Federal Aviation Administration

Memorandum

Date: May 24, 2013

To: Manager, Small Airplane Directorate, ACE-100

From: Manager, Wichita Aircraft Certification Office, ACE-115W

Prepared by: Erik Brown, Flight Test and Program Management, ACE-117W

Subject: Extension of Equivalent Level of Safety (ELOS) ACE-08-19 to include the Cessna Model 208B with the PT6A-140 Engine. The ELOS finding is to the provisions of 14 CFR, part 23, §§ 23.207(c) (Stall Warning).

ELOS Memo#: ACE-08-19A

Regulatory Ref: 14 CFR, part 23, § 23.207(c) Amendment 23-7 (Stall Warning), and

14 CFR, part 23, § 23.1419(b) Amendment 23-14 (Ice Protection)

This memorandum requests your office to review and provide concurrence with the proposed extension of Equivalent Level of Safety (ELOS) finding ACE-08-19 to 14 CFR, part 23, § 23.207(c) Amendment 23-7, which states "The stall warning must begin at a speed exceeding the stalling speed by a margin not less than 5 knots, but not more than the greater of 10 knots or 15 percent of the stalling speed, and must continue until the stall occurs."

Background:

The Cessna Model 208B equipped with the PT6A-140 engine and TKS Ice Protection System (IPS) cannot attain the required 5 knots calibrated airspeed (KCAS) stall warning margin with thin rough ice accretions utilizing the current production stall warning system. Cessna is proposing to utilize the same Low Airspeed Awareness (LAA) System previously used and approved to provide an equivalent means of stall warning for operations in icing conditions for the Model 208B equipped with the PT6A-114A engine.

The Cessna Model 208B Grand Caravan underwent a block point change consisting of a 57 pound gross weight increase, the installation of a variant of the currently approved PT6A-114A engine with improved hot day and high altitude performance (PT6A-140) and enhancements to the internal and external aircraft lighting system. The impact of the gross weight increase of 57

pounds (8807 lbs. MTOW) does not affect or change the aircraft stall warning system or ice protection system's effectiveness, or functionality and is within the weight and Center of Gravity (CG) tolerances of previous testing completed and previously certified under FAA Project Number ST4513WI-A, March 2008. The PT6A-140 engine installed on the Model 208B is flat rated at 867 Shaft Horsepower (SHP). The marketing name is Grand Caravan EX.

In October 2008, the TKS IPS was certified for installation in the Cessna Model 208B equipped with the PT6A-114A rated at 675 SHP with both factory installed electromechanical flight instruments and those equipped with the Garmin G1000 Integrated Flight Control System. During initial production acceptance of the first 208B equipped with TKS, an issue arose that highlighted a concern with the configuration of the stall warning system. Cessna subsequently evaluated the final stall warning system production configuration with critical ice accretions. The critical ice accretions consisted of thin rough ice accretions simulating a delayed/pre-activation ice shape, and the normal operating 45-minute hold ice shape. Test results indicated the following: (Reference ELOS ACE-08-19 and DM208B-31 A00l for data)

1. For the delayed/pre-activation ice shape, the current production stall warning system was not capable of satisfying the requirements of 14 CFR, part 23, § 23.207(c) in all flap positions without causing nuisance indications.
2. For the normal operating 45 minute hold ice shapes, the current production stall warning system meets all the requirements of 14 CFR, part 23, § 23.207.

Due to test result number 1, Cessna sought and was granted an Equivalent Level of Safety (ELOS) ACE-08-19, allowing use of a Low Airspeed Awareness System to provide an equivalent level of safety to the stall warning requirement of 14 CFR, part 23, § 23.207(c).

Applicable Regulation:

The installed TKS system was required to meet 14 CFR, part 23, § 23.1419 at amendment 23-14. Subparagraph (b) of this regulation requires the following:

"An analysis must be performed to establish, on the basis of the airplane's operational needs, the adequacy of the ice protection system for the various components of the airplane. In addition, tests of the ice protection system must be conducted to demonstrate that the airplane is capable of operating safely in continuous maximum and intermittent maximum icing conditions as described in Appendix C of part 25 of this chapter."

Current and past FAA policy has indicated that one of the requirements for demonstrating that an aircraft is capable of operating safely in the icing conditions described in Appendix C is that the aircraft demonstrate compliance to 14 CFR, part 23, § 23.207 for stall warning margin. The applicable amendment to 14 CFR, part 23, § 23.207 for the Cessna 208B, requires the following:

*"The stall warning must begin at a speed exceeding the stalling speed by a margin not less than 5 knots, but not more than the greater of 10 knots or 15 percent of the stalling speed, and must continue until the stall occurs.***"**

Regulations Requiring an ELOS Finding:

The 14 CFR part 23 regulation, applicable to this ELOS: § 23.207(c) Amendment 23-7, Stall Warning.

Description of Compensating Design Features:

The premise of ELOS ACE-08-19 "Cessna 208B Stall Warning", justifies the LAA System to provide an equivalent means of stall warning for operations in icing conditions based on a specific aerodynamic configuration and specific ice shape, which has a limited exposure on the aircraft.

When the LAA system was envisioned as an aerodynamic performance monitor, its purpose was to increase flight crewmember situational awareness during high workload conditions (single pilot operations, IFR, icing, night, etc.). The original LAA was designed as an interim stopgap that could be relatively easily retrofit into the existing Caravan.

The minimum icing speed limitation for operations in icing conditions is:

- 95 KIAS – Flaps UP or Flaps TO/APR

The published recommended speeds for landing/approach for operations in icing conditions with a fully functioning TKS system are:

- 105 KIAS – Flaps UP
- 95 KIAS – Flaps TO/APR

> **NOTE:** These landing/approach speeds were evaluated during certification flight tests. The recommended Flaps UP speed was increased above the minimum 95 KIAS limitation to provide a slightly higher margin above stall during approach maneuvering.

The reduction in flap extension from Flaps 20° to Flaps TO/APR (nominally 15°) for landing in icing conditions required a faster speed on approach than the previous Flaps 20° speed of 85 KIAS. The increased speeds allow the pilot to stay above the minimum speed in icing of 95 KIAS throughout the approach. Company development stall data with the normal operating 45-minute hold ice shapes verified the new approach speeds provide additional margin above stall speed during the approach to landing.

The new Grand Caravan EX will retain the same LAA with the set point of 97.5 ± 2.2 knots as previously approved by ELOS ACE 08-19.

The LAA System provided satisfactory stall margin in the currently approved aero configuration in all conditions tested. The combination “hold-inadvertent” ice shape was the critical shape for

stall warning margin using the LAA system. The data below was validated during certification flight-testing accomplished on April 11-12, 2013, by Cessna Engineering Flight Test personnel and with FAA Wichita Aircraft Certification Office (ACO) pilot participation. The results of the flights are as follows:

Stall speeds with simulated ice shapes (wings level stall):

Ice Shape	Flaps	Stall Speed KCAS	LAA Warning KCAS	Warning Interval KCAS
Combination Hold-Inadvertent*	0	84	94	+10
Combination Hold-Inadvertent*	TO/APR	69.8	95	+25

***** Inadvertent 40-grit sandpaper plus unprotected shapes.

Stall speeds with simulated ice shapes (30° bank angle):

Ice Shape	Flaps	Stall Speed KCAS	LAA Warning KCAS	Warning Interval KCAS
Combination Hold-Inadvertent*	0	88	96	+8
Combination Hold-Inadvertent*	TO/APR	78.3	95	+17

***** Inadvertent 40-grit sandpaper plus unprotected shapes.

Additional guidance in the POH icing supplement will remain unchanged in that it directs the pilot to exit icing conditions, as soon as ice accretion is detected to minimize any ice buildup. The Enroute Tool for Exiting Icing (Section 5 of the FAA Approved TKS Icing Supplement), requires the pilot again to exit icing as soon as accretion is detected, if he is operating in an area where performance could become critical. Both of these items limit the pilot's potential exposure to an eventual loss of significant airspeed as discussed above.

Although the upper boundary of the LAA warning exceeds the 14 CFR 23.207 limit of the greater of 10 knots or 15 percent of the stalling speeds, it has been demonstrated during certification testing and during FAA ICT ACO participation flying that at no time were any nuisance stall warnings, or undue distractions observed that would cause the pilot to delay activation of the Pitot-Static heat system to arm the LAA system. Additionally, AFM procedures will allow the pilot to fly slightly faster speeds (conditions permitting, up to 110 KIAS) in order to preclude LAA activation. Refer to FAA Issue Paper "Cessna Aircraft Company's addition of TKS Ice Protection System to the Cessna Model 208B equipped with the G1000 Integrated Avionics System and the TKS low-profile fairing Project No. TD5461WI-A", dated December 17, 2010, page 10-11 for supporting information.

The Grand Caravan EX with the LAA set point of 97.5 ± 2.2 knots, will remain unchanged since it retains adequate safety margin for operations in icing conditions and based upon the above empirical, and analytically derived data, the warning margin above stall is expected to remain unchanged. Additionally, the TKS IPS and LAA description, operation and functionality remains unchanged from the currently approved installation in the 208B equipped with the PT6A-114A engine with cargo pod.

Federal Aviation Administration Approval:

The Small Airplane Directorate concurs that the LAA System installed on the Cessna Model 208B Grand Caravan EX equipped with the PT6A-140 engine and 57 pound gross weight increase, provides an equivalent level of safety to the requirements of 14 CFR, part 23, § 23.207(c) Amendment 23-7, Stall Warning.

Earl Lawrence	*5/24/13*
Manager, Small Airplane Directorate Aircraft Certification Service	Date

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