



# Federal Aviation Administration

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## Memorandum

Date: June 16, 2016

To: Manager, Atlanta ACO, ACE-115A

From: Manager, Small Airplane Directorate, ACE-100

Prepared by: Mariusz Wisniewski, ACE-116A

Subject: INFORMATION: Equivalent Level of Safety (ELOS)  
Finding for Piper Aircraft Inc., Model PA-46-600TP, Digital  
Display of Engine and Propeller Flight Data, FAA Project #  
AT13893AT-A

ELOS Memo#: AT13893AT-A-P-1

Regulatory Ref: 14 CFR 23.1301; 23.1305(c)(2) and(c)(5); 23.1311(a)(6) and (a)(7); 23.1321;  
and 23.1549

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This memorandum informs the certificate management aircraft certification office of an evaluation made by the Accountable Directorate on the establishment of an equivalent level of safety finding for the PA-46-600TP “M600” airplane.

### **Background:**

Piper Aircraft Corporation (Piper) made an application to the Atlanta Aircraft Certification Office (AACO) for an amended type certification of a new airplane—the model PA-46-600TP (M600). The PA-46-600TP is a 6,000-pound single engine, 6-place airplane powered by a 600 shaft horsepower Pratt & Whitney PT6A-42A turboprop engine.

The PA-46-600TP avionics suite will incorporate a Garmin G3000 Integrated Flight Deck with three Garmin Display Unit (GDU) Active Matrix Liquid Crystal screen displays, two of which are configured as pilot and copilot Primary Flight Displays (PFD) with the third display configured as a Multi-Function Display (MFD). The Engine Indication System (EIS) will display Torque (TORQ), Inter-Turbine Temperature (ITT), Propeller Governor (Ng), Propeller RPM, Oil Temperature, Oil Pressure, and Fuel Quantity, Fuel Flow, Fuel Temperature on the left side of

the MFD. In reversionary mode, the EIS will display in the pilot's and copilot's PFD upper left and right corner respectively.

Piper is requesting an Equivalent Level of Safety (ELOS) finding for the digital displays of RPM and fuel flow and the absence of colored arcs on all remaining analog engine parameter displays as required by §§ 23.1311(a)(6), amendment 23-62 and 23.1549(a)(b) amendment 23-45.

**Applicable regulation(s):**

- 14 CFR 23.1301(a) and (b), amendment 23-62
- 14 CFR 23.1305(c)(2) and (c)(5), amendment 23-52
- 14 CFR 23.1311(a)(6) and (a)(7), amendment 23-62
- 14 CFR 23.1321, amendment 23-62
- 14 CFR 23.1549, amendment 23-45

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

- 14 CFR 23.1305(c)(2) and (c)(5), amendment 23-52
- 14 CFR 23.1311(a)(6), amendment 23-62
- 14 CFR 23.1549, amendment 23-45

**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)**

Fuel Flow Installation Characteristics

Fuel flow is a supporting parameter for engine operation. Ground and flight operations do not require a pilot to monitor fuel flow. ITT and Ng are monitored during engine start, and cruise power is set using engine torque, unless inter-turbine temperature or gas generator limits are encountered. Fuel flow has no maximum or minimum limiting values.

Propeller Speed Installation Characteristics

The PA-46-600TP installation incorporates a fixed propeller governor set to 2,000 RPM, and an engine minimum idle Ng setting which maintains a ground operational propeller RPM greater than 1,200. The propeller governor and engine idle settings maintain the propeller between its upper and lower limit (2,000 and 1,200 RPM) without need for any pilot monitoring or intervention. If the propeller governor malfunctions, an Nf (Free turbine speed) and propeller overspeed governor maintain propeller RPM within acceptable limits. The G3000 EIS display uses color to indicate the current operating condition of RPM. The title "PROP RPM" is white and the RPM digits are green during normal operations. When the RPM value exceeds a limit and activates a Crew Alert System (CAS) WARNING, the RPM digits and title flash inverse

video<sup>1</sup> (Red/White). Once the WARNING has been acknowledged, the “PROP RPM” title and digits are white on a red background until the warning condition is exited.

#### Absences of Green, Yellow and Red Arc on EIS Analog Gages

In an effort to simplify and declutter the EIS, Piper has enabled each engine parameter analog pointer (TORQ, ITT, NG, Oil Press, Oil Temperature) to change color to represent the green, yellow or red arcs. If an analog parameter exceeds a limit, the pilot is alerted to the condition by the pointer turning from green to yellow or red. In addition to the pointer color changes, the applicable CAS CAUTION/WARNING is activated causing the parameter title and digits to flash inverse video (footnote 1) the applicable colors (Yellow/Black or Red/White) and sound a Master CAUTION/WARNING alert chime (single chime/repeating triple chime respectively). Once the CAS CAUTION/WARNING has been acknowledged, the parameter title and digits are yellow on black background/white on a red background respectively until the abnormal condition is exited.

#### **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**

##### **Regulation: §§ 23.1305(c)(2) and (c)(5), and 23.1311(a)(6)**

#### Fuel Flow (FFLOW PPH)

*Use of the fuel flow display is only intended to provide the pilot with fuel consumption information for a given power setting. No rate or trend information is required. There are no limit values for fuel flow therefore the display title “FFLOW PPH” remains white at all times and the flow digital numerals remain green at all times when values are displayed.*

Based on the fact that fuel flow only provides supporting information for engine operation and has no operating limits, the “quick glance” rate and trend information required by §§ 23.1305(c)(2) and 23.1311(a)(6) are not necessary to safely operate the PA-46-600TP airplane using fuel flow digital displays. Additionally, the absence of limit values for fuel flow negates the requirement defined by § 23.1311(a)(7).

#### Propeller Tachometer (PROP RPM)

*There is no direct pilot control of RPM and no requirement for pilot monitoring of RPM rate or trend information since the propeller speed is automatically maintained in its normal operating range by the fixed propeller governor and engine min idle speed. The title “PROP RPM” is white and the RPM digits are green during normal operations. Any exceedance of normal propeller speeds is immediately identified to the pilot by the RPM*

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<sup>1</sup> Inverse Video - parameter digits and title alternate colors with background

*digits and title flashing inverse video (footnote 1) (Red/White). A triple chime aural alert and a CAS WARNING accompany this change. Once the WARNING has been acknowledged, the “PROP RPM” title and digits are white on a red background until the warning condition is exited.*

Based on the automated control of propeller RPM and EIS parameter color/condition information provided to the pilot, the “quick glance” rate and trend information required by §§ 23.1305(c)(5) and 23.1311(a)(6) are not necessary to safely operate the PA-46-600TP airplane using RPM digital displays. Additionally, the EIS parameter color coding and the CAS warning system provides the pilot with the abnormal operational alerts as requirement by § 23.1311(a)(7).

#### Absences of Green, Yellow and Red Arc on EIS Analog Gages

The “quick glance” rate and trend information required by § 23.1311(a)(6) is provided through the use of color coded pointer representation of parameter operating status. The G3000 CAS system and display of parameter limit values, yellow and red tic marks, provides the pilot with the abnormal operational alerts required by § 23.1311(a)(7)

#### **Regulation: § 23.1549(a), (b), and (c)**

#### Fuel Flow (FFLOW PPH)

*During normal operations, the display title “FFLOW PPH” remains white and the fuel flow digits remain green representing a green arc. The color of the display provides instant depiction of the operating condition of the parameter. There are no limit conditions for fuel flow.*

#### Propeller Tachometer (PROP RPM)

*The digital propeller speed indication changes color to depict the current operating condition of the parameter. Red digits represent operation at or beyond limit values (red lines or arcs). In addition to color, the parameter legend and digits flash inverse video (footnote 1) (Red/White) and sound a continuous Master Warning triple chime to alert the pilot of an exceedance. When operating in a normal RPM range, the digital propeller speed indication is green, representing a green arc.*

#### Absences of Green, Yellow and Red Arc on EIS Analog Gages

*The analog indicator pointers change color to depict the current operating condition of the parameter. Yellow and red pointers represent operation at or beyond limit values (yellow or red lines). In addition to pointer color changes, the applicable CAS CAUTION/WARNING is activated causing the parameter title and digits to flash inverse video (footnote 1) the applicable colors (Yellow/Black or Red/White) and sound a Master*

*CAUTION/WARNING alert chime (single chime/repeating triple chime respectively).  
When operating in a normal range, the analog indicator pointers are green, representing a green arc.*

Based on the characteristics of the propeller tachometer, fuel flow, and analog displays in the prosed type design, it is acceptable to provide the digital display of these parameters and that these displays provide the same level of safety attained by the presentation of arcs, lines, and radials on standard analog instruments.

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

The FAA has approved the aforementioned equivalent level of safety finding in project issue paper P-1. This memorandum provides standardized documentation of the ELOS finding that is non-proprietary and can be made available to the public. The Accountable Directorate 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 for TCs & ATCs. An example of an appropriate statement is provided below.

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

1. Digital-only display of fuel flow:
  - a. 14 CFR 23.1305(c)(2)
  - b. 14 CFR 23.1311(a)(6)
  - c. 14 CFR 23.1549
2. Digital-only display of Propeller Tachometer:
  - a. 14 CFR 23.1305(c)(5)
  - b. 14 CFR 23.1311(a)(6)
  - c. 14 CFR 23.1549
3. Absence of green and yellow arcs on the required powerplant instruments:
  - a. 14 CFR 23.1549

//SIGNED//

June 16, 2016

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William Schinstock, Acting Manager  
Small Airplane Directorate  
Aircraft Certification Service

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Date

ELOS Originated by Atlanta ACO:	Mariusz Wisniewski	ACE-116A
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