



Federal Aviation Administration

Memorandum

Date: January 12, 2011

To: Manager, Seattle Aircraft Certification Office, ANM-100S

From: Manager, Transport Airplane Directorate, ANM-100

Prepared by: Marie Hogestad, ANM-130S

Subject: INFORMATION: Equivalent Level of Safety (ELOS) Finding for Aviation Partners, Inc. (API) for the Flight Control System Failure Criteria on Dassault Model Falcon 2000 Airplanes, FAA Project No. ST9686SE-T

ELOS Memo#: ST9686SE-T-SF-1

Regulatory Ref: §§ 25.671(c) and 25.1309

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 finding (ELOS) for the Dassault Model Falcon 2000 (F-2000) series airplanes.

Background

Aviation Partners, Inc. (API) has applied for a supplemental type certificate (STC) for a winglet installation on Dassault Model Falcon 2000 series airplanes. The Dassault Model Falcon 2000 airplane must be shown to be capable of continued safe flight and landing, without requiring exceptional piloting skill or strength, for single failures and certain combinations of failures not shown to be extremely improbable. The requirement for the consideration of failure conditions in the flight control systems are covered specifically by Title 14, Code of Federal Regulations (14 CFR) section § 25.671 and in general by § 25.1309.

API has proposed an ELOS for § 25.671(c)(2) based on the proposal from the Flight Controls Harmonization Working Group (FCHWG) Aviation Rulemaking Advisory Committee (ARAC). This proposal provides guidelines on what should be an acceptable risk level after the occurrence of any single failure in the flight control system.

FAA Memorandum No. 00-113-1034, dated January 4, 2001, allows an applicant to use ARAC rulemaking not yet adopted by the FAA. Section 21.21(b)(1) states that a type certificate may be

issued if it is found that the applicable airworthiness regulations are met or “that any airworthiness provisions not complied with are compensated for by factors that provide an equivalent level of safety.”

Applicable regulation(s)

§ 25.671(c)(2), Amendment 25-23, states:

- (c) The airplane must be shown by analysis, tests, or both, to be capable of continued safe flight and landing after any of the following failures or jamming in the flight control system and surfaces (including trim, lift, drag, and feel systems), within the normal flight envelope, without requiring exceptional piloting skill or strength. Probable malfunctions must have only minor effects on control system operation and must be capable of being readily counteracted by the pilot.
- (2) Any combination of failures not shown to be extremely improbable, excluding jamming (for example, dual electrical or hydraulic system failures, or any single failure in combination with any probable hydraulic or electrical failure).

§ 25.671(c)(2), Draft Harmonized (Advisory Circular/Advisory Material Joint (AMJ)), states:

- (c) The airplane must be shown by analysis, tests, or both, to be capable of continued safe flight and landing after any of the following failures, including jamming, in the flight control system and surfaces (including trim, lift, drag, and feel systems), within the normal flight envelope, without requiring exceptional piloting skill or strength. Probable failures must have only minor effects and must be capable of being readily counteracted by the pilot.
- (2) Any combination of failures not shown to be extremely improbable. Furthermore, in the presence of any single failure in the flight control system, any additional failure states that could prevent continued safe flight and landing shall have a combined probability of less than 1 in 1000. This paragraph excludes failures of the type defined in (c)(3)[jams].”

Regulation(s) requiring an ELOS finding

§ 25.671(c)(2), Amendment 25-23

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

In lieu of compliance with § 25.671(c)(2), Amendment 25-23, API has proposed to comply with the draft harmonized § 25.671(c)(2) rule from the FCHWG ARAC report, dated May 17, 2002, utilizing the means of compliance guidance in the associated draft harmonized Advisory Circular/Advisory Material Joint (AC/AMJ) for § 25.671 and the draft harmonized AC/AMJ 25.1309 (“ARSENAL” version), dated June 10, 2002, from the System Design and Analysis Harmonization Working Group (SDAHWG).

Section 25.671(c)(2), as proposed by the ARAC recommendation, provides a definition of acceptable risk level for subsequent failures. The FAA accepts this definition of acceptable risk level for subsequent failures, however, the FAA does not agree that this definition by itself is sufficient to provide an ELOS to the existing § 25.671(c)(2). Therefore, the following additional criteria must be used:

Failure conditions that are classified as catastrophic and that occur as a result of two or more failures, any of which are latent, must be highlighted in the system safety assessment, subject to review by the FAA. This review will ensure that any such failure conditions are, in fact, extremely improbable by assessing 1) the failure rates and service history of each component, 2) the inspection type and interval for any component whose failure would be latent, and 3) any possible common cause or cascading failure modes.

These criteria are derived from guidance material recently developed by ARAC for use in the proposed revision to AC 25.1309. This guidance states, “The use of periodic maintenance or flight crew checks to detect significant latent failures when they occur is undesirable and should not be used in lieu of practical and reliable failure monitoring and indications. Where this is not accomplished, the system safety assessment should highlight all those significant latent failures that leave the airplane one failure away from a failure condition classified as catastrophic. These cases should be discussed with the FAA as early as possible after identification.”

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

To comply with § 25.671(c)(2), draft harmonized AC/AMJ, API will provide an analysis to show the airplane with winglets is capable of continued safe flight and landing without the use of exceptional piloting skill or strength, after any combination of failures in the flight control system (occurring in the normal flight envelope) that are not shown to be extremely improbable. Probable failures will be shown to have only minor effects that are capable of being readily counteracted by the pilot. Furthermore, per the draft harmonized rule, the analysis will show that after any single failure in the flight control system, any additional failure that could prevent continued safe flight and landing shall have a combined probability of less than 1 in 1000. API will identify any additional failure or failure combinations that could result in the prevention of continued safe flight and landing that does not meet a failure probability of 1 in 1000 for the applicable exposure time of the failure. The addition of exposure time mitigates the effect of latent (unannounced) failures in terms of the safety analysis. The analysis will identify all latent failures that are included in the “combined failures” that are analyzed, along with their inspection type and interval. Any common cause/common mode or cascading failure modes that are identified will be highlighted.

API will address the FAA’s additional criteria by identifying combinations of failures that are classified as catastrophic and occur as a result of two or more failures, any of which are latent. The failure latency will be identified and accounted for in the safety analysis. Latency will be accounted for through the identification and incorporation of exposure time in the probability calculations. Exposure time for latent failures is the inspection interval time and will be noted in

the analysis, along with the inspection type. API will also identify any latent failures that are not checked at specific maintenance intervals.

API will substantiate the safety analysis using in-service failure rates as necessary and also provide the safety analysis for the original Type Design as supporting documentation.

FAA approval and documentation of the ELOS finding

The FAA has approved the aforementioned ELOS in project Issue Paper SF-1. 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 limitations and conditions section of the STC. An example of an appropriate statement is provided below.

Equivalent Safety Findings have been made for the following regulation(s):

§ 25.671(c)(2) Flight Control System Failure Criteria (documented in TAD ELOS Memo ST9686SE-T-SF-1)

 Manager, Transport Airplane Directorate,
 Aircraft Certification Service

FEBRUARY 11, 2011

 Date

ELOS Originated by ACO:	Project Engineer Marie Hogstad	Routing Symbol ANM-130S
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