RTCA
1828L Street, NW, Suite 805
Washington, DC 20036

Microwave Landing System (MLS) Implementation (Volume I)

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Prepared by:
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Copies of this document may be obtained from

RTCA, Incorporated
1828 L Street, NW, Suite 805
Washington, D.C. 20036 U.S.A.

Telephone: 202-833-9339
Facsimile: 202-833-9434

Internet: www.rtca.org

Please contact RTCA for price and ordering information.

F O R E W O R D

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PREFACE

This Document was prepared by the membership of RTCA Special Committee 125 which included a wide spectrum of the prospective users of MLS. The Committee was constantly mindful of the stipulation to their Terms of Reference which states "... assuming that it (MLS) will be the primary system in service by the year 2000." The technical aspects of MLS and ILS equipments were considered; it was also necessary to consider the economic user requirements and facility transition planning during this projected period.

Although there is general recognition of the need for a successor system for ILS, a nationwide implementation beginning date is not specifically recommended. Instead, the recommendations are made in Chapter 7 with regard to the basic direction to the Committee. In the opinion of the Committee, application of the Committee's recommendations at the time a decision is made to implement MLS could result in an effective implementation program.

SUMMARY

S U M M A R Y

This Document responds to the Terms of Reference presented to RTCA Special Committee 125 (see Chapter 2) by providing recommendations for a national Microwave Landing System (MLS) implementation policy.

The recommendations included herein (particularly in Chapter 7) of necessity represent an amalgamation of differing views on how best to transition from VHF/UHF ILS to a standard MLS. In spite of the diverse interests involved, the Committee concluded that on an overall basis, MLS will be a worthy successor to ILS and identified a large number of benefits which MLS may provide. However, the Committee also noted that full exploitation of the potential value of MLS requires FAA's commitment to providing the benefits including taking steps such as changes in FAA's standards and criteria for system implementation, operation, and utilization. Hence, in addition to a proposed implementation strategy, the Document presents a number of complementary recommendations which must be considered in full context with the strategy itself. From a user point of view the recommendations are, perhaps, more important than the strategy. The former are designed to reduce the trauma associated with so large an undertaking as the transition from ILS to MLS by maximizing benefits, minimizing costs, providing for a smooth and evolutionary transition process, and protecting against the premature removal of ILS facilities.

In effect, three individual strategies (short, middle and long term) are presented to match the differing objectives of each phase of the total program. Also, because change is inevitable, the Committee strongly recommends that FAA make a conscious and determined effort to seek and utilize user inputs in the regular review and revision of the strategy to meet changing requirements.

The Document is divided into two parts. Chapter material represents the main body of the Document and provides Committee-approved material including user recommendations in response to the Terms of Reference. The Appendices are the Reports of informal working groups which were assigned responsibility to investigate and report on specific aspects of MLS implementation which might be helpful to the Committee in forming its recommendations. While the Appendices were not subject to the endorsement of the full Committee, they represent the findings of experts who conducted intensive investigation into their assigned subject areas. As such they may be of considerable value to readers who wish to obtain more detailed information in particular interest areas.

A formal MLS Program Steering Committee should be established to serve as a mechanism for soliciting and coordinating views on initiating and updating the MLS implementation plan. This will include identifying and resolving to the extent feasible, problems which may arise; and for generally monitoring program progress. Membership should include duly appointed representatives of user organizations and should be chaired by an FAA representative.

The reader is advised that a number of areas in the Document departed from the precise requirements of the Terms of Reference or were treated somewhat differently than one might expect. Those areas and the Committee's rationale for the specific treatment given are presented below:

1. The Document does not include a specific chapter on military implementation of MLS; however, military considerations are included throughout the Document as appropriate.

2. Although the Terms of Reference do not require the development of cost data it was felt that such data would be of value in developing an appropriate implementation strategy.

3. Inadequacies in the FAA data base made it impossible to determine total program requirements based upon acceptance of the recommendations presented in this Document.

4. The Committee concluded that they could not develop meaningful benefit quantification, except in the area of ground system cost reduction.

1.0 INTRODUCTION AND BACKGROUND

1.1 HISTORY AND STATUS OF LANDING SYSTEM DESIGN

The need for a new precision approach and landing system to replace the current ILS has been recognized and a development program has reached the point of producing prototype hardware.

ILS, The Current Standard. - The Civil Aeronautics Administration demonstrated the first commercial VHF/UHF Instrument Landing System in 1939, over 35 years ago. The ILS was adopted for national service in 1941 and by ICAO as the international standard in 1949. The ILS was used by the U.S. military Services during World War II, and many military ILS systems are installed and utilized by the Army, Navy and Air Force; however, the ground controlled approach (GCA) system has remained a standard military low-approach approach landing aid.

ILS facilities are currently installed on about 500 runways in the United States. Additional facilities are planned through FY-1977, raising this figure to a total of about 660 systems. About 350 of these systems are of vacuum-tube design and, as a result, have inherently higher annual operation and maintenance costs and lower reliability. The balance of the systems are, or will be, of solid state design which perform significantly better in all areas.

The ILS is basically a single fixed path system providing vertical and lateral guidance from a predefined approach path. Range information is supplied by marker beacons installed at critical points along the path. The electronics system, consists of localizer, glideslope, outer and middle (and sometimes inner) markers. The VHF localizer and UHF glide slope are assigned pairs of frequencies from a 20 channel set. Although a reduction in channel spacing (to 50 kHz) will permit a doubling to 40 channels, such channel assignments have not yet been made. Precise localizer guidance is provided within a narrow ($\pm 3^{\circ}$) sector with clearance data furnished outside of these narrow limits to at least $\pm 35^{\circ}$ from the runway centerline.

While ILS has provided highly useful service over the years, its design and technical and operational characteristics impose constraints which are becoming increasingly severe in the current and projected aviation environment. These constraints are detailed in the following topic.

U.S. National MLS Program. - The need for a new precision approach and landing system was recognized in the Department of Transportation's Air Traffic Control Advisory Committee (ATCAC) Report of December 1969 and by RTCA in its SC-117 Report of December 1970. The ATCAC Report recognized that the projected demand for air traffic control services would outstrip the capabilities of the present system and concluded that a Microwave Landing System (MLS) was required as part of the Upgraded Third (UG3RD) Generation System. Approved by FAA and DOT, the ATCAC Report added impetus and importance to the work of RTCA SC-117 which, after three years of work, produced a comprehensive

recommendation for "A New Guidance System for Approach and Landing." The MLS program was conceived as the mechanism for developing and implementing the new system intended to meet both civil and military requirements through at least the year 2000. This program is described in the National Plan for Development of MLS dated July 1971 which was subscribed to by DOD, NASA, DOT and FAA, all of whom are program participants.

International Program. - The need for a successor system to VHF/UHF ILS has been recognized internationally for some time. ILS improvements over the past 30 years have been significant; however, basic system shortcomings will not allow further improvements to keep pace with the more demanding requirements of the future. In particular, a new system is felt to be needed which, simply stated, will provide precise, high-integrity, guidance signals over a wide coverage sector which are relatively unaffected by the physical environment including topography, proximate airport structures, overflying and taxiing aircraft, ground vehicular traffic, and weather effects. Additionally, many developing countries require systems which can be deployed in remote, generally hostile physical environments and which will provide basic, highly-reliable service with minimal attention. Precise landing guidance is recognized as a requirement for the safe operation of aircraft independent of weather factors and, therefore, represents an increasing need in the development of international air commerce.

The operational requirements for a precision approach and landing system for international civil aviation have been developed by ICAO. In response to these requirements, a number of ICAO member states pursued development programs and submitted proposals for international adoption. The most active of the member states, and their submissions were: the U.S. and Australia with a Time Reference Scanning Beam MLS; the United Kingdom with a Doppler MLS; France with a high capacity L-Band data link integrating communications and navigation functions; Germany with an L-Band DME and limited aperture antenna to measure aircraft position and transmit position data to the aircraft. A following topic discusses the ICAO operational requirements and the various submissions in more detail.

Interim Standard Microwave Landing System. - The time schedule for development of a new landing system is driven by two contradictory pressures; the urgent need of the aviation community for improved equipment, and the need to ensure that the MLS development will meet U.S. civil and military needs through the end of this century. As a result of these pressures, several interim solutions were proposed. To eliminate the possibility of proliferating a number of competing, incompatible systems, and to avoid prejudicing the development of the National MLS, the FAA approved an Interim Standard MLS (developed by Tull Aviation) for limited application in locations where VHF/UHF ILS will not perform in an effective manner.