Federal Aviation Administration

Memorandum

Date: July 31, 2006

To: Manager, Wichita Aircraft Certification Office, ACO-115W

From: Manager, Transport Airplane Directorate, ANM-100

Prepared by: Bob Adamson, ACE-116Wp

Subject: Equivalent Level of Safety (ELOS) Finding for Cessna Model 560 Encore BPC, FAA Project # AT4267WI-T

ELOS Memo#: AT4267WI-T-P-1

Regulatory Ref: §§ 21.21(b)(1), 25.1549

This memorandum informs the certificate management aircraft certification office of an evaluation made by the Transport Airplane Directorate on the establishment of an equivalent level of safety finding for the Cessna Model 560 Encore BPC.

Background

The FAA, Collins, and Cessna co-signed a Memorandum of Agreement that prohibits a stand alone STC. As part of the required approval, the Cessna Model 560 Encore BPC has the Collins STC limitation and the Collins STC has the PWC PW535B engine installation as a limitation, neither the avionics installation nor the engine installation can stand-alone. To be consistent with the mutually signed Project Specific Certification Plan and Memorandum Of Agreement, it is appropriate that only Cessna request an Equivalent Level of Safety to 14 CFR part 25.1549 (a) through (d), amendment 40 as required by 14 CFR 21.21(b).

The primary engine displays on turbine engine powered transport aircraft have traditionally displayed the required engine parameters required by 14 CFR 25.1305 in an analog-only or an analog and digital format. Standby Engine Indicators have typically displayed these parameters in either analog-only or digital-only format. An increasing demand to conserve primary display space has led to digital-only primary displays for those rotor speeds not normally used for setting power. This may result in a small, cluttered, low-resolution display.

In addition, it is generally accepted that digital-only displays are often less effective than conventional analog displays at providing the crew with discernible indication of the parameter

during rapid transient, and quick intuitive indication of the parameters approximate level, direction and rate of change, proximity to limits, and relationship to other parameters on the same engine or the same parameters on other engines.

Applicable regulation(s)

§§ 21.21(b)(1) – Issue of type certificates, 25.1305(c)(1), (2), & (3) – Powerplant instruments, 25.1321(c)(2) – Arrangement and visibility, 25.1549 – Powerplant and auxiliary power unit instruments.

Regulation(s) requiring an ELOS finding

§ 25.1549 – Powerplant and auxiliary power unit instruments.

Description of compensating design features or alternative standards which allow the granting of the ELOS (including design changes, limitations or equipment need for equivalency)

Primary display of high-pressure rotor speed (N2)

The Model 560 Encore BPC uses the Pratt & Whitney Canada PW535B engines with dual channel full authority digital engine control (FADEC) system. This engine requires the use of high-pressure turbine rotor speed (N2). This parameter is used as a visual for engine starting and overspeed monitoring. The PWC PW535B engine Installation Manual defines the limits and usage of this parameter.

The FADEC engine control system operates with a software independent overspeed protection system, decreasing fuel flow with increasing N2 speed. For cold conditions, a maximum fuel flow function is included which will cutback fuel with increasing N2 speed to limit engine speed. These features will prevent critical engine overspeed and are considered compensating features.

The digital N2 speed display has green digits against a black background positioned in a central location on the instrument panel with the display for each engine adjacent to each other. Normal operation of the engine high-pressure turbine speed is displayed by illuminated steady green digits, and no other indication.

The Model 560 Encore BPC engine installation will have, as will be shown through flight test, no high pressure turbine speed restrictions which would require an additional N2 red arc or red marking other than the defined maximum speed limitation.

Primary Display of engine fuel flow (Wf)

The fuel flow digital only numeric indication is displayed on the Multi-Function Display, which is centrally located on the instrument panel. The display provides a green digital readout against a black background, with a range from 0 to 2,000 PPH and a resolution of 10 PPH. The

indication is individually displayed for each engine, and is identified by a white "FUEL" above the displays. A white "PPH" is located between the displays for each engine.

Engine operating limits are not defined or required for fuel flow; therefore the digits always remain green during operation. Response of the digital display system is such that fuel flow information is easily discerned for each engine during both transient and steady state operation, and with the logical display location, comparison of engine-to-engine data can be quickly compared. Similar fuel flow displays have been shown by flight test demonstration on other model Citations to meet the requirements for visibility including appropriate conditions of lighting and panel vibration, and will be demonstrated on the Cessna Model 560 Encore BPC.

Standby Display of N1, N2, and ITT

This display incorporates all required engine parameters for engine starting and thrust control. The primary engine instruments are powered from the main electrical bus. A standby engine gage, which contains N1, N2, and ITT indication, is required, and will be powered from the standby electrical bus. The standby gage indications will be digital for all three of the parameters displayed.

This engine requires the use of low-pressure turbine rotor speed (N1), high-pressure turbine rotor speed (N2), and inter-turbine temperature (ITT). The uses of these parameters are for thrust control, engine starting and overspeed monitoring.

The FADEC engine control system operates with a software independent overspeed protection system, decreasing fuel flow with increasing N1 or N2 speed. For cold conditions, a maximum fuel flow function is included, which will cutback fuel with increasing N1 or N2 speed to limit engine speed. These features will prevent critical engine overspeed and are considered compensating features.

The digital N1 and N2 speed displays and ITT temperature displays have white digits against a black background positioned in a central location on the instrument panel with the display for each engine adjacent to each other. Normal operations of the engine parameters are displayed by steady white digits, and no other indication.

Explanation of how design features or alternative standards provide an equivalent level of safety to the level of safety intended by the regulation

Primary display of high-pressure rotor speed (N2)

The FADEC engine control system operates an independent overspeed protection system, decreasing fuel flow with increasing N2 speed. For cold conditions, a maximum fuel flow function is included which will cutback fuel with increasing N2 speed to limit engine speed. These features prevent critical engine overspeed and are compensating features.

The digital N2 speed display has green digits against a black background positioned in a central location on the instrument panel with the display for each engine adjacent to each other. The location of the N2 display for each engine is such that trend or rate of change information can be quickly discerned including information needed for in-flight restarts, and for quickly and accurately comparing engine-to-engine data. This location will be shown by flight test demonstration to meet the requirements for visibility, including appropriate conditions of lighting and panel vibration. Normal operation of the engine high pressure compressor speed is displayed by illuminated steady green lights, and no other indication.

Display of engine fuel flow (Wf)

The fuel flow digital only numeric indication is displayed on the Multi-Function Display, which is centrally located on the instrument panel. The display provides a green digital readout against a black background, with a range from 0 to 2,000 PPH and a resolution of 10 PPH. The indication is individually displayed for each engine, and is identified by a white "FUEL" above the displays. A white "PPH" is located between the displays for each engine.

Engine operating limits are not defined or required for fuel flow; therefore the digits always remain green during operation. Response of the digital display system is such that fuel flow information is easily discerned for each engine during both transient and steady state operation, and with the logical display location, comparison of engine-to-engine data can be quickly compared. Similar fuel flow displays have been shown by flight test demonstration on other model Citations to meet the requirements for visibility including appropriate conditions of lighting and panel vibration, and will be demonstrated on the model 560 Encore BPC.

Standby Display of N1, N2, and ITT

The Model 560 BPC -0751 will use electronic displays for the powerplant instrument required by 14 CFR 25.1305(c)(1), (3). This display incorporates all required engine parameters for engine starting and thrust control. The primary engine instruments are powered from the main electrical bus. A standby engine gage, which contains N1, N2, and ITT indication, is required, and will be powered from the standby electrical bus. The standby gage indications will be digital for all three of the parameters displayed.

This engine requires the use of low-pressure turbine rotor speed (N1), high-pressure turbine rotor speed (N2), and inter-turbine temperature (ITT). The uses of these parameters are for thrust control, engine starting and overspeed monitoring. The PWC PW535B engine installation manual defines the limits and usage of these parameters. Cessna has in the past used a digital only display for standby engine gages.

The N1 and N2 speed display provides digital readouts from 0 to 120% with a resolution of 0.1%. The steady state limit for N1 and N2, as established by PWC, is 100% and the steady state ITT limit is 700 °C. The digital display for the exceeded parameter limit will flash when either N1, N2 or ITT exceed their limit value plus the display resolution limit. If more than one parameter exceeds its limit then exceeded parameters flash in unison.

The digital N1 and N2 speed displays and ITT temperature displays have white digits against a black background positioned in a central location on the instrument panel with the display for each engine adjacent to each other. Normal operations of the engine parameters are displayed by steady white digits, and no other indication.

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 Transport Directorate has assigned a unique ELOS Memorandum number (see front page) 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. [E.g. Equivalent Level of Safety Findings have been made for the following regulation: § 25.1549(a) through (d) – Powerplant and auxiliary power unit instruments. (documented in TAD ELOS Memo AT4267WI-T-P-1)]

Original signed by
Neil D. Schalekamp, for — 7/31/06

Manager, Transport Airplane Directorate, Aircraft Certification Service — Date

ELOS Originated by	Project Engineer:	Routing Symbol
ACO: 115W	Robert Adamson	116Wp