



Federal Aviation Administration

Memorandum

Date: June 16, 2016

To: Manager, Atlanta ACO, ACE-115A

From: Manager, Small Airplane Directorate, ACE-100

Prepared by: Mariusz Wisniewski, ACE-116A

Subject: INFORMATION: Equivalent Level of Safety (ELOS)
Finding for Piper Aircraft Inc., Model PA-46-600TP, Control
Forces, FAA Project # AT13893AT-A

Regulatory Ref: 14 CFR 23.143(c)
14 CFR 23.145(b)(2)(4)

ELOS Memo#: AT13893AT-A-F-1

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 PA-46-600TP “M600” airplane.

Background :

Piper Aircraft Corporation (Piper) made an application to the Atlanta Aircraft Certification Office (AACO) for an amended type certification of a new airplane—the model PA-46-600TP (M600). The PA-46-600TP is a 6,000 pound, single engine, 6-place airplane, powered by a 600 shaft horsepower Pratt & Whitney PT6A-42A turboprop engine. In addition to having 100 more horsepower than its predecessor, the PA-46-500TP, this aircraft also incorporates a new wing, tail, and avionics.

The control force requirements of §§ 23.143 and 23.145 were implemented to allow a pilot of average skill, strength, and ability to maintain aircraft control during all phases of flights and the transitions between these phases. High control forces are particularly detrimental during critical phases of flights, such as a go around or bailed landing.

Piper is requesting an Equivalent Level of Safety (ELOS) finding for the PA-46-600TP longitudinal control forces requirements as defined by §§ 23.143(c), amendment 23-62, and § 23.145(b)(2) and (4), amendment 23-62.

Applicable regulation(s):

14 CFR 23.143(c), amendment 23-62
14 CFR 23.145(b)(2)(4), amendment 23-62

Regulation(s) requiring an ELOS finding:

14 CFR 23.145(b)(2)(4), amendment 23-62

Description of compensating design features or alternative Methods of Compliance (MoC) which allow the granting of the ELOS (including design changes, limitations or equipment needed for equivalency)

Piper has evaluated the aforementioned longitudinal control requirements and developed compensating procedures.

Description of Compensating Features for § 23.145(b)(2):

The following features have been included in the PA-46-600TP design to provide an equivalent level of safety intended by § 23.145(b)(2), amendment 23-62.

1. The aircraft is equipped with an electric pitch trim system, controlled by a thumb switch on the control wheel. The maneuver specified in § 23.145(b)(2) has been demonstrated using less than the force limit specified in § 23.143(c) by applying electric pitch trim simultaneously with power application until pitch forces have been neutralized. In the event of an electric pitch trim failure, the maneuver can also be performed within regulatory force limits using the manual pitch trim hand wheel.

2. The AFM will include a “CAUTION” statement in the Normal Procedures section.

CAUTION

Rapid application of power from low power settings will require a strong push on the control wheel to prevent an excessive nose-up pitch attitude. To reduce the required push force, simultaneously apply nose down electric trim during power application until control forces neutralize.

3. The AFM will include procedures for trimming the airplane in maneuvers similar to those defined by § 23.145(b)(2).

BALKED LANDING (Go-Around)

Power Lever..... SET TO MCP
 Pitch Trim..... APPLY NOSE DOWN ELECTRIC TRIM
 FLAPS..... RETRACT to T/O
 Climb Airspeed..... 95 KIAS
 LANDING GEAR.....UP (after climb established)
 FLAPS (after obstacle cleared)..... RETRACT to UP
 Climb airspeed..... 122 KIAS

Manual pitch trim may be used in place of electric pitch trim if desired.

Description of Compensating Features for § 23.145(b)(4):

The following features have been included in the PA-46-600TP design to provide an equivalent level of safety intended by § 23.145(b)(4), amendment 23-62.

1. The aircraft is equipped with an electric pitch trim system, controlled by a thumb switch on the control wheel. The maneuver specified in § 23.145(b)(4) has been demonstrated using less than the force limit specified in § 23.143(c) by applying electric pitch trim simultaneously with power until pitch forces have been neutralized. In the event of an electric pitch trim failure, the maneuver can also be performed within regulatory force limits using the manual pitch trim hand wheel.

2. The AFM will include a “CAUTION” statement in the Normal Procedures section.

CAUTION

Rapid application of power from low power settings when trimmed at low airspeeds will require a strong push on the control wheel to prevent an excessive nose-up pitch attitude. To reduce the required push force, simultaneously apply nose down electric trim during power application until control forces neutralize.

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

Piper has provided three compensating features for the ELOS determination, the use of electric trim, detailed flight manual procedures, and flight manual warnings.

1. Electric Trim

Piper cited the following precedents in its ELOS request:

C-208B: ELOS ACE-09-03, -11-09, and -13-06. In the case of the C-208B, the ELOS was approved based on allowing the use of electric trim to relieve forces at an intermediate, gated flap setting. This ELOS states, “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.” However, according to the ELOS, this trim is to be applied at the gated, 10° or TO/APR flap position. All three ELOS allow the use of the manual trim system if the electric trim fails. Using this procedure, the stick force did not exceed 50 lbs.

Aero Vodochody AE-270: ELOS ACE-05-13 and -05-14. Electric trim is not part of the AE-270 design. During the AE-270 validation program, the FAA granted the ELOS based on the ease of use of the manual trim. In this case the large radius trim wheel was quickly and easily accessible by the pilot. The forces could be eliminated by, “a single nose down rotation of the trim wheel immediately after moving the power control lever to the maximum power setting position.” Using this procedure, the amount of time in excess of the 50 pound limit was temporary, and deemed sufficiently brief so as to be suitable.

During the certification process, the FAA evaluated both manual and electric trim options as well as the accessibility and ease of use of the trim control. Trim forces during flight tests were evaluated for magnitude and duration remained within the success criteria outlined later in this section.

2. Airplane Flight Manual Procedures

Piper has provided a Balked Landing Procedure in its AFM that utilizes an acceptable method of control inputs to alleviate the control forces. Piper’s mitigating procedure consists of smoothly advancing the power to MCP while the pilot simultaneously applies nose down trim to alleviate all control forces.

3. Flight Manual Warnings

Piper has added warnings to the AFM, which require the use of pitch trim as an Equivalent Level of Safety. The FAA evaluated the proposed flight manual warning statement during the flight evaluations.

4. Flight Test Evaluations

The FAA conducted a thorough flight evaluation in support of this ELOS request. This evaluation was conducted under the following conditions:

- Multiple FAA pilots participated in the evaluation. A formal Multi-Pilot System Usability Evaluation was not necessary.
- Production trim and closeouts were installed around the trim wheel for the evaluation.

- A data acquisition system was used to record time and force traces.
- The maneuvers were conducted using the least favorable weight and C.G.
- The pilots evaluated the use of electric trim and ensured that no additional hazard exists if this feature fails. An evaluation of manual trim was performed for identical maneuvers.
- Pilots trimmed only to relieve stick forces.
- Pilots evaluated the maneuvers required to show compliance with § 23.145 (b)(2) and (4).
- Pilots also evaluated operationally relevant balked landing maneuvers using the following procedure:
 - Balked landing (gear down) with thrust set to maintain approach speed on a three-degree glide path from the three different flaps settings: UP, T/O, and LND, at 200 feet above the runway.
 - Balked landing (gear down) with thrust set to maintain approach speed on a three-degree glide path, with flaps at LND, and 50 feet above the runway.

The flight evaluation had the following success criteria.

- Forces in excess of 50 pounds, which the use of trim could not immediately relieve, were not allowed.
- Forces that would affect the pilot's ability to hold the desired pitch attitude, or result in excessive airspeed or AOA excursions were not allowed.
- Balked landing demonstrations did not require exceptional skill and ability, and did not result in any unsafe condition.
- Workload during these maneuvers was evaluated against a startled or unsuspecting pilot standard.
- The manual pitch trim system must be quickly and easily accessible, and if the electric trim feature fails, easily controllable.

FAA approval and documentation of the ELOS finding:

The FAA has approved the aforementioned equivalent level of safety finding in project issue paper F-1. This memorandum provides standardized documentation of the ELOS finding that is non-proprietary and can be made available to the public. The Accountable Directorate has assigned a unique ELOS Memorandum number (see front page) to facilitate archiving and retrieval of this ELOS. This ELOS Memorandum number must be listed in the Type Certificate Data Sheet under the Certification Basis section for TCs & ATCs. An example of an appropriate statement is provided below.

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

14 CFR 23.145(b)(2)(4)

//SIGNED//

June 16, 2016

Mel Johnson, Acting Manager
Small Airplane Directorate
Aircraft Certification Service

Date

ELOS Originated by Atlanta ACO:	Mariusz Wisniewski	ACE-116A
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