



# Federal Aviation Administration

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## 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 Digital-Only Display of Turbine Engine High Pressure Rotor Speed (N2), Oil Pressure, and Oil Temperature 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-5

Regulatory Ref: 14 CFR 25.901, 25.903, 25.1305, 25.1309, 25.1321, 25.1322 and 25.1549

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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) 25.1549(a) through (c) presume the use of analog instruments. Cessna uses a digital-only presentation of high pressure rotor speed (N2), oil pressure and oil temperature for Model 680 (S/N 680-0501 and on) and Model 680A airplanes. The digital-only presentation of engine parameters do not directly comply with the marking requirements of § 25.1549(a), (b), and (c), and may unacceptably limit the flightcrew's ability to properly monitor and operate the engines.

The primary engine displays on turbine engine powered transport aircraft have traditionally displayed the engine rotor speeds required by § 25.1305(c)(3) in an analog only or an analog and digital format. An increasing demand to conserve primary display space has led to digital-only primary displays for those rotor speeds not normally used for power setting.

Cessna submitted a request for an ELOS finding to § 25.1549(a), (b), and (c) 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.

**Applicable regulation(s)**

14 CFR 25.901, 25.903, 25.1305, 25.1309, 25.1321, 25.1322 and 25.1549

**Regulation(s) requiring an ELOS finding**

14 CFR 25.1549(a), (b), and (c)

**Description of compensating design features or alternative Methods of Compliance (MoC) which allow the granting of 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 engines that are each controlled by full authority digital engine controls (FADEC).

The engine high pressure rotor speed (N2), oil pressure and oil temperature parameters are processed by the Garmin G5000 Avionics system and displayed on the appropriate flight display. These parameters are displayed in green, black, white, amber or red colors, with an inverse video in some cases to indicate the following:

- Green text against a black background: Normal operating range
- Black text on amber inverse video: In cautionary range (above steady state high limit or below steady state low limit)
- White text on red inverse video: Exceedances (above transient high limit or below transient low limit)
- Amber dashes: Invalid signal (indication of out of range or unreliable signal because it is either not available or exceeds the capability of the instrument)

The N2 speed is a secondary engine parameter not used for power setting.

The engine installation manual defines a precautionary range before the redline limit and an amber band is incorporated into the display. The FADEC engine control system serves as an automatic regulating device that limits the speeds from exceeding the redline limit and alleviates the flightcrew from having to continuously monitor values for exceedances. Additional overspeed protection is accomplished via independent dedicated sensors and controlling hardware within the FADEC and fuel metering unit.

The airplane flight manual (AFM) contains procedures following an exceedance event.

The engine oil pressure and oil temperature parameters are not used for controlling the engine. Low and high indications in the amber precautionary range have associated AFM procedures for flightcrew actions. The AFM contains procedures following an exceedance event.

Crew alerting system (CAS) messages are annunciated when a low oil pressure limit is encountered with associated AFM procedures for appropriate flightcrew actions.

### **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**

Section 25.1549 is intended to ensure engine limits are not exceeded and to ensure that engine abnormalities that could lead to engine failure or other undesirable engine behaviors are identified by the flightcrew and addressed in a timely manner. At the time this rule was promulgated, the available technology primarily relied on flightcrew awareness and direct action to respond to engine abnormalities. Analog instrumentation was required to provide appropriate flightcrew awareness. Since that time, the development of automated engine control systems has relieved the flightcrew of much of the burden of monitoring engine indications, particularly for secondary engine parameters not directly used for power setting.

Section 25.1549 also requires the use of markings and colors to represent operating states with yellow to indicate takeoff and caution ranges, red to indicate minimum and maximum safe operating limits, and green to indicate the normal operating range. The proposed display scheme uses green, yellow, and red as envisioned by § 25.1549. The use of colors (red and yellow) is adequate to indicate caution and warning conditions as intended by the rule.

Although noncompliant with § 25.1549(a), (b), and (c), the FADEC engine control system continuous monitoring in-flight of the operating condition of the engine low pressure rotor speed (N2), automatic generation of warnings to the cockpit, with associated flightcrew procedures, engine automatic shutdown if a limit is exceeded are considered to provide an equivalent level of safety as that established by providing analog displays. Additionally, although noncompliant with the regulation, the parameters displayed in green to indicate normal operating range and CAS automatic annunciations of oil pressure, with associated flightcrew procedures, and no immediate action required by the flightcrew to respond are considered to provide an equivalent level of safety as that established by providing analog displays.

### **FAA approval and documentation of the ELOS finding**

The FAA has approved the aforementioned ELOS finding in Model 680 (S/N 680-0501 and on) project issue paper P-5 and Model 680A project issue paper G-5. This memorandum provides standardized documentation of the ELOS finding 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 finding. 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 25.1549(a), (b), and (c) Powerplant and auxiliary power unit instruments  
(documented in TAD ELOS Memo AT5438WI-T-P-5)

Original Signed by

*Victor Wicklund*

Transport Airplane Directorate,  
Aircraft Certification Service

June 3, 2015

Date

ELOS Originated by Wichita ACO	Jeff Englert	ACE-116W
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