Federal Aviation Administration

Memorandum

Date:	July 12, 2016
To:	Manager, Chicago Aircraft Certification Office, ACE-115C
From:	Manager, Small Airplane Directorate, ACE-100
Prepared by:	Wess Rouse, Propulsion & Program Management Branch, ACE-118C
Subject:	INFORMATION: Equivalent Level of Safety (ELOS) Finding for Cirrus Design Corporation, Model SF50 Jet, Spin Requirements, FAA Project #: TC6444CH-A
ELOS Memo #:	TC6444CH-A-F-2
Regulatory Ref:	14 CFR 23.221 at amendment 23-62

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 SF50 jet.

Background:

Artificial stall barriers have proven to successfully manage the stall characteristics of an airplane by providing the needed departure resistance that the original design did not. Not all possibilities and considerations to solve this were foreseeable in the past. Nonetheless, both the Pilatus Aircraft Limited Model PC-12 (ACE-94-8) and the Grob Model G520T (ACE-94-10) have been granted equivalent levels of safety to § 23.221 spin requirements using the stick shaker/stick pusher installations. Cirrus proposes a similar stick shaker/stick pusher installation for the Model SF50 jet to meet the same spin requirements of § 23.221.

Applicable regulation:

14 CFR 23.221

Regulation requiring an ELOS finding:

14 CFR 23.221

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):

Section 23.221, Spinning, at amendment 23-62, states the following:

> "(a) *Normal category airplanes.* A single-engine, normal category airplane must be able to recover from a one-turn spin or a three-second spin, whichever takes longer, in not more than one additional turn after initiation of the first control action for recovery, or demonstrate compliance with the optional spin resistant requirements of this section.
>
> (1) The following apply to one turn or three-second spins:
>
> (i) For both the flaps-retracted and flaps-extended conditions, the applicable airspeed limit and positive limit maneuvering load factor must not be exceeded;
>
> (ii) No control forces or characteristic encountered during the spin or recovery may adversely affect prompt recovery;
>
> (iii) It must be impossible to obtain unrecoverable spins with any use of the flight or engine power controls either at the entry into or during the spin; and
>
> (iv) For the flaps-extended condition, the flaps may be retracted during the recovery but not before rotation has ceased.
>
> (2) At the applicant's option, the airplane may be demonstrated to be spin resistant by the following:
>
> (i) During the stall maneuvers contained in § 23.201, the pitch control must be pulled back and held against the stop. Then, using ailerons and rudders in the proper direction, it must be possible to maintain wings-level flight within 15 degrees of bank and to roll the airplane from a 30 degree bank in one direction to a 30 degree bank in the other direction;
>
> (ii) Reduce the airplane speed using pitch control at a rate of approximately 1 knot per second until the pitch control reaches the stop; then, with the pitch control pulled back and held against the stop, apply full rudder control in a manner to promote spin entry for a period of 7 seconds or through a 360 degree heading change, whichever occurs first. If the 360 degree heading change is reached first, it must have taken no fewer than 4 seconds. This maneuver must be performed first with the ailerons in the neutral position, and then with the ailerons deflected opposite the direction of turn in the most adverse manner. Power and airplane configuration must be set in accordance with § 23.201(e) without change during the maneuver. At the end of 7 seconds or a 360 degree heading change, the airplane must respond immediately and normally to primary flight controls applied to regain coordinated, unstalled flight

without reversal of control effect and without exceeding the temporary control forces specified by § 23.143(c); and

(iii) Compliance with §§ 23.201 and 23.203 must be demonstrated with the airplane in uncoordinated flight, corresponding to one ball width displacement on a slip-skid indicator, unless one ball width displacement cannot be obtained with full rudder, in which case the demonstration must be with full rudder applied.

(b) *Utility category airplanes.* A utility category airplane must meet the requirements of paragraph (a) of this section. In addition, the requirements of paragraph (c) of this section and § 23.807(b)(7) must be met if approval for spinning is requested.

(c) *Acrobatic category airplanes.* An acrobatic category airplane must meet the spin requirements of paragraph (a) of this section and § 23.807(b)(6). In addition, the following requirements must be met in each configuration for which approval for spinning is requested:

(1) The airplane must recover from any point in a spin up to and including six turns, or any greater number of turns for which certification is requested, in not more than one and one-half additional turns after initiation of the first control action for recovery. However, beyond three turns, the spin may be discontinued if spiral characteristics appear.

(2) The applicable airspeed limits and limit maneuvering load factors must not be exceeded. For flaps-extended configurations for which approval is requested, the flaps must not be retracted during the recovery.

(3) It must be impossible to obtain unrecoverable spins with any use of the flight or engine power controls either at the entry into or during the spin.

(4) There must be no characteristics during the spin (such as excessive rates of rotation or extreme oscillatory motion) that might prevent a successful recovery due to disorientation or incapacitation of the pilot."

Section 23.221 requires that normal category aircraft be either, per § 23.221(a)(1), aerodynamically able to recover from incipient spin, or, per § 23.221(a)(2), aerodynamic resistant to spins. Cirrus will install a stick pusher system in the Model SF50 jet that will prevent stall and provide an alternate means of spin resistance relative to the definition provided in § 23.221(a)(2). This method will provide an equivalent level of safety.

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

The Model SF50 jet is designed for benign stall characteristics, meeting the stall requirements of § 23.201 and § 23.203 without the use of an artificial stall barrier. However, to prevent the airplane from entering a spin, Cirrus has designed a stick shaker/stick pusher system.

A pilot evaluation of the stick pusher installation was performed during normal and abused conditions. Furthermore, during conditions where the system may not operate during expected

flight operations. A pilot evaluation verified that the stick pusher/shaker provides a required level of safety. To maintain this equivalent level of safety, the installation will be consistent with the following attributes:

1. Compliance with Stall Regulations: Compliance with § 23.201, Wings level stall, and § 23.203, Turning flight and accelerated stalls, will be demonstrated with the airplane in uncoordinated flight and corresponding to one ball width displacement on a slip skid indicator. If one ball width displacement cannot be obtained with full rudder, the demonstration will be conducted with full rudder applied. For electronic flight displays, the displacement of the slip skid indicator will be calibrated such that one ball of displacement is equal to the following formula:

$$\tan^{-1}\left(\frac{N_y}{N_z}\right) = 3.5°$$

Cirrus will also investigate stick pusher effectiveness during the pushover maneuver described in Advisory Circular AC 23.1419-2D, Zero-g pushover maneuver, to speeds less than the normal 1g stall speed.

2. AOA Margin Evaluation and Verification: The Angle of Attack (AOA) margin between the stick pusher and natural stall AOA will be evaluated. The minimum 1 degree AOA margin will be verified for all cases.

3. Stick Pusher Force, Onset Rate Evaluation: Flight test will evaluate stick pusher force and onset rate to ensure that a pilot cannot mistake the stick pusher for an aerodynamic force and inadvertently maintain pro-stalling input after the pusher is activated. Stick pusher force and onset rate will be evaluated during slow entry wings level stalls, turning stalls, and accelerated stalls.

The Model SF50 jet stick shaker/stick pusher system does perform the intended function of § 23.1301, meets reliability requirements of § 23.1309, and meets the artificial stall barrier requirements of § 23.691. The SF50 stick shaker/stick pusher system meets environmental qualification requirements established by DO-160E that are appropriate for the Model SF50 jet.

A system safety analysis was conducted on the stick shaker/stick pusher while considering the effects of annunciated and unannunciated failures on continued safe flight and landing. In addition, this was factored with the potential of total loss of the system and activation at speeds above the selected activation airspeed. Loss of system function is classified in Appendix 1 of Advisory Circular AC 23.1309-1E, as the following:

- Hazardous, if loss is unannunciated.
- Major, if stall warning is functioning.
- Minor, if failure is annunciated and a stall warning is functioning.

The stick pusher will prevent a stall and effectively prevent a spin, since a stall precedes a spin.

FAA approval and documentation of the ELOS finding:

The FAA has approved the aforementioned equivalent level of safety finding in project issue paper F-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 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.

An Equivalent Level of Safety Finding has been made for the following regulation:

14 CFR 23.221, Spinning, at amendment 23-62
(documented in ELOS Memo TC6444CH-A-F-2)

//SIGNED//

_____ July 12, 2016

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

ELOS Originated by: Chicago ACO	Manager, Chicago ACO: Timothy P. Smyth	Routing Symbol: ACE-115C