

SUBJECT : Equivalent safety finding for installation of Dual EFI system without Independent Secondary Attitude Indicator

REQUIREMENTS incl. Amdt. : CS 23.1311(a)(5) rev 4

ASSOCIATED IM/MoC¹ : Yes ☐ / No ☒

ADVISORY MATERIAL :

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¹ Associated Interpretative Material and/or Means of Compliance may be published for awareness only and they are not subject to public consultation.

INTRODUCTORY NOTE:

The following Equivalent Safety Finding (ESF) has been classified as important and as such is subject to public consultation in accordance with EASA Management Board decision 12/2007 dated 11 September 2007, Article 3 (2.) which states:

"2. Deviations from the applicable airworthiness codes, environmental protection certification specifications and/or acceptable means of compliance with Part 21, as well as important special conditions and equivalent safety findings, shall be submitted to the panel of experts and be subject to a public consultation of at least 3 weeks, except if they have been previously agreed and published in the Official Publication of the Agency. The final decision shall be published in the Official Publication of the Agency."

ABBREVIATIONS:

ELOS	Equivalent Level of Safety
FAA	Federal Aviation Administration
STC	Supplemental Type Certificate

IDENTIFICATION OF ISSUE:

The Equivalent Level of Safety (ELOS) finding Memo SA02949A-A-S-1 has been issued by the FAA for Aspen Avionics AML STC 108822SC to include the EFD1000 MAX Dual EFI in the STC, for Amendment 23-62 of Title 14, Code of Federal Regulations (14 CFR) 23.1311(a)(5). The corresponding CS 23.1311(a)(5) at Amendment 4 has essentially the same design requirements, being the main difference the fact that the FAA requirement is only applicable to IFR operation while the EASA requirement is applicable to VFR and IFR operation, there is also an editorial difference due to the fact that the requirements are written in a different order.

FAA	EASA
SECTION: Sec. 23.1311	CS 23.1311
TITLE: Electronic display instrument systems.	Electronic display instrument systems
Amendment Number: 23-62, Effective Date: 01/31/2012	Amendment 4
(a) Electronic display indicators, including those with features that make isolation and independence	(a) Electronic display indicators, including those with features that make isolation and independence

Consultation paper
Equivalent Safety Finding

Doc. No. : ESF- F23.1311-01

Issue : 1

Date : 22 Dec 2022

 Proposed ☐

 Final ☒

Deadline for comments: 08 Dec 2022

between powerplant instrument systems impractical, must: (5) For certification for Instrument Flight Rules (IFR) operations, have an independent magnetic direction indicator and either an independent secondary mechanical altimeter, airspeed indicator, and attitude instrument or an electronic display parameters for the altitude, airspeed, and attitude that are independent from the airplane's primary electrical power system. These secondary instruments may be installed in panel positions that are displaced from the primary positions specified by Sec. 23.1321(d), but must be located where they meet the pilot's visibility requirements of Sec. 23.1321(a).	between powerplant instrument systems impractical, must – (5) Have an independent magnetic direction indicator and an independent secondary mechanical altimeter, airspeed indicator, magnetic direction indicator, and attitude instrument, or individual electronic display indicators for the altimeter, airspeed, and attitude that are independent from the aeroplane's primary electrical power system. These secondary instruments may be installed in panel positions that are displaced from the primary positions specified by CS 23.1321(d), but must be located where they meet the pilot's visibility requirements of CS 23.1321(a).
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The ELOS Memo is considered by EASA an acceptable Equivalent Safety Finding (ESF) to the corresponding CS 23.1311(a)(5). This ESF has been classified as important; as such it shall be subject to public consultation in accordance with EASA Management Board decision 12/2007 dated 11 September 2007, Article 3 (2.) which states:

"2. Deviations from the applicable airworthiness codes, environmental protection certification specifications and/or acceptable means of compliance with Part 21, as well as important special conditions and equivalent safety findings, shall be submitted to the panel of experts and be subject to a public consultation of at least 3 weeks, except if they have been previously agreed and published in the Official Publication of the Agency. The final decision shall be published in the Official Publication of the Agency."

Note: this consultation is for the EASA ESF and not for the FAA ELOS Memo. Comments and the corresponding resolution will affect the EASA ESF only.

Considering all the above, the following Equivalent Safety Finding is proposed.

**Federal Aviation
Administration**

Memorandum

Date: See Digital Signature

To: Jim Grigg, Manager, Fort Worth Aircraft Certification Office, AIR-7F0

From: Paul Siegmund, Section Manager, Aircraft Information Systems, AIR-622

Prepared by: Quentin Coon, Policy Implementation, AIR-613

Subject: INFORMATION: Equivalent Level of Safety (ELOS) Finding for Aspen Avionics, Approved Model List, ELOS for installation of the Aspen Avionics MAX Dual EFI System without an Independent Secondary Attitude Indicator, Project SA02949AC-A

ELOS Memo#: SA02949A-A-S-1

Regulatory Ref: 14 CFR 23.1311(a)(5)

The revision of this memorandum corrects the amendment level of title 14, Code of Federal Regulations (14 CFR) 23.1311(a)(5), shown in the **Applicable regulation, and Regulations requiring an ELOS finding** sections of original memorandum. The § 23.1311(a)(5) amendment is corrected from 23-49 to 23-62.

This memorandum informs the certificate management aircraft certification office of an evaluation made by the Strategic Policy Management Branch on the establishment of an equivalent level of safety finding for the Aspen Avionics model EFD1000 MAX Dual EFI installed in STC SA10822SC.

Background:

Aspen Avionics (the applicant) is amending AML STC 10822SC to include the EFD1000 MAX Dual EFI in the STC. The MAX is an airspeed and GPS-aided attitude and heading system with a 30-minute internal battery. The applicant requests an Equivalent Level of Safety to 14 CFR 23.1311(a)(5) by replacing the required independent attitude indicator with a gyroscopic rate of turn indicator taking credit for historically acceptable partial panel techniques and requiring and a graphical GPS to assist in course orientation and navigation to a destination.

Airplane Description

Class I and II Part 23 and CAR 3 airplanes listed in AML STC SA10822SC. See the Approved Model List.

Applicable regulation:

14 CFR 23 Amendment 62

Regulations requiring an ELOS finding:

14 CFR 23.1311(a)(5) at amendment 23-62

Description of compensating design features or alternative Methods of Compliance (MoC) which allow the granting of the ELOS (including changes, limitations, or equipment needed for equivalency)

Aspen is proposing, for Part 23/CAR 3 aircraft 6000 pounds or less, to replace vacuum-driven attitude and heading instruments with an Aspen EFD1000 MAX electronically-driven attitude and heading indicator under the following conditions:

The electronic attitude and heading indicator must have an independent standby battery that is capable of at least 30 minutes of power to the new instrument in the event of a loss of primary electrical power.

The final installation and arrangement allows for use of partial panel techniques in the event of a loss of the common electronic display of attitude and heading. Specifically, this requires an independent airspeed indicator and altimeter, a compass and an electric rate-of-turn indicator that meets the requirements of 14 CFR 23.1321.

An installed and operational graphical GPS system (meaning a functioning GPS with display and an operational satellite constellation) for IFR operation with track depiction is required.

Compliance must meet all other applicable regulations as currently defined in AML STC SA10822SC.

Regulations requiring an ELOS finding:

14 CFR 23.1311(a)(5) at amendment 23-62

Sec. 23.1311 Electronic display instrument systems.

- (a) (5) For certification for Instrument Flight Rules (IFR) operations, have an independent magnetic direction indicator and either an independent secondary mechanical altimeter, airspeed indicator, and attitude instrument or individual electronic display parameters for the altitude, airspeed, and attitude that are independent from the airplane's primary electrical power system. These secondary instruments may be installed in panel positions that are displaced from the primary positions specified by Sec. 23.1321(d), but must be located where they meet the pilot's visibility requirements of Sec. 23.1321(a).

Explanation of how design features or alternative Methods of Compliance (MoC) provide an equivalent level of safety intended by the regulation:

Most Class I and II airplanes targeted by the Aspen AML STC were originally certified with individual flight instruments, vacuum-driven gyros, and a vacuum pump. They were also

certified before implementation of a later rule, 14 CFR 23.1353(h), which required a battery that provided 30 minutes of operation in the event of alternator (or generator) failure.

In these older airplanes fitted for instrument flight rules (IFR) it was common to see a single attitude instrument without a backup. If the attitude instrument failed, then the pilot relied on partial panel techniques for continued safe flight and landing. When electronic flight instrument systems (EFIS) were introduced, there was concern that single failures could simultaneously take out all or most of the flight instruments at the same time. This prompted the introduction of § 23.1311 at amendment 23-41 to address this concern. However, § 23.1311 did not distinguish various operational requirements (VFR or IFR), and it generally assumed that loss of the display meant loss of all or most flight instruments. Further, it indicated that a backup attitude indicator was required when part 23 did not otherwise have a requirement for an attitude indicator. Operating rules (14 CFR parts 91 and 135) provide the required instruments for IFR, and the attitude (artificial horizon) is a dispatch requirement for IFR.

A key aspect of replacing mechanical instruments in many older airplanes is the improved reliability of the electronic display. The vacuum pump Mean Time Between Failure (MTBF) is approximately 500 hours, with no prospect for improvement. This represents an in-flight failure rate of about 2×10^{-3} failures per flight hour. Adding in a potential attitude indicator failure worsens this probability. By comparison, the existing Aspen system has been in the field for about ten years. It has an MTBF of about 5000 hours for in flight failures and has shown improvement. This converts to a rough probability of 2×10^{-4} failures per flight hour, which represents a ten-fold improvement over the vacuum pump.

The Aspen system contains internal monitoring to report when the system detects a potential error. In some pre-modification installations, vacuum driven gyro attitude and heading indicators can spin down and sometimes fail to provide a warning. The internal battery for the Aspen system permits an automatic minimum of thirty-minutes of operation that is independent of the airplane electrical system. If the alternator stops working, the Aspen EFD1000 MAX annunciates the condition by displaying an "ON BAT" annunciation. The pilot is then instantly aware of the failed alternator, a condition that is not always immediately evident to the pilot. At the same time, the Aspen display does not present a load on the starter battery, so the remaining energy can be available for other functions such as GPS or other radios.

The prior Aspen system was dependent on airspeed as an aiding input for the attitude solution. Without a separate, independent attitude indicator, an airspeed or pitot failure would present a common mode failure, causing loss of the attitude function. The Aspen EFD1000 MAX has mitigated this dependency by using GPS aiding to replace the pitot input in the event of airspeed or pitot failures. The system will revert to a "Degraded Mode" in accordance with elements of RTCA/DO-334 (Minimum Operational Performance Standards (MOPS) for Strapdown Attitude and Heading Reference Systems (AHRS)). A limitation will be imposed that IFR flight is not permitted unless the GPS system is fully functional.

With respect to 14 CFR 23.1353(h), regarding 30 minutes of battery in the event of an alternator failure: Alternator failure data is not generally available. A cursory examination of Aviation Safety Reporting System data show failures occur on average at 500 hours. The loss of an alternator in a single engine airplane means the main battery could soon follow. Prior to 14 CFR 23.1353(h), there was no requirement for battery performance at all. For this Aspen system, in case of an alternator failure, the attitude and heading would remain operational and independent of the starter battery.

From the preamble to 14 CFR 23.1311, it is the FAA's intent that the requirements that airspeed, altitude, and magnetic compass information will remain available to the pilot after total failure of the airplane's electrical power system. And from AC 23.1309-1E, partial panel techniques may be used in some cases where it has been historically shown to be acceptable.

The final installation and arrangement allows for use of partial panel techniques in the event of a loss of the common electronic display of attitude and heading. Specifically, this requires an independent airspeed indicator and altimeter, a compass and an electric rate-of-turn indicator that meets the requirements of 14 CFR 23.1321.

The electronic attitude and heading indicator must have an independent standby battery that is capable of at least 30 minutes of power to the new instrument in the event of a loss of primary electrical power.

An operational graphical GPS system (meaning a functioning GPS with display and an operational satellite constellation) for IFR operation with track depiction is required.

FAA approval and documentation of the ELOS finding:

The FAA has approved the aforementioned equivalent level of safety finding in project issue paper SA02949AC-A_S-1. This memorandum provides standardized documentation of the ELOS finding that is non-proprietary and can be made available to the public. The Technical Innovation Policy Branch has assigned a unique ELOS Memorandum number (see front page) to facilitate archiving and retrieval of this ELOS. This ELOS Memorandum number must be listed in the Type Certificate Data Sheet under the Certification Basis section (TCs & ATCs) or in the Limitations and Conditions section of the STC. Below is an example of an appropriate statement.

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

14 CFR 23.1311 (a)(5) (documented in ELOS Memo SA02949A-A-S-1)

**PAUL R
SIEGMUND**

Digitally signed by PAUL R
SIEGMUND
Date: 2021.07.13 08:50:10 -07'00'

Paul Siegmund, Section Manager,
Technical Innovation Policy Branch,
Aircraft Certification Service

Date

ELOS Originated by: Fort Worth Aircraft Certification Office: Sung-Hui Cavazos	Choose an item., Choose an office.: Click here to enter Manager's name.	Routing Symbol: Choose a Office Routing.
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Click here to enter a date.