Federal Aviation Administration

Memorandum

Date: November 20, 2015

To: Manager, Boeing Aviation Safety Oversight Office, ANM-100B

From: Manager, Transport Airplane Directorate, ANM-100

Prepared by: Stephen Oshiro, ANM-130S

Subject: INFORMATION: Equivalent Level of Safety (ELOS) Finding for the Flight Control Electronics DC Power System for Boeing Model 787-8/-9/-10 (Project Nos. TC6918SE-T, PS06-0496, PS06-0497, PS13-0546 and PS14-1031)

ELOS Memo#: TC6918SE-T-SE-14

Regulatory Ref: § 25.1351(b)(5)

This memorandum informs the certificate management aircraft certification office of an evaluation made by the Transport Airplane Directorate (TAD) on the establishment of an equivalent level of safety (ELOS) finding for the Boeing 787-8 airplanes.

This memo was subsequently revised to extend this ELOS to the Boeing Model 787-9 and 787-10 airplanes.

Background

The Boeing Model 787-8 electrical system includes permanent magnet generators (PMGs) which provide electrical power to the flight control electronics (FCEs) through the power conditioning modules (PCMs). By design, the outputs of the PMG's are wired to their respective FCE cabinets and do not incorporate a means to allow crewmembers to disconnect the PMG's. Therefore, the design does not comply with Title 14, Code of Federal Regulations (14 CFR) 25.1351(b)(5) which requires that there are means accessible, in flight, to appropriate crewmembers for the individual and collective disconnection of electrical power sources from the system.

Applicable regulation(s)

§ 25.1351(b)(5) states:

> There are means accessible, in flight, to appropriate crewmembers for the individual and collective disconnection of the electrical power sources from the system.

Regulation(s) requiring an ELOS finding

§ 25.1351(b)(5)

Description of compensating design features or alternative standards which allow the granting of the ELOS (including design changes, limitations or equipment need for equivalency)

Boeing will comply with the requirements of § 25.1351(b)(5) for both the main alternating current (AC) and backup AC generating systems. However, the PMGs will not include a disconnect device, because it is not necessary to protect either the generator, or the wiring of the flight control electronics system for the following reasons:

- The PMGs are dedicated to supplying power only to the FCE system and thus constitute only a limited source of power compared to the main or backup power sources.
- The generator windings are sized to carry the maximum overload current continuously without overheating.
- The PMG/PCM system has no connection or voltage reference to aircraft structure, therefore, no single fault can cause a hazard to either the aircraft or personnel. The individual wires and wire bundles in the system are protected from penetration that could lead to a fault and the wires are also sized to protect against a short circuit of the PMG causing the wire to overheat or fail.
- The FCE system loads are protected by redundant voltage protection to protect against output voltages exceeding or falling below permissible limits.
- Incorporation of a means to disconnect a PMG from the corresponding FCE PCM would introduce an additional potential failure point and failure modes that could prevent the PCM from providing power to the FCE loads.

Explanation of how design features or alternative standards provide an equivalent level of safety to the level of safety intended by the regulation

An ELOS can be made based on the design features of the 787-8 PMG/PCM system. The PMGs are dedicated to the flight control electronics only and have a limited power output capability. The PMG/PCM system is isolated from structure to preclude against a single fault hazarding the airplane or personnel. The generators, wire bundles, and individual wiring are protected against damage and overheating, and the PCMs provide redundant voltage protection for overvoltage and under voltage conditions. Incorporation of a means to disconnect a PMG from the corresponding PCM could also introduce an additional potential failure point and failure modes

that could prevent the PCM from providing power to the FCE. Along with these design features, Boeing will provide wire diagrams, drawings, test data, and/or other engineering data as needed to verify the design meets an ELOS to that required by § 25.1351(b)(5).

FAA approval and documentation of the ELOS finding

The FAA has approved the aforementioned ELOS finding in Issue Paper SE-14 or Administrative Collector Issue Paper G-6. This memorandum provides standardized documentation of the ELOS that is non-proprietary and can be made available to the public. The TAD has assigned a unique ELOS memorandum number (see front page) to facilitate archiving and retrieval of this ELOS. This ELOS memorandum number should be listed in the type certificate data sheet under the certification basis section. An example of an appropriate statement is provided below.

Equivalent Level of Safety Findings have been made for the following regulation(s):
§ 25.1351(b)(5) Flight Control Electronics DC Power System (documented in TAD ELOS Memo No. TC6918SE-T-SE-14)

Transport Airplane Directorate,
Aircraft Certification Service

11/24/15
Date

ELOS Originated by ACO:	Project Engineer Stephen Oshiro	Routing Symbol ANM-130S