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Microwave Landing System Requirements for Non-Federal Navigational Facilities

DEPARTMENT OF TRANSPORTATION

Federal Aviation Administration

14 CFR Part 171 See 2 corrections

[Docket No. 20669; Amdt. 171-11]

Microwave Landing System Requirements for Non-Federal Navigational Facilities

AGENCY: Federal Administration (FAA), DOT.

ACTION: Final rule.

SUMMARY: This amendment establishes minimum standards and procedures for the approval, installation, operation, and maintenance of a Microwave Landing System (MLS) facility that is not operated and maintained by the FAA or other Federal agency. MLS is a system designed to take the place of the Instrument Landing System (ILS) used at commercial airports in the United States and around the world since 1945. MLS is projected to meet both civil and military requirements for the foreseeable future and to provide more flexibility in terminal area operations, abate noise, and be cost effective. MLS has been selected for standardization by the International Civil Aviation Organization (ICAO) for eventual installation at terminal areas of member States. The aviation community recognized the need for a new system to fulfill future requirements. MLS has been chosen to satisfy this need. Since these facilities may be operated and maintained by persons other than the FAA, the requisite standards and procedures to operate these facilities in the National Airspace System (NAS) must be provided in the form of a regulation to govern those activities. This amendment is consistent with the requirements of Executive Order 12291.

EFFECTIVE DATE: December 17, 1981.

FOR FURTHER INFORMATION CONTACT: Mr. Sotires P. Mantis, Airway Facilities Service, (AAF-720), Airway Systems Division, Federal Aviation Administration, 800 Independence Avenue, SW., Washington, D.C. 20591; telephone (202) 426-3008.

SUPPLEMENTARY INFORMATION:

I. Background

This rule is based on Notice of Proposed Rule Making (NPRM), Notice Number 80-15, Non-Federal Navigation Facilities; Proposed Microwave Landing System Requirements (45 FR 59256) published in the **Federal Register** September 8, 1980. All interested persons have been given an opportunity to participate in the making of this rule and due consideration has been given to all information submitted.

The search for an adequate successor to the present ILS has been underway for several decades. ILS was adopted for national service in 1941 and has been installed at approximately 700 locations in the United States. ILS is also the international standard and as such is installed in many other locations worldwide. Although significant improvements in system design have been made since it entered service, ILS is basically the creation of an older technology which limits its utility in some applications and falls short of meeting the full range of operational requirements as now defined nationally and internationally.

In 1967, the Radio Technical Commission for Aeronautics (RTCA) formed a special committee (SC-117) to collect user requirements and synthesize a set of operational requirements which would meet the needs of a wide range of civil and military users for precision approach and landing guidance well into the future. The RTCA operational requirements emerged in 1969 with a recommendation that microwave systems using a Doppler or scanning beam signal format should be investigated for implementation.

In the early 1970s ICAO adopted similar operational requirements and invited member states to propose candidate systems as a successor to the standard ILS. In July 1971, a U.S. National Plan for the joint development of an MLS was published by the Department of Transportation (DOT), Department of Defense (DOD) and the National Aeronautics and Space Administration (NASA). The time referenced scanning beam (TRSB) MLS which emerged from this development program became the U.S. candidate system proposed for international adoption. In April 1979 ICAO selected the TRSB MLS for international standardization.

It should be noted that an interim standard microwave landing system (ISMLS) was adopted in 1975 for use at locations where a VHF/UHF ILS would not perform in an effective manner, or where the need for a low approach service would be better served by the use of the ISMLS. This system was intended as an adjunct to the ILS system and was considered necessary to fulfill some immediate aviation growth needs during a transition period. That transition period was the time necessary to develop an MLS which meets international standards.

II. Need for the Regulation

This regulation makes provision for approval of an instrument approach procedure using an MLS not provided by the Federal Government, which will satisfy the needs of various operators. Among these are operators who desire an instrument approach procedure but do not qualify for Federally provided equipment; operators who qualify for Federally provided equipment but prefer an MLS to an ILS; operators with locations on which the ILS cannot be properly sited; and operators who desire immediate installation of an MLS system without having to wait for the installation of a Federal system.

In the next one to three years the FAA expects no more than ten facilities to be installed and five to ten per year thereafter. These numbers, however, are estimates since there is no way of identifying the requirements for privately funded facilities. The numbers will vary depending upon manufacturer prices and consumer needs.

There are no current FAA MLS facilities; however, FAA is preparing Federal specifications to proceed with a procurement of approximately 95 systems beginning in 1983. The FAA has programmed for the installation of over one thousand systems by the year 2000.

The MLS system proposed herein provides for a ±10° approach sector and a continuum of glideslopes consistent with a minimum vertical proportional guidance sector of 0.9° to 7.5°. This minimal system does not preclude the use of additional units to produce a system with a wider approach sector, steeper glidepaths, a back azimuth capability, precision DME, or the use of redundant units to maximize system availability. While the MLS specified in this proposal is the minimum system which would be approved for use in an IFR procedure, the provisions of this proposed subpart are not intended to prevent the selection of an MLS system which has increased performance characteristics, as long as the system selected performs in accordance with the standards now in process of publication by ICAO. A finding of no significant environmental impact can be found in the public docket for this rulemaking action.

III. Relationship to International Standards

Subsequent to the ICAO selection of an MLS in 1978, the process of creating and adopting international Standards and Recommended Practices (SARPS) has proceeded. The basic SARPS, which will assure interoperability between

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ground and airborne equipment, was approved for inclusion in Annex 10 to the Convention of International Civil Aviation at the divisional meeting in April 1981 at Montreal.

All ground systems must be interoperable with regard to channeling, signal format, timing, and performance accuracy. This includes non-Federal, Federal, and International systems. The United States, as a member of ICAO comprising 148 member states, has contributed to the standardization of precision landing systems to insure interoperability worldwide. Both the FAR and FAA procurement specifications will be identical with respect to interoperability and performance requirements, both of which conform to the ICAO SARPS.

IV. General

This amendment adds a new subpart to Part 171 of the Federal Aviation Regulations to provide requirements for a non-Federal MLS facility. This rule sets forth minimum requirements that must be met before the FAA authorizes instrument flight rule approaches to the airport and air traffic control procedures incorporating that facility. Such a facility is designed to interface with existing and planned Federal facilities and systems.

The performance requirements of this rule are derived from the SARPS on MLS developed by ICAO. The SARPS as adopted by ICAO in Montreal in April 1981 are a culmination of the efforts of the member states. The United States, as a member, contributed and assisted in the recommendation process for inclusion of SARPS for MLS in the amendment of Annex 10. The FAA has and will continue to fully participate in the international standardization process.

In addition, persons affected by this rule should determine the applicability of FCC regulations to the installation and operation of the MLS. The regulations of the FCC applicable to radio frequency allocations and use are found in Parts 2 and 87 of Title 47 of the Code of Federal Regulations.

As part of the requirements, the FAA also incorporates by reference several technical documents in accordance with 5 U.S.C. 552. The following documents are available for inspection in accordance with § 171.71, and also at the Office of the Federal Register Information Center, Room 8301, 1100 L Street, NW., Washington, D.C. 20408, and may be purchased from the National Technical Information Service, 5285 Port Royal Road, Springfield, Virginia 22161: FAA Handbook 8260.3, through change 3 dated June 3, 1980, United States Standard for Terminal Instrument Procedures (TERPS), and FAA Handbook AOP 8200.1, through change 35, dated May 15, 1981, United States Standard Flight Inspection Manual.

In addition, the following publication of ICAO is available from ICAO, Aviation Building, 1080 University Street, Montreal 101, Quebec, Canada, Attention: Distribution Officer; International Standards and Recommended Practices, Aeronautical Telecommunications, Volume 1 of Annex 10 to ICAO, through amendment 61 dated April 10, 1980. This incorporated material is not subject to frequent change. Readers, however, should contact the FAA to assure that they are consulting the current edition. This incorporation by reference was approved by the Director of Federal Register on October 20, 1981.

V. Discussion of Comments

Forty-five comments were received in response to Notice 80-15. These represent views from a broad cross section of user groups including airport operators, state and county aviation authorities, pilot and airline associations, communter airlines, manufacturers and others. The majority of the comments received supported the rule as proposed.

One commenter states that the implementation of non-Federal MLS at this time is "premature" and recommends that the rule be deferred until after implementation of the national MLS program. The FAA concludes an immediate requirement exists for a non-Federal MLS program. At the MLS public hearings in January 1981, there was an overwhelming positive response to rapid transition to MLS in both the Federal and non-Federal areas. This view is supported by a positive response to the proposed rule from the many segments of the aviation community.

One commenter states that the proposed rule, as written, would not encourage rapid and widespread implementation of non-Federal MLS. This was based on the assessment that the specified system accuracy and volumetric coverage requirements were excessive and, in their view, favored larger airports. The FAA does not agree. The rule specifies requirements for a minimum capability, single accuracy system as defined by ICAO and should prove beneficial at all airports, large or small.

Several commenters state that the requirements of specification FAA-G-2100, incorporated by reference in various sections of the rule, which provides general equipment requirements, and governs quality control, type testing, reliability and maintainability, establishes environmental requirements, and identifies component selection parts lists, are excessive. They contend that the specification levies reliability and maintainability requirements which are inappropriate for non-Federal application and the inclusion of FAA-G-2100 would have a negative cost impact on the program. After further analysis, the FAA concurs that the inclusion of FAA-G-2100 would increase the initial cost of a non-Federal MLS; therefore, all reference to FAA-G-2100 is deleted from the rule, however, the requirement to design for high reliability and maintainability remains in § 171.323. These requirements provide for system integrity.

One commenter concludes MLS is not ready for implementation since no FAA (Federal) MLS system exists. The FAA recognizes the need for implementation of Federal MLS where needs and justifications are provided; however, this rule provides the public a means to establish an MLS without Federal justification. Since the public is soliciting for MLS at this time, the FAA is providing for a non-Federal MLS standards consistent with ICAO recommendations. Further, the FAA is currently preparing Federal specifications in conformance with ICAO, resulting in a compatible interface between Federal and non-Federal MLS.

Several commenters suggested relaxing, tightening, deleting or adding to the MLS functions, signal formats, tolerances, specifications, performance, and definitions. As already noted, the FAA concurs with the ICAO SARPS and the rule reflects these standards.

The majority of the comments to the proposed rule involved specific technical issues concerning the MLS. These comments are addressed in the sections that follow:

Section 171.303 Definitions.

The rule describes twenty four definitions in an initial section that apply throughout the subpart.

One commenter objected to the stated definition of "mean time between failures" and submitted a revised definition. The revised definition submitted defines "mean time between outages." After analysis, the FAA concludes that the use of the phrase "mean time between failures" is correct but that a definition is needed for the word "failure" to avoid

misinterpretation of the meaning of that word.

Another commenter states that the definition of "minimum glidepath" is ambiguous and it is not clear whether the word consistent as used in the definition means the highest angle or the lowest angle. The FAA concludes that the definition conforms to the definition given in the SARPS and is not ambiguous. (The term "SARPS" is used herein to describe the provisions agreed upon by ICAO at the April 1981 meeting in Montreal, concurred in by the FAA.)

Additionally, the FAA adds to the rule a definition for "beamwidth," and revises the definitions of "MLS approach reference datum," "MLS back azimuth reference datum," "data rate," and "path following error" to make these definitions consistent with ICAO standards. The definition for "clearance guidance sector" is revised to be consistent with the use of the terms "fly-left/fly-right clearance" as used in § 171.311(i)(2)(iv) and Figure 8.

Section 171.305 Requests for IFR procedure.

That section lists the requirements for each person who requests an IFR procedure based on an MLS facility which that person owns. The required information includes a description of the facility and shows that the equipment meets specified performance requirements; a proposed procedure for operating the facility; a proposed maintenance organization and manual; a statement of intent to meet the requirements of the subpart, and a demonstration that the MLS facility has an acceptable level of operational reliability and maintainability. A provision also specifies the procedures to be followed after the FAA inspects and evaluates the facility. No comments were received on these requirements and the rule is adopted without change.

Section 171.307 Minimum requirements for approval.

That section prescribes the minimum requirements that must be met before the FAA approves an IFR procedure for an MLS facility. Those requirements relate to performance, installation, operation, maintenance, operational records, inspection, withdrawal from service, and costs.

One commenter suggests that the FAA should bear all costs of FAA-required normal flight and ground inspections. This suggestion is not accepted since the requirement as written in the rule reflects existing FAA policy; furthermore, the systems proposed by this order are systems installed and maintained by the owner for his benefit at his own expense. As stated in the rule, the owner must bear all costs of installation and flight inspection prior to commissioning. The rule is adopted as proposed.

Section 171.309 General requirements.

That section describes the MLS as a precision approach and landing guidance system which provides position information and various ground to air data. It also states that the position information is provided in a wide coverage section and is determined by an azimuth angle measurement, an elevation angle measurement and a range (distance) measurement.

An MLS constructed to meet the requirements of this subpart must include: approach azimuth equipment, associated monitor, remote control and indicator equipment; approach elevation equipment, associated monitor, remote control and indicator equipment; a means for the transmission of basic data words, associated monitor, remote control and indicator equipment; and distance measuring equipment (DME), associated monitor, remote control and indicator equipment. In addition, MLS may include as an option, back azimuth equipment, associated monitor, remote control and indicator equipment; a wider proportional guidance; precision DME, associated monitor, remote control and indicator equipment; and VHF marker beacons (75 MHz), associated monitor, remote control and indicator equipment. That section also prescribes environmental ambient conditions covering temperature, humidity, wind, hail, rain, and ice loading that the electronic equipment must meet when installed in shelters and outdoors. The MLS and its components must meet specified standards prescribed under this subpart.

One commenter suggests specifying the MLS performance requirements as those contained in ICAO SARPS, thus eliminating the need for §§ 171.311 through 171.319. This commenter points out that other Subparts of FAR 171 incorporate by reference performance requirements contained in ICAO SARPS. The FAA concludes that due to the present unavailability of an ICAO MLS SARPS publication, the specifications must be fully presented in this rule.

Another commenter requests that an option be granted allowing the requirement of § 171.309(b)(3) which provides a means for the transmission of data, to be included with § 171.309(b)(1) which includes the azimuth equipment. The FAA disagrees. The order of the paragraphs as proposed does not inhibit the combining of functions where appropriate but provides clarity and this change is not accepted.

Another commenter asks whether or not DME monitor, remote control, and indicator equipment could be integrated with the MLS. After analysis of this comment, the FAA agrees that the equipment can be integrated. Therefore, the rule is changed in §§ 171.309 (b) and (c) by including a note stating that this equipment may be integrated.

Another commenter requests a clearer definition of the capabilities of remote control and indicator equipment. Accordingly, a note is added to § 171.309(b)(4) setting the minimum requirements for the remote control and indicator equipment.

One commenter points out that § 171.309(c)(2), which provides for a wider proportional guidance sector, does not include the wider proportional guidance sector cited in § 171.317, Elevation performance requirements. An addition is made to § 171.309(c)(2) citing § 171.317.

Another commenter recommends that 15 degrees of proportional guidance be specified on the elevation equipment instead of 7.5 degrees. Since the SARPS specifies the minimum elevation proportional guidance as 7.5 degrees, proportional guidance above 7.5 degrees is optional, and the rule is adopted as proposed.

Several commenters object to the service and environmental conditions requirements as specified in § 171.309(d). One commenter states that the requirements are too restrictive and appear to be written for FAA procurement. Another commenter suggests specifying optional environmental requirements for different climatic conditions. Another commenter states that a reduced ambient temperature requirement would reduce costs and satisfy the requirements of most of the purchasers of the equipment. After considering these comments, the FAA concludes that a change in the service and environmental condition requirements would be inconsistent with standardized design concepts. Electronic equipment installed outdoors must conform to environmental standards regardless of geographical placement. A geographic boundary for climatic variations would be difficult to describe. For example, even though Florida would seem an inappropriate locale for the use of de-icers, there are occasions when de-icers would be necessary. The rule is adopted as proposed.

Several commenters object to the applicability of specification FAA-G-2100 as it relates to DME and markers. Clarification is made to § 171.309 which

now describes DME and marker requirements separately in two paragraphs (e) and (f), respectively. It is made clear that when DME, or markers are components of MLS, they must conform to the requirements of FAR 171, Subpart G and H, respectively. All reference to Specification FAA-G-2100 is removed from this rule.

Additionally, in accordance with the requirements of SARPS, a change is made in § 171.309(b)(4). This change deletes the mandatory requirement for a marker beacon and a note is added which permits the use of a VHF marker beacon (75 MHz) in lieu of a DME at locations where the VHF marker beacon (75 MHz) is already located. Also §§ 171.309(c) (3) and (4) are added allowing as an option the use of a precision DME and marker beacon respectively. The rain requirements in § 171.309(d)(4) are restated for clarification since the proposed wording was confusing.

Section 171.311 Signal format requirements.

That section provides for signals radiated by the MLS which must conform to the signal format which describes specific minimum requirements such as frequency assignment, tranmission rates and sequences, digital codes, and data modulation.

One commenter interprets § 171.311(a) Frequency Assignment to mean that all ground equipments must operate on more than one channel. This is not the intent. The ground components must operate on a single frequency assignment; however, the design of the ground equipment must allow for the capability to incorporate any one of the 200 listed channels with minimum adjustment. Accordingly the rule is changed to clarify this fact.

One commenter suggests deleting the requirement for short-term frequency stability. No changes are made since the above requirements are consistent with the SARPS, and the rule is adopted as proposed.

A recommendation is made to delete the requirement for OCI signals and another commenter recommends that OCI be made mandatory on all installations. The FAA does not agree. The OCI pulse requirements are needed to accommodate those sites where OCI signal is necessary to suppress false courses. The need for OCI signal is highly site dependent and not considered essential at all minimum capability system installations. OCI signal remains an option to be provided as needed.

Another commenter states that the preamble of the signal format should indicate carrier transmission termination time. The FAA concurs and a note is added to Tables 2, 4a, 4b, 5, and 7, in § 171.311 explaining that when the "event time slot begins, the previous event time slot ends."

Another commenter recommends that the test pulses of the system test pulse requirements in § 171.311 should be artificially beam shaped. After reevaluation the system test pulse requirements are eliminated as the characteristics of the pulses have not been standardized; however, the time slot is retained.

One commenter suggests deleting the high rate approach azimuth function in § 171.311(f). The FAA concludes that this function has applicable system benefits. The rule is adopted as proposed.

Another commenter requests more information on the meaning of the phrase "undesirable flag action" in § 171.311(i)(2)(ii). After further evaluation the FAA concludes that this phrase is inappropriate and it is deleted. One commenter suggests clarification of the phrase "positive clockwise angles" in § 171.311(i)(2)(iii)(B) as it is ambiguous. The FAA concludes that this phrase is in common use and is widely understood. The rule is adopted as proposed.

One commenter suggests deleting the clearance function in § 171.311(i)(2)(iv) based on the premise that insufficient testing has been performed on this function. This commenter makes this same point again regarding § 171.313. The FAA concludes that the clearance function must be retained as a design option to be required at minimum capability installations where proportional guidance is provided to less than ±40 degrees in accordance with ICAO SARPS. A commenter also suggests that the width of the clearance pulse be equivalent to the scanning beam pulse (150 μs) for a 3° beamwidth. This change is not acceptable since tests of the clearance signal resulted in the optimization of the clearance pulse width as stated. Another commenter states that it is inconsistent to use the phrase "right clearance pulse/left clearance pulse" in the text of § 171.311(i)(2)(iv) and to use the phrase "fly-right clearance pulse/fly-left clearance pulse" in Figure 8 of § 171.311. The FAA concurs and the phrase "fly-right clearance pulse/fly-left clearance pulse" is inserted accordingly. Another commenter recommends deletion of the clearance function in § 171.311(i)(2)(iv) and replacing it with full proportional scan to that angle necessary to overcome erroneous signals which are generated at a particular site by causes such as multipath. The FAA concludes that deletion of the clearance function can optionally be permitted if the required approach guidance sector is provided by proportional guidance and adds a phrase so stating to that section.

Another commenter states that the data element in § 171.311(j)(3) requires ground equipments to do something which is not yet defined. This data element is undefined; however, a space in the timing sequence for the data element remains. In the future, the data transmission of the operational status of the equipment in use will be standardized and defined. A standard format for this Basic Data Word requirement has not been formalized; however, this data word space must be available in the data timing for future use and definition.

One commenter states that the allowable range of the back azimuth distance in Basic Data Word Seven is not balanced against the allowable range of the approach azimuth to threshold distance in Basic Data Word One in § 171.311, Table 8. After further analysis, the FAA concludes that the 3,100 meter (10,000 feet) maximum permitted in Basic Data Word One is sufficient for this application.

Another commenter suggests the need for additional Basic Data regarding DME distance information. The FAA concurs and includes this information in Tables 3 and 8 of § 171.311 and §§ 171.311(j) (17), (18), and (19), as recommended by ICAO.

Additionally, § 171.311(c)(1) and Figure 1 of this section are changed so that the phase transition is made without amplitude modulation and the phase rate of change is consistent with the requirements of paragraph (d) of this section. This change makes the DPSK compatible with the receiver decoding circuit chosen by the Radio Technical Committee on Aeronautics, Special Committee—139 (RTCA SC-139) for MLS receiver standards and as agreed upon by ICAO at the meeting in Montreal in April 1981.

Section 171.313 Azimuth performance requirements.

The performance requirements for the azimuth equipment components of the MLS are listed. Included are requirements concerning approach and back azimuth coverage, siting, accuracy, and antenna coordinates and characteristics.

Some commenters recommend relaxing the accuracy and coverage requirements. Another suggests

establishing various levels or categories of MLS service. The provisions of the SARPS, which were approved for adoption by ICAO in April 1981, served as the technical base for the requirements of the rule. Comments which suggest changes to the accuracy, coverage, signal format, or timing cannot be implemented since this would make the rule inconsistent with SARPS.

One commenter states that there is no means to indicate to the airborne receiver whether the azimuth antenna coordinates are, as permitted in § 171.313(d), conical or planar. The small displacements between conical and planar beams in this sector are operationally acceptable and need not be identified. Further, highest capability users can obtain this information from auxiliary data transmissions, where provided. The rule is adopted as proposed.

One commenter states that a "fundamental problem" exists with including airborne error and ground system error with the specification of accuracy on a system basis in regard to Table 10 in § 171.313. Another commenter, with regard to Table 10, states that the CMN error accuracy requirement should be annotated "for information only" since it was only "a recommendation" in the SARPS. Beam stepping noise is controlled by the CMN value for the ground subsystem. The values stated in Table 10 limit the beam stepping noise of the ground equipment; therefore, it is a requirement rather than a recommendation. The system accuracy numbers give the equipment designer the information he needs on allowances for propagation errors. The rule is adopted as proposed.

One commenter suggests inclusion of the degradation allowance to the approach azimuth accuracy requirement. The FAA concurs and § 171.313(e) is modified to include the degradation allowance to make the rule consistent with the SARPS.

One commenter states that in § 171.313(a)(1) a reduction in the specified ±40 degree coverage sector when intervening obstacles prevent full coverage should be allowed. After further analysis, the FAA concurs. A reduction in the specified ±40 degree coverage sector must be permitted when full coverage is prevented by intervening obstacles. Therefore, a sentence is added to the end of § 171.313(a)(1) to so provide.

One commenter states that in § 171.313(a)(3) the proportional guidance requirements in the runway region do not allow for offset installations for a minimum system. The FAA concludes that this requirement should not apply to azimuth offset installations and, therefore, the statement, "This requirement does not apply to azimuth offset installations," is added to the rule.

One commenter states that in § 171.313(f)(1) the drift requirement for the approach azimuth antenna characteristics should be reduced and furthermore met without internal environmental control equipment. The FAA concludes that the given tolerances are adequate for system performance; however, the FAA agrees that the service conditions should be met without internal environmental control equipment to provide for maximum system availability and integrity and the rule is changed in § 171.313(f)(1) to so require.

One commenter suggests that in § 171.313(f)(2) the beam pointing error be defined, and another commenter states that drift and beam pointing error be deleted due to the inability to separate the two in actual field installations. After further evaluation, the FAA concludes that beam pointing error is defined in § 171.313(f) (1) and (2) as is the requirement that the measurement be made in a multipath free environment. Another commenter suggests that beam pointing error be deleted as it is overly restrictive. Beam pointing error cannot be deleted because it is needed to assure linearity of the azimuth guidance in the centerline region and acceptable PFE when flying orthogonal to the centerline; however, the required coverage within which the beam pointing error applies is reduced from full coverage to ±0.5 degree of the zero degree azimuth.

Several commenters request that § 171.313(f)(3) on boresighting be expanded to include means other than only mechanical or optical for accomplishing the boresight procedure. The FAA concludes that electrical boresighting procedures can be utilized and the option for electrical boresighting is added to the rule. Another commenter requests that the antenna alignment tolerance in this section be relaxed. The FAA does not agree and the antenna alignment tolerance is adopted as proposed to insure system accuracies.

One commenter states that § 171.313(f)(4) refers to "sidelobe levels shown in Figure 10"; however, Figure 10 does not mention sidelobes and therefore reference to sidelobe levels in Figure 10 is deleted. The commenter further states that no minimum beamwidth is specified and that there is no limit to the amount of beam broadening that may occur off boresight of the scanning antenna. The FAA concurs. This section is changed to permit the beamwidth to broaden from the value at boresight by a factor of 1/cos D, where D is the angle off boresight. The scanning beam pulse width is now specified as 0.5 degrees minimum and 5.0 degrees maximum anywhere in proportional coverage. Another commenter suggests expanding this section to include effective sidelobe levels. The FAA concurs and adds a new § 171.313(f)(4)(ii) on effective sidelobe levels. One commenter states that the sidelobe levels specified are three decibels stronger than those shown in specification FAA-ER-700-08C. The change in the rule to specify effective sidelobe levels removes this ambiguity.

One commenter states that in § 171.313(g)(1) the minimum proportional guidance for back azimuth is omitted from the proposed rule. Also, that certain provisions are missing for siting the back azimuth. The FAA concurs and adds a provision for the minimum proportional guidance for back azimuth and provisions for siting the back azimuth in § 171.313(h) (1) through (6).

With reference to § 171.313(g)(4), one commenter states that the back azimuth power density levels are excessive, based on the reduced back azimuth range requirement. After further analysis, the FAA concludes that the minimum power densities required for back azimuth are consistent with the levels required in ICAO SARPS and are not excessive. Another commenter states that back azimuth coverage could be misinterpreted to mean that back azimuth must be provided at all facilities. The requirements for back azimuth in § 171.309 are clearly stated and should not be misinterpreted to mean that back azimuth must be provided at all facilities. The rule is adopted as proposed.

In addition a new § 171.313(f)(6) is added describing the radiation pattern of the data antenna. Also § 171.313(j) is expanded by adding back azimuth accuracy degradation allowances. These requirements were inadvertently omitted from the proposed rule and are now included to be consistent with ICAO SARPS.

Section 171.315 Azimuth monitor system requirements.

This section prescribes monitor systems that must provide an "Executive Alert" to the designated control points if any one of several conditions persist, such as an abnormal reduction in radiated power.

One commenter submits extensive revision to § 171.315 on azimuth monitor requirements. This proposal is not adopted as it is not necessary that the

rule specify the arrangement of the monitor system. Another commenter describes the timing accuracy tolerance (reference Table 11) as unrealistic due to a 10 μsec switching time. He further states that this requirement may also be difficult if not impossible to check during routine maintenance monitor checks. Table 11 specifies the timing tolerances for events internal to the transmitting equipment and is easily measured. The 10 microseconds referenced concern a rise time which occurs subsequent to the event time; therefore, the stated timing accuracy is a realistic requirement. This commenter also advises including degradation allowance in § 171.315(a)(1). The FAA concurs and degradation allowance is included in this section.

One commenter states that when referring to internal timing accuracies in Table 11 of § 171.315 that a specification should be included to indicate that the scan must be symmetrical about the mid scan point. The FAA concurs and adds Note 1 to Table 11 indicating that the tolerances shown therein apply to the timing of the specific events as shown in Tables 2, 4a, 4b, 5 and 7 of § 171.311.

Section 171.317 Approach elevation performance requirements.

The performance requirements for the elevation equipment components of the MLS included are requirements as to elevation coverage, siting, accuracy, and antenna coordinates and characteristics.

This section generated a number of comments. Many of the comments to § 171.313 were either repeated or are similar to the comments in this section. Accordingly, the explanations given earlier are equally valid here and are not repeated.

One commenter states that the threshold crossing height (TCH) requirement of this section does not provide for STOL aircraft. After further analysis, the FAA concludes that elevation siting requirements for STOL operations should be included. Section 171.317(b)(2)(i) is added to the rule to include TCH requirements for STOL aircraft operations.

Several commenters suggest that elevation accuracy degradations of § 171.317(d)(1) be allowed to be consistent with ICAO SARPS. The FAA concurs. This section is changed so that degradation limits are included in the rule to conform to SARPS.

Information relative to the glidepath planar angle was inadvertently omitted in the proposed rule and is now included in § 171.317(b)(2) to be consistent with ICAO SARPS.

Section 171.319 Approach elevation monitor system requirements.

That section prescribes monitor systems that must provide an "Executive Alert" to the designated control points if any one of several conditions persist, such as an abnormal reduction in radiated power.

One commenter states that § 171.319(a)(1) should include a reference to § 171.317(d). The FAA concurs and the reference is added to the rule.

One commenter states that § 171.319(a) should include requirements that when multiple sensor inputs are used to monitor a single parameter, at least two sensors must agree. The FAA disagrees. A monitor must insure integrity; however, it is left to the designer to incorporate specific design parameters. The rule is adopted as proposed.

One commenter suggests deletion in § 171.319(a)(1) of the phrase "consistent with published approach procedures and obstacle clearance criteria." The FAA concurs that the deletion removes an undesirable restriction on monitoring and deletes the phrase.

Section 171.321 DME and marker performance requirements.

DME equipment must meet the performance requirements prescribed in Subpart G of this part and marker beacon equipment must meet the performance requirements prescribed in Subpart H of this part. Both subparts impose requirements that performance features must comply with International Standards and Recommended Practices, Aeronautical Telecommunications, Part I, to ICAO Annex 10.

One commenter suggests including the DME location and the zero range point in this section. After further consideration the FAA concurs and includes in this section the location of the DME and zero range point.

One commenter suggests that a reference to compass locators should be added to § 171.321. The FAA concludes that a compass locator is not part of an MLS and no changes are made in this section.

Section 171.323 Fabrication and installation requirements.

The MLS facility must be permanent in nature, located, and installed in accordance with best commercial engineering practices, and with applicable safety codes and Federal Communications Commission (FCC) licensing requirements. Suitable primary and secondary power sources must be provided. The facility must also have, or be supplemented by ground, air or landline communications services with the location of antenna phase centers and the runway centerline at threshold determined by a survey within certain limits of accuracy.

One commenter states that § 171.323 (a) and (b) appear to be beyond the scope of the minimum requirements, further stating that the requirements of § 171.323 (b), (d), and (e) should be a "market place" item rather than Federal regulations. These requirements are provided to ensure maintainability and integrity of the MLS which is part of the NAS. These are the minimum requirements. No change is made since the requirements as stated are in the best interest of the owner and the NAS and the rule is adopted as proposed.

Two commenters suggest that in § 171.323(b) of the proposed rule traveling wave tube amplifiers (TWTA) should not be excluded from use. The FAA concurs and a phrase is added to § 171.323(b) that in addition to allowing the use of solid state amplifiers the rule permits the use of TWTA.

One commenter states inconsistencies in referencing Tables 10 and 13 for maintenance alerts in § 171.323(c). The FAA concurs and the references to Tables 10 and 13 are deleted from § 171.323(c). Several commenters further state that the requirements for interfacing with FAA remote monitoring are unclear. The FAA concurs and states in § 171.323(d) that this requirement may be complied with by the addition of optional software and/or hardware in space provided in the original equipment. Furthermore, this interface requirement exists only in the event the sponsor requests the FAA to assume ownership of the MLS.

One commenter requests a reduction of the requirement to operate on the battery backup power in § 171.323(h) and also a clarification of the intent that battery power is not required for the environmental subsystem or de-icing. After further analysis, the FAA concurs. The requirement for battery operations was reduced from 3 hours to 2 hours. This reduction will reduce costs and not significantly impact operation. The text further clarifies that radome de-icers and the environmental systems need not operate from the battery during periods when prime power is not available.

One commenter states that in § 171.323(l) the marking and accuracy of the location of the phase centers of the antenna enclosures is beyond the minimum requirements of this regulation. The antenna phase centers must be marked, since this is considered essential in satisfying siting and installation requirements. Furthermore, the accuracy of the established phase centers is considered essential to flight inspection. Experience has shown that

many operational problems have been the result of poor location surveys. Meaningful flight inspection is not possible without precise location of the origin of the signal. Therefore, the FAA concludes that the marking and the accuracy of the location of the phase centers of the antenna enclosures must be a requirement; however, this section is clarified by specifying the two separate accuracy requirements necessary to locate both the MLS datum point and the lateral and vertical offsets from the MLS datum point. The survey accuracy requirement for latitude, longitude and mean sea level elevation of the MLS datum point is ±3 meters (±10 feet) laterally and ±0.3 meter, (±1.0 foot) vertically, while the accuracy for lateral and vertical offsets from the MLS datum point for the other elements referenced to it is ±0.3 meter (±1.0 foot) laterally and ±0.03 meter (±0.1 foot) vertically. Another commenter requests clarification on who is to conduct the survey. The responsibility for conducting the antenna phase center survey is clarified in this Section and clearly states that the owner must bear all costs of the survey.

Section 171.325 Maintenance and operations requirements.

The owner of the facility must establish an adequate maintenance system and provide qualified maintenance personnel to maintain the facility at the level attained at the time it was commissioned. The owner must have an approved operations and maintenance manual that sets forth the mandatory procedures for operations and periodic and emergency maintenance.

One commenter questions the requirement in § 171.325(a) for written approval of the qualification of maintenance personnel. This requirement is deleted since the criteria for its application are not finalized. One commenter states that procedures in § 171.325(c)(17) for conducting ground checks of the DME and marker beacon are not described. The requirement to ground check DME and marker beacons is deleted as no formal procedure exists for ground checking these components.

One commenter states that § 171.325(e) on equipment modifications is ambiguous in that it is not clear whether or not manufacturers' suggested modifications are mandatory. The FAA concurs. The statement was ambiguous and the paragraph is revised so that all FAA approved modifications must be accomplished.

One commenter states that § 171.325(g) could permit various FAA regions to establish changes and maintenance procedures without public process and concludes that this provision should be deleted. After further analysis, the FAA concurs. FAA regions should not be permitted to establish changes and maintenance procedures, therefore, § 171.325(g) is deleted from the rule. One commenter states that requirements for FAA approved test equipment in § 171.325(i) is outside the scope of the MLS proposal. The FAA concludes that the test equipment used on the NAS facilities must be approved by the FAA to insure system integrity and is within the scope of the proposal. The rule is adopted as proposed.

One commenter suggests that the inservice test evaluation of the system in § 171.325(k) should be made more specific to avoid multiple interpretations in the field. The FAA concurs and adds information to this section specifying the frequency of checking the monitor and the length of the burn-in time. Another commenter suggests adding the DME to the list of equipment being checked in § 171.325(k). The FAA concurs and the DME is added.

Section 171.327 Operational Records.

The owner of the facility, or his maintenance representative, must submit the following data at the indicated time to the appropriate FAA regional office: (1) Facility Equipment Performance and Adjustment Data (FAA Form 198); (2) Facility Maintenance Log (FAA Form 6030-1); and (3) Technical Performance Records (FAA Form 6830).

One commenter questions whether or not the forms referenced in this section contained reasonable data requirements as the specific forms were not included in the proposed rule for examination. The FAA concludes that these forms are necessary and they are required in all other non-Federal facilities. These forms constitute a record establishing a description and the operational performance requirements for each components of the MLS. The rule is adopted as proposed.

VI. The Amendment

Accordingly, Part 171 of the Federal Aviation Regulations (14 CFR Part 171) is amended, effective December 17, 1981, by adding a new Subpart J to read as follows:

PART 171—NON-FEDERAL NAVIGATION FACILITIES

* * * * *

Subpart J—Microwave Landing System (MLS)

Sec.
171.301 Scope.
171.303 Definitions.
171.305 Requests for IFR procedure.
171.307 Minimum requirements for approval.
171.309 General requirements.
171.311 Signal format requirements.
171.313 Azimuth performance requirements.
171.315 Azimuth monitor system requirements.
171.317 Approach elevation performance requirements.
171.319 Approach elevation monitor system requirements.
171.321 DME and marker beacon performance requirements.
171.323 Fabrication and installation requirements.
171.325 Maintenance and operations requirements.
171.327 Operational records.

Authority: Secs. 305, 307, 313(a), 601, and 606, Federal Aviation Act of 1958, as amended (49 U.S.C. 1346, 1348, 1354(a), 1421, 1426); sec. 6(c), Department of Transportation Act (49 U.S.C. 1655(c)).

Subpart J—Microwave Landing System (MLS)

§ 171.301 Scope.

This subpart sets forth minimum requirements for the approval, installation, operation and maintenance of non-Federal Microwave Landing System (MLS) facilities that provide the basis for instrument flight rules (IFR) and air traffic control procedures.

§ 171.303 Definitions.

As used in this subpart:

"Back azimuth reference datum" means a point located 15 meters (50 feet) above the runway centerline at the runway midpoint.

"Basic data" means data transmitted by the ground equipment that are associated directly with the operation of the landing guidance system.

"Beamwidth" means the width of the scanning beam main lobe measured at the −3 dB points and defined in angular units on the boresight, in the horizontal plane for the azimuth function and in the vertical plane for the elevation function.

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

"Control Motion Noise (CMN)" means those fluctuations in the guidance which

affect aircraft attitude, control surface motion, column motion, and wheel motion. Control motion noise is evaluated by filtering the flight error record with a band-pass filter which has corner frequencies at 0.3 radian/sec and 10 radians/sec for azimuth data and 0.5 radian/sec and 10 radians/sec for elevation data.

"Data rate" means the average number of times per second that transmissions occur for a given function.

"Differential Phase Shift Keying (DPSK)" means differential phase modulation of the radio frequency carrier with relative phase states of 0 degree or 180 degrees.

"Failure" means the inability of an item to perform within previously specified limits.

"Guard time" means an unused period of time provided in the transmitted signal format to allow for equipment tolerances.

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

"Mean corrective time" means the average time required to correct an equipment failure over a given period, after a service technician reaches the facility.

"Mean course error" means the mean value of the azimuth error along a specified radial of the azimuth function.

"Mean glide path error" means the mean value of the elevation error along the glidepath of the elevation function.

"Mean time between failures (MTBF)" means the average time between equipment failures over a given period.

"Microwave Landing System (MLS)" means the MLS selected by ICAO for international standardization.

"Minimum glidepath" means the lowest angle of descent along the zero degree azimuth that is consistent with published approach procedures and obstacle clearance criteria.

"MLS approach reference datum" means a point 15 meters (50 feet) above the runway threshold on the minimum glidepath.

"MLS back azimuth reference datum" means a point 15 meters (50 feet) above the runway centerline at the runway midpoint.

"MLS datum point" means a point defined by the intersection of the runway centerline with a vertical plane perpendicular to the centerline and passing through the elevation antenna phase center.

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

"Path Following Error (PFE)" means the guidance perturbations which could cause aircraft displacement from the desired course or glidepath. It is composed of a path following noise and of the mean course error in the case of azimuth functions, or the mean glidepath error in the case of elevation functions. Path following errors are evaluated by filtering the flight error record with a second order low pass filter which has a corner frequency at 0.5 radian/sec for azimuth data or 1.5 radians/sec for elevation data.

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

"Split-site ground station" means the type of ground station in which the azimuth portion of the ground station is located on the centerline beyond the stop end of the runway, and the elevation portion is located alongside the runway near the approach end.

"Time Division Multiplex (TDM)" means that each function is transmitted on the same frequency in time sequence, with a distinct preamble preceding each function transmission.

§ 171.305 Requests for IFR procedure.

(a) Each person who requests an IFR procedure based on an MLS facility which that person owns must submit the following information with that request:

(1) A description of the facility and evidence that the equipment meets the performance requirements of §§ 171.309, 171.311, 171.313, 171.315, 171.317, 171.319, and 171.321 and is fabricated and installed in accordance with § 171.323.

(2) A proposed procedure for operating the facility.

(3) A proposed maintenance organization and a maintenance manual that meets the requirements of § 171.325.

(4) A statement of intent to meet the requirements of this subpart.

(5) A showing that the facility has an acceptable level of operational reliability and an acceptable standard of performance. Previous equivalent operational experience with a facility with identical design and operational characteristics will be considered in showing compliance with this subparagraph.

(b) FAA inspects and evaluates the MLS facility; it advises the owner of the results, and of any required changes in the MLS facility or in the maintenance manual or maintenance organization. The owner must then correct the deficiencies, if any, and operate the MLS facility for an in-service evaluation by the FAA.

§ 171.307 Minimum requirements for approval.

(a) The following are the minimum requirements that must be met before the FAA approves an IFR procedure for a non-Federal MLS facility:

(1) The performance of the MLS facility, as determined by flight and ground inspection conducted by the FAA, must meet the requirements of §§ 171.309, 171.311, 171.313, 171.315, 171.317, 171.319, and 171.321.

(2) The fabrication and installation of the equipment must meet the requirements of § 171.323.

(3) The owner must agree to operate and maintain the MLS facility in accordance with § 171.325.

(4) The owner must agree to furnish operational records as set forth in § 171.327 and agree to allow the FAA to inspect the facility and its operation whenever necessary.

(5) The owner must assure the FAA that he will not withdraw the MLS facility from service without the permission of the FAA.

(6) The owner must bear all costs of meeting the requirements of this section and of any flight or ground inspection in accordance with the FAA Flight Inspection Manual made before the MLS facility is commissioned, except that the FAA may bear certain costs subject to budgetary limitations and policy established by the Administrator. Incorporated by reference is Flight Inspection Manual, FAA Handbook 8200.1 through change 35, dated May 15, 1981, which prescribed standardized procedures for flight inspection of air navigation facilities. It is available from the National Technical Information Service, 5285 Port Royal Road, Springfield, Virginia 22161 and also available for inspection at the Office of the Federal Register Information Center, Room 8301, 1100 L Street, NW., Washington, D.C., 20408.

(b) [Reserved]

§ 171.309 General requirements.

The MLS is a precision approach and landing guidance system which provides position information and various ground-to-air data. The position information is provided in a wide coverage sector and is determined by an azimuth angle measurement, an elevation angle measurement and a range (distance) measurement.

(a) An MLS constructed to meet the requirements of this subpart must include:

(1) Approach azimuth equipment, associated monitor, remote control and indicator equipment.

(2) Approach elevation equipment, associated monitor, remote control and indicator equipment.

(3) A means for the transmission of basic data words, associated monitor, remote control and indicator equipment.

(4) Distance measuring equipment (DME), associated monitor, remote control and indicator equipment.

(5) Remote controls for paragraph (a)(1), (2), (3), and (4) of this section must include as a minimum on/off and reset capabilities and may be integrated in the same equipment.

(6) At locations where a VHF marker beacon (75 MHz) is already installed, it may be used in lieu of the DME equipment.

(b) In addition to the equipment required in paragraph (a) of this section the MLS may include:

(1) Back azimuth equipment, associated monitor, remote control and indicator equipment.

(2) A wider proportional guidance sector which exceeds the minimum specified in §§ 171.313 and 171.317.

(3) Precision DME, associated monitor, remote control and indicator equipment.

(4) VHF marker beacon (75 MHz), associated monitor, remote control and indicator equipment.

(5) The MLS signal format will accomodate additional functions (e.g., flare elevation) which may be included as desired. Remote controls for paragraphs (b)(1), (2) and (3) of this section must include as a minimum on/off and reset capabilities, and may be integrated in the same equipment.

(c) MLS ground equipment must be designed to operate on a nominal 120/240 volt, 60 Hz, 3-wire single phase AC power source and must meet the following service conditions:

(1) AC line parameters, DC voltage, elevation and duty:

120 VAC nominal value—102 V to 138 V (±1 V)*
240 VAC nominal value—204 V to 276 V (±2 V)*
60 Hz AC line frequency—57 Hz to 63 Hz (±0.2 Hz)*
24 VDC nominal value—20 V to 30 V (±0.25 V)*

*Note.—Where discrete values of the above frequency or voltages are specified for testing purposes, the tolerances given in parentheses indicated by an asterisk apply to the test instruments used to measure these parameters.

Elevation—0 to 3,000 meters (10,000 feet) above sea level
Duty—Continuous, unattended

(2) Ambient conditions within the shelter for electronic equipment installed in shelters are:

Temperature, −10°C to +50°C
Relative humidity, 5% to 90%

(3) Ambient conditions for electronic equipment and all other equipment installed outdoors (for example, antenna, field detectors, and shelters):

Temperature, −50°C to +70°C
Relative humidity, 5% to 100%

(4) All equipment installed outdoors must operate satisfactorily under the following conditions:

Wind Velocity: The ground equipment shall remain within monitor limits with wind velocities of up to 70 knots from such directions that the velocity component perpendicular to runway centerline does not exceed 35 knots. The ground equipment shall withstand winds up to 100 knots from any direction without damage.
Hail Stones: 1.25 centimeters (½ inch) diameter.
Rain: Provide required coverage with rain falling at a rate of 50 millimeters (2 inches) per hour, through a distance of 9 kilometers (5 nautical miles) and with rain falling at the rate of 25 millimeters (1 inch) per hour for the additional 28 kilometers (15 nautical miles).
Ice Loading: Encased in 1.25 centimeters (½ inch) radial thickness of clear ice.
Antenna Radome De-Icing: Down to −6°C (20°F) and wind up to 35 knots.

(d) The transmitter frequencies of an MLS must be in accordance with the frequency plan approved by the FAA.

(e) The DME component listed in paragraph (a)(4) of this section must comply with the minimum standard performance requirements specified in Subpart G of this part.

(f) The marker beacon components listed in paragraph (b)(4) of this section must comply with the minimum standard performance requirements specified in Subpart H of this part.

§ 171.311 Signal format requirements.

The signals radiated by the MLS must conform to the signal format in which angle guidance functions and data functions are transmitted sequentially on the same C-band frequency. Each function is identified by a unique digital code which initializes the airborne receiver for proper processing. The signal format must meet the following minimum requirements:

(a) *Frequency Assignment.* The ground components (except DME/Marker Beacon) must operate on a single frequency assignment or channel, using time division multiplexing. These components must be capable of operating on any one of the 200 channels spaced 300 KHz apart with center frequencies from 5031.0 MHz to 5090.7 MHz and with channel numbering as shown in Table 1. The operating radio frequencies of all ground components must not vary by more than ±10 KHz from the assigned frequency. Any one transmitter frequency must not vary more than ±50 Hz in any one second period.

TABLE 1.—FREQUENCY CHANNEL PLAN

Channel No.	Frequency (MHz)
500	5031.0
501	5031.3
502	5031.6
503	5031.9
504	5032.2
505	5032.5
506	5032.8
507	5033.1
508	5033.4
509	5033.7
510	5034.0
511	5034.3
598	5060.4
599	5060.7
600	5061.0
601	5061.3
698	5090.4
699	5090.7

(b) *Polarization.* (1) The radio frequency emissions from all ground equipment must be nominally vertically polarized. Any horizontally polarized radio frequency emission component from the ground equipment must not have incorrectly coded angle information such that the limits specified in paragraphs (b)(2) and (3), of this section are exceeded.

(2) Rotation of the receiving antenna thirty degrees from the vertically polarized position must not cause the guidance information to change by more than 40% of the allowable path following error applicable at that location.

(3) All system accuracy limits must be met with the receiving antenna up to thirty degrees from the vertically polarized position.

(c) *Modulation Requirements.* Each function transmitter must be capable of DPSK and continuous wave (CW) modulations of the RF carrier which have the following characteristics:

(1) *DPSK.* The DPSK signal must have the following characteristics:

bit rate	15.625KHz
bit length	64 usec.
logic "0"	no phase transition
logic "1"	phase transition
phase transition	less than 10μsec.
phase tolerance	± 10 degrees

It is intended that the phase transition be made without amplitude modulation. Figure 1 illustrates the phase characteristics of two logic "1" bits in sequence. Control must be such that the time interval for phase transition does not exceed 10μsec and the phase rate of change is consistent with the requirements of paragraph (d) of this section. The phase characteristic inside

section. The phase characteristic inside the transition region must be as linear as possible and in no case deviate more than ± 90 degrees from a linear transition.

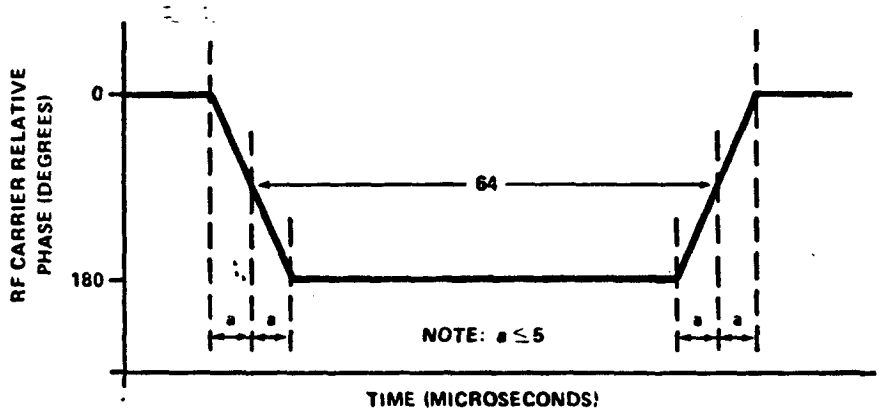

FIGURE 1. DPSK PHASE CHARACTERISTICS

(2) *CW.* The CW pulse transmissions and the CW angle transmissions as may be required in the signal format of any function must have characteristics such that the requirements of paragraph (d) of this section are met.

(d) *Radio Frequency Signal Spectrum.* The transmitted signal must be such that during the transmission time, the mean power density above a height of 600 meters (2000 feet) does not exceed −100.5 dBW/m² for angle guidance and −95.5 dBW/m² for data, as measured in 150 KHz bandwidth centered at a frequency of 840 KHz or more from the assigned frequency.

(e) *Synchronization.* Synchronization between the azimuth and elevation components is required and, in split-site configurations, would normally be accomplished by landline interconnections. Synchronization monitoring must be provided to preclude function overlap.

(f) *Transmission Rates.* Angle guidance and data signals must be transmitted at the following average repetition rates:

Function	Average data rate (Hertz per second)
Approach Azimuth	13 ± 0.5
High Rate Approach Azimuth	[1] 39 ± 1.5
Approach Elevation	39 ± 1.5
Back Azimuth	6.5 ± 0.25
Basic Data	([2])

[1] The higher rate is recommended for azimuth scanning antennas with beamwidths greater than two degrees. It should be noted that the time available in the signal format for additional functions is limited when the higher rate is used.

[2] Refer to Basic Data Functions Timing, Table 7.

(g) *Transmission Sequences.* Sequences of angle transmissions which will generate the required repetition rates are shown in Figures 2 and 3.

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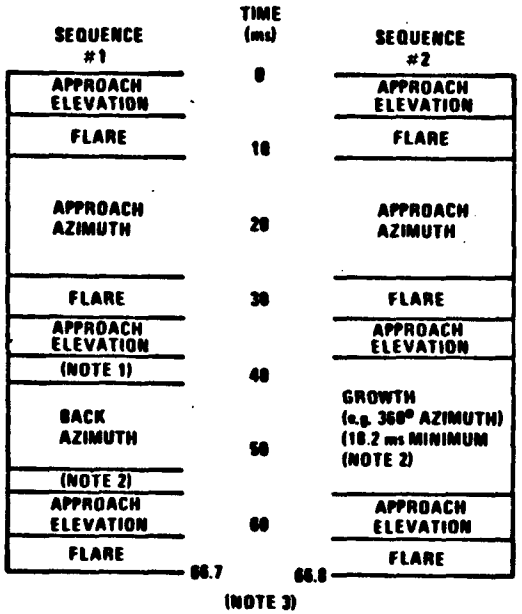
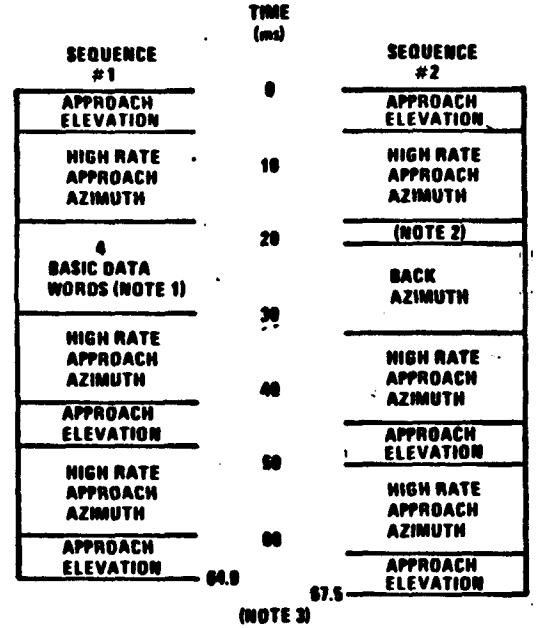


NOTES:

1. WHEN BACK AZIMUTH IS PROVIDED, BASIC DATA WORD #2 MUST BE TRANSMITTED ONLY IN THIS POSITION.
2. BASIC DATA WORDS MAY BE TRANSMITTED IN ANY OPEN TIME PERIODS.
3. THE TOTAL TIME DURATION OF SEQUENCE #1 PLUS SEQUENCE #2 MUST NOT EXCEED 134 ms.

FIGURE 2. TRANSMISSION SEQUENCE PAIR WHICH PROVIDES FOR ALL MLS ANGLE GUIDANCE FUNCTIONS



NOTES:

1. BASIC DATA WORDS MAY BE TRANSMITTED IN ANY OPEN TIME PERIODS.
2. WHEN BACK AZIMUTH IS PROVIDED, BASIC DATA WORD #2 MUST BE TRANSMITTED ONLY IN THIS POSITION.
3. THE TOTAL TIME DURATION OF SEQUENCE #1 PLUS SEQUENCE #2 MUST NOT EXCEED 134 ms.

FIGURE 3. TRANSMISSION SEQUENCE PAIR WHICH PROVIDES FOR THE MLS HIGH RATE APPROACH AZIMUTH ANGLE GUIDANCE FUNCTION

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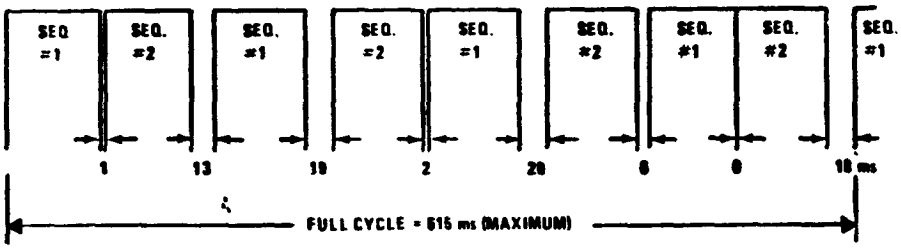
(h) *TDM Cycle.* The time periods between angle transmission sequences must be varied so that exact repetitions do not occur within periods of less than 0.5 second in order to protect against synchronous interference. One such combination of sequences is shown in Figure 4 which forms a full multiplex cycle. Basic data may be transmitted during suitable open times within or between the sequences.



NOTE: Angle sequences are those from Figure 2 or 3. Do not mix sequences.

FIGURE 4. A COMPLETE FUNCTION MUTIPLEX CYCLE

(i) *Function Formats (General).* Each angle function must contain the following elements: A preamble; sector signals; and a TO and FRO angle scan organized as shown in Figure 5a. Each data function must contain a preamble and a data transmission period organized as shown in Figure 5b.

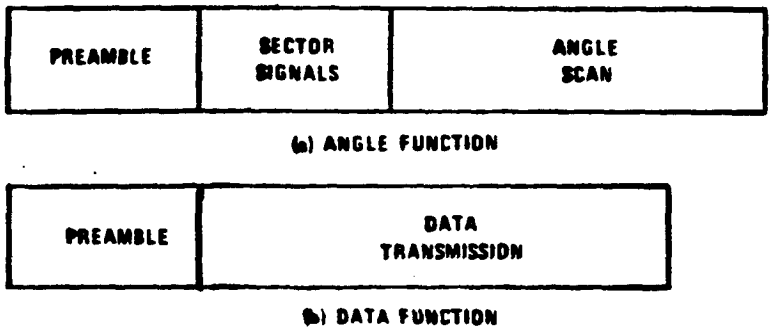


FIGURE 5. FUNCTION FORMAT

(1) *Preamble Format.* The transmitted angle and data functions must use the preamble format shown in Figure 6. This format consists of a carrier acquisition period of unmodulated CW transmission followed by a receiver synchronization code and a function identification code. The preamble timing must be in accordance with Table 2.

FIGURE 6.—PREAMBLE ORGANIZATION

	Carrier acquisition	Synchronization code	Function identification code
Clock pulse 0	13	18	25

(i) *Digital Codes.* The coding used in the preamble for receiver synchronization is a Barker code logic 11101. Receiver timing is established on the transition to the last bit (I_5) of the code (see Table 2). The function identification codes must be as shown in Table 3. The last two bits (I_{11} and I_{12}) of the code are parity bits obeying the equations:

$$I_6+I_7+I_8+I_9+I_{10}+I_{11}=\text{Even}$$
$$I_6+I_8+I_{10}+I_{12}=\text{Even}$$

(ii) *Data Modulation.* The digital code portions of the preamble must be DPSK modulated in accordance with § 171.311(c)(1) and must be transmitted throughout the function coverage volume.

TABLE 2.—PREAMBLE TIMING [1]

Event	Event time slot begins at: [2] 15.625 kHz clock pulse (number)	Time (milliseconds)
Carrier acquisition (CW transmission)	0	0
Receiver reference time code:		
$I_1=1$	13	0.832
$I_2=1$	14	0.896
$I_3=1$	15	0.960
$I_4=0$	16	1.024
$I_5=1$	17	[3] 1.088
Function identification code:		
I_6	18	1.152
I_7	19	1.216
I_8	20	1.280
I_9 (see Table 3)	21	1.344
I_{10}	22	1.408
I_{11}	23	1.472
I_{12}	24	1.536
End preamble	25	1.600

[1] Applies to all functions transmitted.
[2] The previous event time slot ends at this time.
[3] Reference time for receiver synchronization for all function timing.

TABLE 3.—FUNCTION IDENTIFICATION CODES

Function	Code I_6	I_7	I_8	I_9	I_{10}	I_{11}	I_{12}
Approach azimuth	0	0	1	1	0	0	1
High rate approach azimuth	0	0	1	0	1	0	0
Approach elevation	1	1	0	0	0	0	1
Back azimuth	1	0	0	1	0	0	1
Basic data 1	0	1	0	1	0	0	0
Basic data 2	0	1	1	1	1	0	0
Basic data 3	1	0	1	0	0	0	0
Basic data 4	1	0	0	0	1	0	0
Basic data 5	1	1	0	1	1	0	0
Basic data 6	0	0	0	1	1	0	1
Basic data 7	1	1	1	0	0	1	0
Basic data 8	1	0	1	0	1	1	1

(2) *Angle Function Formats.* The timing of the angle transmissions must be in accordance with Tables 4a, 4b, and 5. The actual timing of the TO and FRO scans must be as required to meet the accuracy requirements of §§ 171.313 amd 171.317.

(i) *Preamble.* Must be in accordance with requirements of § 171.311(i)(1).

(ii) *Sector Signals.* In all azimuth formats, sector signals must be transmitted to provide Morse Code identification, airborne antenna selection, and system test signals. These signals are not required in the elevation

formats. In addition, if the signal from an installed ground component results in a valid indication in an area where no valid guidance exists, OCI signals must be radiated as provided for in the signal format (see Tables 4a, 4b, and 5). The sector signals are defined as follows:

(A) *Morse Code.* DPSK transmissions that will permit Morse Code facility identification in the aircraft by a four letter code starting with the letter "M" must be included in all azimuth functions. They must be transmitted and repeated at approximately equal intervals, not less than six times per minute, during which time the ground subsystem is available for operational use. When the transmissions of the ground subsystem are not available, the identification signal must be suppressed. The audible tone in the aircraft is started by setting the Morse Code bit to logic "1" and stopped by a logic "0" (see Tables 4a and 4b). The identification code characteristics must conform to the following: The dot must be between 0.13 and 0.16 second in duration, and the dash between 0.39 and 0.48 second. The duration between dots and/or dashes must be one dot plus or minus 10%. The duration between characters (letters) must not be less then three dots.

(B) *Airborne Antenna Selection.* A signal for airborne antenna selection shall be transmitted as a "zero" DPSK signal lasting for a six-bit period (See Tables 4a and 4b).

TABLE 4a.—APPROACH AZIMUTH FUNCTION TIMING

Event	Event time slot begins at: [1]	
	15.625 kHz clock pulse (number)	Time (milliseconds)
Preamble	0	0
Morse code	25	1.600
Antenna select	26	1.664
Rear OCI	32	2.048
Left OCI	34	2.176
Right OCI	36	2.304
TO test	38	2.432
TO scan [2]	40	2.560
Pause		8.760
Mid scan point		9.060
FRO scan [2]		9.360
FRO test		15.560
End function (airborne)		15.688
End guard time; end function (ground)		15.900

[1] The previous event time slot ends at this time.
[2] The actual commencement and completion of the TO and FRO scan transmissions are dependent on the amount of proportional guidance provided. The time slots provided will accommodate a maximum scan of ±62 degrees. Scan timing must be compatible with accuracy requirements.

TABLE 4b.—HIGH RATE APPROACH AZIMUTH AND BACK AZIMUTH FUNCTION TIMING

Event	Event time slot begins at: [1]	
	15.625 kHz clock pulse (number)	Time (milliseconds)
Preamble	0	0
Morse code	25	1.600
Antenna select	26	1.664
Rear OCI	32	2.048
Left OCI	34	2.176
Right OCI	36	2.304
TO test	38	2.432
TO scan [2]	40	2.560
Pause		6.760
Mid scan point		7.060
FRO scan [2]		7.360
FRO test		11.560
End function (airborne)		11.688
End guard time; end function (ground)		11.900

[1] The previous event time slot ends at this time.
[2] The actual commencement and completion of the TO and FRO scan transmissions are dependent upon the amount of proportional guidance provided. The time slots provided will accommodate a maximum scan of ±42 degrees. Scan timing must be compatible with accuracy requirements.

TABLE 5.—APPROACH ELEVATION FUNCTION TIMING

Event	Event time slot begins at: [1]	
	15.625 kHz clock pulse (number)	Time (milliseconds)
Preamble	0	0
Processor pause	25	1.600
OCI	27	1.728
TO scan [2]	29	1.856
Pause		3.406
Mid scan point		3.606
FRO scan [2]		3.806
End function (airborne)		5.356
End guard time; end function (ground)		5.600

[1] The previous event time slot ends at this time.
[2] The actual commencement and completion of the TO and FRO scan transmissions are dependent upon the amount of proportional guidance provided. The time slots provided will accommodate a maximum scan of −1.5 degrees to +29.5 degrees. Scan timing must be compatible with accuracy requirements.

(C) *OCI.* Where OCI pulses are used, they must be: (*1*) Greater than any guidance signal in the OCI sector; (*2*) at least 5dB less than the level of the scanning beam within the proportional guidance sector; and (*3*) for azimuth functions with clearance signals, at least 5dB less than the level of the left (right) clearance pulses within the left (right) clearance sector. The duration of each pulse measured at the half amplitude points must be 100 (±10) microseconds and the rise and fall times must be less than 10 microseconds.

Note.—If desired, two pulses may be sequentially transmitted in each OCI time slot. Where pulse pairs are used, the duration of each pulse must be 45 (±5) microseconds and the rise and fall times must be less than 10 microseconds.

(D) *System Test.* Time slots are provided in Tables 4a and 4b to allow radiation of TO and FRO test pulses. Radiation of these pulses is not required, however, since the characteristics of these pulses have not yet been standardized.

(iii) *Angle encoding.* The encoding must be as follows:

(A) *General.* Azimuth and elevation angles are encoded by scanning a narrow beam between the limits of the proportional coverage sector first in one direction (the "TO" scan) and then in the opposite direction (the "FRO" scan). Angular information must be encoded by the amount of time separation between the beam centers of the TO and FRO scanning beam pulses. The TO and FRO transmissions must be symmetrically disposed about the midscan point listed in Table 4a, 4b, 5, and 7. The midscan point and the center of the time interval between the TO and FRO scan transmissions must coincide with a tolerance of ±10 μsec. Angular coding must be linear with angle and properly decoded using the formula:

$$\theta = \frac{V}{2}(T_o - t) \text{ where:}$$

θ = Receiver angle in degrees
V = Scan velocity in degrees per microsecond
T_o = Time separation in microseconds between TO and FRO beam centers corresponding to zero degrees.
t = Time separation in microseconds between TO and FRO beam centers

The timing requirements are listed in Table 6 and illustrated in Figure 7.

TABLE 6.—ANGLE SCAN TIMING CONSTANTS

Function	Max value of t_i (μsec)	T_o (μsec)	V(deg/μsec)	T_m (μsec)	Pause time (μsec)	T_i (μsec)
Approach azimuth	13,000	6,800	0.02	7,972	600	13,128
High rate approach azimuth	9,000	4,800	.02	5,972	600	9,128
Approach elevation	3,500	3,350	.02	2,518	400	NA
Back azimuth	9,000	4,800	.02	5,972	600	9,128

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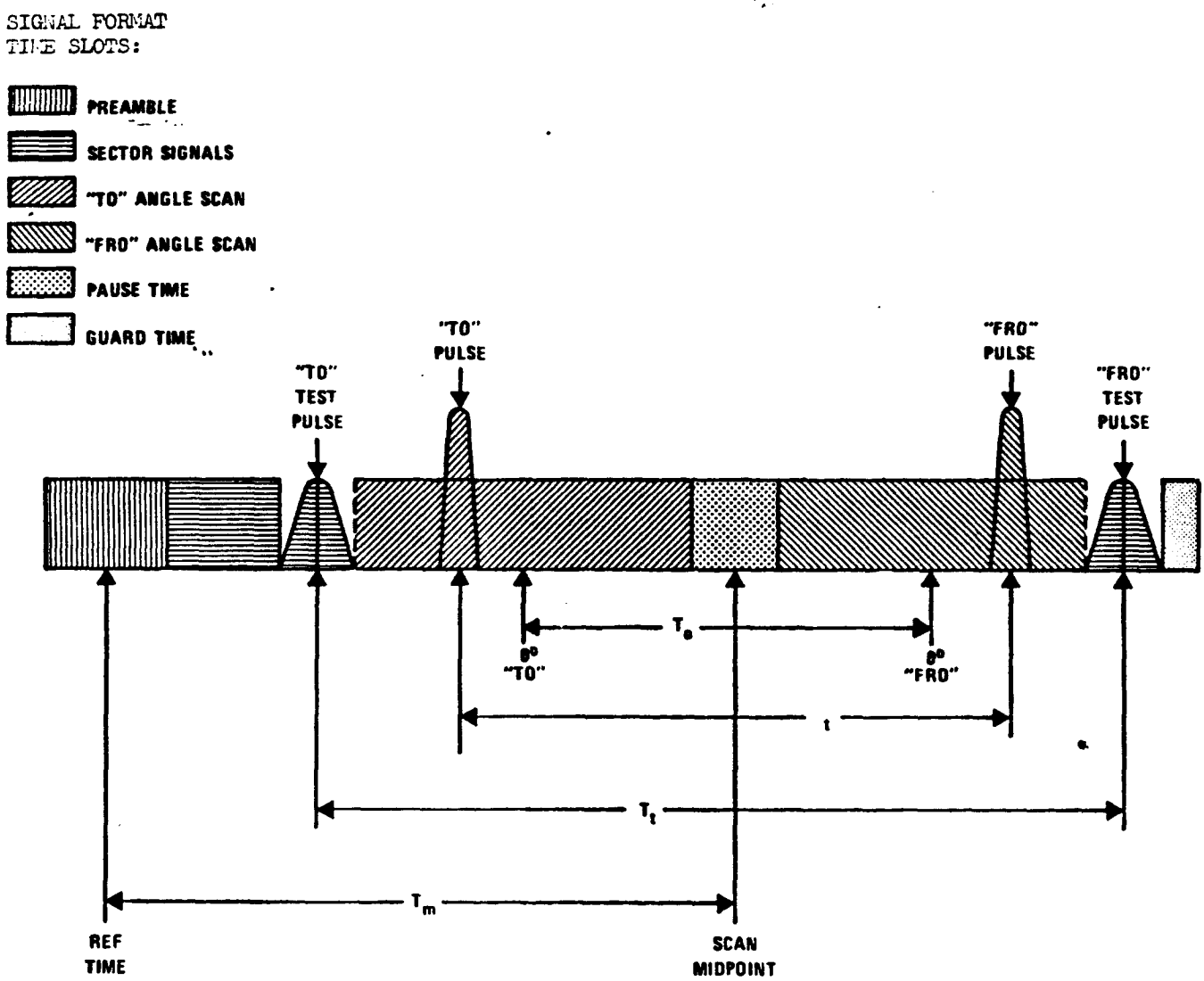

FIGURE 7. AZIMUTH ANGLE SCAN TIMING (NOT TO SCALE)

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(B) *Azimuth Angle Encoding.* The ıdiation from azimuth equipment must roduce a beam that scans from egative to positive azimuth angles and ıen scans back through the roportional coverage sector. The ntenna has a narrow beam in the plane f the scan direction and a broad beam ı the orthogonal plane which fills the ertical coverage. Increasing positive ngles must be seen as a clockwise otation when viewed from above. Zero ngle must be defined along the nidpoint of the proportional sector.

(C) *Elevation Angle Encoding.* The ·adiation from elevation equipment must ɔroduce a beam which scans from the ıorizon up to the highest elevation ángle ınd then scans back down to the ıorizon. The antenna has a narrow ɔeam in the plane of the scan direction and a broad beam in the orthogonal plane which fills the horizontal coverage. Elevation angles are defined from the horizonal plane containing the antenna phase center; positive angles are above the horizontal and zero angle is along the horizontal.

(iv) *Clearance Guidance.* The timing of the clearance pulses must be in accordance with figure 8. For azimuth elements with proportional coverage of less than ±40 degrees, clearance guidance information must be provided by transmitting pulses in a TO and FRO format adjacent to the stop/start times of the scanning beam signal. The fly right clearance pulses must represent positive angles and the fly left clearance pulses must represent negative angles. The duration of each clearance pulse must be 50 microseconds with a tolerance of ±5 microseconds. The transmitter switching time between the clearance pulses and the scanning beam transmissions must not exceed 10 microseconds. The rise time at the edge of each clearance pulse must be less than 10 microseconds. In the right clearance guidance sector, the transmitted fly right clearance pulses must exceed the transmitted fly left clearance pulses by more than 15 dB and must exceed the sidelobes of the scanning beam signal by at least 5 dB. The fly right clearance pulses must be at least 5 dB below the scanning beam leval at the scanning beam positive angle scan limit. The converse applies to the fly left clearance guidance sector. Clearance guidance pulses must be at least 5 dB greater than any other signal in the appropriate clearance sector. Optionally, clearance guidance may be provided by scanning throughout the approach guidance sector. For angles outside the approach azimuth proportional coverage limits as set in Basic Data Word One, proper decode and display of clearance guidance must occur to the limits of the guidance region.

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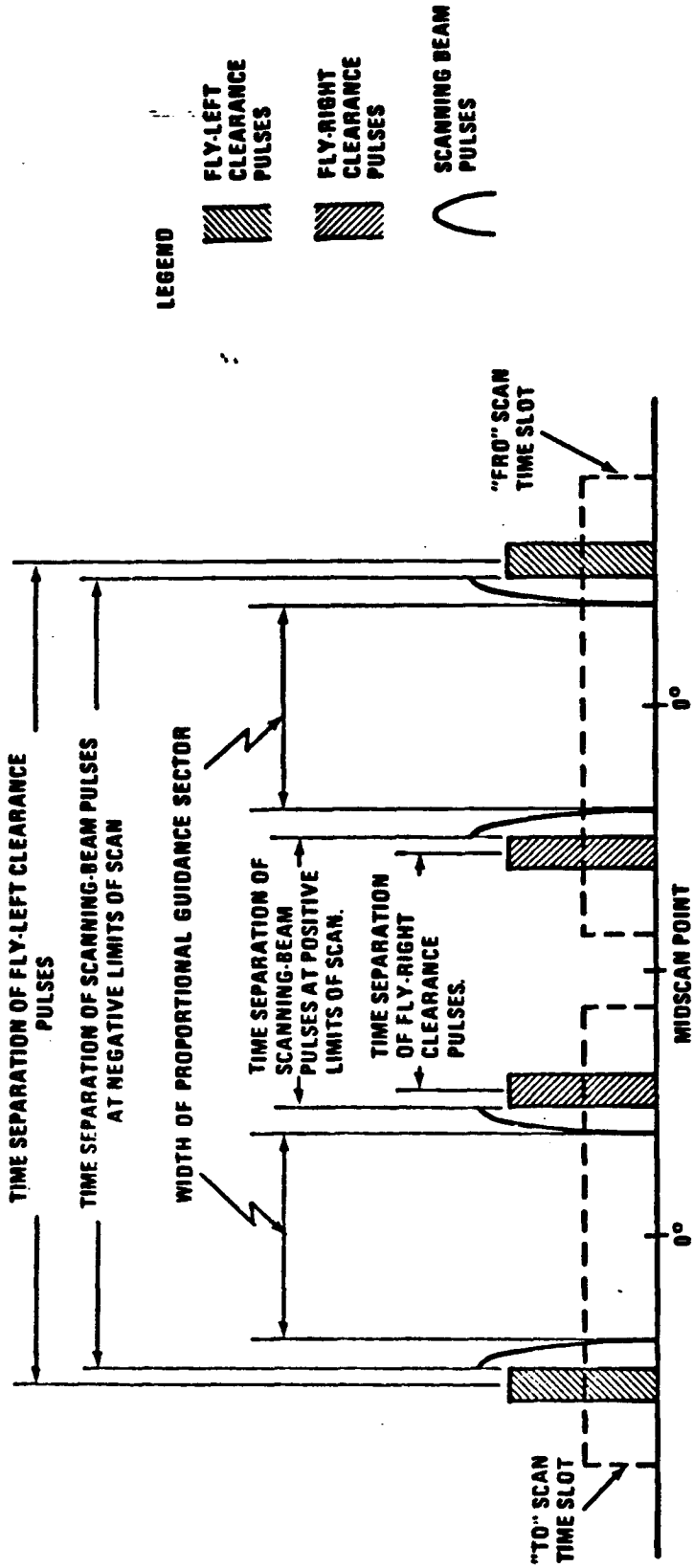

FIGURE 8. CLEARANCE PULSE TIMING FOR AZIMUTH FUNCTIONS

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(3) *Data Function Format.* Basic data words provide equipment characteristics and certain siting information. Basic data words must be transmitted from an antenna located at the approach azimuth or back azimuth site which provides coverage throughout the appropriate sector. Data function timing must be in accordance with Table 7 as follows:

TABLE 7.—BASIC DATA FUNCTION TIMING

Event	Event time slot begins at:[1]	
	15.625 kHz clock pulse (number)	Time (milliseconds)
Preamble	0	0
Data transmission (bits I_{12}–I_{36})	25	1.600
Parity Transmission (bits I_{51}–I_{55})	43	2.752
End function (airborne)	45	2.880
End guard time; end function (ground)		3.100

[1] The previous event time slot ends at this time.

(i) *Preamble.* Must be in accordance with requirements of § 171.311(i)(l).

(ii) *Data Transmissions.* Basic data must be transmitted using DPSK modulation. The content and repetition rate of each basic data word must be in accordance with Table 8. For data containing digital information, binary number 1 must represent the lower range limit with increments in binary steps to the upper range limit shown in Table 8.

(j) *Basic Data Word Requirement.* Specific basic data word requirements are as follows:

(1) Approach azimuth to threshold distance must represent the distance measured parallel to the runway centerline from the approach azimuth antenna to runway landing threshold.

(2) Approach azimuth proportional coverage limit must represent the limit of the sector in which proportional approach azimuth guidance is provided.

(3) Ground equipment performance level must represent the operational status of the equipment in use. The exact use of this basic data item is not yet defined.

(4) Approach elevation antenna height must represent the height of the elevation antenna phase center relative to the height of the MLS datum point.

(5) Approach elevation antenna offset must represent the minimum distance between the elevation antenna phase center and a vertical plane containing the runway centerline.

(6) Back azimuth next function must indicate that the next function to be transmitted will be back azimuth.

(7) Minimum glidepath must represent the minimum glidepath as defined.

(8) Beamwidth must represent, for a particular function, the antenna beamwidth as defined to the nearest least significant bit provided for in the data word.

(9) Approach azimuth guidance alert must represent the elevation angle in the specified azimuth sector below which guidance is unreliable or unsafe. A binary code "0" on this message element must indicate that all approach azimuth angles in a particular sector are usable.

(10) DME distance must represent the distance measured parallel to the runway centerline from the DME antenna phase center to the MLS datum point.

(11) DME offset must represent the minimum distance between the DME antenna phase center and a vertical plane containing runway centerline.

(12) DME channel must represent the DME channel associated with the selected MLS channel.

(13) Approach azimuth antenna offset must represent the minimum distance between the approach azimuth antenna phase center and a vertical plane containing runway centerline.

(14) MLS ground equipment identification must represent the last 3 characters of the system identification specified in § 171.311(i)(2). The characters must be encoded in accordance with the 5-unit code of the International Telegraph Alphabet No. 2. Even character parity must also be provided.

Note.—Restriction of data content to alpha characters eliminates the need for transmission of signal numbers 29 and 30 designating letters and figures.

(15) Back azimuth antenna distance must represent the horizontal distance measured parellel to the runway centerline from the back azimuth antenna phase center to the back azimuth reference datum.

(16) Back azimuth proportional coverage limit must represent the limit of the sector in which proportional back azimuth guidance is provided.

(17) DME status must represent the operational status of the equipment in use.

(18) DME or DME/P must represent whether the equipment in use is conventional or precision DME.

(19) MLS datum point to threshold distance must represent the distance measured along the runway centerline from the MLS datum point to the runway threshold.

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TABLE 8. BASIC DATA

WORD	DATA CONTENT	MAX. TIME BETWEEN TRANSMISSIONS (SECONDS)	BITS USED	RANGE OF VALUES	LEAST SIGNI-FICANT BIT	BIT NUMBER
1	PREAMBLE	0.4	12			$I_1 - I_{12}$
	Approach Azimuth to Threshold Distance		6	0M to 6300M	100M	$I_{13} - I_{18}$
	Approach Azimuth Proportional Coverage Limit		5	-10° to -60°	2°	$I_{19} - I_{23}$
	Approach Azimuth Proportional Coverage Limit		5	$+10^\circ$ to $+60^\circ$	2°	$I_{24} - I_{28}$
	SPARE		2			$I_{29} - I_{30}$
	PARITY		2	SEE NOTE 1		$I_{31} - I_{32}$
2	PREAMBLE	0.16	12			$I_1 - I_{12}$
	Ground Equipment Performance Level		2	SEE NOTE 2		$I_{13} - I_{14}$
	Minimum Glide-path		6	2° to 8.2°	0.1°	$I_{15} - I_{20}$
	Back Azimuth Next Function		1	SEE NOTE 3		I_{21}
	SPARE		7	SEE NOTE 6		$I_{22} - I_{28}$
	DME Status		2	SEE NOTE 2		$I_{29} - I_{30}$
	PARITY		2	SEE NOTE 1		$I_{31} - I_{32}$
3	PREAMBLE	10	12			$I_1 - I_{12}$
	Approach Azimuth Beamwidth		3	0.5° to 4°	0.5°	$I_{13} - I_{15}$
	Approach Elevation Beamwidth		3	0.5° to 2.5°	0.5°	$I_{16} - I_{18}$
	Flare Elevation Beamwidth		2	0.5° to 1°	0.25°	$I_{19} - I_{20}$

TABLE 8. BASIC DATA (Continued)

WORD	DATA CONTENT	MAX. TIME BETWEEN TRANSMISSIONS (SECONDS)	BITS USED	RANGE OF VALUES	LEAST SIGNI-FICANT BIT	BIT NUMBER
	Approach Azimuth Sector guidance Alert					
	-60° to -20°		3	1° to 8°	1°	$I_{21} - I_{23}$
	-20° to -5°		2	1° to 4°	1°	$I_{24} - I_{25}$
	$+20^\circ$ to $+5^\circ$		2	1° to 4°	1°	$I_{26} - I_{27}$
	$+60^\circ$ to $+20^\circ$		3	1° to 8°	1°	$I_{28} - I_{30}$
	PARITY		2	SEE NOTE 1		$I_{31} - I_{32}$
4	PREAMBLE	10	12			$I_1 - I_{12}$
	DME Distance		11	0M to 8000 M	4M	$I_{13} - I_{23}$
	DME Offset		6	-155M to +155M SEE NOTE 7	5M	$I_{24} - I_{29}$
	SPARE		1			I_{30}
	PARITY		2	SEE NOTE 1		$I_{31} - I_{32}$
5	PREAMBLE	10	12			$I_1 - I_{12}$
	Approach Azimuth Antenna Offset		7	-126M to +126M SEE NOTE 7	2M	$I_{13} - I_{19}$
	DME or DME/P		1	DME = 0 DME/P = 1		I_{20}
	DME Channel		9	SEE NOTE 8		$I_{21} - I_{29}$
	SPARE		1			I_{30}
	PARITY		2	SEE NOTE 1		$I_{31} - I_{32}$

TABLE 8. BASIC DATA (Continued)

WORD	DATA CONTENT	MAX. TIME BETWEEN TRANSMISSIONS (SECONDS)	BITS USED	RANGE OF VALUES	LEAST SIGNI-FICANT BIT	BIT NUMBER
6	PREAMBLE	10	12			$I_1 - I_{12}$
	MLS Ground Subsystem Identification (SEE NOTE 4)			LETTERS A to Z		
	Character 2		6			$I_{13} - I_{18}$
	Character 3		6			$I_{19} - I_{24}$
	Character 4		6			$I_{25} - I_{30}$
	PARITY		2	SEE NOTE 1		$I_{31} - I_{32}$
7	PREAMBLE	1	12	SEE NOTE 5		$I_1 - I_{12}$
	Ground Equipment Performance Level		2	SEE NOTE 2		$I_{13} - I_{14}$
	Back Azimuth Antenna Distance		5	0M to 3100M	100M	$I_{15} - I_{19}$
	Back Azimuth Proportional Coverage Limit		4	-10° to -40°	2°	$I_{20} - I_{23}$
	Back Azimuth Proportional Coverage Limit		4	$+10^\circ$ to $+40^\circ$	2°	$I_{24} - I_{27}$
	Back Azimuth Beamwidth		2	1° to 4°	1°	$I_{28} - I_{29}$
	SPARE		1			I_{30}
	PARITY		2	SEE NOTE 1		$I_{31} - I_{32}$
8	PREAMBLE	10	12			$I_1 - I_{12}$
	Elevation Antenna Height		6	-5M +5 2M SEE NOTE 7	0.2M	$I_{13} - I_{18}$
	Elevation Antenna Offset		5	-150M to +150M SEE NOTE 7	10M	$I_{19} - I_{23}$
	MLS Datum Point to threshold distance		7	0M to 630M	5M	$I_{24} - I_{30}$
	PARITY		2	SEE NOTE 1		$I_{31} - I_{32}$

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TABLE 8. BASIC DATA (Continued)

NOTES

NOTE 1 Parity checks that there is an even number of ones in Bits I_{13} to I_{30} and obeys the equations:

$$I_{13} + I_{14} \ldots + I_{29} + I_{30} + I_{31} = \text{EVEN}$$

$$I_{14} + I_{16} + I_{18} \ldots + I_{28} + I_{30} + I_{32} = \text{EVEN}$$

NOTE 2 Coding not yet defined.

NOTE 3 Code for I_{21} is:

0 = No Back Azimuth Transmission
1 = Back Azimuth Transmission to follow

NOTE 4 Data word 6 is transmitted for both approach azimuth and back azimuth coverages alternately and at the 10-second maximum time between transmissions for each coverage sector, if back azimuth guidance is provided.

NOTE 5 Data word 7 is transmitted from the back azimuth equipment.

NOTE 6 These bits are reserved for future applications requiring high transmission rates.

NOTE 7 The convention for the coding of negative numbers is as follows:

MSB is the sign bit: 0 = +
1 = -

Other bits represent the absolute value.

The convention for the antenna location is as follows: as viewed from the MLS approach reference datum looking toward the MLS datum point, a positive number shall represent a location to the right of the runway centre line (lateral offset) or above the runway (vertical offset).

NOTE 8 Coding not yet defined. 9 bits provide the capability to encode frequency and mode separately

§ 171.313 Azimuth performance requirements.

This section prescribes the performance requirements for the azimuth equipment of the MLS as follows:

(a) *Approach Azimuth Coverage Requirements.* The approach azimuth equipment must provide guidance information in at least the following volume of space (see Figure 9).

(1) Horizontally within a sector plus or minus 40 degrees about the runway centerline originating at the datum point and extending in the direction of the approach to 20 nautical miles from the runway threshold. The minimum proportional guidance sector must be plus or minus 10 degrees about the runway centerline. Clearance signals must be used to provide the balance of the required coverage, where the proportional sector is less than plus or minus 40 degrees. When intervening obstacles prevent full coverage, the ±40° guidance sector can be reduced as required.

(2) Vertically between:

(i) A conical surface originating 2.5 meters (8 feet) above the runway centerline at threshold inclined at 0.9 degree above the horizontal, and

(ii) A conical surface originating at the azimuth ground equipment antenna inclined at 15 degrees above the horizontal to a height of 6,000 meters (20,000 feet).

(iii) Where intervening obstacles penetrate the lower surface, coverage need be provided only to the minimum line of sight.

(3) Runway region.

(i) Proportional guidance horizontally within a sector 45 meters (150 feet) each side of the runway centerline beginning at the stop end and extending parallel with the runway centerline in the direction of the approach to join the approach region. This requirement does not apply to azimuth offset installations.

(ii) Vertically between a horizontal surface which is 2.5 meters (8 feet) above the farthest point of runway centerline which is in line of sight of the azimuth antenna, and, a conical surface originating at the azimuth ground equipment antenna inclined at 20 degrees above the horizontal up to a height of 600 meters (2,000 feet). This requirement does not apply to azimuth offset installations.

(4) Within the approach azimuth coverage sector defined in paragraph (a) (1), (2) and (3) of this section, the power densities must not be less than those shown in Table 9 but the equipment design must also allow for:

(i) Transmitter power degradation from normal by −1.5 dB;

(ii) Rain loss of −2.2 dB at the longitudinal coverage extremes.

(b) *Siting Requirements.* The approach azimuth antenna system must, except as allowed in paragraph (c) of this section:

(1) Be located on the extension of the centerline of the runway beyond the stop end;

(2) Be adjusted so that the zero degree azimuth plane will be a vertical plane which contains the centerline of the runway served;

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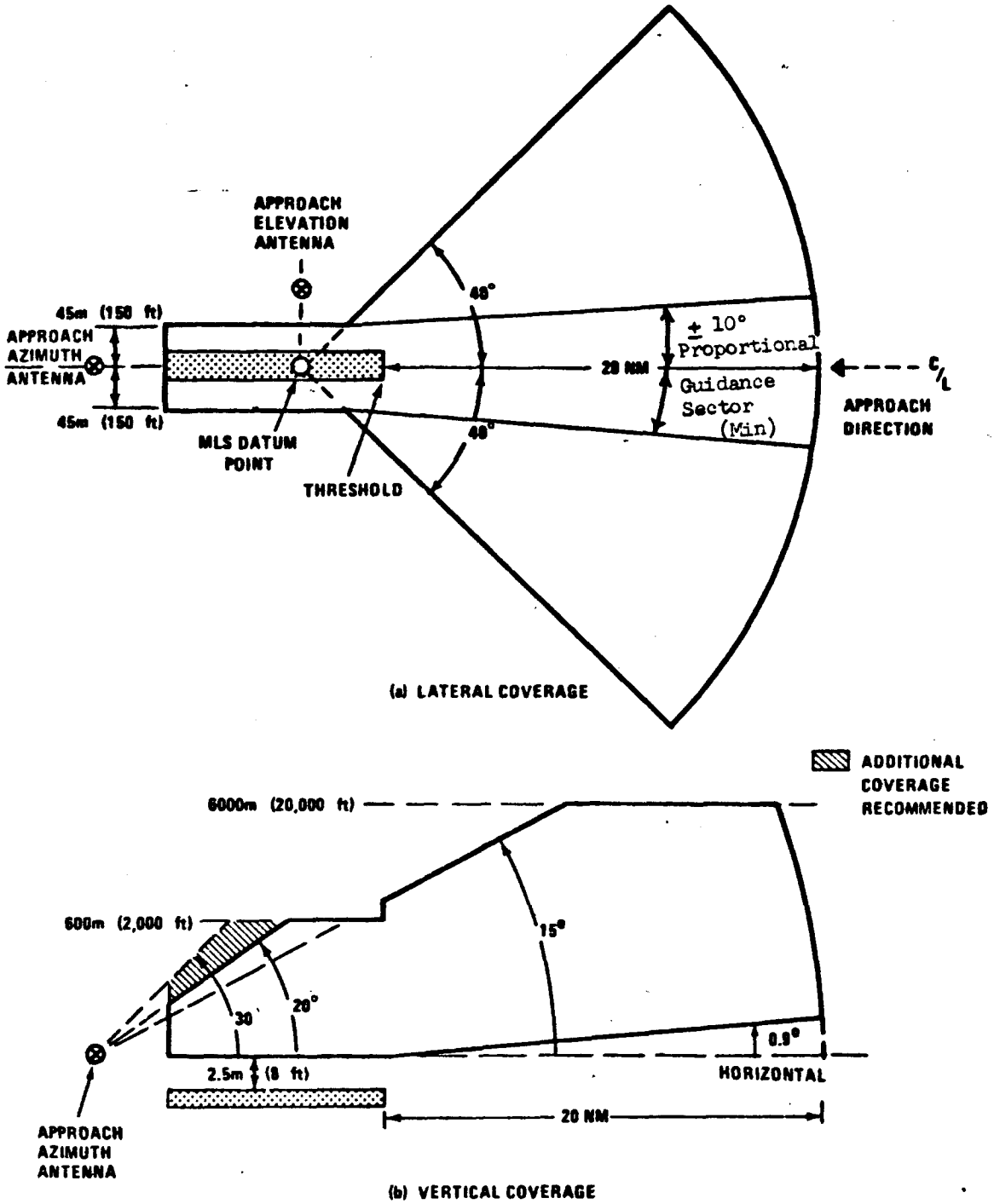

FIGURE 9. APPROACH AZIMUTH COVERAGE

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TABLE 9.—AZIMUTH POWER DENSITY REQUIREMENTS (dBW/m²)

Function	DPSK	Clearance	Antenna beamwidth (3dB)		
			1°	2°	3°
Approach azimuth	−89.5	−88	−88	−85.5	−82
High rate approach azimuth	−89.5	−88	−88	−88	−86.8
Back azimuth	−81	−88	−79.5	−77	−73.5

(3) Have the minimum height necessary to comply with the coverage requirements prescribed in paragraph (a) of this section;

(4) Be located at a distance from the stop end of the runway that is consistent with safe obstruction clearance practices;

(5) Not obscure any light of an approach lighting system; and

(6) Be installed on frangible mounts or beyond the 300 meter (1,000 feet) light bar.

(c) On runways where limited terrain prevents the azimuth antenna from being positioned on the runway centerline extended, and the cost of the land fill or a tall tower antenna support is prohibitive, the azimuth antenna may be offset. In an offset azimuth antenna is used, the criteria in Subpart C of Part 97 (TERPS) of this chapter is applicable. Incorporated by reference is United States Standard for Terminal Instrument Procedures (TERPS), FAA Handbook AOP 8260.3 through change 3, dated June 3, 1980, which prescribes standardized methods for use in designing instrument flight procedures. It is available from the National Technical Information Service, 5285 Port Royal Road, Springfield, Virginia 22161 and also available for inspection at the Office of the Federal Register Information Center, Room 8301, 1100 L Street, N.W., Washington, D.C. 20408.

(d) Antenna coordinates. The scanning beams transmitted by the approach azimuth equipment within ±40° of the centerline may be either conical or planar.

(e) Approach azimuth accuracy.

(1) The system and subsystem accuracies shown in Table 10 and the associated notes are required at the approach reference datum. From this point accuracy degradations must not exceed the following limits:

(i) *With distance.* The system PFE limit and PFN limit, expressed in angular terms at 20 nautical miles from the runway threshold along the extended runway centerline at the lower coverage limit is the lesser of either 2 times the value specified at the approach reference datum or 0.3 degrees. The CMN limits expressed in angular terms at 10 nautical miles from the reference datum along the extended runway centerline is 1.3 times the value specified at the approach reference datum or 0.1 degree, whichever is less.

(ii) *With azimuth angle.* The system PFE limit and PFN limit, expressed in angular terms at plus or minus 40 degrees azimuth angle is 1.5 times the value on the extended runway centerline at the same distance from the approach reference datum. The CMN limit, expressed in angular terms at plus or minus 40 degrees azimuth angle is 1.3 times the value on the extended runway centerline at the same distance from the approach reference datum.

(iii) *With elevation angle.* The system PFE and PFN limit, do not degrade from the lower coverage limit up to an elevation angle of 9 degrees. The system PFE limit or PFN limit expressed in angular terms at an elevation angle of 15 degrees from the approach azimuth antenna phase center is 2 times the value permitted below 9 degrees at the same distance from the approach reference datum and the same azimuth angle. The CMN limit does not degrade with elevation angle.

(2) The system and ground subsystem accuracies shown in Table 10 are to be demonstrated at commissioning as maximum error limits. Subsequent to commissioning, the accuracies are considered to be the 95% probability limits.

TABLE 10.—APPROACH AZIMUTH ACCURACIES AT THE APPROACH REFERENCE DATUM

Error type	System	Angular error (degrees)	
		Ground subsystem	Airborne[5] subsystem
PFE	±20 ft.[1 2] (6.1m).	±10 ft.[3]	±0.017
CMN	±10.5 ft. (3.2m)[2 4].	±0.030	±0.015

NOTES:
[1] Includes errors due to ground and airborne equipment and propagation effects.
[2] The system PFN component must not exceed ±3.5 meters (11.5 feet).
[3] The equivalent angular error must not exceed 0.12°.
[4] The system control motion noise must not exceed 0.1°.
[5] The airborne subsystem angular errors are provided for information only.

(f) Approach azimuth antenna characteristics are as follows:

(1) *Drift.* Any azimuth angle as encoded by the scanning beam at any point within the proportional coverage sector must not vary more than ±0.07 degree over the range of service conditions specified in § 171.309(d) without the use of internal environmental controls. Multipath effects are excluded from this requirement.

(2) *Beam pointing errors.* The azimuth angle as encoded by the scanning beam at any point within ±0.5 degree of the zero degree azimuth must not deviate from the true azimuth angle at that point by more than ±0.05 degree. Multipath and drift effects are excluded from this requirement.

(3) *Antenna alignment.* The antenna must be equipped with suitable optical, electrical or mechanical means or any combination of the three, to bring the zero degree azimuth radial into coincidence with the approach reference datum with a maximum error of 0.02 degree. Additionally, the azimuth antenna bias adjustment must be electronically steerable at least to the monitor limits in steps not greater than 0.01 degree.

(4) *Antenna far field patterns in the plane of scan.* On boresight, the azimuth antenna mainlobe pattern must conform to Figure 10, and the beamwidth must be such that, in the installed environment, no significant lateral reflections of the mainlobe exist along the approach course. In any case the beamwidth must not exceed three degrees. Anywhere within coverage the −3 dB width of the antenna mainlobe, while scanning normally, must not be less than 25 microseconds (0.5 degree) or greater than 250 microseconds (5 degrees). The antenna mainlobe may be allowed to broaden from the value at boresight by a factor of $1/\cos\phi$, where ϕ is the angle off boresight. The sidelobe levels must be as follows:

(i) *Dynamic sidelobe levels.* With the antenna scanning normally, the dynamic sidelobe level that is detected by a receiver at any point within the proportional coverage sector must be down at least 10dB from the peak of the main beam. Outside the coverage sector, the radiation from the scanning beam antenna must be of such a nature that receiver warnings will not be removed or suitable OCI signals must be provided.

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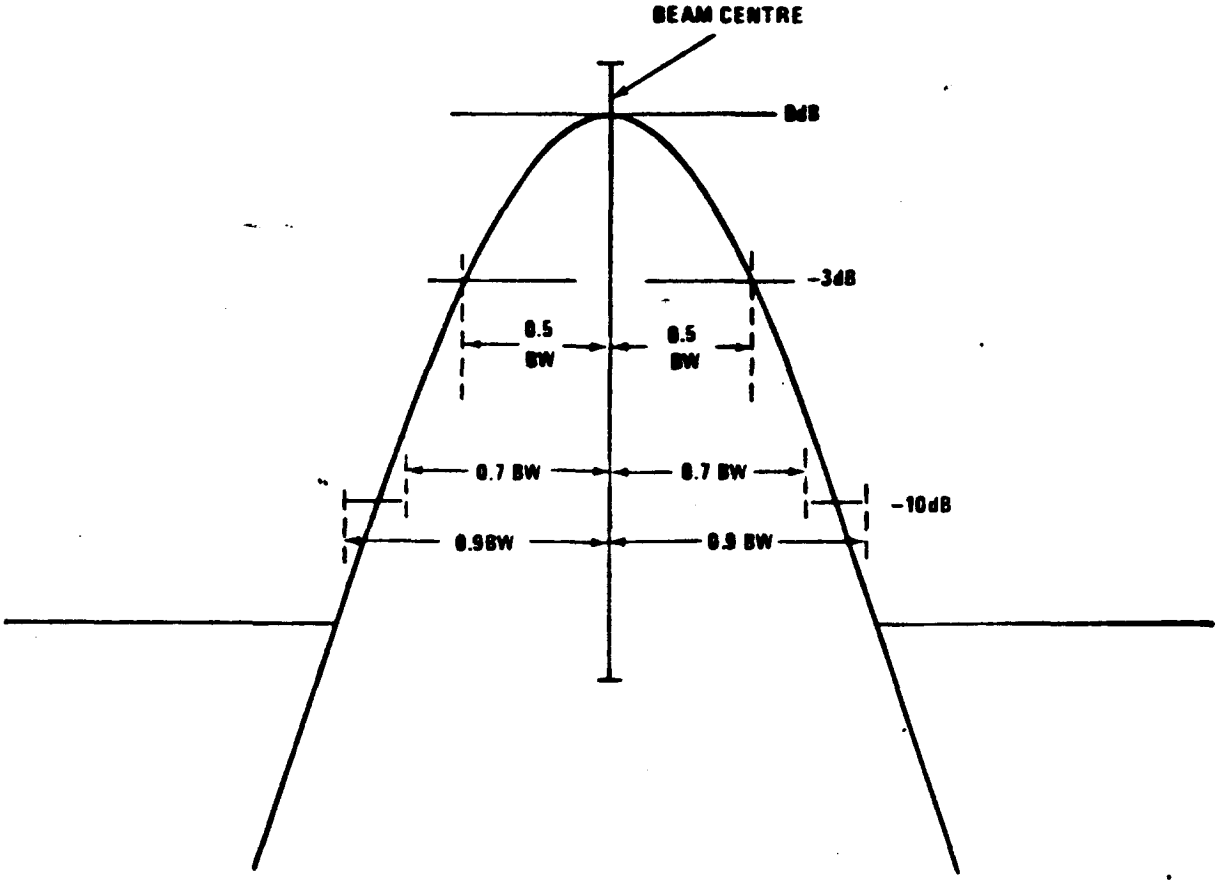

NOTES: THE BEAM ENVELOPE IS SMOOTHED BY A 26 kHz VIDEO FILTER BEFORE MEASUREMENT.
BW=BEAMWIDTH.

FIGURE 10. FAR FIELD DYNAMIC SIGNAL IN SPACE

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(ii) *Effective sidelobe levels.* With the antenna scanning normally, the sidelobe levels in the plane of scan must be such that, in the installed environment, errors contributed by sidelobe reflections will not exceed the angular equivalent of 9 feet at the approach reference datum over the required range of aircraft approach speeds.

(5) *Antenna far field pattern in the vertical plane.* The azimuth antenna free space radiation pattern below the horizon must have a slope of at least −8dB/degree at the horizon and all sidelobes below the horizon must be at least 13 dB below the pattern peak. The antenna radiation pattern above the horizon must satisfy both the system coverage requirements and the spurious radiation requirement.

(6) *Data antenna.* The data antenna must have horizontal and vertical patterns as required for its function.

(g) *Back azimuth coverage requirements.* The back azimuth equipment where used must provide guidance information in at least the following volume of space (see Figure 11):

(1) Horizontally within a sector plus or minus 20 degrees about the runway centerline originating at the back azimuth ground equipment antenna and extending in the direction of the missed approach at least to 5 nautical miles from the runway stop end. The minimum proportional guidance sector must be ±10 degrees about the runway centerline. Clearance signals must be used to provide the balance of the required coverage where the proportional sector is less than ±20 degrees.

(2) Vertically in the runway region between:

(i) A horizontal surface 2.5 meters (8 feet) above the farthest point of runway centerline which is in line of sight of the azimuth antenna, and,

(ii) A conical surface originating at the azimuth ground equipment antenna inclined at 20 degrees above the horizontal up to a height of 600 meters (2000 feet).

(3) Vertically in the back azimuth region between:

(i) A conical surface originating 2.5 meters (8 feet) above the runway stop end, inclined at 0.9 degree above the horizontal, and,

(ii) A conical surface originating at the missed approach azimuth ground equipment antenna, inclined at 15 degrees above the horizontal up to a height of 1500 meters (5000 feet).

(iii) Where obstacles penetrate the lower coverage limits, coverage need be provided only to minimum line of sight.

(4) Within the back azimuth coverage sector defined in paragraph (g) (1), (2), and (3) of this section, the power densities must not be less than those shown in table 9, but the equipment design must also allow for:

(i) Transmitter power degradation from normal by −1.5 dB.

(ii) Rain loss of −2.2 dB at the longitudinal coverage extremes.

(h) *Back azimuth siting.* The back azimuth equipment antenna must:

(1) Normally be located on the extension of the runway centerline at the threshold end;

(2) Be adjusted so that the vertical plane containing the zero degree course line contains the back azimuth reference datum;

(3) Have minimum height necessary to comply with the course requirements prescribed in paragraph (g) of this section;

(4) Be located at a distance from the threshold end that is consistent with safe obstruction clearance practices;

(5) Not obstruct any light of an approach lighting system; and

(6) Be installed on frangible mounts or beyond the 300 meter (1,000 feet) light bar.

(i) *Back azimuth antenna coordinates.* The scanning beams transmitted by the back azimuth equipment may be either conical or planar.

(j) *Back azimuth accuracy.* The requirements specified in § 171.313(e) apply except for the degradation allowance which must not exceed the following:

(1) *With distance.* The system PFE limit and PFN limit, expressed in angular terms at the maximum range and lower limit of coverage along the extended runway centerline is the lesser of either 2 times the value specified at the back azimuth reference datum or 0.6 degree. The CMN limit, expressed in angular terms at 7.5 nautical miles from the runway stop end along the extended runway centerline is 1.3 times the value specified at the back azimuth reference datum.

(2) *With azimuth angle.* The system PFE limit and PFN limit, expressed in angular terms at plus or minus 20 degree azimuth angle is 1.5 times the value on the extended runway centerline at the same distance from the back azimuth reference datum. The CMN limit, expressed in angular terms at plus or minus 20 degrees azimuth angle is 1.3 times the value on the extended runway centerline at the same distance from the back azimuth reference datum.

(3) *With elevation angle.* The system PFE limit and PFN limit do not degrade from the lower coverage limit up to an elevation angle of 9 degrees. The system PFE limit or PFN limit expressed in angular terms at an elevation angle of 15 degrees from the back azimuth antenna phase center is 2 times the value permitted below 9 degrees at the same distance from the back azimuth reference datum and the same azimuth angle. The CMN limit does not degrade with elevation angle.

(k) Back azimuth antenna characteristics. The requirements specified in § 171.313(f) apply.

(l) *Scanning conventions.* Figure 12 shows the approach azimuth and back azimuth scanning conventions.

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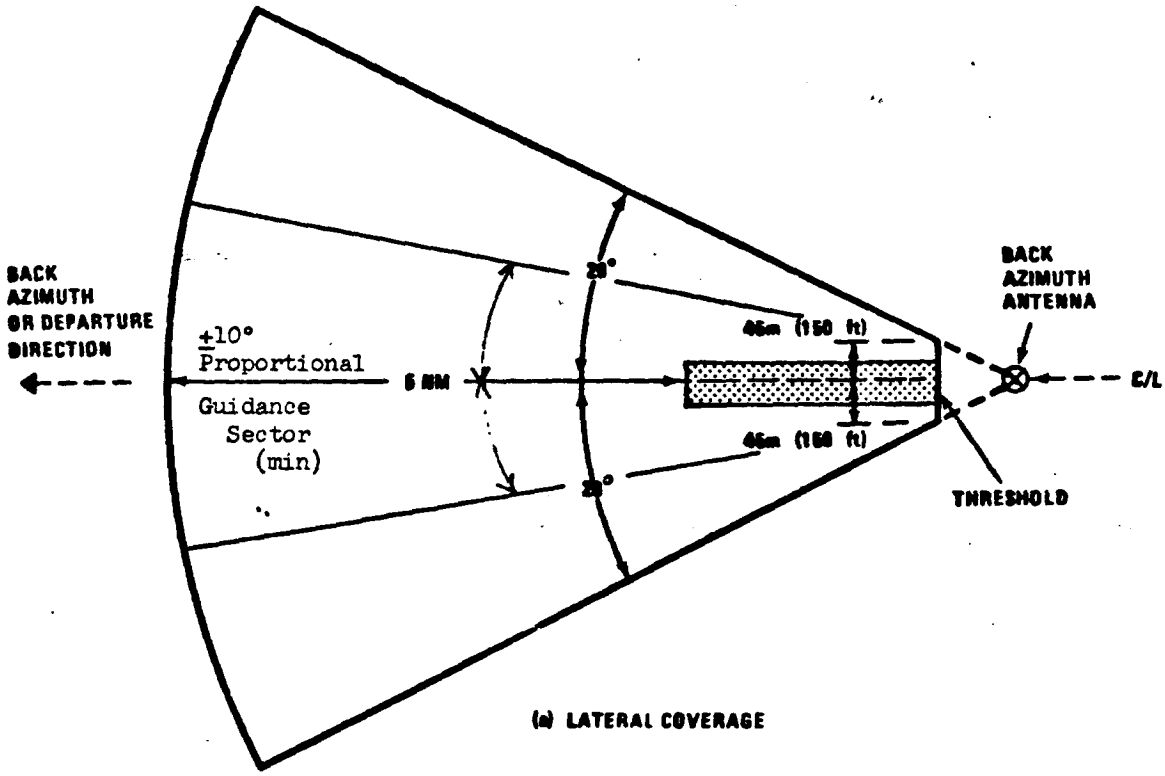
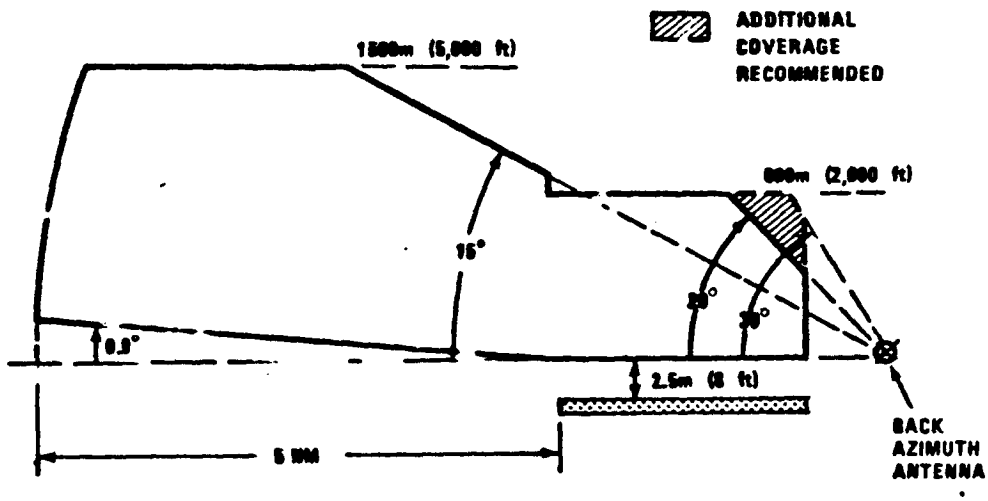


(a) LATERAL COVERAGE



(b) VERTICAL COVERAGE

FIGURE 11. BACK AZIMUTH COVERAGE

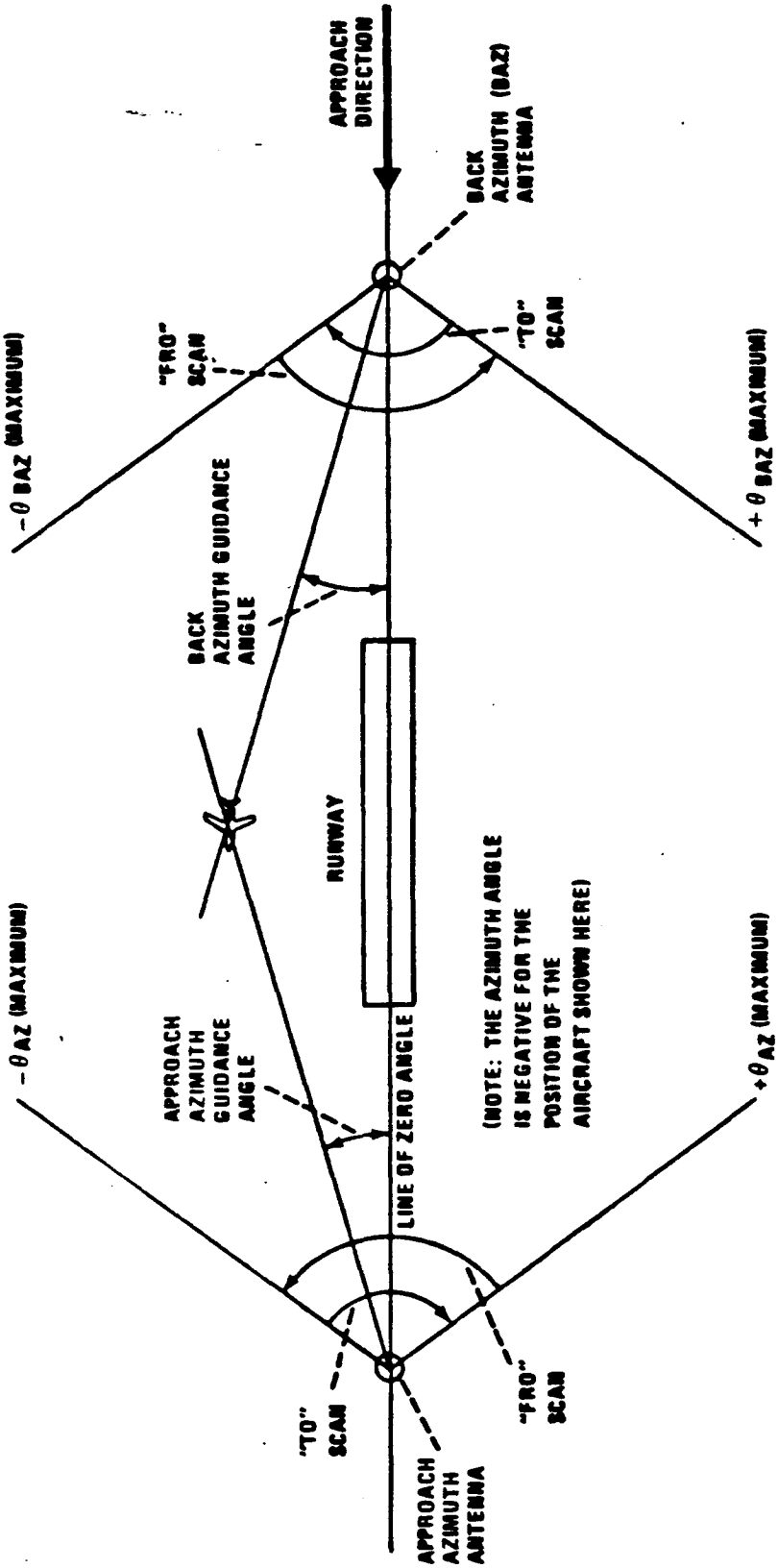


FIGURE 12. AZIMUTH GUIDANCE FUNCTIONS SCANNING CONVENTIONS

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§ 171.315 Azimuth monitor system requirements.

(a) The approach azimuth or back azimuth monitor system must cause the radiation to cease and a warning must be provided at the designated control point if any of the following conditions persist for longer than the periods specified:

(1) There is a change in the ground equipment contribution to the mean course error component such that the path following error at the reference datum or in the direction of any azimuth radial, exceeds the limits specified in § 171.313(e)(l) or § 171.313(j) for a period of more than one second.

(2) There is a reduction in the radiated power to a level not less than that specified in § 171.313(a)(4) or § 171.313(g)(4) for a period of more than one second.

(3) There is an error in the preamble DPSK transmissions which occurs more than once in any one second period.

(4) The timing standards specified in Table 11 are exceeded for a period of more than one second.

(5) There is an error in the time division multiplex synchronization of a particular azimuth function such that the requirement specified in § 171.311(e) is not satisfied and if this condition persists for more than one second.

(6) A failure of the monitor is detected.

TABLE 11.—SIGNAL FORMAT TIMING TOLERANCES

Signal format item	Timing tolerance
Clearance and OCI signals	As specified ± 2 μsec.
DPSK phase transitions	As specified ± 2 μsec.
TO-FRO scan timing (internal to scan).	As required to meet accuracy specs.

NOTE 1.—The tolerances shown apply to the timing of the specific events as shown in Tables 2, 4a, 4b, 5 and 7.
NOTE 2.—The timing jitter relative to the specified value plus the tolerance above, must be less than 1 μsec rms.

(b) The period during which erroneous guidance information is radiated must not exceed the periods specified in § 171.315(a). If the fault is not cleared within the time allowed, the ground equipment must be shutdown. After shutdown, no attempt must be made to restore service until a period of 20 seconds has elapsed.

§ 171.317 Approach elevation performance requirements.

This section prescribes the performance requirements for the elevation equipment components of the MLS as follows:

(a) *Elevation coverage requirements.* The approach elevation facility must provide proportional guidance information in at least the following volume of space (see Figure 13):

(1) Laterally within a sector originating at the datum point which is at least equal to the proportional guidance sector provided by the approach azimuth ground equipment.

(2) Longitudinally from 75 meters (250 feet) from the datum point to 20 nautical miles from threshold in the direction of the approach.

(3) Vertically within the sector bounded by:

(i) A surface which is the locus of points 2.5 meters (8 feet) above the runway surface;

(ii) A conical surface originating at the datum point and inclined 0.9 degree above the horizontal and,

(iii) A conical surface originating at the datum point and inclined at 7.5 degrees above the horizontal up to a height of 6000 meters (20,000 feet).

Where the physical characteristics of the approach region prevent the achievement of the standards under paragraph (a) (1), (2), and (3) of this section, guidance need not be provided below a conical surface originating at the elevation antenna and inclined 0.9 degree above the line of sight.

(4) Within the elevation coverage sector defined in paragraph (a) (1), (2), and (3) of this section, the power densities must not be less than those shown in Table 12, but the equipment design must also allow for:

(i) Transmitter power degradation from normal by −1.5 dB.

(ii) Rain loss of −2.2 dB at the coverage extremes.

(b) *Elevation siting requirements.* The elevation antenna system must:

(1) Be located within 150 meters (500 feet) of runway centerline.

(2) Be located near runway threshold such that the minimum glidepath planar angle with respect to the antenna phase center and the horizontal plane crosses runway threshold at a height between 15 and 18 meters (50 and 60 feet).

(i) For STOL operations using minimum glidepaths of greater than 4°, this height may be as low as 12 meters (35 feet).

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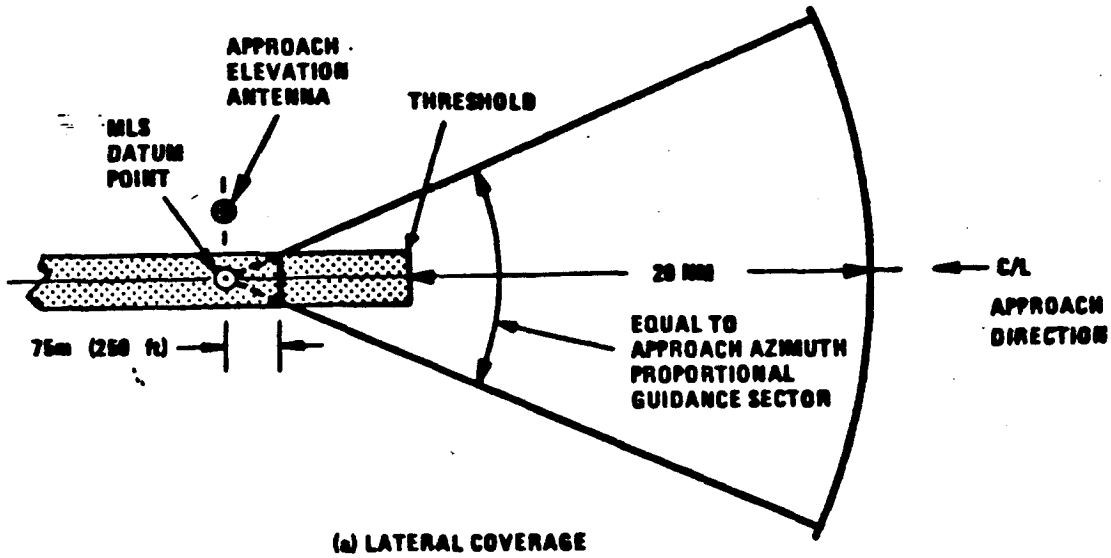
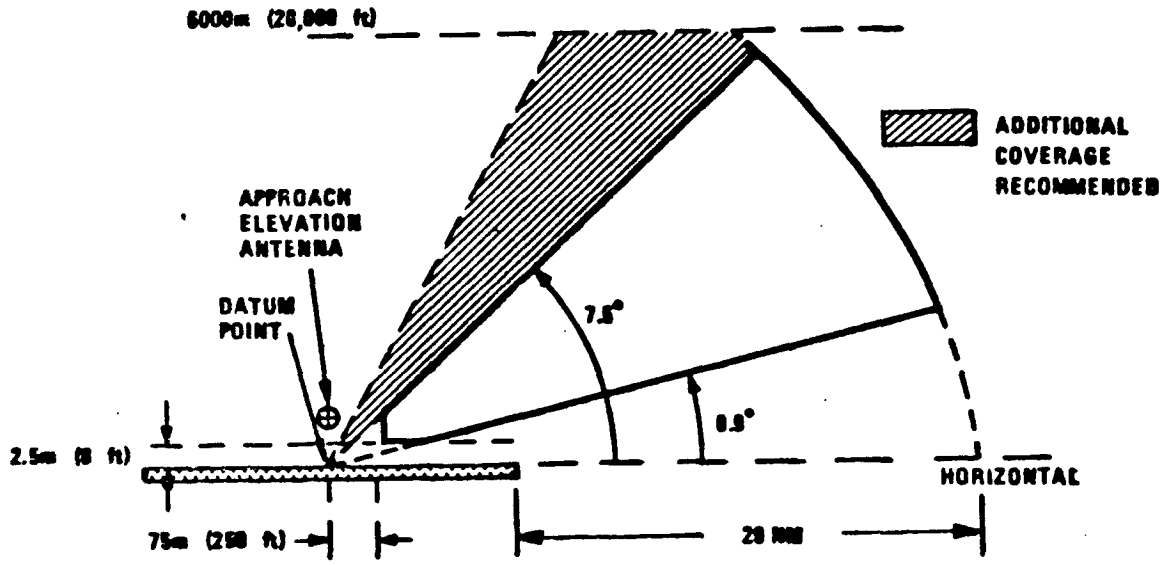


(a) LATERAL COVERAGE



(b) VERTICAL COVERAGE

FIGURE 13. APPROACH ELEVATION COVERAGE

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(3) Satisfy obstacle clearance criteria specified in Subpart C of Part 97 of this chapter.

(c) *Antenna coordinates.* The scanning beams transmitted by the elevation subsystem must be conical.

TABLE 12.—ELEVATION POWER DENSITY REQUIREMENTS (dBW/m ²)

DPSK	Antenna beamwidth (3dB)	
	1°	2°
−89.5	−88.0	−88.0

TABLE 13.—ELEVATION ACCURACIES AT THE APPROACH REFERENCE DATUM

Error type	System	Angular error (degrees)	
		Ground subsystem	Airborne [4] subsystem
PFE	±2.0 ft.[1] (0.6m) [2]	[3] 0.093	0.017
CMN	±.75 ft. (0.3m) [1]	0.020	0.010

[1] Angular error calculations assume the following: 262 meters (861 feet) antenna to reference datum. Distance calculation assumed 15 meters (50 feet) threshold crossing on 3° glidepath, 3 meters (10 feet) antenna phase center height and a 122 meters (400) feet antenna offset from runway centerline. Elevation equipment sited to provide a minimum glidepath higher than 3° must provide angular accuracies no less than those specified for equipment sited for a 3° minimum glidepath.

[2] The system PFN component must not exceed ±0.4 meter (1.3 feet).

[3] The mean glidepath error component contributed by the ground equipment must not exceed ±0.3 meters (1 foot).

[4] The airborne subsystem angular errors are provided for information only.

(d) *Elevation accuracy.* (1) The accuracies shown in Table 13 ae required at the approach reference datum. From this point, the degradation limits must not exceed the following:

(i) With distance—The system PFE limit and PFN limit, expressed in angular terms at 20 nautical miles from the runway threshold on the minimum glidepath is 0.2 degree. The CMN limit, expressed in angular terms at 10 nautical miles from the reference datum on the minimum glidepath is 1.3 times the value specified at the approach reference datum.

(ii) With azimuth angle—The system PFE limit and PFN limit expressed in angular terms at plus or minus 40 degrees azimuth angle is 1.3 times the value on the extended runway centerline at the same distance from the approach reference datum. The CMN limit, expressed in angular terms at plus or minus 40 degrees azimuth angle is 1.3 times the value on the extended runway centerline at the same distance from the approach reference datum.

(iii) With elevation angle—For elevation angles above the minimum glidepath or 3 degrees, whichever is less and up to the maximum of the proportional guidance coverage and at the locus of points directly above the approach reference datum the system PFE limit, PFN limit and CMN limit expressed in angular terms is allowed to degrade linearly such that at an elevation angle of 15 degrees the limit is 2 times the value specified at the reference datum. In no case will the CMN directly above the reference datum exceed plus or minus 0.07 degree. For other regions of coverage within the angular sector from an elevation angle equivalent to the minimum glidepath up to the maximum angle of proportional coverage the degradations with distance and azimuth angle specified in paragraph (d)(1) (i) and (ii) of this section apply.

(iv) For elevation angles below 60 percent of the minimum glidepath and down to the limit of coverage and at the locus of points directly below the approach reference datum the system PFE limit, the PFN limit and the CMN limit expressed in angular terms, is allowed to increase linearly to 6 times the value at the approach reference datum. For other regions of coverage within the angular sector from an elevation angle equivalent to 60 percent of the minimum glidepath value, and down to the limit of coverage, the degradations with distance and azimuth angle specified in paragraph (d)(1) (i) and (ii) of this section apply. In no case will the PFE be allowed to exceed 0.8 degree, or the CMN be allowed to exceed 0.4 degree.

(2) The system and ground subsystem accuracies shown in Table 13 are to be demonstrated at commissioning as maximum error limits. Subsequent to commissioning, the accuracies are to be considered at 95% probability limits.

(e) Elevation antenna chacteristics are as follows:

(1) *Drift.* Any elevation angle as encoded by the scanning beam at any point within the coverage sector must not vary more than 0.04 degree over the range of service conditions specified in § 171.309(d) without the use of internal environmental controls. Multipath effects are excluded from this requirements.

(2) *Beam pointing errors.* The elevation angle as encoded by the scanning beam at any point within the coverage sector must not deviate from the true elevation angle at that point by more than ±0.04 degree for elevation angles from 2.5° to 3.5°. Above 3.5°, these errors may linearly increase to ±0.1 degree at 7.5°. Multipath and drift effects are excluded from this requirements.

(3) *Antenna alignment.* The antenna must be equipped with suitable optical, electrical, or mechanical means or any combination of the three, to align the lowest operationally required glidepath to the true glidepath angle with a maximum error of 0.01 degree. Additionally, the elevation antenna bias adjustment must be electronically steerable at least to the monitor limits in steps not greater than 0.005 degree.

(4) *Antenna far field patterns in the plane of scan.* On the lowest operationally required glidepath, the antenna mainlobe pattern must conform to Figure 10, and the beamwidth must be such that in the installed environment, no significant ground reflections of the mainlobe exist. In any case, the beamwidth must not exceed 2 degrees. The antenna mainlobe may be allowed to broaden from the value at boresight by a factor of $1/\cos\phi$, where ϕ is the angle off boresight. Anywhere within coverage, the 3 dB width of the antenna mainlobe, while scanning normally, must not be less than 25 microseconds (0.5 degree) or greater than 250 microseconds (5 degrees). The sidelobe levels must be as follows:

(i) *Dynamic sidelobe levels.* With the antenna scanning normally, the dynamic sidelobe levels that is detected by a receiver at any point within the proportional coverage sector must be down at least 10 dB from the peak of the mainlobe. Outside the proportional coverage sector, the radiation from the scanning beam antenna must be of such a nature that receiver warnings will not be removed or a suitable OCI signal must be provided.

(ii) *Effective sidelobe levels.* With the antenna scanning normally, the sidelobe levels in the plane of scan must be such that, when reflected from the ground, the resultant angular errors along any glidepath do not exceed 0.09 degree.

(5) *Antenna far field pattern in the horizontal plane.* The horizontal pattern of the antenna must gradually deemphasize the signal away from antenna boresight. Typically, the horizontal pattern should be reduced by at least 3 dB at 20 degrees off boresight and by at least 6 dB at 40 degrees off boresight. Depending on the actual multipath conditions, the horizontal radiation patterns may require more or less deemphasis.

(6) *Data antenna.* The data antenna must have horizontal and vertical patterns as required for its function.

§ 171.319 Approach elevation monitor system requirements.

(a) The monitor system must act to ensure that any of the following conditions do not persist for longer than the periods specified when:

(1) There is a change in the ground component contribution to the mean

glidepath error component such that the path following error on any glidepath exceeds the limits specified in § 171.317 (d) for a period of more than one second.

(2) There is a reduction in the radiated power to a level not less than that specified in § 171.317(a)(4) for a period of more than one second.

(3) There is an error in the preamble DPSK transmissions which occurs more than once in any one second period.

(4) The timing standards specified in Table 11 are exceeded for a period of more than one second.

(5) There is an error in the time division multiplex synchronization of a particular elevation function such that the requirement specified in § 171.311(e) is not satisfied and this condition persists for more than one second.

(6) A failure of the monitor is detected.

(b) The period during which erroneous guidance information is radiated must not exceed the periods specified in §171.319(a). If the fault is not cleared within the time allowed, radiation shall cease. After shutdown, no attempt must be made to restore service until a period of 20 seconds has elapsed.

§ 171.321 DME and marker beacon performance requirements.

(a) The DME equipment must meet the performance requirements prescribed in Subpart G of this part. This subpart imposes requirements that performance features must comply with International Standards and Recommended Practices, Aeronautical Telecommunications, Vol. I of Annex 10 to ICAO. In addition, this equipment must be sited near the azimuth antenna site and adjusted such that zero range is at the DME antenna. Incorporated by reference is International Standards and Recommended Practices, Aeronautical Telecommunications, Volume I of Annex 10 to ICAO through Amendment 61 dated April 10, 1980 which prescribes applicability of standards and recommended practice for certain forms of equipment for air navigation aids and procedures for air navigation service. It is available from ICAO, Aviation Building, 1080 University Street, Montreal 101, Quebec, Canada, Attention: Distribution Officer and also available for inspection at the Office of the Federal Register Information Center, Room 8301, 1100 L Street, NW., Washington, D.C. 20408.

(b) MLS marker beacon equipment must meet the performance requirements prescribed in Subpart H of this part. This subpart imposes requirements that performance features must comply with International Standards and Recommended Practices, Aeronautical Telecommunications, Vol. I of Annex 10 to ICAO.

§ 171.323 Fabrication and installation requirements.

(a) The MLS facility must be permanent and must be located, constructed, and installed in accordance with best commercial engineering practices, using applicable electric and safety codes and Federal Communications Commission (FCC) licensing requirements and siting requirements of §§ 171.313 (b) and 171.317(b).

(b) The MLS facility components must utilize solid state technology except that traveling wave tube amplifiers (TWTA) may be used. A maximum level of common modularity must be provided along with diagnostics to facilitate maintenance and troubleshooting.

(c) An approved monitoring capability must be provided which indicates the status of the equipment at the site and at a remotely located maintenance area, with monitor capability that provides prealarm of impending system failures. This monitoring feature must be capable of transmitting the status and prealarm over standard phone lines to a remote location. In the event the sponsor requests the FAA to assume ownership of the facility, the monitoring feature must also be capable of interfacing with FAA remote monitoring requirements. This requirement may be complied with by the addition of optional software and/or hardware in space provided in the original equipment.

(d) The mean corrective maintenance time of the MLS equipment must be equal to or less than 0.5 hours with a maximum corrective maintenance time not to exceed 1.5 hours. This measure applies to correction of unscheduled failures of the monitor, transmitter and associated antenna assemblies, limited to unscheduled outage and out of tolerance conditions.

(e) The mean time between failures of the MLS angle system must not be less than 1,500 hours. This measure applies to unscheduled outrage, out-of-tolerance conditions, and failures of the monitor, transmitter, and associated antenna assemblies.

(f) The MLS facility must have a reliable source of suitable primary power, either from a power distribution system or locally generated. Adequate power capacity must be provided for the operation of the MLS as well as the test and working equipment of the MLS.

(g) The MLS facility must have a continuously engaged or floating battery power source for the continued normal operation of the ground station operation if the primary power fails. A trickle charge must be supplied to recharge the batteries during the period of available primary power. Upon loss and subsequent restoration of power, the battery must be restored to full charge within 24 hours. When primary power is applied, the state of the battery charge must not affect the operation of the MLS ground station. The battery must allow continuation of normal operation of the MLS facility for at least 2 hours without the use of additional sources of power. When the system is operating from the battery supply without prime power, the radome de-icers and the environmental system need not operate. The equipment must meet all specification requirements with or without batteries installed.

(h) There must be a means for determining, from the ground, the performance of the system including antenna, both initially and periodically.

(i) The facility must have, or be supplemented by ground, air or landline communications services. At facilities within or immediately adjacent to air traffic control areas, that are intended for use as instrument approach aids for an airport, there must be ground air communications or reliable communications (at least a landline telephone) from the airport to the nearest FAA air traffic control or communication facility. Compliance with this paragraph need not be shown at airports where an adjacent FAA facility can communicate with aircraft on the ground at the airport and during the entire proposed instrument approach procedure. In addition, at low traffic density airports within or immediately adjacent to air traffic control zones or areas, and where extensive delays are not a factor, the requirements of this paragraph may be reduced to reliable communications from the airport to the nearest FAA air traffic control or communications facility. If the adjacent FAA facility can communicate with aircraft during the proposed instrument approach procedure down to the airport surface or at least down to the minimum approach altitude, this would require at least a landline telephone.

(j) The location of the phase centers for all antennas must be clearly marked on the antenna enclosures.

(k) The latitude, longitude and mean sea level elevation of the MLS datum point must be determined by survey with an accuracy of ±3 meters (±10 feet) laterally and ±0.3 meter (±1.0 foot) vertically. The lateral and vertical offsets from the MLS datum point of all antenna phase centers, the back azimuth reference datum (if applicable), and the intersection of runway threshold with

runway centerline must be determined with an accuracy of ±0.3 meter (±1.0 foot) laterally and ±0.03 meter (±0.1 foot) vertically. The owner must bear all costs of the survey. The results of this survey must be included in the "operations and maintenance" manual required by § 171.325 of this subpart and will be noted on FAA Form 198 required by § 171.327.

§ 171.325 Maintenance and operations requirements.

(a) The owner of the facility must establish an adequate maintenance system and provide MLS qualified maintenance personnel to maintain the facility at the level attained at the time it was commissioned. Each person who maintains a facility must meet at least the FCC licensing requirements and demonstrate that he has the special knowledge and skills needed to maintain an MLS facility, including proficiency in maintenance procedures and the use of specialized test equipment.

(b) In the event of out of tolerance conditions or malfunctions, as evidenced by receiving two successive pilot reports, the owner must close the facility by ceasing radiation, and issue a "Notice to Airmen" (NOTAM) that the facility is out of service.

(c) The owner must prepare, and obtain approval of, an operations and maintenance manual that sets forth mandatory procedures for operations, periodic maintenance, and emergency maintenance, including instructions on each of the following:

(1) Physical security of the facility.

(2) Maintenance and operations by authorized persons.

(3) FCC licensing requirements for operations and maintenance personnel.

(4) Posting of licenses and signs.

(5) Relations between the facility and FAA air traffic control facilities, with a description of the boundaries of controlled airspace over or near the facility, instructions for relaying air traffic control instructions and information, if applicable, and instructions for the operation of an air traffic advisory service if the facility is located outside of controlled airspace.

(6) Notice to the Administrator of any suspension of service.

(7) Detailed and specific maintenance procedures and servicing guides stating the frequency of servicing.

(8) Air-ground communications, if provided, expressly written or incorporating appropriate sections of FAA manuals by reference.

(9) Keeping the station logs and other technical reports, and the submission of reports required by § 171.327.

(10) Monitoring of the MLS facility.

(11) Inspections by United States personnel.

(12) Names, addresses, and telephone numbers of persons to be notified in an emergency.

(13) Shutdowns for periodic maintenance and issuing of NOTAM for routine or emergency shutdowns.

(14) Commissioning of the MLS facility.

(15) An acceptable procedure for amending or revising the manual.

(16) An explanation of the kinds of activities (such as construction or grading) in the vicinity of the MLS facility that may require shutdown or recertification of the MLS facility by FAA flight check.

(17) Procedures for conducting a ground check of the azimuth and elevation alignment.

(18) The following information concerning the MLS facility:

(i) Facility component locations with respect to airport layout, instrument runways, and similar areas.

(ii) The type, make and model of the basic radio equipment that provides the service including required test equipment.

(iii) The station power emission, channel, and frequency of the azimuth, elevation, DME, marker beacon, and associated compass locators, if any.

(iv) The hours of operation.

(v) Station identification call letters and method of station identification and the time spacing of the identification.

(vi) A description of the critical parts that may not be changed, adjusted, or repaired without an FAA flight check to confirm published operations.

(d) The owner or his maintenance representative must make a ground check of the MLS facility periodically in accordance with procedures approved by the FAA at the time of commissioning, and must report the results of the checks as provided in § 171.327.

(e) The only modifications permitted are those that are submitted to FAA for approval by the MLS equipment manufacturer. The owner or sponsor of the facility must incorporate these modifications in the MLS equipment. Associated changes must also be made to the operations and maintenance manual required in paragraph (c) of this section. These and all other corrections and additions to this operations and maintenance manual must also be submitted to FAA for approval.

(f) The owner or the owner's maintenance representative must participate in inspections made by the FAA.

(g) The owner must ensure the availability of a sufficient stock of spare parts, including solid state components, or modules to make possible the prompt replacement of components or modules that fail or deteriorate in service.

(h) FAA approved test instruments must be used for maintenance of the MLS facility.

(i) Inspection consists of an examination of the MLS equipment to ensure that unsafe operating conditions do not exist.

(j) Monitoring of the MLS radiated signal must ensure a high degree of integrity and minimize the requirements for ground and flight inspection. The monitor must be checked daily during the in-service test evaluation period (96 hour burn in) for calibration and stability. These tests and ground checks of azimuth, elevation, DME, and marker beacon radiation characteristics must be conducted in accordance with the maintenance requirements of this section.

§ 171.327 Operational records.

The owner of the MLS facility or his maintenance representative must submit the following operational records at the indicated time to the appropriate FAA regional office where the facility is located.

(a) *Facility Equipment Performance and Adjustment Data (FAA Form 198).* The FAA Form 198 shall be filled out by the owner or his maintenance representative with the equipment adjustments and meter readings as of the time of facility commissioning. One copy must be kept in the permanent records of the facility and two copies must be sent to the appropriate FAA regional office. The owner or his maintenance representative must revise the FAA Form 198 data after any major repair, modernization, or retuning to reflect an accurate record of facility operation and adjustment.

(b) *Facility Maintenance Log (FAA Form 6030-1).* FAA Form 6030-1 is permanent record of all the activities required to maintain the MLS facility. The entries must include all malfunctions met in maintaining the facility including information on the kind of work and adjustments made, equipment failures, causes (if determined) and corrective action taken. In addition, the entries must include completion of periodic maintenance required to maintain the facility. The owner or his maintenance representative must keep the original of each form at the facility and send a copy to the appropriate FAA regional office at the end of each month in which it is

prepared. However, where an FAA approved remote monitoring system is installed which precludes the need for periodic maintenance visits to the facility, monthly reports from the remote monitoring system control point must be forwarded to the appropriate FAA regional office, and a hard copy retained at the control point.

(c) *Technical Performance Record (FAA Form 6830 (formerly FAA Form 418)).* This form contains a record of system parameters as specified in the manufacturers equipment manual. This data will be recorded on each scheduled visit to the facility. The owner or his maintenance representative shall keep the original of each record at the facility and send a copy of the form to the appropriate FAA regional office.

(Secs. 305, 307, 313(a), 601, 606, Federal Aviation Act of 1958, as amended (49 U.S.C. 1346, 1348, 1354(a), 1421, 1426); sec. 6(c), Department of Transportation Act (49 U.S.C. 1655(c)).

Note.—The MLS is a newly developed alternative landing system which can be used in place of a conventional ILS. While this regulation describes the technical aspects of an MLS the installation of any non-Federal facility is not mandatory and this subpart provides an additional choice from which to choose when instrumenting an airport. Usually less than 10–20 non-Federal systems of all types, not just MLS, are installed per year with the voluntary installation of a landing aid at only a small number of airports by small entities. Cost of compliance with this MLS standard will be minimal. As a result, the FAA has determined that this document involves a regulation which:

(1) Is not considered to be major under the procedures and criteria prescribed by Executive Order 12291; and

(2) Is not considered significant under DOT Regulatory Policies and Procedures (44 FR 11034; February 26, 1979); and

(3) Will not have a significant economic impact on a substantial number of small entities under the criteria of the Regulatory Flexibility Act.

A copy of the evaluation prepared for this regulation has been placed in the regulatory docket and a copy of it may be obtained by contacting the person identified under the caption, "FOR FURTHER INFORMATION CONTACT".

The reporting and recordkeeping requirements contained herein have been approved by the Office of Management and Budget and forms cleared under OMB #2120–0014.

Issued in Washington, D.C., on November 3, 1981.

J. Lynn Helms,

Administrator, Federal Aviation Administration.

[FR Doc. 81–35514 Filed 12–16–81; 8:45 am]

BILLING CODE 4910–13–M