



# Federal Aviation Administration

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## Memorandum

Date: October 13, 2016

To: Manager, Fort Worth Aircraft Certification Office, ASW-130

From: Manager, Small Airplane Directorate, ACE-100

Prepared by: Trong Pham, Fort Worth Aircraft Certification Office, ASW-130

Subject: INFORMATION: Equivalent Level of Safety (ELOS) Finding for BHE & Associates, Ltd., Textron-Beechcraft King Air Model B200 and B200C Airplanes, Powerplant Engine Instrument Display, FAA Project #: SA1967DRB-A

ELOS Memo#: SA1967DRB-A-P-1

Regulatory Ref: 14 CFR 23.1305(a)(2), (a)(3), (c)(2), and (c)(5), at amendment 23-52  
14 CFR 23.1311(a)(6) and (a)(7), at amendment 23-62  
14 CFR 23.1549(a), (b), and (c), at amendment 23-45

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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 Model B200 and B200C airplanes.

### **Background:**

This ELOS finding pertains to the usage of a digital only display and alternate markings for the ProLine Fusion® Powerplant Engine Instrument Display, manufactured by Rockwell Collins, Inc., in Textron-Beechcraft King Air Model B200 and B200C airplanes. The digital only display includes engine oil pressure, oil temperature, fuel flow, and high-pressure rotor speed (N1) rpm instead of full time analog display for each item. The digital only 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 in the following paragraphs.

### Digital Only Display

Advisory Circular, [AC 23.1311-1C](#), *Installation of Electronic Display in Part 23 Airplanes*, paragraph 9.4c, provides the basis for establishing an equivalent level of safety for a digital only display of oil pressure, oil temperature, fuel flow, and engine high-pressure rotor speed

(N1) rpm.

### Sensory Cues

1. Advisory Circular, [AC 23.1311-1C](#), paragraph 9.4, specifies that “Section 23.1311(a)(6), at 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.”
2. Advisory Circular, [AC 23.1311-1C](#), paragraph 9.5, specifies that “Alternate markings that do not comply with the requirements of § 23.1549 require an ELOS.”

### **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)

### **Regulations requiring an ELOS finding:**

#### Digital Only Display:

1. Section 23.1305, Powerplant instruments, paragraphs (a) and (c), in part, at amendment 23-52, states the following:

“(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. . . .”

Note: The Notice of Proposed Rulemaking for amendment 23-43 determined for powerplant instruments that “where trend information is needed, the word indicator should be retained.” Trend information is needed for any 14 CFR 23.1305 required engine instruments that use the term indicator.

2. Section 23.1549, Powerplant and auxiliary power unit instruments, paragraphs (a), (b),

and (c), at amendment 23-45, states the following:

- “(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; . . .”

#### Sensory Cues:

1. Section 23.1311, Electronic display instrument systems, paragraph (a), in part, at amendment 23-62, states the following:

- “(a) Electronic display indicators, including those with features that make isolation and independence between powerplant instrument systems impractical, must: . . . .”
- “(6) Incorporate sensory cues that provide a quick glance sense of rate and, where appropriate, trend information to the parameter being displayed to the pilot.
- (7) Incorporate visual displays of 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. . . .”

2. Section 23.1549, Powerplant and auxiliary power unit instruments, paragraphs (a), (b), and (c), at amendment 23-45, states the following:

- “(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; . . .”

#### **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 high-pressure rotor rpm (N1) are those identified in [AC 23.1311-1C](#), paragraph 9.4c, and are described in the following paragraphs.

1. Digital only display of N1 Gas Generator Speed: The ProLine Fusion® primary engine

indication only displays digits to indicate N1 gas generator speed. Section 23.1305(c)(5) requires an indicator to display rotor speed. Section 23.1549(a)(b)(c), amendment 23-45, requires green, yellow, and red markings on the instruments to denote the normal, cautionary, and danger levels of operation. The maximum and minimum values cannot be marked with the required radial or line on a digital-only indicator.

The compensating features of this indicator are that 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 limits. The digits are green when in the normal operating range. The ProLine Fusion® Engine Synoptic page is available at any time, and provides N1 as two left and right engine analog dials. Additionally, an automatic N1 overspeed protection system is provided mitigating need for immediate flightcrew action to prevent exceeding part 33 limits.

2. Digital only display of oil temperature and oil pressure: The ProLine Fusion® primary engine indication only displays digits to indicate the oil temperature and pressure. Section 23.1549(a)(b)(c), at amendment 23-45, requires green, yellow, and red markings on the instruments to denote the normal, cautionary, and danger levels of operation. The maximum and minimum values cannot be marked with the required radial or line on a digital-only indicator.

These two instruments provide a compensating feature by displaying the digits in color when reaching a caution (yellow) or warning (red) value, clearly indicating when the operating value is at, or exceeding the maximum or minimum limit. The digits are green when in the normal operating range. The ProLine Fusion® engine synoptic page provides oil temperature and pressure indicators as two vertical bars with digits on either side indicating the left and right engine values. The bars are color coded consistent with guidance to indicate the normal, cautionary, and warning regions. When a low oil pressure condition occurs, a red Crew Alerting System (CAS) message, with accompanying master chime and aural tone, is displayed to the crew to increase awareness.

3. Digital only display of fuel flow: The ProLine Fusion® primary engine indication has digits only to indicate Fuel Flow (FF), and these digits will always be green. Section 23.1305(c)(2) requires an indicator. Section 23.1549(a)(b)(c), amendment 23-45, requires green, yellow, and red markings on the instruments to denote the normal, cautionary, and warning levels of operation. However, there are no maximum and minimum values to be marked on this indicator. Therefore, the digits are always green in color. In addition, a ProLine Fusion® engine synoptic is available at any time to the flightcrew and provides Fuel Flow (FF) indications in an analog format as a vertical bar having green digits on either side indicating the left and right engine values.

#### Sensory Cues:

Sensory cues that are alternative to the regulatory required sensory cues include aural annunciators, left to right comparators, flashing display features, and a propeller synchronization indicator. These features provide compensation for the quick sense of rate

change or trend information provided by a traditional analog indicator.

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

Digital Only Display:

Advisory Circular, [AC 23.1311-1C](#), paragraph 9.4c, provides for compensating features for the digital only display of engine oil pressure, oil temperature, fuel flow, and high-pressure rotor rpm (N1). The explanation of how the design features for the digital only display of engine oil pressure, oil temperature, fuel flow, and high-pressure rotor rpm (N1) provide an ELOS are described in the following paragraphs.

1. Digital only display of N1 Gas Generator Speed: The flightcrew indirectly controls N1 speed. The flightcrew 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 are used to ensure safe engine operation at normal power settings. A mechanical flyweight governor and mechanical stop included in the engine design prevent N1 overspeed without flightcrew intervention.

The ProLine Fusion® Engine Synoptic page is available at any time, showing N1 as two left and right engine analog dials marked in accordance with § 23.1549. If the control system fails and N1 rotor speed exceeds its allowable limits, the N1 digital indication changes color and includes an aural indication to warn the flightcrew if any limits are exceeded. These features provide an equivalent level of safety to the required indicator.

2. Digital only display of oil temperature and oil pressure: Oil temperature and pressure are not directly controlled by the flightcrew. A device within the oil system, independent of any flightcrew action, regulates the oil pressure. A thermostat within the oil system regulates oil temperature. Oil pressure and oil temperature do not typically change rapidly such that the flightcrew would be required to act rapidly to prevent exceeding a limit. Oil pressure can rapidly change, but low oil pressure is the only indication requiring flightcrew action.

When a low oil pressure condition occurs, a red CAS message, with accompanying master chime and aural tone, is displayed to the crew to increase awareness. The oil pressure and oil temperature digital indications change color in accordance with § 23.1549, to 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.

A ProLine Fusion® engine synoptic page is available at any time to the crew showing oil temperature and pressure indications in an analog format as two vertical bars with digits on each side indicating left and right values. The bars are color coded consistent with § 23.1549, amendment 23-45, to indicate normal, caution, and warning levels. These features provide an equivalent level of safety to the required indicators.

3. Digital only display of fuel flow: Engine fuel flow display for the Model B200 and B200C airplanes does not have fuel flow limits and is not used to 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. The ProLine® Fusion system fuel flow digits will always be green in accordance with § 23.1549.

A ProLine Fusion® engine synoptic page is available at any time to the flightcrew showing Fuel Flow (FF) indications in an analog format as a vertical bar having green digits on either side indicating the left and right engine values. 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, flashing display features, and a propeller synchronization indicator to assist in providing a quick sense of rate change or trend information.

**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 Small Airplane Directorate has assigned a unique ELOS Memorandum number to facilitate archiving and retrieval of this ELOS. This ELOS Memorandum number should be listed in the Type Certificate Data Sheet under the Certification Basis section for the airplane Type Certificate. 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), at amendment 23-52

14 CFR 23.1311(a)(6)(7), at amendment 23-62

14 CFR 23.1549(a), (b), and (c), at amendment 23-45

(documented in ELOS Memo SA1967DRB-A-P-1)

//SIGNED//

October 13, 2016

Pat Mullen, Acting Manager, Small Airplane Directorate  
Aircraft Certification Service

Date

ELOS Originated by: Delegation Systems Certification Office	Manager, Delegation Systems Certification Office: Fran Cox	Routing Symbol: ASW-130
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