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Next Generation Air/Ground Communication System (NEXCOM)
Safety and Performance Requirements (SPR)

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Prepared by SC-198

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FOREWORD

This report was prepared by RTCA Special Committee 198 and approved by the RTCA Program Management Committee (PMC) on January 23, 2003.

RTCA, Incorporated is a not-for-profit corporation formed to advance the art and science of aviation and aviation electronic systems for the benefit of the public. The organization functions as a Federal Advisory Committee and develops consensus-based recommendations on contemporary aviation issues. RTCA's objectives include but are not limited to:

- coalescing aviation system user and provider technical requirements in a manner that helps government and industry meet their mutual objectives and responsibilities;

- analyzing and recommending solutions to the system technical issues that aviation faces as it continues to pursue increased safety, system capacity and efficiency;

- 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.

The organization's recommendations are often used as the basis for government and private sector decisions as well as the foundation for many Federal Aviation Administration Technical Standard Orders.

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EXECUTIVE SUMMARY

This Government/Industry NEXCOM Safety and Performance Requirements (SPR) document identifies the operational safety and performance requirements for air traffic services supported by digital voice and data communications in the U.S. National Airspace System (NAS).

Note: The requirements in this document represent the best engineering judgement that can be derived from available data, and are intended to provide guidance for initial NEXCOM implementation activities. As the community and industry gather more data, and initial operational experience, this document will be updated as necessary.

The NEXCOM SPR provides a brief description of digital voice and data services for the systems' users. Data communications requirements were developed by RTCA SC-189/EUROCAE WG-53. On publication of RTCA SC-189/EUROCAE WG-53's Initial Continental SPR (ICSPR), this document will be updated as required to include those data requirements applicable to the NAS.

Background

The demand for air traffic services within the national airspace is projected to rise sharply in the 21st century. Air traffic management depends on timely and accurate communications of information during all segments of the flight (gate to gate). Modernization of today's air/ground communications is necessary to replace outdated hardware, to leverage VDL Mode 3 technology to expand the Very High Frequency (VHF) spectrum capacity, and to integrate both voice and data into a seamless network using digital technology. During the programmed transition period, NEXCOM will continue to support existing A/G communications systems using the analog capability of the Multimode Digital Radio (MDR). The NAS will migrate to a digital telecommunications infrastructure to take advantage of new technology and the growing number of digital services. The new telecommunications infrastructure will continue to support current analog voice switches and legacy protocols, and Emergency services will remain as an analog capability to ensure the widest information dissemination to other aircraft in the vicinity of the emergency aircraft.

The SPR document defines the operational safety hazards and performance requirements of the NEXCOM system (both airborne and ground subsystems). The SPR will be used to coordinate safety objectives and to allocate performance requirements for the system. It has been developed using the NEXCOM Operational Safety Assessment (OSA) and the NEXCOM Operational Performance Assessment (OPA). These two assessments define the safety functions, performance expectations, and characteristics of the operational environments needed to support the Air Traffic Services (ATS) identified in the NEXCOM Operational Services and Environment Definition (OSED). The SPR document identifies the objectives and allocated requirements (including substantiation) for a specific operation. The SPR provides traceability of each requirement to its source, and operating environments described in the OSED. RTCA DO-279, *Next Generation Air/Ground Communications System (NEXCOM) Principles of Operation VDL Mode 3*, serves the function of the OSED as described in RTCA DO-264.

Development and Deployment

The FAA completed its first milestone on the development path to digital communications when a contract was awarded July 31, 2001 for the procurement of the MDRs. These MDRs will be used initially as ground infrastructure replacement radios operating in the current 25 KHz analog voice mode until the transition to digital voice commences.

The deployment of the NEXCOM Ground System (Radio Interface Units and Ground Network Interfaces) to high and super high en route sectors is planned to begin in 2007 to allow for operational transition to digital voice in the NAS beginning in late 2009.

For affordability, ease of transition and risk reduction, the operational transition to NEXCOM is planned for three segments. These three segments are:

Segment One
The NEXCOM Ground System will be in a Rapid Preliminary Development Effort (RPDE) phase through late 2004, and will move to the Full Scale Development (FSD) phase through 2007. Installation starts after FSD and completes in 2011. The system operational and technical evaluation takes place in a single, to be determined, Air Route Traffic Control Center (ARTCC) location between 2004 and 2006. A final rule is expected to be published in 2005 allowing the system to become initially operational in late 2009 with voice communications only. Users will be required to equip with VDL mode 3 capability to enter NEXCOM airspace after 2009.

The FAA facilities to be upgraded during Segment One include ARTCCs in the contiguous United States and associated Remote Communications Air/Ground Facilities (RCAG), Back-up Emergency Communications (BUEC) facilities and Enroute Flight Service Stations.

Segment Two
This segment adds data capabilities such as Controller Pilot Data Link Communications over the VDL Mode 3 system in those En Route Sectors converted to VDL Mode 3 voice in Segment One.

Segment Three
Segment Three completes the transition of VDL Mode 3 throughout the remainder of En Route and extends the system to the terminal environment. NEXCOM will provide both digital voice and data link to FAA facilities requiring air/ground VHF communications.

Operational Safety Assessment (OSA) (Provided as Appendix B1)

The NEXCOM OSA was conducted as a qualitative assessment of hazards related to the operational services documented in RTCA DO-279. A high-level operational assessment was made to identify and classify hazards that could adversely affect the services defined in RTCA DO-279 and to identify safety requirements at the service or functional level. This safety assessment is based on the how the system (including its capabilities) is used in operation. The Operational Hazard Assessment (OHA) serves as the basis for the

Allocation of Safety Objectives and Requirements (ASOR) among components of the Communication, Navigation, Surveillance / Air Traffic Management (CNS/ATM) system and organizations responsible for those components.

Summary of the OHA

The OHA for the voice segment was developed using information from RTCA DO-279, *NEXCOM Principles of Operations VDL Mode 3* and is provided in Appendix B1. RTCA DO-279 serves the purpose of an OSED. The data segment analysis was conducted by RTCA SC-189/EUROCAE WG-53 and is included in Appendix B2. In the OHA, each operational capability and objective has been associated with one or more of its ATS service(s). The summary of the results of the OHA includes a list of operational hazards, ranked by severity classification, and a list of candidate operational safety requirements for consideration when developing requirement documents, including an SPR for communications services. As each Hazard Class was compiled, the low number of operational hazards indicated a realistic opportunity to develop NEXCOM VDL Mode 3 using the same mitigating factors in use today to ensure system integrity, fidelity and capability. There were no Class 1 (most severe) hazards, and the remaining Hazard Classes (2 through 5) contained 35 hazards, all within the scope of accepted mitigation measures.

Methodology

Each Service and Domain listed was analyzed, and hazards were identified that would impair the effectiveness of that service. Each hazard was described at a service or functional level (in accordance with RTCA DO-264) as a malfunction or failure related to either the voice or data communication for implementation by NEXCOM. Only the loss of the capability was used in the hazard analysis.

Hazard Mitigation, Classification and Candidate Requirements

Considering the failure condition, the effect of each hazard was then described in sufficient detail to classify the severity of the hazard, and include the mitigation identified for the hazard. The system state is provided to show under what operating conditions the hazard has been assessed. Candidate requirements derived from the hazard analysis, safety goals based on the severity of the hazard, and environmental requirements are provided. The environmental requirements are characteristics of the operating environment that mitigate the hazard and thereby reduce its severity. Candidate Probability Requirements consider the minimum safety objective. Human factors safety issues (e.g., NEXCOM user errors) were captured in the Hazard Causes, Existing Controls, and Recommendations areas of the OHA. The severity determined in this analysis points to the relative significance of the hazard in an operational service-level context.

Allocated Safety Objectives and Requirements (ASOR)

The ASOR presents two tables of allocated requirements: Table 9-1: Safety Objectives and Requirements Applicable to Aircraft Systems and Procedures and Table 9-2: Safety Objectives and Requirements Applicable to Ground Systems and Procedures. In some cases, requirements and objectives apply to both areas. In these cases it is necessary for the stakeholders to mutually determine how much of the requirement or objective belongs

to each system (air or ground). If the requirements are not implemented, the safety goal may not be met by the system.

Twenty-one voice safety and six operational performance requirements were identified for application to NEXCOM.

Operational Performance Assessment (OPA) (Provided as Appendix C1)

The OPA derives the required communication performance (RCP) from the OSED, based on the RCP concept. The RCP concept is the framework to express the communication performance necessary for operation within a defined airspace or to perform a specified operation.

The OPA includes the determination of RCP for various RCP Types. Next, performance requirements specified by the RCP are allocated to the technical elements of the system as the Required Communication Technical Performance (RCTP) and to the human elements of the system. Finally, the OPA further allocates the technical system performance to the ground and aircraft domains.

Note: The actual human performance times in comparison to the assumed human performance values in the OPA shall not be used for certification of pilots or controllers.

Allocated Safety and Performance Requirements

The requirements for technical safety and performance of the NEXCOM voice system are compiled and listed in Table 8-2: NEXCOM Allocated Safety and Performance Requirements. These voice safety and performance requirements are derived in the OSA and OPA found in Appendices B1 and C1, respectively. The data safety and performance requirements are listed separately in the respective data OSA (Appendix B2) and OPA (Appendix C2) prepared by RTCA SC-189/EUROCAE WG-53.

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1. PURPOSE

The Safety and Performance Requirements (SPR) document defines the Operational Safety and Performance Requirements of the NEXCOM system (both airborne and ground subsystems).

Note: The requirements in this document represent the best engineering judgement that can be derived from available data, and are intended to provide guidance for initial NEXCOM implementation activities. As the community and industry gather more data, and initial operational experience, this document will be updated as necessary.

The SPR will be used to coordinate safety objectives and to allocate performance requirements for the system. It has been developed using the NEXCOM *Operational Safety Assessment* (OSA) and the NEXCOM *Operational Performance Assessment* (OPA) of the functions, performance expectations, and characteristics of the operational environments needed to support the Air Traffic Services (ATS) identified in the NEXCOM Operational Services and Environment Definition (OSED). The OSA and the OPA are included in this document as Appendices B, and C respectively. For the purposes of this document, RTCA DO-279, *Next Generation Air/Ground Communications (NEXCOM) Principles of Operation VDL Mode 3* serves the function of the NEXCOM OSED.

The SPR document identifies the objectives and allocated requirements (including substantiation) for a specific operation. The SPR provides traceability of each requirement to it source, the services, and operating environments described in the OSED and captures the results of the OSA and the OPA.

The demand for air traffic services within the national airspace is projected to rise sharply in the 21st century. Air traffic management depends on timely and accurate transmission of information during all segments of the flight (gate to gate). With the projected growth in air traffic, today's communications systems must be modernized to handle the additional demand. Modernization will require replacing outdated hardware, better use of the available VHF spectrum, and integrating systems into a seamless network using digital technology. During the transition, NEXCOM will continue to support legacy A/G communications systems.

Technological advances in the areas of Communication, Navigation, Surveillance (CNS) and decision support must support the FAA's evolution of a modernized National Airspace System (NAS). From a NAS user and NAS service provider perspective, this modernized system must be seamless and fully integrated with the international global aviation community.

The NAS will migrate to a digital telecommunications infrastructure to take advantage of new technology and the growing number of digital services. The new telecommunications infrastructure will also support current analog voice switches and legacy protocols.