



U.S. Department  
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**Federal Aviation  
Administration**

# Memorandum

Subject: INFORMATION: Report on the Boeing 757 / 767 Future Air Navigation System (FANS) 1 Pegasus Navigation Functional Hazard Assessment (FHA)

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This memo provides an update on the guidelines and assumptions on the Functional Hazard Assessment (FHA) process for Flight Management Computer Systems (FMCS) installed in Boeing Transport Category Aircraft. Before we address the FHA process, a high level description of the FMCS architecture and evolution is required.

### **Boeing FMCS High Level System Description and Evolution:**

The first FMCS systems with glass cockpits and navigation map displays were certified on the Boeing 757/767 aircraft in the late 1970's. Besides containing the navigation function, the Boeing 747-400 FMCS Future Air Navigation System (FANS) also contain communication / data link and automatic dependent surveillance (ADS) functions. Each FMC computes a separate independent on side aircraft position solution for the Captain and First Officer navigation displays. This design improved the assurance that misleading navigation information would not be displayed to both the Captain and First Officer.

However, synchronization of the two FMCS navigation solutions is difficult and may result in synchronization errors which causes both navigation displays to become inoperative for up to two minutes before refresh. To compensate for the synchronization problem, the Boeing 777 and 757/767 FMCS Pegasus systems are designed with a single identical navigation map solution displayed to both the Captain and First Officer. Depending on the power on sequence either the left or right FMCS drives both navigation map displays. To protect against single point navigation failures, each FMCS system is designed with dual lock step microprocessors with hardware that is built to protect to an hazardous hardware level classification. The new FMCS do have a cross channel data link for flight plan transfer and data integrity checks. In addition, the new computer architecture uses partitioning (hardware and software) for the navigation, communication and data base functions. Each function now resides in its own separate partition.

### **RTCA DO-178B Software Level Definitions for Hazardous and Major Failure Conditions:**

**Level B:** Software whose anomalous behavior, as shown by the system safety assessment process, would cause or contribute to a failure of system function resulting in a hazardous / severe major failure condition for the aircraft.

**Level C:** Software whose anomalous behavior, as shown by the system safety assessment process, would cause or contribute to a failure of system function resulting in a major failure condition for the aircraft.

### **Navigation FHA (General):**

Historically, the FHA classification of Boeing aircraft navigation components has been determined to be "Major" with embedded DO-178A Level II or DO-178B level C software. The Navigation Data Base (NDB) which is an integral part of the FMCS ability to determine aircraft position is not part of the airworthiness certification process and is approved for flight operations by the Flight Standards Service.

Assumptions on the FMCS operational environment and underlying ground and satellite based navigation capabilities are required for the development of the FHA and are documented in the Airplane flight Manual (AFM). Aircraft phase of flight: (1) en route, (2) en route remote / oceanic, (3) terminal area, (4) approach and, (5) takeoff should be considered during the FHA assessment process. The Flight Standards Service reviews the aircraft communication, navigation and surveillance (CNS) capabilities combined with the ground and satellite based capabilities for each flight phase when defining operational criteria and granting operational approvals.

As an example, the safety considerations for FMCS position availability, accuracy and integrity in the en route / oceanic environment where 60 mile lateral and 80 mile longitudinal aircraft separation are typical, are much different than when shooting an FMCS approach to near category I. The ability of the aircraft to correctly navigate to the FMCS computed navigation position and ability of Air Traffic Control (ATC) to monitor aircraft position should also be considered.

FMCS have not been approved for Category I, II and III precision approaches. When shooting an FMCS non-precision approach both the navigation map and raw position data are displayed to the flight crew where differences between the map and raw data could alert the crew to misleading navigation information.

**Current FAA Navigation Certification Guidelines:**

Advisory Circular (AC) 20-130A, Airworthiness Approval of Navigation or Flight Management Systems Integrating Multiple Navigation Sensors published on June 14, 1995 states in part:

“AC 20-115B, which refers to RTCA/DO-178B, provides an acceptable means for showing that software complies with pertinent airworthiness requirements. The applicant should substantiate software levels in the safety assessment. As an alternative to substantiating software level(s) in a safety assessment, the applicant may develop all software that contains or affects navigation and integrity functions to at least the level C criteria, as defined in RTCA/DO-178B.” In summary, the current FAA certification guidelines for the FMCS navigation function FHA is major.

**Boeing 757/767 FANS 1 Pegasus Navigation FHA:**

Due to the increased complexity of the FMCS functions and operations, some members of the Joint Aviation Authorities (JAA) believe the current FMCS FHA classification should be changed from major to hazardous. For this reason Boeing proposes to certify the navigation function of the FMCS to level B software and update the FHA for the Joint Aviation Regulations (JAR 25.1309) to hazardous for computing or displaying misleading navigation data without annunciation of error. The FHA classification for the FAR's would remain as major. Boeing has proposed that the Seattle ACO certify the 757/767 FANS FMCS to DO-178B Level B software.

It is very important to note that the JAA is not involved in this initial 757/767 FANS certification program. All reference to JAR's and associated guidance materials have been added to the certification documents as place holders. In the future, the JAA may become involved in the certification of the 757/767 FANS program and could require that the FMCS meet the hazardous classification and may accept or reject the Boeing design as meeting their criteria.

In summary, the FAA plans on approving the 757/767 FANS FMCS to the major classification with Level B software. The JAR's will not be approved by either the FAA or JAA for this initial certification, but may be reviewed and approved by the JAA during a future 757/767 certification program update. The FAA and JAA will continue to harmonize on this issue with the end goal of establishing a standard position. It should be noted that future JAA certifications could change the FHA classification and could require FMCS avionics hardware / software upgrades.

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