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Minimum Operational Characteristics for Vertical Guidance Equipment Used in Airborne Volumetric Navigation Systems

RTCA DO-152
March 17, 1972
Includes Appendix D

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FOREWORD

This report was prepared by Special Committee 116-E of the Radio Technical Commission for Aeronautics (RTCA). It was approved by RTCA on March 17, 1972.

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PART ONE

CONCEPTS, PHILOSOPHY, AND DEVELOPMENT OF MINIMUM OPERATIONAL CHARACTERISTICS (MOC's) FOR AIRBORNE SYSTEMS

(NOTE: This PART was prepared by the SC-116 Steering Committee.)

SECTION I

THE NEED FOR BASIC CHARACTERISTICS FOR NAVIGATION AND COMMUNICATION SYSTEMS USED IN AIR TRAFFIC CONTROL (ATC)

Many devices carried aboard aircraft to fulfill navigation, communication and ATC requirements are important not only to the aircraft itself and its occupants, but can have an effect on other aircraft sharing the airspace. The latter is particularly true when the airborne devices are used to transmit, receive or share intelligence in communication or navigation media in common usage. Agreement must exist on the minimum operational characteristics necessary not only to assure satisfactory performance for each aircraft but also to prevent derogation of the service being provided to other users or recipients of communication or navigation services.

Promulgation of basic characteristics of these systems, or System Characteristics, upon which the minimum operational characteristics for the airborne element must be based, has in the past often lagged implementation of systems by unacceptable periods of time; yet their timely issuance is necessary so that participants in the systems will know how properly to equip themselves.

If a satisfactory air navigation, communication and traffic control service is to be provided, a clear statement of minimum operational characteristics for airborne systems must be agreed upon and must be adhered to by all participants in the system. For example, where separation between aircraft is achieved based on assumptions of certain characteristics of the individual aircraft devices, minimum requirements for these devices are needed, in order to assure adequate separation of one aircraft from another.

SECTION II

MINIMUM OPERATIONAL CHARACTERISTICS OF THE AIRBORNE SYSTEM ELEMENTS

For achievement of satisfactory air navigation, communication and traffic control services, clear statements of minimum operational characteristics of airborne systems are needed in two major areas:

A. For all users of aviation navigation and communication services, minimum operational characteristics of the airborne system elements are needed to insure against derogation of service to other users of these services.

B. For those who are required by regulation to participate in the ATC system or who voluntarily choose to do so, additional minimum operational characteristics for navigation, communication and air traffic control airborne system elements are needed to achieve at least that minimum performance on which control and separation are based.

SECTION III

EQUIPMENT SPECIFICATIONS AND ENVIRONMENTAL STANDARDS

Minimum operational characteristics of navigation, communication and ATC systems should be established and widely published. Where services provided in these areas depend upon certain characteristics of the airborne elements, minimum requirements must be established to assure that all airborne equipments are compatible with and operate properly within the service being provided. Such minimum requirements should be restricted to the actual minimum operational or performance characteristics and should not contain equipment specifications. These should be the prerogatives of the purchaser or seller of the equipment.

Further, the minimum requirements need not contain environmental standards, although such standards may be found useful and be utilized by manufacturers and purchasers to indicate that a given device can meet its operational characteristics in the intended application. The need is simply for the user to assure that his equipment will meet the needed operational characteristics in the environmental conditions in which he operates. As a means of determining the environmental characteristics of airborne equipment, there should be a convenient grouping of categories of environment encountered in typical aircraft. This type of standard is optional or guidance material and may be used by equipment manufacturers or users to identify given equipment environmental capability. An equipment manufacturer has the option of:

A. Using the FAA "Environmental Test Procedures for Airborne Electronic Equipment," set forth in FAA Technical Standard Orders (TSO's); or

B. Using industry-developed environmental standards (such as RTCA, SAE); or

C. Stating the range of environmental conditions over which his equipment is capable of operating. As a minimum, temperature and altitude limitations should be stated. In order to achieve some degree of uniformity in the manner in which manufacturers state the range of environmental conditions over which their equipment is capable of operating, it is recommended that the environmental categories defined in the report of RTCA Special Committee 112 be employed for this purpose.1/

1/ RTCA Document DO-138

SECTION IV

INTERNATIONAL STANDARDS

International standards exist for several electronic systems (e.g., VOR, ILS, and DME ICAO Standards). It is essential that navigation and communication systems that are international in character be covered by international standards. It follows that national and international standards, insofar as practical, should be the same so that aircraft are not forced to carry more than one type of equipment for a function or to meet more than one set of standards as they traverse international boundaries.

Minimum operational characteristics for airborne elements of navigation, communication and ATC systems should also be uniform, country to country. It is not desirable for foreign administrations to impose requirements on U.S. aircraft which are different from, or more stringent than, those imposed by the United States. The converse is equally true. Therefore, minimum requirements should be coordinated insofar as possible among the countries of the world to assure a single uniform level of requirement. Upon completion of informal coordination, it is appropriate to amend existing ICAO Standards to define the systems more fully and to describe the minimum acceptable characteristics of airborne elements.

SECTION V

PREPARATION OF MINIMUM OPERATIONAL CHARACTERISTICS FOR AIRBORNE SYSTEMS

The Federal Aviation Administration is the responsible agency for certain aviation standards. However, FAA's regulatory effort is vastly improved by intelligent utilization of government/industry working arrangements, by which a variety and wealth of talent may be brought to bear on the development of a particular minimum requirement.

Therefore, to implement the concepts that have been outlined, RTCA established Special Committee 116 to develop the Minimum Operational Characteristics for Airborne System Elements, together with a method of demonstration of compliance. However, as pointed out in these concepts, concise statements of system characteristics are a prerequisite to meaningful minimum operational characteristics for airborne systems. Accordingly, SC-116 was directed to consider such system characteristics that exist and to include them in its reports. If none exists, best assumptions were to be formulated by SC-116 and included in the reports.

The following is the outline provided to the several SC-116 Committees for developing the needed Minimum Operational Characteristic (MOC's) for each major airborne system element:

I. System Characteristics

A concise statement of the technical and operational characteristics of the particular system.

II. Minimum Operational Characteristics of the Airborne System Element

A. A concise statement of the minimum operational characteristics of the airborne system element needed to insure against derogation of service to other users of aviation navigation and communication services. These MOC's are applicable to all users of such airborne system element.

B. A concise statement of the minimum operational characteristics of the airborne system element needed to achieve at least that minimum performance on which control and separation of aircraft are based. These MOC's are applicable to all participants in controlled operations keyed to the use of such system elements.

III. Demonstration of Compliance

A. For those MOC's covered by IIA, above, demonstration of compliance shall be by the equipment manufacturer's certification and statement of limitations.

B. For those MOC's covered by IIB, above, demonstration of compliance shall be by any of the following (or combination thereof) alternative methods:

1. An approved Minimum Performance Standard (such as a TSO, an SAE Aeronautical Standard, or an RTCA Minimum Performance Standard) supplemented, if necessary, by a flight check to assure adequate performance of the equipment in its installation; or

2. An approved Statement of Minimum In-Flight Performance; or

3. The level of performance demonstrated during aircraft certification; or

4. Other methods of demonstrating capability.

SECTION VI

APPLICABILITY OF MINIMUM OPERATIONAL CHARACTERISTICS (MOC's) FOR AIRBORNE SYSTEM ELEMENTS

In the preparation of the specific MOC's by the several SC-116 Committees, it was recognized that in some cases (depending upon the specific airborne system element involved) some of the parameter values recommended are objective in nature and are not met by a large percentage of equipments presently in service. Therefore, it is not considered practical to adopt and impose these characteristics without adequate provision for a reasonable future service life for equipments in service and in production which do not meet the objectives of these MOC's.

PART TWO

MINIMUM OPERATIONAL CHARACTERISTICS FOR VERTICAL GUIDANCE EQUIPMENT USED IN AIRBORNE VOLUMETRIC NAVIGATION SYSTEMS

Prepared by:
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SECTION I

SYSTEM CHARACTERISTICS

A. Concept

The programming of vertical guidance commands adds a third dimension of control (VNAV) to the two dimensions provided by conventional airborne area navigation (RNAV) systems. The further addition of ground speed control will provide the fourth dimension ultimately required for complete volumetric navigation. With airborne equipment providing four dimensions of control, it will be possible to navigate within a specified three-dimensional flight path from takeoff to touchdown and to make good predetermined arrival times consistent with guaranteed approach clearances. It is anticipated that volumetric navigation routes will be sized and spaced on the basis of differential vertical and horizontal accuracy tolerances appropriate to enroute, terminal area, and final approach operations, respectively. Furthermore, it is anticipated that, as improved airborne equipment capabilities are achieved, it will be possible to establish different nonprecision approach category minimums consistent with aircraft type and local operational restraints.

B. System Functions

The Minimum Operational Characteristics (MOC's) for airborne vertical guidance (VNAV) systems stated in Section II, apply to equipment that will:

1. Permit aircraft operation along vertical corridors with preestablished departure climb gradients, enroute altitude changes, terminal descents, approaches to noninstrumented runways, interception of ILS approach paths, and missed approach procedures.

2. Permit aircraft operation along more complex vertical flight paths for such purposes as obstacle, traffic, or wake turbulence avoidance, noise abatement, operational efficiency, or passenger comfort.

C. Applicability

The MOC's are applicable to any system that provides computation and presentation of an arbitrarily designated vertical flight profile and/or vertical flight path commands relative to such a profile. The MOC's are intended to encompass vertical guidance functions of airborne area navigation systems in the most general sense, i.e., equipment which can be utilized with any one or a combination of navigation sensors whose errors, when combined with the error contributions of the area navigation system, can meet the navigation and position fixing requirements of the particular airspace structure under consideration.