



Federal Aviation Administration

Memorandum

Date: June 3, 2015

To: Manager, Wichita ACO, ACE-115W

From: Manager, Transport Airplane Directorate, ANM-100

Prepared by: Jeff Englert, ACE-116W

Subject: INFORMATION: Equivalent Level of Safety (ELOS) Finding for Auxiliary Power Unit (APU) Indications on Cessna Model 680 (S/N 680-0501 and on) and Model 680A Airplanes, FAA Project Numbers AT5438WI-T and Cessna-072100

ELOS Memo # AT5438WI-T-P-1

Regulatory Ref: 14 CFR 25.1305 and 25.1549

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 Cessna Model 680 (S/N 680-0501 and on) and Model 680A airplanes.

Background

Title 14, Code of Federal Regulations (14 CFR) 25.1305 requires provisions for the display and monitoring of specific powerplant instruments. Additionally, § 25.1549(a) through (c) presume the use of analog instruments. It is the intent of §§ 25.1305 and 25.1549 to permit crew monitoring and corrective action for engine exceedances that could jeopardize continued safe flight.

Model 680 (S/N 680-0501 and on) and Model 680A airplanes include a non-essential, flight operational auxiliary power unit (APU), which incorporates an electronic control unit (ECU) that provides complete monitoring and control of the APU. Cessna did not provide oil pressure, oil pressure warning means and oil temperature indications for the APU. These indications are required by § 25.1305(a)(4), (a)(5), and (a)(6). Cessna also includes a digital-only display of APU exhaust gas temperature (EGT) and rotor speed (RPM). The digital-only presentation of these parameters do not directly comply with the marking requirements of § 25.1549(a), (b), and (c).

Cessna submitted a request for an ELOS finding to §§ 25.1305 and 25.1549 for Model 680 (S/N 680-0501 and on) airplanes. Cessna subsequently requested to extend the ELOS finding to include Model 680A airplanes, based on the same rationale.

The APU ECU is designed to maintain certain APU operating parameters within normal operating ranges when operated within approved flight and ground operating envelopes. In the event that a monitored parameter reaches its operating limit, or a fault develops, an automatic APU shutdown is initiated.

Applicable regulation(s)

14 CFR 25.1305(a)(4), (a)(5), (a)(6), (c)(1), and (c)(3); and 25.1549(a), (b), and (c)

Regulation(s) requiring an ELOS

14 CFR 25.1305(a)(4), (a)(5), and (a)(6); and 25.1549(a), (b), and (c)

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

Model 680 (S/N 680-0501 and on) and Model 680A airplanes are equipped with a non-essential Honeywell International Model RE-100[CS] APU that is controlled by an ECU. The APU ECU provides complete monitoring and control of the APU during normal operation and starting, which includes including oil pressure, oil temperature, EGT, and rotor speed. If the ECU detects an internal fault, a sensor failure, or a parameter exceeding operational limits in flight or on the ground, a protective shutdown is automatically initiated and an amber “APU SYS FAIL” message is annunciated to the flight crew. There is no expectation for flight crew intervention in order to prevent the APU shaft speed from exceeding the rotor integrity limit level.

The automatic shutdown of the APU provides the same corrective action that would be required by the flight crew if the parameters required by § 25.1305(a)(4), (a)(5), and (a)(6) were provided and displayed in accordance with § 25.1549(a), (b), and (c). Since the Model 680 (S/N 680-0501 and on) and Model 680A APU is classified as non-essential equipment, no hazard is introduced by an automatic protective shutdown. In addition, the ECU sensors and interface components are dynamically tested prior to APU startup and periodically during normal operation to detect component or circuitry failures. If a malfunction is found, either start is inhibited or an automatic protective shutdown is initiated by the ECU.

During normal operation, the APU EGT parameter digits are green when the displayed value is in the normal range, and they are black text on amber inverse video background when the displayed value exceeds normal range. When the value is invalid, three amber dashes are displayed. If the display value is not in-range, the value is displayed in black text on amber background.

During normal operation, the APU rotor speed parameter digits are green when the displayed value is in the normal range, and they are black text on amber inverse video background when the displayed value exceeds normal range. When the value is invalid, three amber dashes are displayed. If the display value is not in-range, the value is displayed in black text on amber background.

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

Sections 25.1305 and 25.1549 are intended to ensure APU limits are not exceeded and to ensure that APU abnormalities that could lead to APU failure or other undesirable APU behaviors are identified by the flight crew and addressed in a timely manner. At the time these rules were promulgated, the available technology primarily relied on flight crew awareness and direct action to respond to APU abnormalities. Analog instrumentation was required to provide appropriate flight crew awareness. Since that time, the development of automatic engine control systems has relieved the flight crew of much of the burden of monitoring APU indications.

The compensating factor(s) raise the level of safety to that required by §§ 25.1305(a)(4), (a)(5), (a)(6), (c)(1), and (c)(3) and 25.1549(a) through (c) because the APU ECU's monitoring (of oil temperature, oil pressure, EGT and RPM, and commanding automatic shutdown in the event of an exceedance and informing the crew via an "APU FAIL" light) provides an equivalent function and level of safety to crew monitoring of dial gages (for the same parameters, when marked in accordance with § 25.1549), and having to take the same protective shutdown action in the event of an exceedance.

FAA approval and documentation of the ELOS

The FAA has approved the aforementioned ELOS finding in Model 680 (S/N 680-0501 and on) project issue paper P-1 and Model 680A project issue paper G-5. 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 must 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):

14 CFR 25.1305(a)(4), (a)(5), and (a)(6) Powerplant instruments; and

14 CFR 25.1549(a), (b), and (c) Powerplant and auxiliary power unit instruments

(documented in TAD ELOS Memo AT5438WI-T-P-1)

Original Signed by

Victor Wicklund

June 3, 2015

Transport Airplane Directorate,
Aircraft Certification Service

Date

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