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Minimum Operation Performance Standards (MOPS) for Automatic Flight Guidance and Control Systems and Equipment

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FOREWORD

This document was prepared by Special Committee 220 (SC-220) and approved by RTCA Program Management Committee (PMC) on December 8, 2010.

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- 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.

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1 PURPOSE AND SCOPE

1.1 Introduction

This document contains minimum operational performance standards (MOPS) for Automatic Flight Guidance and Control Systems (AFGCS) and applicable interfaces. These standards specify system characteristics that should be useful to designers, manufacturers, installers and users of the system and equipment.

Compliance with these standards is recommended as one means of assuring that the system/equipment will perform its intended functions(s) satisfactorily under all conditions normally encountered in routine aeronautical operation. Any regulatory application of this document is the sole responsibility of appropriate governmental agencies.

Section 1.0 Purpose and Scope. This section provides information needed to understand the rationale for system/equipment characteristics and requirements stated in the remaining sections. It describes typical system/equipment applications and operation goals, as envisioned by the members of Special Committee 220, and establishes the basis for the standards stated in Sections 2.0 through 3.0. Definitions and assumptions essential to proper understanding of this document are also provided in this section.

Section 2.0 System/Equipment Performance Requirements and Test Procedures. This section contains the MOPS for the AFGCS equipment and recommended test procedures to demonstrate system/equipment MOPS compliance.

Section 3.0 Installation Instructions. This section contains criteria for the installation of the AFGCS. Installation criteria are included as guidance for equipment installers and for performance which may not be adequately demonstrated during equipment MOPS testing.

Title 14 Codes of Federal Regulations (CFR) or European Aviation Safety Agency (EASA) function hazard categorizations contained in 14 CFR Sections or Certification Specification (CS) 23, 25, 27, and 29.1309 for compliance, the Advisory Circulars (AC) 23.1309-1D (or current revision) and 25.1309-1A (or current revision) provide a basis for the evaluation to be performed for the effects of the loss or malfunction of these functions. An equipment manufacturer may define limits on intended installation and document hazard category limitations accordingly.

This document provides minimum operational performance standards (MOPS) for the automatic flight guidance and control functions consisting of four equipment classes:

- Class A, autopilot.
- Class B, yaw damper.
- Class C, flight director.
- Class D, autothrust/autothrottle.

Performance standards for functions or components that describe capabilities that exceed the MOPS are identified as optional features.

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The word "function" is defined as the intended behavior of a product based on a defined set of requirements regardless of implementation. The word "system" is defined as a combination of inter-related hardware or software elements arranged to perform specific function(s).

Normative Appendix C to this document describes requirements for autopilot/flight director/autothrust coupled to Traffic Alert and Collision Avoidance System (TCAS). Appendix D to this document describes guidance for Minimum Use Height (MUH) approach. Appendix E to this document describes requirements for autopilot/flight director/autothrust Required Navigation Performance (RNP) mode.

1.2 System Overview

Automatic Flight Guidance and Control Systems (AFGCS) have evolved into highly capable systems that have contributed immensely to the improvement of aviation safety. This is so, because automatic systems operate in accordance with a control algorithm designed and proven to safely execute specific tasks (assuming correct pilot interaction), without being subject to human foibles of tiredness, emotion, lapse of attention, sleepiness, unfounded expectations and misperceptions that can all lead to human errors with serious safety consequences. Thus, the increased reliance on automation has helped reduce the number of safety incidents and accidents attributable to a wide variety of human failings of the pilot.

Dramatic changes in technology and design techniques associated with AFGCS have resulted in much higher levels of complexity, automation, and integration. These changes have also redefined the allocation of functions and interfaces between systems. Relatively simple, dedicated systems have been replaced with digital multi–function systems with more modes and automatic changes in modes of operation. These new systems are capable of providing better performance, increased safety, and decreased workload. These systems, if designed properly, provide the functional and operational capability and performance needed to operate in today's and Next Generation air transportation system (NextGen) environment.

Implementation of certain functions and operational modes of the AFGCS may vary for different types of aircraft.

1.3 MOPS Applications(s)

The standards defined in this MOPS have been scoped to support AFGCS applications (autopilot, flight director, yaw damper, autothrust). The system may also provide workload relief to the pilots and provide a means to fly a flight path more accurately to support specific operational requirements.

Other applications supported by this MOPS are the coupling of the AFGCS with TCAS during a TCAS Resolution Advisory (RA) in order to assist the pilot(s) in flying TCAS resolution orders (See Normative Appendix C). This MOPS also describes requirements and guidance for MUH approach, and autopilot/flight director/autothrust Area Navigation (RNAV) and RNP mode (See Appendices D, E).

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1.4 Scope

Figure 1.4-1 provides an overview of the automatic flight guidance and control functional diagram and depicts the interfaces between the functional elements. The figure also depicts the interfaces between the automatic flight guidance and control and the manual control functions. Figure 1.4-1 describes an overview of the AFGC functions regardless of the implementation of these functions for different types of aircraft models.

The AFGCS outer and inner loops typically receive feedback from a combination of sensors (inertial reference system data; air data; and position errors – ILS, GLS, or MLS (i.e., xLS), Global Navigation Satellite System (GNSS)) information. The AFGCS outer loop control functions are typically composed of the pitch outer loop control and mode logic, the autothrust / power control (collective power for rotorcraft) and mode logic, the directional outer loop control, the lateral outer loop control and mode logic, and envelope protection functions.

The classic AFGCS outer loop control functions provide all outer loop modes and command functions, as well as the mode logic, which are part of the aircraft trajectory control. The outer loop command functions are sent to the inner loop controls (pitch, engine / collective control (for rotorcraft), yaw and roll inner loop controls) to establish the required commands to the servos for aircraft state control. Pilot inputs can be provided to the outer loop controls, to the inner loop controls, or both depending on the flight guidance and control modes and the implementation of these functions for different categories of aircraft. The figure also depicts the interfaces between the fly-by-wire and the inner loop controls. The dotted boxes represent different levels of functional integration of the various inner and outer loop control modes.

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