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VHF Air-Ground Communications System Improvements Alternatives Study and Selection of Proposals for Future Action

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Prepared by:
SC-172

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FOREWORD

This report was prepared by Special Committee 172 (SC-172) and approved by the RTCA Technical Management Committee (TMC) on November 17, 1994.

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- developing consensus on the application of pertinent technology to fulfill user and provider requirements, including development of minimum operational performance standards for electronic systems and equipment that support aviation; and

- assisting in developing the appropriate technical material upon which positions for the International Civil Aviation Organization and the International Telecommunication Union and other appropriate international organizations can be based.

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EXECUTIVE SUMMARY

This report represents the results of a broad study of very high frequency (VHF) air-ground communications system improvements. The study was initiated on recommendations made at the 1990 International Civil Aviation Organization (ICAO) Communications, Meteorology, and Operations Divisional Meeting. This study was primarily concerned with North American system users, service providers, and industry, but took into account the perspectives of other regions of the world. The report reflects developments up to the end of the study, which was essentially completed by the end of February 1994.

During the early stage of this study, it became apparent that while present system improvements should be sought and implemented to allow the present system to last as long as possible, a new system would need to be pursued to satisfy future capacity and functional requirements. The future VHF system should not be compromised by basing a design on predictions of the availability and use of specific functions or other air-ground communications systems.

The study included: (1) gaining an understanding of the present VHF air-ground communications system, (2) developing future Air Traffic Service (ATS) and Aeronautical Operational Control (AOC) communications functional requirements and desirable features, (3) studying present system improvements, (4) developing and analyzing alternative future system candidates, (5) selecting a future system candidate to pursue towards implementation, and (6) developing recommendations resulting from this study.

A total of 12 present system improvements were identified and analyzed during the study. The future system candidates were required to provide voice and data link in a practical manner to all users, and to provide these functions without interference (functionally simultaneous access to voice and data link). Seven candidate future system alternatives were evaluated against the future system requirements and desirable features.

The comparative analysis highlighted a number of high-level factors pointing toward the selection of a class of system design. A fully digital system, preferably with multiple circuits provided on the same RF channel, emerged as the optimum choice to meet future VHF air-ground voice and data link communications system requirements. Based on the comparative analysis, the Time Division Multiple Access (TDMA) architecture was recommended as the best candidate that would satisfy the identified future system requirements and desirable features. The above conclusions are consistent with the study of ICAO Aeronautical Mobile Communications Panel (AMCP) WG-B, and its report to AMCP/3, which evaluated the same seven future system candidates. The 8.33 kHz candidate was also highlighted in ICAO AMCP WG-B's report to AMCP/3 as a mature system design that could be available for implementation with minimum schedule risk.

European experts in AMCP WG-B concluded that no combination of present system improvements would allow a more relaxed implementation timescale of a system to gain additional voice capacity in Western Europe. Several European civil aviation authorities have concluded that 8.33 kHz DSB-AM is the only choice given the need to implement by 1998. This RTCA study did not surface any significant issues that would prevent 8.33 kHz from being implemented.

As a result of this study, six recommendations to pursue present and future system improvements were adopted.

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1.0 INTRODUCTION AND BACKGROUND

RTCA Special Committee 172 (SC-172) began its work in mid-1991. The work was initiated in response to requests from the U.S. Federal Aviation Administration (FAA) and Aeronautical Radio, Incorporated (ARINC). They requested the establishment of a government and industry forum in the United States that would investigate and make recommendations on improvements to meet both near-term and longer-term requirements for the very high frequency (VHF) Aeronautical Mobile (Route) Service (AM(R)S) allocated in the 117.975–137 megahertz (MHz) band. This service includes Air Traffic Service (ATS) and Aeronautical Operational Control (AOC) communications.

1.1 Introduction

This document is a report of the study efforts undertaken and recommendations made by RTCA SC-172 WG-1. This study was primarily concerned with North American system users, service providers, and industry, but took into account the perspectives of other regions of the world. The report reflects developments up to the end of the study, which was essentially completed by the end of February 1994. It covers the various aspects of the WG-1 work, including the following:

1. The development of a statement of VHF air-ground communications system characteristics and principles of operation for both VHF air-ground voice and data link communications system elements (Section 2)

2. The analysis and development of civil aviation user and provider requirements and desirable features for ATS and AOC voice and data link communications (Sections 3 and 4)

3. A study of present system near-term improvements that could be implemented without requiring changes to user avionics (Section 5)

4. The development and comparative analysis of future system improvement alternatives aimed at satisfying the defined ATS and AOC communications candidate requirements in a cost-effective and spectrum-efficient manner (Section 6)

5. The selection of a future system candidate, taking into account the satisfaction of requirements and desirable features, including spectrum efficiency and cost-effectiveness, as well as various implementation considerations, particularly transitional capabilities (Section 6)

6. The development of a statement of system improvement recommendations resulting from the above efforts (Section 7)

The WG-1 study in the above areas took into account the results of U.S. and U.K. studies on VHF air-ground voice communications system improvements, a Canadian study on carrier sense multiple access (CSMA) versus time division multiple access (TDMA), the VHF data link system development by the AEEC, the work of RTCA SC-172 WG-2, and reflections on the activities of ICAO AMCP WG-B and WG-C.

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Key definitions and acronyms used in this document are listed in Appendices B and C, respectively. A list of the RTCA, Inc. SC-172 WG-1 members is provided in Appendix D. Appendices E through P provide additional supporting information for this study.

1.2 Background

RTCA SC-172 was initiated as part of an international effort to study and seek agreements on VHF air-ground communications system improvements. The broad study of VHF improvements resulted from recommendations made at the 1990 International Civil Aviation Organization (ICAO) Communications, Meteorology and Operations (COM/MET/OPS) Divisional Meeting. In particular, Recommendation 2/2 recommended development of Standards and Recommended Practices (SARPs) for VHF data link, while Recommendation 2/4 called for studies to identify future VHF air-ground communications system improvements. It was also recommended that a special divisional meeting be held in the 1993–94 time frame to make decisions on the recommendations resulting from those studies (subsequently, a date of March 1995 was agreed upon). Recommendations 2/2 and 2/4 are presented in Appendix A for reference.

Recommendation 2/2 was initiated as a result of the recognition that ICAO SARPs should begin to be developed for a bit-oriented, Aeronautical Telecommunication Network (ATN)-compatible VHF data link. Such SARPs are needed because over the last 10 years, many aircraft operators around the world have taken advantage of the communications benefits of industry-developed character-oriented data links. Recommendation 2/4 was initiated, in particular, as a result of the persistence of Europe in stating that the VHF AM(R)S band was already saturated in Europe, and action was needed to seek frequency congestion relief as soon as possible.

It was recognized that Recommendations 2/2 and 2/4 could not be addressed independently, since the specific choice of VHF air-ground communications system improvements could impact the formulation of the data link SARPs. Consequently, the terms of reference of the ICAO Aeronautical Mobile Satellite Service (AMSS) Panel (AMSSP) were expanded to address Recommendations 2/2 and 2/4, and the name of the panel was changed to the Aeronautical Mobile Communications Panel (AMCP). The AMCP developed its VHF study program at its first meeting, in November 1991. Subsequent working group and panel meetings were held to assess the progress of the VHF study work. Other States and international organizations also made contributions to the VHF study efforts. These included a contracted study by the United Kingdom, concentrating on VHF air-ground communications voice system improvements; a study by Canada on CSMA versus TDMA; and VHF data link system development by the Airlines Electronic Engineering Committee (AEEC). FAA-sponsored study efforts were carried out by The MITRE Corporation in support of the RTCA SC-172 activity.

The terms of reference for RTCA SC-172 are as follows:

> "Special Committee 172, for the VHF Aeronautical Band (118-137 MHz), shall:
>
> A. Develop and propose recommendations for future VHF air-ground communications system improvements.

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