Memorandum

U.S. Department
of Transportation
Federal Aviation
Administration

Subject: **ACTION**: Review and Concurrence, Equivalent Level of Safety ; ACE-02-16

Date: June 3, 2003

From: Harvey Nero, Program Manager, ACE-117W, Wichita Aircraft Certification Office

Reply to Attn. of: James P. Galstad

To: Manager, Small Airplane Directorate, ACE-100

Background

The Type Certificate configuration of Super KingAir Model B200 and B200C airplanes used round dial analog cockpit instruments to display engine information. Rockwell Collins is installing an electronic Engine Indicating System (EIS) as a portion of the Proline 21 installation by DAS approved STC in the B200/B200C airplanes. Digital only indications are proposed for some of the engine indications that require an indicator. These indications require an Equivalent Level of Safety (ELOS).

Applicable Regulations and Guidance Material

§21.21(b)(1)
§21.461
§23.1305 at Amendment 23-52
§23.1311 at Amendment 23-49
§23.1549 at Amendment 23-45
AC23.1311-1A

Regulation(s) Requiring an ELOS

§23.1305(a)(2) at Amendment 23-52

Sec. 23.1305 Powerplant instruments.

The following are required powerplant instruments:

(a) *For all airplanes.*

...

(2) An oil pressure indicator for each engine.

...

§23.1305(a)(3) at Amendment 23-52

Sec. 23.1305 Powerplant instruments.

The following are required powerplant instruments:

(a) *For all airplanes.*

...

(3) An oil temperature indicator for each engine.

...

§23.1305(c)(2) at Amendment 23-52

Sec. 23.1305 Powerplant instruments.

The following are required powerplant instruments:

...

(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.

...

§23.1549(a)(b)(c) at Amendment 23-45

Sec. 23.1549 Powerplant [and auxiliary power unit instruments.]

[For each required powerplant and auxiliary power unit instrument, as appropriate to the type of instruments--]

(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

...

AC23.1311-1A, Installation of Electronic Displays in Part 23 Airplanes

...

8.5.6 Direct-reading alphanumeric-only displays are most valuable when integrated with an analog display by adding a precise, quantitative indication to compliment an analog display's qualitative indication. Direct-reading alphanumeric powerplant displays should not be used in place of analog instruments to indicate values of engine parameters where trend or rate-of-change information is important. Direct-reading alphanumeric displays limit the flight crew's ability to assess trend information and result in reduced crew awareness. Direct-reading alphanumeric displays are also limited in their ability to provide a comparison of parameters from multiple

engines or to check the general proximity of differing parameters against their individual limits. While these shortcomings can be compensated for with additional design provisions, the use of direct-reading alphanumeric displays should be made with care and evaluated for each airframe, engine, and airframe/engine integration. The required § 23.1305 powerplant instruments referred to as "indicators" should have the ability to provide trend or rate-of-change information, unless a finding of equivalence is made for direct-reading alphanumeric displays. The finding of equivalence should consider the following factors:

8.5.6.1 The visibility and relative location of the indicated parameter should be reviewed, including appropriate conditions of lighting and instrument panel vibration.

8.5.6.2 The ability to assess necessary trend or rate-of-change information quickly, including if and when this information may be needed during in-flight engine restarts.

8.5.6.3 The ability to assess how close the indicated parameter is relative to a limit.

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Description of Compensating Features

Digital Oil Pressure Indicator

Regulation: §23.1305(a)(2)

See the Regulation and Guidance Section above for text of the regulation.

Compensating Feature

The regulation specifies an indicator. The FAA has concluded that where trend information is needed the word "indicator" should be retained. The indicator has been replaced by a digital only indication and the associated trend information provided by a round analog indicator is no longer present. A compensating feature of the digital only indication is that the digits change color as the oil

pressure transitions from normal to cautionary to limit pressures. This color change provides trend information.

Regulation: §23.1549(a)(b)(c)

See the Regulation and Guidance Section above for text of the regulation.

Compensating Feature

(a) The maximum and minimum oil pressure limits cannot be marked with the required red radial or a red line on a digital only indication. The compensating feature is that the digits are displayed in color and are red when the value is at and exceeding the maximum or minimum limit.
(b) Normal operating ranges cannot be marked with the required green arc or green line on a digital only indication. The compensating feature is that the digits are displayed in color and are green when the value displayed is within the normal operating range.
(c) The cautionary range(s) cannot be marked with the required yellow arc or yellow line on a digital only indication. The compensating feature is that the digits are colored and are yellow when the value displayed is within a cautionary range.

Guidance Material: AC23.1311-1A

See the Regulation and Guidance Section above for selected text from the Advisory Circular.

Compensating Feature:

AC 23.1311-1A paragraph 8.5.6.1 addresses visibility and relative location of the indicated parameter. The EIS display, including oil pressure, is located at the top of the MFD display.

AC23.1311-1A paragraph 8.5.6.2 addresses the ability to assess trend or rate-of-change information quickly including in-flight airstarts. Trend or rate-of-change information is indicated by a color change of the digital display.

AC23.1311-1A paragraph 8.5.6.3 addresses the ability to assess how close the indicated parameter is relative to a limit. The AFM includes the range of normal, caution, and limit values.

Digital Oil Temperature Indicator

Regulation: §23.1305(a)(3)

See the Regulation and Guidance Section above for text of the regulation.

Compensating Feature

The regulation specifies an indicator. The FAA has concluded that where trend information is needed the word "indicator" should be retained. The indicator has been replaced by a digital only indication and the associated trend information provided by a round analog indicator is no longer present. A compensating feature of the digital only indication is that the digits change color as the oil temperature transitions from normal to cautionary to limit temperatures. This color change provides trend information.

Regulation: §23.1549(a)(b)(c)

See the Regulation and Guidance Section above for the text of the regulation.

Compensating Feature

(a) The maximum and minimum oil pressure limits cannot be marked with the required red radial or a red line on a digital only indication. The compensating feature is that the digits are displayed in color and are red when the value is at and exceeding the maximum or minimum limit.
(b) Normal operating ranges cannot be marked with the required green arc or green line on a digital only indication. The compensating feature is that the digits are displayed in color and are green when the value displayed is within the normal operating range.
(c) The cautionary range(s) cannot be marked with the required yellow arc or yellow line on a digital only indication. The compensating feature is that the digits are colored and are yellow when the value displayed is within a cautionary range.

Guidance Material: AC23.1311-1A

See the Regulation and Guidance Section above for selected portions of the text of the Advisory Circular.

Compensating Feature

AC 23.1311-1A paragraph 8.5.6.1 addresses visibility and relative location of the indicated parameter. The EIS display, including oil temperature, is located at the top of the MFD display.

AC23.1311-1A paragraph 8.5.6.2 addresses the ability to assess trend or rate-of-change information quickly including in-flight airstarts. Trend or rate-of-change information is indicated by a color change of the digital display.

AC23.1311-1A paragraph 8.5.6.3 addresses the ability to assess how close the indicated parameter is relative to a limit. The AFM includes the range of normal, caution, and limit values.

Digital Fuel Flow Indication

Regulation: §23.1305(c)(2)

See the Regulation and Guidance Section above for text of the regulation.

Compensating Feature

The regulation specifies an indicator. The FAA has concluded that where trend information is needed the word "indicator" should be retained. The indicator has been replaced by a digital only indication and the associated trend information provided by a round analog indicator is no longer present. A limited amount of trend and rate-of-change information is available by observing the fuel flow digits. Also, the fuel flow parameter does not have a cautionary range or limit value and therefore does not include a corresponding change in digit color. The trend information available is adequate for the operational requirement.

Regulation: §23.1549(a)(b)(c)

See the Regulation and Guidance Section above for text of the regulation.

Compensating Feature

(a) The fuel flow does not have maximum or minimum flow limit. The digits are displayed in green and red digits for limit values are not required.

(b) Normal operating ranges cannot be marked with the required green arc or green line on a digital only indication. The compensating feature is that the digits are displayed in green, which corresponds to the normal operating range.
(c) The cautionary range(s) cannot be marked with the required yellow arc on a digital only indication. As fuel flow does not have defined cautionary range no corresponding yellow digit color is displayed.

Guidance Material: AC23.1311-1A

See the Regulation and Guidance Section above for selected portions of the text of the Advisory Circular.

Compensating Feature

AC 23.1311-1A paragraph 8.5.6.1 addresses visibility and relative location of the indicated parameter. The EIS display, including fuel flow, is located at the top of the MFD display.

AC23.1311-1A paragraph 8.5.6.2 addresses the ability to assess trend or rate-of-change information quickly including in-flight airstarts. Trend or rate-of-change information is indicated by the change of the digits.

AC23.1311-1A paragraph 8.5.6.3 addresses the ability to assess how close the indicated parameter is relative to a limit. As there are not limits for fuel flow, this aspect is not applicable.

Explanation of Equivalent Safety

Oil Pressure Indicator

Regulation: §23.1305(a)(2)

See the Regulation and Guidance Section above for text of the regulation.

Explanation of Equivalency

The trend information of the indicator required by the regulation can be equivalently provided by the digit color changes of the digital only indications. This also considers the rate of change of the oil pressure parameter for this airplane. Flight test evaluation will verify the equivalency.

Regulation: §23.1549(a)(b)(c)

See the Regulation and Guidance Section above for text of the regulation.

Explanation of Equivalency

The digit color corresponds to the normal, caution, or limit marking. Flight test evaluation will verify that the digit color provides equivalency to the normal, caution, and limit marking requirements of §23.1549(a)(b)(c).

Guidance Material: AC23.1311-1A

See the Regulation and Guidance Section above for selected text from the AC.

Explanation of Equivalency

AC 23.1311-1A paragraph 8.5.6.1 addresses visibility and relative location of the indicated parameter. The EIS display, including oil pressure, is located at the top of the MFD display. Flight test will review and verify that the visibility, relative locations, and lighting are acceptable.

AC23.1311-1A paragraph 8.5.6.2 addresses the ability to assess trend or rate-of-change information quickly including in-flight airstarts. Trend or rate-of-change information is indicated by a color change of the digital display. Flight test will review and verify the ability to assess trend or rate-of change information quickly is provided by digit color changes.

AC23.1311-1A paragraph 8.5.6.3 addresses the ability to assess how close the indicated parameter is relative to a limit. The AFM includes the range of normal, caution, and limit values. Flight test will assess the ability to determine how close the parameter is to a limit via the AFM information and that a placard is not required.

Oil Temperature Indication

Regulation: §23.1305(a)(3) at Amendment 23-52

See the Regulation and Guidance Section above for text of the regulation.

Explanation of Equivalency

The trend information of the indicator required by the regulation can be equivalently provided by the digit color changes of the digital only indications. This also includes the rate of change for oil temperature for this airplane. Flight test evaluation will verify the equivalency.

Regulation: §23.1549(a)(b)(c) at Amendment 23-45

See the Regulation and Guidance Section above for text of the regulation.

Explanation of Equivalency

The digit color corresponds to the normal, caution, or limit marking. Flight test evaluation will verify that the digit color provides equivalency to the normal, caution, and limit marking requirements of §23.1549(a)(b)(c).

Guidance Material: AC23.1311-1A

See the Regulation and Guidance Section above for text of the regulation

Explanation of Equivalency

AC 23.1311-1A paragraph 8.5.6.1 addresses visibility and relative location of the indicated parameter. The EIS display, including oil temperature, is located at the top of the MFD display. Flight test will review and verify that the visibility, relative locations, and lighting are acceptable.

AC23.1311-1A paragraph 8.5.6.2 addresses the ability to assess trend or rate-of-change information quickly including in-flight airstarts. Trend or rate-of-change information is indicated by a color change of the digital display. Flight test will review and verify the ability to assess trend or rate-of change information quickly is provided by digit color changes.

AC23.1311-1A paragraph 8.5.6.3 addresses the ability to assess how close the indicated parameter is relative to a limit. The AFM includes the range of normal, caution, and limit values. Flight test will assess the ability to determine how close the parameter is to a limit via the AFM information and that a placard is not required.

Fuel Flow Indication

Regulation: §23.1305(c)(2) at Amendment 23-52

See the Regulation and Guidance Section above for text of the regulation

Explanation of Equivalency

The fuel flow parameter does not have a caution or limit value. Therefore, no caution or limit markings are required and there is no associated pilot action. As a result, limited rate-of-change and trend information available by the green digit display is adequate and the available trend information is equivalent to that required of the analog indicator. Flight test will verify this equivalency.

Regulation: §23. 1549(a)(b)(c) at Amendment 23-45

See the Regulation and Guidance Section above for text of the regulation.

Explanation of Equivalency

Fuel flow caution and limit markings do not exist and are not required. The display of digits in a green color is considered equivalent to marking a green arc on an analog indication. Flight test will verify this equivalency.

Guidance Material: AC23.1311-1A

See the Regulation and Guidance Section above for text of the regulation

Explanation of Equivalency

AC 23.1311-1A paragraph 8.5.6.1 addresses visibility and relative location of the indicated parameter. The EIS display, including fuel flow, is located at the top of the MFD display. Flight test will review and verify that the visibility, relative locations, and lighting are acceptable.

AC23.1311-1A paragraph 8.5.6.2 addresses the ability to assess trend or rate-of-change information quickly including in-flight airstarts. Trend or rate-of-change information is indicated by the change of the digits. Flight test will verify that for fuel flow, the

change of digits is equivalent to that required of the analog indicator.

ACO Recommendation

The ACO concurs with the applicant, Rockwell International Corp., position that the Rockwell Collins Proline 21 installation in the B200/B200C be granted an equivalent level of safety for:

Digital Only Indication	ELOS Provided for 14 CFR Part 23
Engine Oil Pressure	§23.1305(a)(2) and §23.1549(a)(b)(c)
Engine Oil Temperature	§23.1305(a)(3) and §23.1549(a)(b)(c)
Engine Fuel Flow	§23.1305(c)(2) and §23.1549(a)(b)(c)

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Concurrence

ELOS Number ACE-02-16 is provided for Project ST3539WI-A

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