



Federal Aviation Administration

Memorandum

Date: February 24, 2009

To: Manager, Anchorage Aircraft Certification Office, ACE-115

From: Manager, Small Airplane Directorate, ACE-100

Prepared by: August Asay, Airplane Certification Office, ASW-115

Subject: INFORMATION: Equivalent Level of Safety (ELOS) Finding Cessna 208 Longitudinal Control During Takeoff Flap Retraction Project on a Cessna Model 208, FAA Project SA1119AK-A.

ELOS Memo#: ACE-09-03

Regulatory Ref: 14 CFR, part 23, § 23.145

This memorandum informs the aircraft certification office of an evaluation made by the accountable directorate on the establishment of an equivalent level of safety (ELOS) finding for the Cessna 208.

Background:

The applicant, Aero Twin, Inc., has applied for a STC to install the Honeywell TPE331-12JR engine and a Hartzell HC-B4NL-1089N 109.5 inch, four bladed propeller on the Cessna C208B Grand Caravan. The modification de-rates the Honeywell engine to 950 SHP for installation in the 208B. Aero Twin, Inc. has previously certified the installation of the Honeywell engine on the Cessna C208 Caravan, de-rated to 850 SHP, as part of STC number SA02291AK. As part of the certification process, the aircraft has been flight tested to show compliance with 14 CFR, part 23, § 23.145, Longitudinal control, per Amendment 23-50. As a result of those tests, Aero Twin, Inc. requests an equivalent safety finding for § 23.145, Longitudinal control.

Applicable regulation:

14 CFR, part 23, § 23.145, Longitudinal control, per Amendment 23-50, paragraph (b)(6) states:

“(b) Unless otherwise required, it must be possible to carry out the following maneuvers without requiring the application of single-handed control forces exceeding those specified in Sec. 23.143(c). The trimming controls must not be adjusted during the maneuvers: ... (6) With

maximum takeoff power, landing gear retracted, flaps in the takeoff position, and the airplane as nearly as possible in trim at V_{FE} appropriate to the takeoff flap position, retract the flaps as rapidly as possible while maintaining constant speed.”

Regulation requiring an ELOS finding:

The single-handed control force limit specified in Section 23.143(c) is 50 pounds. During certification of the modified 208, the stick force was recorded during the flap retraction at 145 KIAS. It was found at that time that although the stick force exceeded 50 pounds during the test, it was not until after the flaps were fully retracted.

Explanation of how design features provide an equivalent level of safety to the level of safety intended by the regulation:

As part of the certification process, the aircraft has been flight tested to show compliance with 14 CFR, part 23, § 23.145, Longitudinal control, per Amendment 23-50. Paragraph (b)(6) of that regulation states:

“(b) Unless otherwise required, it must be possible to carry out the following maneuvers without requiring the application of single-handed control forces exceeding those specified in Section 23.143(c). The trimming controls must not be adjusted during the maneuvers: ... (6) With maximum takeoff power, landing gear retracted, flaps in the takeoff position, and the airplane as nearly as possible in trim at V_{FE} appropriate to the takeoff flap position, retract the flaps as rapidly as possible while maintaining constant speed.”

Note that the original certification basis for the Cessna 208 and 208B, per TCDS A37CE, is Amendment 23-28, at which time Amendment 23-17 of 14 CFR, part 23, § 23.145 was current. Aero Twin, Inc.’s research indicates that the amendment did not contain the maneuver specified in the modern amendment paragraph (b)(6). During the initial project planning for the modified 208, the FAA asked Aero Twin, Inc. to show compliance with the most modern amendment of § 23.145.

The takeoff flaps position of the 208B is 20°. The flap selector is gated at 0°, 10°, 20°, and 30° (full flaps). V_{FE} for flaps 20° in the standard 208 and 208B is 150 KIAS. This limitation has been changed to 145 KIAS for the modified aircraft to account for the increase in slipstream velocity in the wake of the propeller. The single-handed control force limit specified in Section 23.143(c) is 50 pounds. During certification of the modified 208, the stick force was recorded during the flap retraction at 145 KIAS. It was found at that time that although the stick force exceeded 50 pounds during the test, it was not until after the flaps were fully retracted. During the flap retraction, the force history showed that the stick force did not exceed 40 pounds until after the flaps were fully retracted, after which time the force peaked at about 75 pounds. Consultation with the Federal Aviation Administration (FAA) at that time indicated that the maneuver specified in 14 CFR, part 23, § 23.145(b)(6) was a transitory condition, and the force needed to remain less than the limit only for as long as the flaps were in transition. Based on this

supposition, the modified 208 was found to be compliant with the regulation. When flight testing the 208B in company R&D testing, it was found that the maximum stick force during flap retraction was 44 pounds, but it increased to 70 pounds after the flaps were fully retracted. The FAA asked that this result be validated by a FAA DER Test Pilot during Show Compliance flight testing. The DER pilot was unable to repeat these results, and concluded that the force required to accomplish the maneuver in 14 CFR, part 23, § 23.145(b)(6), per Amendment 23-50 was greater than the 50 pound limit of 14 CFR, part 23, § 23.143(c).

The 208 and 208B make use of electric trim that is operated by the pilot through a thumb operated switch on the left hand side of the control yoke. Cessna demonstration pilots recommend that pilots operate this trim whenever the flaps are being repositioned, trimming down while flaps are coming down and trimming up while flaps are coming up. Using this technique, it is possible to keep elevator control forces nearly 0 during flap transition.

It is possible to keep the stick forces on the modified aircraft below the limits of 14 CFR, part 23, § 23.143, if the maneuver of 14 CFR, part 23, § 23.145(b)(6), is modified to allow flap retraction to be done in stages with re-trimming at the 10° flap gate. The Cessna Pilot's Operating Handbook specifies raising the flaps after takeoff in increments, with a pause at 10° flaps to allow the aircraft to accelerate.

Aero Twin, Inc. is asking for relief from showing compliance with 14 CFR, part 23, § 23.145(b)(6), per Amendment 23-50 based on the following:

1. The original certification basis of the unmodified aircraft appears to not have required the specified maneuver to be tested.
2. The aircraft makes use of an electric trim system that may easily be used by the pilot during flap transition to cancel the resulting stick force. This procedure has been recommended in the Aircraft Flight Manual (AFM) for the unmodified aircraft and will continue to be included in the AFM.

The flap system is gated at 10° flap, allowing the pilot to retract the flaps in increments and re-trim, keeping the stick forces less than the one handed limit of 14 CFR, part 23, § 23.143(c).

FAA approval and documentation of the ELOS finding:

The FAA has approved the aforementioned equivalent level of safety finding in project issue paper G-2. 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 (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 (TC's & ATC's) or in the Limitations and Conditions Section of the STC. An example of an appropriate statement is provided below.

Equivalent Level of Safety Findings have been made for the following regulation(s):

14 CFR, part 23, § 23.143, Emergency Landing Dynamic Conditions (documented in ELOS Memo ACE-09-03)

John Colomy for
Kim Smith, Manager, Small Airplane Directorate
Aircraft Certification Service

2-24-09
Date

ELOS Originated by Anchorage ACO:	Greg Holt, Manager)	Routing Symbol ACE-115
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