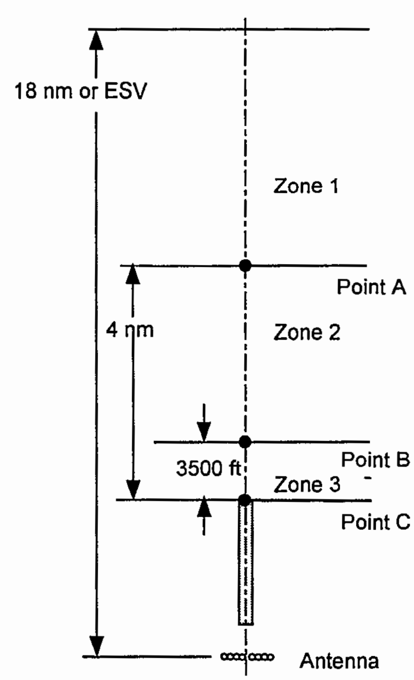
FIGURE 6-3. POINTS AND ZONES OF LDA'S



BACK COURSE LOCALIZER/SDF



LOCALIZER/SDF APPROACH



SECTION 1. AIRBORNE INFORMATION (Continued)

l. Zone 3. Category I: The distance from point B to point C on localizer course. Category II and III: The distance from point B to the runway threshold.

m. Zone 4. The distance from runway threshold to point D on localizer course.

n. Zone 5. The distance from point D to point E on localizer course.

o. Localizer Back Course Zone 1. The distance from the coverage limit to 4 nmi (7.4 km) from the localizer antenna on localizer course.

p. Localizer Back Course Zone 2. Four (4) nmi (7.4 km) from the localizer antenna to one (1) nautical mile from the localizer antenna on localizer course.

q. Localizer Back Course Zone 3. One (1) nmi from the localizer antenna to 3000 ft (915 m) from the localizer antenna on localizer course

r. Service Volume.

(1) Localizer. Coverage in sector 1 is 18 nmi from the localizer antenna and within 10° each side of runway centerline extended. The coverage of sector 2 is 10 nautical miles from the localizer antenna and from 10° to 35° each side of runway centerline extended. If there is a procedural requirement and the facility supports it, coverage may be required beyond 35° each side of centerline. If a back course is provided and used, the coverage is the same as for the front course.

(2) Glide Slope. Coverage is 10 nautical miles from the antenna and within 8° each side of the localizer on course at the final approach altitude.

(3) Extended Service Volume (ESV). When Air Traffic requires service beyond the normal limits, an ESV specifying the coverage area required is requested. The ESV must be within 10° of runway centerline extended and be approved by Frequency Management. All usable distance checks are performed with the facility in rf alarm.

* *

* 6-8. AUTOMATED FLIGHT INSPECTION SYSTEM (AFIS). *

a. General. The AFIS provides the capability to track the position of the flight inspection aircraft and provide computer analysis of most flight inspection data. The results are displayed to the Airborne Electronic Technician (AET) on a plasma display. Radio telemetry theodolite (RTT) positioning capability still exists on a few flight inspection aircraft and is available on special request. Graphic recordings are made during AFIS operation to retain the capability of detailed analysis and provide hard copy historical data.

b. Position Tracking. The position tracking of AFIS is an area navigation (RNAV) system consisting of a LaserRef * inertial reference unit (IRU), the navigation computer unit * (NCU), and a DME transponder update system. A control display unit (CDU) provides the man/machine interface with the system. When the system is powered-up, it is provided the latitude and longitude of the current aircraft position. Movement of the aircraft is then detected by the Iru in the form of velocities (N-S and E-W). Instead of mechanical gyro sensors, the system utilizes rings of polarized laser light to sense position changes. The NCU uses the on board database to constantly select DME stations in the vicinity of the aircraft and global positioning system (GPS) satellite signals for update information to correct any position errors within the system.

c. Areas of Poor DME Coverage. In areas of poor DME coverage or in the event of aircraft DME failure, position updates can be inserted manually utilizing known navaid antenna locations. GPS signals are also available for position updates with near 100 percent world-wide coverage available.

* **d. Receivers.** The flight inspection system has two vhf * omnidirectional radio range (VOR)/ILS receivers which are independent of those the flight crew uses for navigation. These receivers are dedicated to the measurement system and the NCU for computations. The AET can

SECTION 1. AIRBORNE INFORMATION (Continued)

select either, or both, receivers as input to the AFIS. All test equipment used to calibrate these receivers is calibrated to a source traceable to the National Institute of Standards and Technology (NIST).

e. Recorder. The flight inspection system includes a thermal dot-matrix printer operated as a 32-channel chart recorder with alphanumeric annotation provided by the NCU. The printer is automatically setup and scaled according to the mode of inspection initiated. The AET can also manually select channels and scaling. When an out-of-tolerance parameter is shown to exist during a flight inspection and difficulty is encountered in correcting the parameter, consider requesting the recording for further analysis.

6-9. AFIS ILS MODES. AFIS has three programmed modes for automatic data gathering and computation of ILS localizer and glide slope signals. The NCU uses the facility data available from the on board database and the programmed flight pattern to execute the specific check to be performed. A brief description of the AFIS ILS modes follows.

a. ILS-1 Mode (Localizer ARC).

(1) This mode evaluates the following conditions of the localizer:

(a) Localizer sector clearances.

(b) Signal strengths throughout the areas inspected.

(c) Width and symmetry.

(2) This mode is a partial orbit that can be flown either clockwise or counterclockwise at a set distance from the facility. Repeated measurements, required for monitor checks, may be conducted in an oval flight pattern. The crosspointer deviation is monitored in the front and back courses and values are recorded. The lowest clearance values and the bearing at which it occurred in each sector is displayed on the CDU.

b. ILS-2 Mode (Glide Slope Level Run).

(1) This mode evaluates the following conditions of the glide slope:

(a) Glide slope width.

(b) Symmetry.

(c) Below path structure (190 microamperes).

(d) Clearances.

(e) Alignment.

(2) The ILS-2 mode is flown at a constant altitude (normally the procedural intercept altitude) inbound along the runway bearing. The radiated signal is evaluated to calculate structure below path, width, symmetry, and clearances. During the run, the glide slope automatic gain control (agc) and modulation levels are monitored. Glide slope angle and width monitor checks may be performed with this mode. If the symmetry is out-of-tolerance during this run, it will be remeasured in the ILS-3 mode using above and below path runs.

c. ILS-3 Mode (ILS Approach).

(1) This mode evaluates the following conditions of the localizer, glide slope, and marker beacons:

(a) Glide slope and localizer alignment.

* (1) Localizer alignment:

a Front course alignment is the average course between one (1) nautical mile and the runway threshold.

b Back course alignment is the average course from two (2) to one (1) nautical miles from the localizer antenna.

(2) Glide slope angle alignment: Glide slope angle alignment is the average angle from point A to point B. *

(b) Modulation levels and structure.

(c) Widths and signal levels of marker beacons.

(2) The ILS-3 mode can evaluate either the front or * back course conditions. The mode will evaluate structure for the glide slope in zones 1, 2, and 3, and for the localizer in zones 1, 2, 3, 4, and 5. The mode will display the worst structure in each zone in microamps/nautical miles. * Position fixes are manually executed at the runway threshold and runway end along with centerline off-set.

SECTION 1. AIRBORNE INFORMATION (Continued)

With these updates, the NCU computes the correction to be applied to all data samples and computes alignment and structure for the localizer and glide slope.

(3) Offset localizers are checked in ILS-3 mode in the normal manner, except that the aircraft is flown manually down the runway for fix updates. Limitations of the system require that at the approach end of the runway, the aircraft be within 150 microamperes of the on course signal. Also, the ILS-3 mode will not correct data properly if the localizer antenna is located before the approach end of the runway.

(4) The ILS-3 mode may be programmed to measure symmetry of the glide slope path width throughout zone 2. This method will provide the final measurement when out-of-tolerance symmetry is found with the ILS-2 mode and on commissioning checks. Three runs are required, above path, below path, and on path. The aircraft is normally flown 75 microamperes above/ below path.

6-10. AIR-TO-GROUND COMMUNICATIONS AND MONITOR FLIGHT INSPECTION CHECKLISTS.

a. Transceivers. Flight inspection aircraft have one uhf and three vhf transceivers installed. The specialist and pilots must communicate via interphone. There are times, especially in high density traffic areas, when all communication systems are in use. This may prevent immediate response to the ground specialist. Because this can happen at any time, the crews appreciate a response to all calls as fast as possible with direct answers, particularly to inform the crew when the facility is ready for the next run.

b. Checklists. To expedite communications and more effectively use flight time, tables 6-1 through 6-7 provide checklists for monitors flight inspections of the different types of facilities. These checklists are a suggested sequence for best use of flight time and meet the requirements of the Order 8200.1. Using these checklists aids anticipation of and preparation for the next adjustment. While a flight inspection run is in progress, readings should be taken and any calculations for the next run may be made. * Ensure the airborne technician provides all required data for each run. If you need additional data, do not hesitate to ask for it. *

TABLE 6-1. SINGLE-FREQUENCY LOCALIZER PERIODIC WITH MONITORS

CHECK	*TRANSMITTER CONFIGURATION*
1. Course Width (Maintenance Request).	Normal
2. Course[1] (35° to 35°; Width, Clr).	Wide Alarm[2]
3. Course[1] (Ident, Mod Level, Width, Sym, Clr).	Normal
4. Approach[1] (Alignment, Structure, Mod Percent).	Normal

[1] Back course checks - if back course used.
[2] As established (reference point).

SECTION 1. AIRBORNE INFORMATION (Continued)

TABLE 6-2. DUAL-FREQUENCY LOCALIZER WITHOUT BACK COURSE PERIODIC WITH MONITORS

CHECK	*TRANSMITTER CONFIGURATION*	
	COURSE XMTR	*CLEARANCE XMTR*
1. Course Width (Maintenance Request).	Normal	Normal
2. Course (35° to 35°, Width, Clr).	Wide Alarm[1]	Wide Alarm[1]
3. Course (Ident, Mod Level, Width, Sym, Clr).	Normal	Normal
4. Approach (Alignment, Structure, Mod Percent).	Normal	Normal

[1] As established (reference point).

*

TABLE 6-3. DUAL-FREQUENCY LOCALIZER WITH BACK COURSE PERIODIC WITH MONITORS

CHECK	*TRANSMITTER CONFIGURATION*	
	COURSE XMTR	*CLEARANCE SMTR*
1. Front Course Width (Maintenance Request).	Normal	Normal
2. Front Course Width (35° to 35°). [1]	Wide Alarm	Wide Alarm
3. Front Course Width. [1]	Normal	Normal
4. Approach (Alignment, Structure, Mod Percent).	Normal	Normal
5. Back Course Width (35° to 35°). [1]	Wide Alarm	Wide Alarm
6. Back Course Width. [1]	Normal	Normal
7. Back Course Approach (Alignment, Structure, Mod Percent).	Normal	Normal

*

[1] Can be done as 1 run (full orbit).

SECTION 1. AIRBORNE INFORMATION (Continued)

TABLE 6-4. NULL-REFERENCE GLIDE SLOPE PERIODIC WITH MONITORS

CHECK[1]	*TRANSMITTER CONFIGURATION*
* 1. Path Width and Angle (Maintenance Request).	Normal *
2. Path Width and Angle.	Wide Alarm
3. Path Width and Angle.	Advance Phasing to Alarm (Report no. of degrees) [2]
4. Path Width and Angle.	Retard Phasing to Alarm (Report no. of degrees) [2]
5. Path Width and Angle.	Normal
6. Approach (Angle, Structure, Mod Percent).	Normal

[1] Structure Below Path Angle (190 microamperes) must be checked on all level runs.
[2] Fixed line sections may be used for dephasing checks.

TABLE 6-5. SIDEBAND-REFERENCE GLIDE SLOPE PERIODIC WITH MONITORS

CHECK[1]	*TRANSMITTER CONFIGURATION*
1. Path Width and Angle (Maintenance Request).	Normal
2. Path Width and Angle.	Wide Alarm
3. Path Width and Angle.	Upper Antenna Advanced to Alarm (Report no. of degrees) [2]
4. Path Width and Angle.	Upper Antenna Retarded to Alarm (Report no. of degrees) [2]
5. Path Width and Angle. [3]	Low Angle Alarm
* 6. Path Width and Angle. [3] (Maintenance Request).	High Angle Alarm *
7. Path Width and Angle.	Normal
8. Approach (Angle, Structure, Mod Percent).	Normal

[1] Structure Below Path Angle (190 microamperes) must be checked on all level runs.
[2] Fixed line sections may be used for dephasing checks.
[3] Only 1 transmitter if common power divider AND parallel monitors.

SECTION 1. AIRBORNE INFORMATION (Continued)

TABLE 6-6. CAPTURE-EFFECT GLIDE SLOPE PERIODIC WITH MONITORS

*

	TRANSMITTER CONFIGURATION	
CHECK[1]	*COURSE XMTR*	*CLEARANCE XMTR*
1. Path Width and Angle (Maintenance Request).	Normal	Normal
2. Path Width and Angle.	Wide Alarm	Mod Percent Alarm
3. Path Width and Angle.	Middle Antenna Advanced (Report no. degrees) [2]	Normal
4. Path Width and Angle.	Middle Antenna Retarded (Report no. degrees) [2]	Normal
5. Path Width and Angle.	Upper Antenna Attenuated to Path Alarm (Report dB)	Normal
6. Path Width and Angle	Normal	Normal
7. Approach (Angle, Structure, Mod Percent)	Normal	Normal

*

[1] Structure Below Path Angle (190 microamperes) must be checked on all level runs.
[2] Fixed line sections may be used for dephasing checks.

TABLE 6-7. END-FIRE GLIDE SLOPE PERIODIC WITH MONITORS

*

	TRANSMITTER CONFIGURATION	
CHECK[1]	*COURSE XMTR*	*CLEARANCE XMTR*
1. Transverse Structure Arc at FAF[2], 10° to 10°. (Maintenance Request).	Normal	Normal
2. Path Width and Angle (Maintenance Request).	Normal	Normal
3. Path Width and Angle.	Wide Alarm	Normal
4. High Angle and Path Width (Maintenance Request).	Main Array Dephased (Report no. degrees)[3]	Normal
5. Low Angle and Path Width.	Main Array Dephased (Report no. degrees)[3]	Normal
6. Path Width and Angle.	Normal	Normal
7. Approach (Angle, Structure, Mod Percent).	Normal	Normal

*

[1] Structure Below Path Angle (190 microamperes) must be checked on all level runs.
[2] Final approach fix.
[3] Fixed line sections may be used for dephasing checks.

SECTION 1. AIRBORNE INFORMATION (Continued)

6-11. FLIGHT INSPECTION REPORTS.

a. Discussion. Following flight inspection, a report is completed in accordance with the latest edition of Order 8240.36, Instructions for Flight Inspection Reporting. When the monitors are inspected, two forms are required: ★ FAA Form 8240-8, Flight Inspection Report — Instrument Landing System, and FAA Form 8240-9, Flight Inspection Report — Instrument Landing System Supplement Sheet. These forms are discussed here in general. For more detail, refer to Order 8240.36. FAA Form 8240-8 contains the majority of the localizer data, all normal glide slope data, and ancillary equipment information. FAA Form 8240-9 contains all glide slope monitor and airborne phasing data. Both forms contain facility name, ★ identification, and date of inspection. Reported data by flight inspection is usually derived from the AFIS computer announcements and manual analysis of the facility recordings.

★ **b. FAA Form 8240-8, Flight Inspection Report — Instrument Landing Systems.** ★ Refer to figure 6-4. The column labeled OT to the left in front course, back course, and glide slope data columns in fields 8 and 9 will not have any marks unless an out-of-tolerance condition was found during the inspection. When a parameter was found out of tolerance and corrected, a C is placed in the OT column on the line corresponding with the INITIAL column value. If the out-of-tolerance condition was not corrected during the inspection, an X is placed in the OT column on the line corresponding with the FINAL column value. All uncorrected out-of-tolerances are explained in the REMARKS section. The FINAL column is for the "as left" values after all adjustments have been made. Both fields have a line for system category, i.e., 1, 2, or 3. The assigned category does not change even if the facility fails to meet category 2 or 3 tolerances. To change the category designation, the system and approach plates must be changed.

★ **(1) Fields 1 through 7.** Self-explanatory: Identify ★ the system by airport, identification, date, owner, type of inspection, and which component(s) of the system were inspected.

★ **(2) Field 8, Localizer:** Contains localizer front and ★ back course data.

★ (a) Comd Width: The established optimum course width for the facility. This is normally the "Tailored" width but may be other than "Tailored" for CAT I systems. See paragraph 6-34a. ★

(b) Category: Lowest minima performance category of the facility (I, II, or III).

NOTE: A, B, or C are not used for report.

(c) TX1/TX2 OT column: Under the appropriate transmitter number, an "X" is entered for any out-of-tolerance condition found and not corrected during the inspection. A "C" is entered whenever the condition is corrected.

(d) TX1/TX2 Initial column: Under the appropriate transmitter number the "as found" operating condition is entered if this condition was changed or altered during the inspection.

(e) TX1/TX2 Final column: Under the appropriate transmitter number the operation condition at the completion of the inspection is entered. Also used to report results of after accident checks.

(f) Course Width: The measured width in normal.

(g) Modulation: The measured modulation of approach run (ILS Mode-3).

(h) Clearance 150: Lowest value on 150 Hz side. Reported as microamperes/degrees. Measured with width in normal. Usually only reported on commissioning and periodic inspection WITHOUT monitors.

(i) Clearance 90: Lowest value on 90 Hz side. Reported as microamperes/degrees. Measured with width in normal. Usually only reported on commissioning and periodic inspection WITHOUT monitors.

(j) Course Structure-Z1 through -Z5: The roughness, scalloping, or bends in the respective zones as measured during the approach run. The values are shown as microamperes/nautical miles from the runway threshold. These values are the worst or closest to tolerance values for each ★ zone. Zone 1 results are measured as deviation from the ★ graphical average. Values of zones 2 and 3 represent deviation of the course from the measured average alignment.

SECTION 1. AIRBORNE INFORMATION (Continued)

* FIGURE 6-4. SAMPLE FAA FORM 8240-8, FLIGHT INSPECTION REPORT *

FLIGHT INSPECTION REPORT--INSTRUMENT LANDING SYSTEM	REVIEW INITIALS
1. LOCATION:	2. IDENT:
3. RUNWAY NO: / 4. DATE(S) OF INSPECTION:	5. OWNER:

6. TYPE OF INSPECTION						
		SITE EVALUATION		PERIODIC		SPECIAL
		COMMISSIONING		SURVEILLANCE		INCOMPLETE

7. FACILITY INSPECTED											
		LOCALIZER		SDF		GLIDE SLOPE		75 mHz MARKERS		DME	
		LDA		TLS		LIGHTING SYSTEM		COMPASS LOCATORS		OTHER	

8. AZIMUTH

FRONT COURSE						COMD WIDTH:	BACK COURSE					
TX 1			TX 2				TX 1			TX 2		
O T	INITIAL	FINAL	O T	INITIAL	FINAL	CATEGORY:	O T	INITIAL	FINAL	O T	INITIAL	FINAL
						COURSE WIDTH						
						MODULATION						
						CLEARANCE 150						
						CLEARANCE 90						
						COURSE STRUCTURE-Z 1						
						COURSE STRUCTURE-Z 2						
						COURSE STRUCTURE-Z 3						
						COURSE STRUCTURE-Z 4						
						COURSE STRUCTURE-Z 5						
						VERTICAL POLARIZATION						
						SYMMETRY						
						ALIGNMENT						
						VOICE						
						IDENTIFICATION						
						USABLE DISTANCE						
						MONITOR						
						COURSE WIDTH *(Narrow)*						
						COURSE WIDTH *(Wide)*						
						CLEARANCE 150						
						CLEARANCE 90						
						ALIGNMENT 150 (L)						
						ALIGNMENT 90 (R)						

9. GLIDE SLOPE

TX 1			TX 2			COMD ANGLE:
O T	INITIAL	FINAL	O T	INITIAL	FINAL	CATEGORY:
						ANGLE
						MODULATION
						WIDTH
						CLEARANCE BELOW PATH
						STRUCTURE BELOW PATH
						PATH STRUCTURE-Z 1
						PATH STRUCTURE-Z 2
						PATH STRUCTURE-Z 3
						USABLE DISTANCE
						SYMMETRY

10. GENERAL

	SAT	UNSAT
75 mHz MARKERS		
COMPASS LOCATORS		
D M E		
LIGHTING SYSTEMS		

11. FACILITY STATUS

	F / C	G / S	B / C
UNRESTRICTED			
RESTRICTED			
UNUSABLE			
ILS CLASSIFICATION SYSTEM			

NOTAM's:

12. REMARKS:

REGION:	FLIGHT INSPECTOR 'S SIGNATURE:	TECHNICIAN 'S SIGNATURE:	AIRCRAFT NO :
FIO:			

FAA FORM 8240 - 8 (3/2000) (FORMFLOW) (Formerly FAA Form 8240-7)

SECTION 1. AIRBORNE INFORMATION (Continued)

(k) Vertical Polarization: The amount of course displacement in microamperes caused by vertical polarization, and the distance the check was conducted at (e.g., 2 microamperes/8.0 nautical miles; 2/8.0).

(l) Symmetry: The percentage of symmetry of the 90 Hz side.

(m) Alignment: The value is the average number of microamperes (μA) left or right of the localizer course from runway centerline (or procedural course in the case of offset localizers or LDA's) measured through the alignment area. A report of a 5-μA left would indicate that the course centerline was found to the left of runway centerline, and that an approximate increase of 0.005 DDM/90 Hz would be necessary to move the front course centerline over to the runway centerline. Reverse sensing occurs on the back course; therefore, a report of a 5 μA left would require an increase of 0.005/150 Hz to correctly align the back course.

(n) Voice: If localizer has voice capabilities, shown as an S (satisfactory) or U (unsatisfactory). Voice should not cause any other parameter to exceed tolerance.

(o) Identification: As with voice, an S or U. Identification is checked for correctness and clarity, not level. Identification is checked throughout the coverage area of the localizer.

(p) Usable Distance: Normally checked on commissioning only. It may be checked when coverage is suspect or an extended service volume (ESV) is requested by Air Traffic. When inspected, facility is in rf alarm and distance is in nautical miles.

(q) Monitor: Last date all monitor functions were
* inspected. Flight inspection no longer reports this date.

(r) Course Width (Narrow): Measured width in narrow alarm.

(s) Course Width (Wide): Measured width in wide alarm.

(t) Clearance 150: Lowest value on 150 Hz side in wide alarm for single-frequency localizers or course wide/clearance wide alarms for two-frequency localizer. *
Reported as microamperes/degrees.

(u) Clearance 90: Lowest value on 90 Hz side in wide alarm for single-frequency localizers or course wide/clearance wide alarms for two-frequency localizer.
* Reported as microamperes/degrees. *

(v) Alignment 150: Alignment monitor value reported in microamperes. The 150 Hz entry is the course displaced to the right of centerline as viewed at the threshold facing the localizer. To achieve this requires an increase in the 90 Hz modulation of the modulation balance in the localizer signal.

(w) Alignment 90: Alignment monitor value reported in microamperes. The 90 Hz entry is the course displaced to the left of centerline as viewed at the threshold facing the localizer.

NOTE: When there is a procedural use for the back
* course, the measured values are entered in the appropri- *
ate columns. For localizers with independently monitored and adjustable back course alignments (waveguide), alignment monitor values shall be shown. Usually monitor inspection reports will not have values for clearances in normal, as the clearances are checked in worst case alarm conditions.

* **(3) Field 9, Glide Slope:** *

(a) Commissioned Angle: The assigned angle prior to commissioning. This angle is the design value used by flight standards personnel prior to establishing the facility.

(b) Category: Lowest minima performance category of the facility (I, II, or III). Note: A, B, or C are not used for report.

(c) TX1/TX2 OT Column: Under the appropriate transmitter number, an "X" is entered for any out-of-tolerance condition found and not corrected during the inspection. A "C" is entered whenever the condition is corrected.

(d) TX1/TX2 Initial Column: Under the appropriate transmitter number "as found" operating condition is entered if this condition was changed or altered during the inspection.

(e) TX1/TX2 Final Column: Under the appropriate transmitter number the operation condition at the

SECTION 2. FACILITY INFORMATION

completion of the inspection is entered. Also used to report results of after accident checks.

(f) Angle: The actual measured angle is entered; if not the same as the commissioned angle.

(g) Modulation: The measured modulation on approach run (ILS-3 Mode-3).

(h) Width: The measured width in normal.

(i) Clearance Below Path: Normally this is only checked and reported at commissioning. However, it may be checked at other times when clearance appears to be a problem (structure below path angle is low or can't be found). When reported, it will be a S or U. Clearance below path with the facility in normal must be 180 microamperes of 150 Hz from the final approach fix (FAF) to point C (category I) or threshold (category II/III) with the aircraft clearing all obstacles.

(j) Structure Below Path: The highest measured angle at which 190 microamperes of 150 Hz occurs with the facility at normal width. This must be no lower than 30 percent of the commissioned angle and is an indication of below-path clearances.

(k) Path Structure -Z1, -Z2, and -Z3: Similar to localizer course structure above. Zone 1 values are measured based on the graphical path average. Zone 2 is the deviation from the measured average angle, and zone 3 is also a graphical average. Zones 1, 2 and 3 values are computer announced. Values are reported as microamperes/nautical miles.

(l) Usable Distance: Same as that of localizer.

(m) Symmetry: The percentage of symmetry of the 90 Hz side.

(n) Monitor: Last date all monitor functions were inspected. Flight inspection no longer reports this date.

(4) **Field 10, General:** Provides documentation of visual aids and facilities that are checked concurrently with the ILS. Any unsatisfactory (UNSAT) condition will be listed in the remarks section. Unless there is a DME at the localizer, the identification and facility type will be entered following DME, e.g., XYZ, VTAC, ZYX, VDME. This is done where a DME other than an ILS DME is part of the procedure.

(5) **Field 11, Facility Status:** Indicates if an ILS facility meets all requirements or if it has a restriction. When removed from service by flight inspection, the UNUSABLE line will be marked. Any change must have a Notice to Airmen (NOTAM) issued by the Flight Inspection Office (FIO). The NOTAM field is only for NOTEM's issued due to this inspection. The ILS Classification System entry indicates the furthest point that the localizer structure meets category III tolerances. This data is used to support autolandings. Reference 6750.24.

(6) **Field 12, Remarks:** Must contain objective information. May include any comments and additional data needed to document and explain results.

(7) **Region:** The three-letter code of the region in which the facility is located.

(8) **FIO:** The three-letter code of the FIO conducting the inspection.

(9) **Flight Inspector's Signature:** Certifies the operational status of the facility and that the facility supports the approved instrument flight procedure(s) inspected.

(10) **Specialist's Signature:** Followed by "ET," certifies that the data reported conforms to national standards and specifications, and is complete and accurate.

(11) **Aircraft No.:** Contains the flight inspection aircraft "N" number.

SECTION 1. AIRBORNE INFORMATION (Continued)

★ **c. FAA Form 8240-9, Flight Inspection Report - Instrument Landing System Supplement Sheet. Refer to figure 6-5.** ★

(1) **Fields 1 through 3:** Self-explanatory.

(2) **Field 4, Glide Slope:** Lines 4a through 4j provided to cover monitor checks for all types of glide slope systems. Only those that apply to the facility being reported will be filled in. All lines contain angle, width, and structure below path (190-microampere angle).

(a) Glide Slope Type: Null-reference (NR); Sideband-Reference (SBR); Capture-Effect (CE); or End-Fire (EF).

(b) Dephase; Advance and Retard: The system dephased to the established reference alarm value. The number of degrees advanced and retarded must be reported for each transmitter. The dephasing check reported depends on the facility type:

Null-reference	Main Sideband Phaser
Sideband-reference	Upper Antenna Phaser
Capture-effect	Middle Antenna Phaser
End-fire	Main Array Phaser

(c) Path Angle Lowered to Limit: Glide slope angle set to the established reference low-angle alarm value with appropriate adjustment (e.g., power divider, phaser, modulation balance). Normally done on commissioning only.

(d) Path Angle Raised to Limit: Glide slope angle set to the established reference high-angle alarm value with appropriate adjustment (e.g., power divider, phaser, modulation balance).

(e) Path Width Narrowed to Limit: Measured with sideband power set for the established reference narrow alarm. Normally done on commissioning only.

(f) Path Width Widened to Limit: Measured with sideband power set for the established reference alarm value.

(g) Clearance Tx Modulation Decreased to Limit: For capture-effect systems only: the facility set for the established reference wide and clearance transmitter modulation alarm values simultaneously. The values are entered on this line, and line 4f is left blank.

(h) Attenuate Middle Antenna to Limit (Alarm): For capture effect systems only, measured with the middle antenna attenuated to WIDE established reference alarm value.

(i) Attenuate Upper Antenna to Limit: For capture-effect systems only, measured with the upper antenna attenuated to PATH established reference alarm value.

(j) Transverse Structure: Completed only for end-fire glide slopes. The maximum glide slope cross-pointer deviations for the localizer course sector and the localizer edge sector are reported.

(k) Modulation Balance TX1/TX2: When modulation balance is checked, entered as microamperes/ predominate tone.

(l) Phasing TX1/TX2: If airborne phasing is checked, entered the same as (k).

(m) Front Course Area Where Phasing Was Conducted: If airborne phasing is checked, the left block indicates the distance in nautical miles from the antenna where repeatable phasing existed (i.e., 10/7). The altitude flown, above mean sea level, is in the right block.

(n) Clearance Below Path TX1/TX2: When below path runs are made, an "S" is entered if all below path clearances are satisfactory. If unsatisfactory, an asterisk is placed in this field and explained in field 5. Normally this would only be done during commissioning checks.

(3) **Field 5, Remarks:** Used to clarify any items on the form.

6-12. thru 6-29. RESERVED.

SECTION 1. AIRBORNE INFORMATION (Continued)

FIGURE 6-5. SAMPLE FAA FORM 8240-9, FLIGHT INSPECTION SUPPLEMENTAL SHEET

PAGE OF PAGES

FLIGHT INSPECTION REPORT--INSTRUMENT LANDING SYSTEM SUPPLEMENTAL SHEET	REVIEW INITIALS
1. LOCATION:	2. IDENT:
3. DATE(S) OF INSPECTION:	

4. GLIDE SLOPE									
4a. GLIDE SLOPE TYPE:				PATH ANGLE		PATH WIDTH		STRUCTURE BELOW PATH	
				TX1	TX2	TX1	TX2	TX1	TX2
4b. DEPHASE	ADVANCE	TX1	TX2						
	RETARD	TX1	TX2						
4c. PATH ANGLE LOWERED TO LIMIT									
4d. PATH ANGLE RAISED TO LIMIT									
4e PATH WIDTH NARROWED TO LIMIT									
4f. PATH WIDTH WIDENED TO LIMIT									
4g. CLEARANCE TX MODULATION DECREASED TO LIMIT - (PRIMARY TX WIDE LIMIT)									
4h. ATTENUATE MIDDLE ANT TO LIMIT		TX1	TX2						
4i. ATTENUATE UPPER ANT TO LIMIT		TX1	TX2						

4j. TRANSVERSE STRUCTURE	CRS SECTOR	FAF ALT:	
	EDGE SECTOR	FAF ALT:	
4k. MODULATION BALANCE		TX1	TX2
4l. PHASING		TX1	TX2
4m. FRONT COURSE AREA WHERE PHASING WAS CONDUCTED		NM	MSL
4n. CLEARANCE BELOW PATH		TX1	TX2

5. REMARKS

FAA FORM 8240 - 9 (3/2000) (FORMFLOW) (Formerly FAA Form 8240-16)

SECTION 2. FACILITY INFORMATION

6-30. FLIGHT INSPECTION CONSIDERATIONS.

a. General. Flight inspections are conducted on an ILS facility for a variety of purposes. Maintenance personnel involved with a flight inspection should be familiar with the required adjustments of the facility and the airborne procedures used (see section 6-33) to minimize the time and expense required.

b. Flight Inspection of RMM Equipped ILS Facilities. Specialists are not required to be on site to perform a monitor flight inspection of an ILS facility equipped with RMM, providing the following conditions are met.

(1) The specialist conducting the flight inspection has direct communications with the aircraft.

(2) The specialist has the capability to remotely make * all routine adjustments required by flight inspection. For glide slope facilities this includes the capability of advancing and retarding the phase of the glide slope antenna signals, as well as attenuating capture effect glide slope antenna signals. *

(3) A copy of the current monitor reference data for the ILS is on hand for the specialist conducting the flight inspection.

(4) The specialist conducting the flight inspection insures that the activities required in this chapter are accomplished.

c. Types of Flight Inspections.

(1) Periodic. Periodic flight inspections are conducted on a surveillance basis to document the performance of the facility as the user experiences it. These inspections typically alternate with monitor flight inspections. The flight inspection aircraft documents the as-found condition with the equipment in normal/operating condition (not purposely adjusted to alarm * limits). Since no facility adjustments, ground checks, or record * keeping is required, maintenance personnel do not need to be at the facility being flight-checked.

(2) Monitor. Monitor flight inspections are conducted to initially (or occasionally) set and routinely confirm that the facility remains within airborne tolerances, when the transmitting equipment is adjusted to the limits of the radiated signal, which will initiate monitor action. Since it is undesirable to require a flight inspection should either the radiating or monitoring half of the system fail, it is necessary that the limits of the radiated, rather than monitored, signal be documented. This means that the monitor does not need to be optimized, adjusted, or centered during the flight inspection due to changes resulting from the flight inspection. It may be adjusted for these conditions after the flight inspection, as long as the ground parameters corresponding to the flown limits are well documented and used to set the monitor.

(3) Special. Special flight inspections are conducted on an as-needed basis to permit changing or reestablishing reference values. Periodic or monitor types of flight inspections have prescheduled activities. The special flight inspection permits airway facilities personnel to take flight check time to verify equipment performance following equipment component changes and monitor adjustments. A recommended time to request a special flight inspection is when flight inspection is in the area or before a scheduled flight inspection.

(4) After-Accident. The purpose of after-accident flight inspection is to document the as-found condition of the signal in space, without any facility adjustments. Should any airborne parameters be found out of tolerance, monitor alarm limits will be flown. (At the discretion of the flight inspector, as-found parameters that are nearly out of tolerance may be flown at their monitor limits as well.) FOR AFTER-ACCIDENT MONITOR ALARM LIMIT CHECKS, the radiated signal is adjusted until the monitor (unadjusted) actually alarms.

d. Preparation. Before a monitor flight inspection, maintenance personnel should prepare for the effort in accordance with the requirements outlined in this order. In particular, FAA Forms 6750-3 and 6750-4, localizer and glide slope flight inspection data worksheets, should be on hand. A calculator is necessary for efficient adjustments of sideband power. The airborne tolerances section of chapter 3 of this order and any previously established flight inspection reference limits as documented on FAA forms should also be readily available.

SECTION 2. FACILITY INFORMATION (Continued)

6-31. ACTIVITIES PRECEDING FLIGHT INSPECTION.

a. Frequency of Flight Inspections. Since the frequency of routine flight inspections is tailored to the stability and dependability of the instrument landing system (ILS), the specialist should ensure that the facility is representative of the day-to-day ILS operation before each flight inspection. The interval between inspections is scheduled to be as long as possible without compromising system safety. During the first year a facility is operational, the flight inspections are more frequent to establish * facility baseline data. *

b. Reminder of Next Inspection. Post the date of the next scheduled monitor flight inspection in a prominent location at the facility. This will serve as a reminder to complete the following items in a timely manner.

c. Preflight Inspection Activities. Perform the preflight inspection activities in chapter 4.

d. Facility Shutdown. Arrange a facility shutdown for a monitor flight inspection.

e. Test Equipment. Have the proper test equipment such as PIR, modulation meter, wattmeter, and optional digital multimeter (dmm), available.

f. Coordination of Communications Frequency. Prepare to use a flight inspection communications frequency of 135.85 MHz. However, coordination with flight inspection is essential, as a different frequency may be * used. The transceiver shall be tested for proper operation prior to a flight inspection. *

g. Worksheets. Use the appropriate flight inspection data worksheet, FAA Form 6750-3 for localizer and FAA Form 6750-4 for glide slope. (Refer to figures 6-6 and 6-7.)

h. Checklists. Use the checklists tables 6-1 through 6-7. These checklists are a suggested order of occurrence for best use of flight inspection hours and meet the minimum requirements of the flight inspection manual.

i. Calculation of Power Ratios. Have the sideband power formula and a scientific calculator available, as new power ratios may have to be calculated during flight inspection.

6-32. EQUIPMENT ADJUSTMENTS BEFORE FLIGHT INSPECTION. The following checks will verify the quality of radiated parameters before flight inspection. The values must equal the established normal reference values.

a. Modulation Levels.

b. Tuning of All Transmitting Equipment.

c. Path Width/Course Width.

d. Path Angle/Course Alignment.

e. Equality Between Equipments (Dual Equipment).

f. Power Levels.

* **g. System Phasing.** Paragraphs 5-16, 5-48, 5-50, 5-52, 5-54, or 5-55. *

h. Ground Check. For localizer, paragraph 5-12 and end-fire glide slope, paragraph 5-42.

NOTE: The facility parameters listed above should be adjusted to the reference values previously established for the facility. Review the reference values and have them available during flight inspection. Do not adjust the monitor alarm points to the reference flight inspection values. (The monitor is not flight inspected.)

SECTION 2. FACILITY INFORMATION (Continued)

FIGURE 6-6. FAA FORM 6750-3, LOCALIZER FLIGHT INSPECTION DATA WORKSHEET

Technical Performance Record — **Localizer Flight Inspection Data Work Sheet**

Identification	Location	Date	Runway

Technician(s)	Flight Check Aircraft Number	Crew

	Facility Data														Flight Check Data							Remarks
		R.F. Power				Monitor DDM				Carrier Feedline		Mod. %									Notes: * If applicable # Dual Power and digital voltmeter readings are acceptable.
		Course		Clearance		CRS	CLR	CRS	CLR	CRS	CLR	CRS	CLR								
Run Number	Transmitter Number	# Carrier Watts	# Sideband Milliwatts	* # Carrier Watts	* # Sideband Milliwatts	Centerline DDM/Hz	* Centerline DDM/Hz	Width	* Width	Course DDM/Hz	* Clearance DDM/Hz	Course 90/150 Hz	* Clearance 90/150 Hz	Course Width	Alignment	Low Clearance 90Hz	Low Clearance 150 Hz	Modulation Percent			

FAA Form 6750-3 (12-84) Supersedes 6750-3 (3/75)

SECTION 2. FACILITY INFORMATION (Continued)

FIGURE 6-7. FAA FORM 6750-4, GLIDE SLOPE FLIGHT INSPECTION DATA WORKSHEET

Glide Slope Flight Inspection Data Work Sheet

Identification	Location	Date	Runway

Technician(s)	Flight Check Aircraft Number	Crew

	Facility Data														Flight Check Data						Remarks
		RF Power						Monitor DDM				Mod %									
Run Number	Transmitter Number	Carrier Watts #	Sideband Milliwatts #	Clearance Watts *#	Lower Antenna Watts *#	Middle Antenna Milliwatts *#	Upper Antenna Milliwatts *#	Integral Path DDM/Hz *	Field Path DDM/Hz	Width	Clearance *	Course 90/150 Hz	Clearance *	Carrier Feedline DDM/Hz	Path Width	Path Angle	Structure Below Path Angle	Symmetry	Modulation Percent		NOTES: * If applicable # Dual Power and digital voltmeter readings are acceptable.

FAA Form 6750-4 (12-84) Supersedes 6750-4 (3/75)

SECTION 2. FACILITY INFORMATION (Continued)

6-33. ACTIVITIES DURING FLIGHT INSPECTION.

a. Instructions for Preparation of the Flight Inspection Data Worksheets.

(1) Put the facility in the proper configuration for the first run. (See the checklists, tables 6-1 through 6-7.) Advise flight inspection of the equipment configuration and of readiness for the first run. Identify the runs in order of occurrences (1, 2, etc.). The run numbers should agree with the run numbers kept by the flight inspection specialist on his/her worksheet. This enables ground-air correlation later should any difficulties arise. (Refer to figures 6-6 and 6-7.)

(2) The data columns identified as FACILITY DATA are those readings taken inside the shelter during the flight inspection.

(3) The data columns identified as FLIGHT CHECK DATA are those readings taken by the airborne specialist and reported by radio.

(4) In the REMARKS column, enter the facility configuration for that run, such as normal, wide alarm upper attenuated 2.5 dB, middle advanced 15, etc.

b. Conducting the Flight Inspection.

(1) The purpose of a monitor flight inspection is to verify the limits of the radiated signal. In the shelter, this is * done with the transmitter measurements, NOT the monitor. * Monitors are not adjusted during flight inspection. Do not depend on the monitor to adjust the radiated parameters. The facility is adjusted to the established reference values for the configuration being checked. After flight inspection personnel depart, the monitor shall be adjusted for proper action when the radiated signal exceeds the established reference values previously verified during flight inspection. (Note that after a facility outage or monitor failure, the facility must be certified based on radiated parameters only, such as phasing, modulation balance, power ratios, etc. Thus it is not necessary to recenter or adjust the monitor between flight check runs, this wastes valuable flight time.)

(2) When making corrective adjustments to radiated parameters, use every resource available to predict and produce the precise change requested or needed. Giving the knob a "tweak" in the "right direction" without regard to the amount of adjustment often requires unnecessary re-adjustment and repeated runs, and may result in the facility having out-of-tolerance indications in the air and/or on the ground. Do not guess when making sideband power adjustments to set course or path width. Use the following formulas.

New sideband power =

$$\text{Old sideband power} \times \frac{\text{Old course width}^2}{\text{New course width}^2}$$

New width monitor DDM reading =

$$\text{Old width monitor DDM reading} \times \frac{\text{Old course width}}{\text{New course width}}$$

Make the calculations, then the adjustment. Notify flight inspection when ready. If the measurement agrees with your prediction, it will build confidence. If it does not, it reveals inaccuracies in the airborne measurement, ground measurement, or the calculations.

(3) Anticipate and be ready to make the next adjustment long before it is requested. Use the appropriate checklist (tables referenced in paragraph 6-9) and coordinate with the flight inspection personnel.

(4) Promptly make adjustments, observing only radiated parameters, NOT the monitor. NO ADJUSTMENT SHOULD TAKE LONGER THAN 60 SECONDS. Notify flight inspection personnel when the adjustment is completed and obtain their acknowledgement. (At times, the aircraft crew is busy and may be listening to higher-priority traffic.)

(5) Do not delay flight inspection by taking readings after the run. This time should be for setting up for the next run. Measure and record the data on the data worksheet DURING the run. The run takes approximately 7 minutes.

(6) Do not ask flight inspection to set facility phasing. All facilities should be ground phased only. Refer to * paragraphs 5-16, 5-48, 5-50, 5-52, 5-54, and 5-55. *

SECTION 2. FACILITY INFORMATION (Continued)

(7) Flight inspection will not set facility modulation. Facility modulation shall be set on the ground with the modulation meter by the facility specialist.

(8) Be prepared to set the localizer alignment monitor alarm points while flight inspection is on extended runway centerline. Do not adjust the monitor at this time. This is done by measuring the carrier feedline DDM, then changing modulation balance plus and minus to the established reference values. The modulation balance should remain at each alarm point for five or six seconds so the average value may be measured by flight inspection personnel. This can save considerable time and eliminate the need for having the flight inspection aircraft on the runway for long periods of time.

(9) When the flight inspection results do not agree with the expected results, discuss the problem with flight inspection. If the specific problem cannot be resolved, continue to work with flight inspection to complete the remaining work. After the flight inspection is completed, the problem should be analyzed by the facility specialist and his/her supervisor, to determine if additional flight inspection is required or if sector or regional engineering personnel should be contacted.

(10) Ensure that all required data is obtained and the data is satisfactory before flight inspection personnel depart. This requires prompt analysis of the flight inspection data. On several occasions, flight inspection personnel have been required to return to a facility because insufficient data was taken during the inspection.

(11) During flight inspection make efficient use of available flight time for cost efficiency.

c. Modulation Adjustments During Flight Inspection.

(1) If flight inspection reports the modulation high or low, maintenance personnel should:

(a) Check the equipment modulation with the FA-9438 ILS modulation meter. Correct the modulation, as necessary. If the modulation is within tolerance, advise flight inspection. Proceed with step (b), if necessary.

(b) Check the carrier and sideband modulation components. If the modulation components are high, correct them. If the modulation components are within tolerance, advise flight inspection.

NOTE: High modulation distortion components, especially in the frequency range of 60 to 180 Hz, could pass through bandpass filters in the aircraft receiver, causing the indicated 90 and 150 Hz modulation to appear high.

(2) If flight inspection still requires a modulation adjustment after being advised that the ground readings are within tolerance, make the adjustment and:

(a) If possible, verify the calibration of the FA-9438 ILS modulation meter. Check the modulation using the wattmeter element and oscilloscope.

(b) Ask flight inspection to check the calibration of the avionics equipment at the first opportunity. Their receivers are calibrated with the same FA-9438 modulation meter Airway Facilities uses.

(c) Follow up with flight inspection to resolve the difference in modulation readings.

NOTE: Changes to equipment adjustments should be made in accordance with chapter 5 of this order or the equipment instruction books.

6-34. LOCALIZER ACTIVITIES.

a. Flight Inspection Course Width. Localizer facilities * have a desired tailored course width of 700 feet (213 m) at runway threshold provided the width is not greater than 6°. All Cat II/III localizer "commissioned course width" must be tailored. With region approval, Cat I localizers may deviate from the tailored value if necessary to improve service, usually course structure or clearances. Deviation from the tailored value should be the minimum needed to achieve the desired results. This value is established as the "commissioned course width" for the facility. *

b. Flight Inspection Measurement. Course width as measured by flight inspection personnel for normal, wide * alarm, and narrow alarm is referenced to the commissioned course width. These three flight inspection values shall be entered on FAA Form 6750-3, Localizer Flight Inspection * Data Worksheet, and compared with the tolerances of paragraph 3-30a. During a flight inspection preceding a

SECTION 2. FACILITY INFORMATION (Continued)

★ reference ground check, additional flight inspection runs shall be requested until initial tolerances are obtained. In certain cases, the use of a signal-in-space evaluation type package may be desirable to save on flight inspection cost. Initial tolerances are desirable since the reference ground check establishes the operating limits which all subsequent normal ground checks must meet. ★

★ **c. Flight Inspection Low Clearance.** Flight inspection measurement of the facility's low clearance points determines if the facility provides adequate off-course indications. The low clearance of the facility will be reported to the facility specialist in microamps at a particular azimuth. This value shall be entered on FAA Form 6750-3, Localizer Flight Inspection Data Worksheet. (Note: 150 microamps equals 0.155 DDM.) ★

★ **d. Flight Inspection Course Alignment (Monitors).** The alignment of the localizer course and shift to monitor alarms shall be accomplished by ground maintenance from the announced airborne alignment given by flight inspection. The philosophy is that it is desirable to adjust and maintain the localizer course alignment as close to "zero microamps" as possible by deriving a centerline reference based on flight inspection.

When making the necessary calculations to bring the alignment to zero it will be assumed that .001 ddm is equivalent to 1 microamp. Also, the airborne alignment should be adjusted until a value of 3 microamps or less is announced before proceeding . A few short examples are provided below for clarity.

Example one: Flight inspection gives an announced alignment of 4 microamps left. This indicates that the course centerline was found to the left of runway centerline, and that an approximate increase of .004 ddm/90 Hz would be necessary to move the course centerline over to the runway centerline. At the centerline ground check point or the carrier feedline note the "DDM" reading on the PIR. Increase the modulation balance until a shift of .004/90 Hz, is indicated from the reading previously noted on the PIR. This sets the proper alignment. Now shift course centerline to the initial alignment alarm tolerances prescribed for the Category of ILS, using the PIR DDM indications at the centerline ground check point or the carrier feedline. Document these ★ ★ values and set the monitor accordingly to protect these limits.

Example two: Flight inspection gives an announced alignment of 4 microamps right. This indicates that the course centerline was found to the right of runway centerline, and that an approximate increase of .004 ddm/150 Hz would be necessary to move the course centerline over to the runway centerline. At the centerline ground check point or the carrier feedline note the "DDM" reading on the PIR. Increase the modulation balance until a shift of .004/150 Hz is indicated from the reading previously noted on the PIR. This sets the proper alignment. Now shift course centerline symmetrically around this reference, to the initial alignment alarm tolerances prescribed for the Category of ILS, using the PIR DDM indications at the centerline ground check point or the carrier feedline. Document these values and set the monitor accordingly to protect these limits.

Because of measurement repeatability it is desirable , but not a requirement to adjust the alignment if it is announced less than 3 microamps. ★

6-35. GLIDE SLOPE ACTIVITIES.

a. Flight Inspection Path Angle. Glide slope facilities have a path angle designated by the procedures specialist developing the approach procedure. The chosen path angle is nominally 3.0°. This designated angle is defined as "commissioned path angle" and will vary from glide slope to glide slope. Path angle as measured by flight inspection for normal, low angle alarm, and high angle alarm is compared to commissioned path angle. These three values, as measured by flight inspection, shall be logged on FAA Form 6750-4, Glide Slope Flight Inspection Data Worksheet. The corrected angle will be measured during the approach run. Angle alarms are normally checked only on sideband reference and end fire systems.

b. Flight Inspection Path Width. Flight inspection measurement of the facility's path width determines if the facility provides proper aircraft crosspointer sensitivity indications. The path width of the facility will be reported to the facility specialist as width in degrees. The path width is determined between the fly up and fly down 75 microampere points as measured with the aircraft on the extended runway centerline. This value shall be logged on FAA Form 6750-4.

SECTION 2. FACILITY INFORMATION (Continued)

c. Flight Inspection Structure Below Path. The highest vertical angle at which 190 microamps of fly up signal last occurs will be determined by flight inspection during the same runs as the path width measurement. The structure below path angle tolerances ensure that the aircraft will have adequate fly up indications to clear any below path obstructions within the approach corridor. At commissioning, flight inspection also flies at low angles to verify obstruction clearance. Following commissioning, the structure below path angle value is used to verify that facility performance has not deteriorated. The initial values in Chapter 3, Standards and Tolerances, ensure that the low angle fly up signals are better than required for safe operation. The structure below path angles shall be recorded on FAA Form 6750-4.

d. Flight Inspection Path Symmetry. Glide slope path symmetry is a quantitative comparison of the amount of total path width (75 to 75 microamps) that occurs above and below the measured path angle. A perfect facility has 50 percent symmetry. This will occur when the 75 microamp points occur exactly the same number of degrees (0.35) above and below the on path signal. In image systems, this verifies that the antenna heights, power ratios, and phasing are properly adjusted for the site. The symmetry value shall be recorded on FAA Form 6750-4. The value is reported in percent for the 90 Hz (above path) lobe.

e. Flight Inspection System Dephasing and Attenuation.

(1) Variances in normal system phasing and amplitudes can cause substantial changes in normal path characteristics; therefore, these abnormal conditions are verified by flight inspection. If reported by flight inspection, the flight inspection values for angle, width, symmetry, and structure below path shall be recorded on FAA Form 6750-4 for each required configuration. The configuration and values shall be annotated in the remarks column (i.e., Middle Advanced 15).

(2) To ensure repeatability between successive flight inspections, dephasing checks should be performed using fixed line lengths rather than the internal variable phasers. This technique will give the same results over time even when different facility technicians perform the flight inspection and will provide symmetrical changes in the facility for both advanced and retard conditions. See subparagraph f, below, for typical phase lengths of common coaxial fittings. All * image glide slopes should be able to dephase 30° for SBO * dephase. Sideband reference facilities should be able to dephase the upper antenna 30°. Capture-effect facilities should be able to dephase the middle antenna 20°.

f. Phase Lengths of Coaxial Fittings at Glide Slope Frequencies.

(1) Type N double male and type N double female 30°.

(2) Type N elbow 19°.

(3) Type BNC/TNC elbow 15°.

(4) Type N double male, type N double female, type N elbow 49°.

6-36. MARKER ADJUSTMENTS DURING FLIGHT INSPECTION.

a. General. ILS marker facilities must meet the two requirements for the following when checked by flight inspection personnel: minor axis width and major axis width. The most frequent requests for changes in facility characteristics by flight inspection involve radiation pattern width. The pattern width is a function of power output and modulation percent; that is, the more power output or the higher the modulation, the wider the pattern.

b. Minor Axis Width. This check is made on glide slope path and localizer on course (approach run), and verifies that the minor axis width is within prescribed tolerances.

c. Major Axis Width. This check is made on glide slope path and at localizer edges-of-course (150 microamperes) to ensure that the marker pattern is minimally sufficient to momentarily activate the cockpit marker indicators (2 mA level on the recording).

d. Width Adjustments.

(1) If flight inspection personnel advises that either axis is narrow, the marker power must be increased until the required widths are achieved.

(2) If the axes are too wide, the power must be reduced. Whenever power changes are made, verify that the modulation percentage is also correct.

SECTION 2. FACILITY INFORMATION (Continued)

e. Unpredictable Results. When airborne indications are appreciably different than those predicted by ground data, the flight inspection should be stopped until the reason for the disparity can be determined. Some of the possible cause of abnormal airborne indications are:

(1) Transmitter output frequency outside the specified tolerance. This creates a requirement for excessive output power to produce a normal radiation pattern indication in the airborne receiver.

(2) Incorrect modulation frequency, which results in a reduced output from the airborne receiver's bandpass filters.

(3) Excessive antenna system leakage resistance, resulting in reduced radiation and/or a distorted pattern.

(4) Low modulation, which results in a reduced output from the airborne receiver.

NOTE: If changes that invalidate previously established reference values are made, new reference values must be established on FAA Form 6770-4.

6-37. ACTIVITIES FOLLOWING FLIGHT INSPECTION.

a. General.

(1) The activities required following a flight inspection depend upon which activities were performed before and during the flight inspection. If the flight inspection involved no corrective adjustments that invalidated the established reference values, updating the reference values or ground checks is not required.

(2) If equipment parameters were changed beyond the established reference values, new reference values for the affected parameters shall be established. If applicable, a ground check shall be made.

b. Monitor Alarm Adjustments Following Flight Inspection.

(1) Monitor alarm points are checked by changing the radiated parameters to the same value used during flight inspection (usually established reference values). The appropriate monitor control is adjusted to cause a continuous alarm at or before the values used during flight inspection.

(2) The equipment shall not be returned to service before measuring and recording all parameters on the appropriate FAA form. These readings should be made as soon as possible and before weather or other changes invalidate the readings, especially when ground checks are required.

(3) The Flight Inspection Data Worksheet used ⋆ during the flight inspection shall be retained until the facility is decommissioned. When the flight inspection ⋆ report arrives (usually 5 to 6 weeks after the flight inspection), staple it to the Flight Inspection Data Worksheet. These documents are the source of data for the FAA Forms 6750-22 to -32.

(4) Make the proper Facility Maintenance Log entries including the facility certification statement. Advise air traffic and other concerned parties that the facility is returned to service and that the NOTAM may be canceled.

6-38. thru 6-99. RESERVED.

APPENDIX 1. CERTIFICATION REQUIREMENTS

* **TABLE 1. INSTRUMENT LANDING SYSTEM** *

Service	*Certification Parameters*	*Reference Paragraph STDS and TOL/Limits*
*	Overall certification is based on the knowledge that the localizer, glide slope, and associated markers have all been properly certified. There are no overall system certification parameters.	*

NORMAL CERTIFICATION INTERVAL: Quarterly.

MAXIMUM CERTIFICATION INTERVAL: 120 days.

PERSON RESPONSIBLE FOR CERTIFICATION: ILS certified specialist.

CERTIFICATION ENTRY IN FACILITY MAINTENANCE LOG: ILS certified.
(Enter in the localizer maintenance log.)

TABLE 2. LOCALIZER SUBSYSTEMS

Service	*Certification Parameters*	*Reference Paragraph STDS and TOL/Limits*
1. Coverage	Power output	3-10
2. Course accuracy	Course alignment	3-31
3. Course sensitivity	Course width	3-14, 3-31
4. Identification	Modulation level (1020 Hz)	3-11
5. Flag action	Modulation level (90/150 Hz)	3-11
6. Operational continuity and integrity	Automatic transfer/shutdown action, remote alarm, and remote reset/control	3-21
7. Monitor	Power reduction alarm Course shift alarm Course width alarm Modulation reduction alarm	3-20

NORMAL CERTIFICATION INTERVAL: Monthly (Cat I, II, and III).

MAXIMUM CERTIFICATION INTERVAL: Bi-monthly (Cat I, II, and III).

PERSON RESPONSIBLE FOR CERTIFICATION: ILS certified specialist.

* CERTIFICATION ENTRY IN FACILITY MAINTENANCE LOG: Localizer certified, or LOC certified. *

TABLE 3. GLIDE SLOPE SUBSYSTEMS

Service	*Certification Parameters*	*Reference Paragraph STDS and TOL/Limits*
1. Coverage	Power output	3-40
2. Course accuracy	Path angle	3-40, 3-41
3. Course sensitivity	Path width	3-40, 3-44
4. Flag action	Modulation level (90/150 Hz)	3-41
5. Operational continuity and integrity	Automatic transfer/shutdown action, remote alarm, and remote reset/control	3-51
6. Monitor	Power reduction alarm Path angle alarm Path width alarm Modulation reduction alarm	3-50

NORMAL CERTIFICATION INTERVAL: Monthly (CAT I, II, and III).

MAXIMUM CERTIFICATION INTERVAL: Bi-monthly (CAT I, II, and III).

PERSON RESPONSIBLE FOR CERTIFICATION: ILS certified specialist.

* CERTIFICATION ENTRY IN FACILITY MAINTENANCE LOG: Glide slope certified, or GS certified. *

TABLE 4. 75 MHZ ILS MARKER SUBSYSTEMS

Service	*Certification Parameters*	*Reference Paragraph STDS and TOL/Limits*
1. Coverage	Power output, modulation frequency, and level.	3-70, 3-71, 3-72
2. Identification	Modulation level.	3-71
3. Operational continuity and integrity	Automatic transfer/shutdown action, remote alarm, and remote reset/control.	3-81
4. Monitor	Power reduction alarm, loss of tone alarm, and continuous tone alarm.	3-80

NORMAL CERTIFICATION INTERVAL: Semiannual.

MAXIMUM CERTIFICATION INTERVAL: 240 days.

PERSON RESPONSIBLE FOR CERTIFICATION: ILS certified specialist.

* CERTIFICATION ENTRY IN FACILITY MAINTENANCE LOG: OM certified, or MM certified, or IM certified, or FM certified. *