Federal Aviation Administration

Memorandum

Date:	August 31, 2015
To:	Manager, Aircraft Certification Office, ACE-115W
From:	Manager, Small Airplane Directorate, ACE-100
Prepared by:	Jeff Englert, Mechanical Systems and Propulsion Branch, ACE-116W
Subject:	INFORMATION: Equivalent Level of Safety (ELOS) Finding for Installing Rockwell Collins, Inc., Powerplant Engine Instrument Display on Beechcraft, Model King Air C90GTi Airplane, Project #: ST05938W1-A
ELOS Memo#:	ACE-15-18
Regulatory Ref:	14 CFR 23.1305(a)(2), (a)(3), (c)(2), and (c)(5), amendment 23-52 14 CFR 23.1311(a)(6), (a)(7) amendment 23-49 14 CFR 23.1549(a), (b), and (c), amendment 23-45

This memorandum informs the certificate management aircraft certification office of an evaluation made by the Small Airplane Directorate (SAD) on the establishment of an equivalent level of safety (ELOS) finding for installing Rockwell Collins, Inc., Pro Line Fusion® Integrated Avionics System (powerplant engine instrument digital display) on the Beechcraft, Model King Air C90GTi airplane.

Background:

This ELOS finding pertains to the usage of digital only display and alternate markings for the Pro Line Fusion® Integrated Avionics System (digital display), manufactured by Rockwell Collins, Inc., in certain Beechcraft Model King Air C90GTi airplanes. A digital only display of engine oil pressure, oil temperature, fuel flow, and high-pressure rotor speed (N1) revolutions per minute (rpm) is included instead of full time analog display for each parameter. The digital display utilizes sensory cues that are alternative and in addition to those required by regulation. Regulatory and guidance material for the applicable areas relevant to this ELOS finding are identified below.

Digital Only Display

Advisory Circular (AC) 23.1311-1C, Installation of Electronic Display in Part 23 Airplanes, paragraph 9.4c, advises that “An ELOS will be necessary for digital-reading alphanumeric only displays that are not associated with any scale, tape, or pointer.” It provides the basis for establishing an equivalent level of safety for a digital only display of oil pressure, oil temperature, fuel flow, and engine N1 speed.

Sensory Cues

AC 23.1311-1C, paragraph 9.4(b), specifies that "Section 23.1311(a)(6), amendment 23-62, requires sensory cues that provide a quick glance sense of rate and, where appropriate, trend information to the parameter being displayed to the pilot."

Restricted Propeller RPM

Section 23.1549(d) requires restricted propeller rpm ranges to be marked with a red arc or red line. The electronic display utilizes additional colors and a conditional timer for the red arc marking.

Applicable Regulations:

Digital Only Display

- 14 CFR 23.1305(a)(2), (a)(3), (c)(2), and (c)(5)
- 14 CFR 23.1549(a), (b), and (c)

Sensory Cues

- 14 CFR 23.1311(a)(6) and (a)(7)
- 14 CFR 23.1549(a), (b), and (c)

Restricted Propeller RPM

- 14 CFR 23.1311(a)(7)
- 14 CFR 23.1549(d)

Regulations Requiring an ELOS Finding:

Digital Only Display:

Section 23.1305, amendment 23-52, in part, states:

> "(a) For all airplanes."
>
> "(2) An oil pressure indicator for each engine."
>
> "(3) An oil temperature indicator for each engine."
>
> "(c) For turbine engine-powered airplanes. In addition to the powerplant instruments required by paragraph (a) of this section, the following powerplant instruments are required:"
>
> "(2) A fuel flowmeter indicator for each engine."

> "(5) A tachometer indicator (to indicate the speed of the rotors with established limiting speeds) for each engine."

Section 23.1549, amendment 23-45, in part, states:

> "(a) Each maximum and, if applicable, minimum safe operating limit must be marked with a red radial or a red line;"
>
> "(b) Each normal operating range must be marked with a green arc or green line, not extending beyond the maximum and minimum safe limits;"
>
> "(c) Each takeoff and precautionary range must be marked with a yellow arc or a yellow line; and . . ."

Sensory Cues:

Section 23.1311, amendment 23-49, in part, states:

> "(a) Electronic display indicators, including those with features that make isolation and independence between powerplant instrument systems impractical, must:"
>
> "(6) Incorporate sensory cues for the pilot that are equivalent to those in the instrument being replaced by the electronic display indicators."
>
> "(7) Incorporate equivalent visual displays of the instrument markings required by §§ 23.1541 through 23.1553, or visual displays that alert the pilot to abnormal operational values or approaches to established limitation values, for each parameter required to be displayed by this part"

Section 23.1549, amendment 23-45, in part, states:

> "(a) Each maximum and, if applicable, minimum safe operating limit must be marked with a red radial or a red line;"
>
> "(b) Each normal operating range must be marked with a green arc or green line, not extending beyond the maximum and minimum safe limits;"
>
> "(c) Each takeoff and precautionary range must be marked with a yellow arc or a yellow line; and . . ."

Restricted Propeller RPM

Section 23.1311(a)(7), amendment 23-49, states the following:

> "Incorporate equivalent visual displays of the instrument markings required by §§ 23.1541 through 23.1553, or visual displays that alert the pilot to abnormal operational values or approaches to established limitation values, for each parameter required to be displayed by this part."

Section 23.1549(d), amendment 23-45, states the following:

> "Each engine, auxiliary power unit, or propeller range that is restricted because of excessive vibration stresses must be marked with red arcs or red lines."

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):

Digital Only Display:

The compensating features provided for the digital only display of engine oil pressure, oil temperature, fuel flow, and engine N1 speed are described below.

Digital only display of N1 Gas Generator Speed:

The Pro Line Fusion® primary engine indication only displays digits to indicate N1 gas generator speed as shown in figure 1. Section 23.1305 (c)(5) requires an indicator to display rotor speed.

Section 23.1549(a),(b), and (c), amendment 23-45, require green, yellow, and red markings on the instruments to denote the normal, precautionary, and maximum safe regions of operation. It is not practical to mark the required maximum or minimum values with required radials or lines on a digital-only indicator. The compensating features of this indicator are that—

(1) The digits are displayed in color when a caution (yellow) or warning (red) value is reached, clearly indicating when the operating value is at or exceeding the maximum or minimum limit;

(2) The digits will be green in the normal operating range and a redundant N1 overspeed protection system is provided mitigating need for flightcrew action to prevent exceeding part 33 limits.

Digital only display of oil temperature and oil pressure:

The Pro Line Fusion® primary engine indication only displays digits to indicate the oil temperature and pressure as shown in figure 1. Section 23.1305 (a)(2) and (a)(3) requires an indicator. Section 23.1549(a),(b), and (c), amendment 23-45 requires green, yellow, and red markings on the instruments to denote the normal, cautionary, and warning regions of operation. It is not practical to mark the required maximum or minimum values with required radials or lines on a digital-only indicator. The compensating features of this indicator are that oil temperature and pressure are not controlled by the flight crew. Oil temperature changes do not typically occur so rapidly that required flightcrew action is necessary to prevent a limit exceedence. Oil pressure can rapidly change, but low oil pressure is the only region requiring flight crew action. A red crew-alerting system (CAS) message, with accompanying master chime and aural tone, is displayed to the crew to increase awareness.

Digital only display of fuel flow:

The Pro Line Fusion® primary engine indication has digits only to indicate Fuel Flow (FF), these digits will always be green as shown in Figure 1. Section 23.1305 (c)(2) requires an indicator. Section 23.1549(a),(b), and (c), amendment 23-45, require green, yellow, and red markings on the instruments to denote the normal, cautionary, and warning regions of operation. It is not practical to mark the required maximum or minimum values with required radials or lines on a digital-only indicator. However, there are no maximum and minimum values for fuel flow. The compensating feature of this indicator is that there are no limits for fuel flow. With no limits, there is no need to assess rate of change or exceedence.

Sensory Cues:

The Pro Line Fusion® digital display provides sensory cues that are alternative to the regulatory required sensory cues. The additional cues include aural annunciations, left to right comparators, flashing display features, and a propeller synchronization indicator. The compensating feature of these cues is that they provide a quick sense of rate change or trend information.

Restricted Propeller RPM:

The propeller restricted marking includes additional colors and a conditionally timed display of the red arc for the restricted rpm.

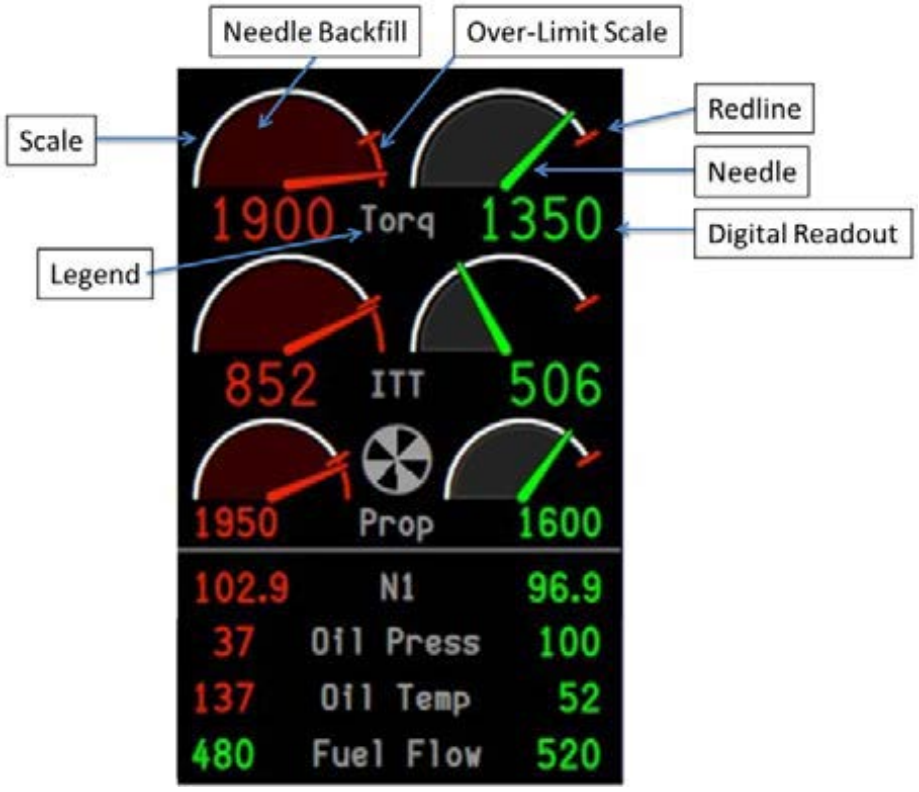

Figure 1 – Pro Line Fusion® Integrated Avionics System Display

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

Digital Only Display:

The explanation of how the design features for the digital only display of engine oil pressure, oil temperature, fuel flow, and engine N1 speed provide an ELOS are described in the following paragraphs.

Digital only display of N1 Gas Generator Speed:

The flight crew indirectly controls N1 speed. The flight crew uses propeller rpm and torque to set power. N1 speed will vary depending on ambient conditions, power extraction, engine condition etc. While N1 speed can change rapidly, trend information is not used to manage the engine. Limit exceedances ensure safe engine operation at normal power settings. A mechanical flyweight governor and mechanical stop, included in the engine design, prevents N1 overspeed without flight crew intervention. Should the control system fail and N1 rotor speed exceed its allowable limits, the N1 digital indication, which changes color to warn the flight crew if any limit is exceeded, along with an aural indication provides an equivalent level of safety to the required indicator.

Digital only display of oil temperature and oil pressure:

Oil temperature and pressure are not directly controlled by the flight crew. A device within the oil system, independent of any flight crew action, regulates the oil pressure. A thermostat within the oil system regulates oil temperature. Oil pressure and oil temperature do not typically change rapidly. Rapid action by the flight crew is not required to prevent exceeding a limit. The oil pressure and temperature digital indication color changes warn the crew if any limit is exceeded. Variable limits based on engine operating condition are programmed into the system to reduce the need for multiple marking on a single indicator. These features provide an equivalent level of safety to the required indicators.

Digital only display of fuel flow:

Engine fuel flow for the C90GTi does not have limits and does not indicate engine power or condition. As there are no fuel flow limits, there is no need to assess rapid rates of change to prevent an exceedance. Therefore, the Pro Line Fusion® system fuel flow digits will always be green. Thus with no reason to monitor fuel flow to assure proper engine operation, the digital fuel flow indicator provides an equivalent level of safety to the required fuel flow indicator.

Sensory Cues:

The sensory cue design features provide an ELOS because the instruments incorporate aural annunciations, left to right comparators, and flashing display features to assist in provide a quick sense of rate change or trend information.

Restricted Propeller RPM:

The propeller restricted rpm markings combine additional colors and a conditionally timed display of the red arc. These sensory cues are evaluated using the FAA's criteria set forth in Small Airplane Airworthiness Review Program Notice No. 5, Notice of Proposed Rule Making, and Notice No. 89-6 (Docket No. 25812) that describe electronic display features that may be beneficial to safety when they are "less prone to misreading" based on the "tasks they perform for the pilot."

FAA approval and documentation of the ELOS finding:

The FAA approved this equivalent level of safety finding using the Project Specific Policy Memorandum for Rockwell Collins, Incorporated, Beechcraft Model C90GTi, Project #ST05938WI-A, 14 CFR Part 23 Aircraft Powerplant Instruments (Displays) issued August 25, 2015. 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 Type Certificate (TC) and Amended Type Certificate (ATC) or in the Limitations and Conditions section of the Supplemental Type Certificate (STC). An example of an appropriate statement is provided below.

Equivalent Level of Safety Findings have been made for the following regulations:

14 CFR 23.1305(a)(2), (a)(3), (c)(2), and (c)(5), amendment 23-52
14 CFR 23.1311(a)(6), amendment 23-49
14 CFR 23.1549(a), (b), and (c), amendment 23-45
(documented in ELOS Memo ACE-15-18)

//SIGNED//	August 31, 2015
Earl Lawrence, Manager, Small Airplane Directorate, Aircraft Certification Service	Date

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