



# Federal Aviation Administration

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## Memorandum

Date: January 8, 2008

From: Manager, Small Airplane Directorate, ACE-100

To: Pilatus PC-12/47E Project File and ELOS File

Prepared by: Doug Rudolph, Aerospace Engineer, ACE-112

Subject: Equivalent Level of Safety to 14 CFR Part 23.1545 (b)(4); Pilatus PC-12/47E, Finding No. ACE-07-15

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This memorandum requests your office to review and provide concurrence with the proposed finding of Equivalent Level of Safety (ELOS) to the ASI Flap Markings 14 CFR, part 23, § 23.1545 (b)(4).

### **BACKGROUND**

The Pilatus PC-12/47E is a 10,450-pound single-engine, 9 passenger airplane powered by a new 1,200 shaft horsepower (SHP) Pratt & Whitney PT6A-67P turboprop engine. The PC-12/47E is an upgrade of the certified PC-12/47 model airplane with the following improvements:

- APEX New Cockpit and Avionics System (Honeywell)
- PGDS Power Generation and Distribution System
- CPCS Cabin Pressurization and Control System
- ECS Environmental Control System
- ENGINE Pratt & Whitney PT6A-67P
- ESIS Electronic Standby Instrument System

As part of this new model certification, the certification basis for the areas that are not affected by the modification should remain the same from the PC-12/47 model, unless an unsafe condition exists. This includes one ELOS that was granted for the PC-12/47 and the one ELOS that was extended for that model.

## APPLICABLE REGULATIONS

Section 23.1545 (b)(4) requires:

*(b) The following markings must be made:*

*(4) For the flap operating range, a white arc with the lower limit at VSO at the maximum weight and the upper limit at the flaps extended speed VFE established under § 23.1511.*

## REGULATIONS REQUIRING AN ELOS

In considering the current design, the applicant has requested an ELOS for one specific condition of the *Airspeed indicator* Section of 14 CFR, part 23. The Federal Office of Civil Aviation (FOCA) has issued an ELOS to this regulation for the corresponding European Aviation Safety Agency (EASA) type certificate (TC), per FOCA CRI F-11 stage 1.0. The Federal Aviation Administration (FAA) has determined that an appropriate level of safety can be provided by the issuance of an ELOS, in accordance with the provisions of 14 CFR, part 21, § 21.21(b)(1).

## DESCRIPTION OF COMPENSATING FEATURES

### Discussion

The Pilatus PC-12/47E aircraft incorporates the Honeywell Primus Apex™ integrated avionics suite and an “all-glass” cockpit. Primary flight information is indicated to the crew on the pilot’s Primary Flight Display (PFD) and optionally the copilot’s PFD. Airspeed is indicated to the crew by means of a moving vertical tape in combination with a rolling digit indicator on the left hand side of the ADI section of each pilot’s PFD.

In accordance with guidance provided in FAA Advisory Circular AC 23.1311-1B, the linear airspeed tape indicator includes airspeed awareness cues that are equivalent, or superior to the cues provided by traditional round dial type indicators. These awareness cues include:

- Altitude dependent  $V_{MO}/M_{MO}$  airspeed limitation indication (barber pole bar).
- Aircraft configuration related airspeed constraints (red bar and speed bugs).
- Airspeed trend vector, indicating predicted airspeed with 6 seconds look ahead (white bar).
- Aircraft configuration dependent low-speed awareness indication (red bar).

In addition to these awareness cues, the system also includes the following “attention getters” to alert the crew of imminent or actual alert conditions:

- “STALL” and “OVERSPEED” annunciations displayed on the ADI section of the PFD to alert the pilot of an imminent stall or speed exceedance condition.

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- Color changes or emphasis of display elements (e.g. color change of digital airspeed readout).

Figure 1 provides examples of the airspeed awareness cues provided by the PC-12E Primus Apex™ system.

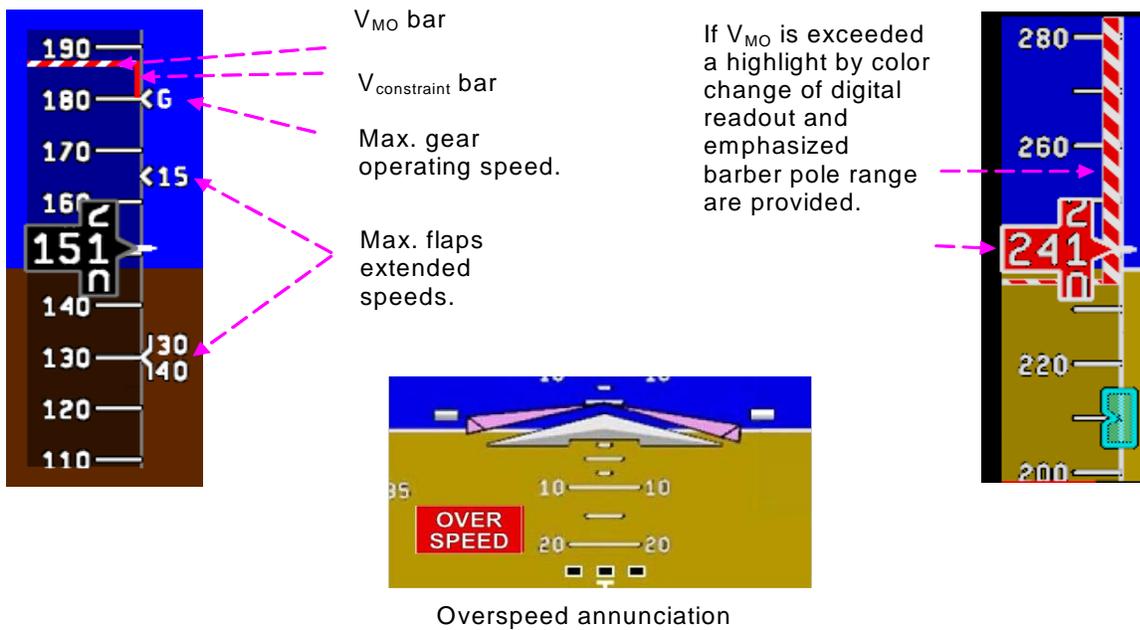


Figure 1 – Examples of airspeed awareness cues on the PC-12E Primus Apex system<sup>1</sup>.

<sup>1</sup> All airspeed values in the figures are generic and may not actually represent the airspeed limitations of the PC-12E.

Pilatus is of the opinion that the airspeed indication and airspeed awareness cues implemented in the PC-12E Primus Apex system, provide an equivalent level of safety to what is required by 14 CFR, part 23, § 23.1545 (b)(4) for the following reasons:

1. The intent of 14 CFR, part 23, § 23.1545 (b)(4) is to provide awareness to the crew of the airspeed range (relative to the present airspeed) within, which the flaps can be safely fully extended.
2. The implementation of the PC-12E Primus Apex airspeed indicator follows the guidance provided in AC 23.1311-1B and provides airspeed awareness cues that are equivalent, or superior to the traditional round dial type indicator.
3. The airspeed indicator markings required by 14 CFR, part 23, § 23.1545 are very much written with a round-dial type indicator in mind. Applying these markings to linear tape style airspeed indicators may under some circumstances lead to conflicts with other symbols. On the PC-12E Primus Apex™ system, such a conflict would exist between the Flaps operating range marking required by 14 CFR, part 23, § 23.1545 (b)(4) and the airspeed trend vector, both of which have the appearance of a white bar alongside the airspeed tape.
4. The PC-12E Primus Apex™ system will display speed constraints associated with flap and gear configuration as described below.

The safe flap extension and landing gear operating speed constraints as published in the Limitations section of the Aircraft Flight Manual (AFM) are marked on the airspeed tape by bugs as shown in the table below (see Fig. 1 for an example of the actual appearance on the airspeed tape):

| Meaning                                      | Symbol | Speed Bug Label | Speed Bug Fixed Position |
|--|--------|-----------------|--------------------------|
| Landing gear operation speed constraint.     | <      | G               | 180 KCAS                 |
| Flaps extended 15° speed constraint.         | <      | 15              | 165 KCAS                 |
| Flaps extended 30° and 40° speed constraint. | ⋈      | 30<br>40        | 130 KCAS                 |

In addition, the following aircraft configuration dependent speed constraint symbols are displayed on the airspeed tape:

| Condition  | Speed constraint symbols  |
|--|---|
| Landing gear in transit (extending or retracting). | Red speed constraint bar from $V_{MO}$ down to the landing gear operation speed bug (180 KCAS).   |
| Flaps extended 15°.                                | Red speed constraint bar from $V_{MO}$ down to the flap extended 15° speed bug (165 KCAS).        |
| Flaps extended 30° or 40°.                         | Red speed constraint bar from $V_{MO}$ down to the flap extended 30° or 40° speed bug (130 KCAS). |

If the current airspeed exceeds a speed limit (as marked by the red speed constraint bar or the  $V_{MO}$  barber pole), the Primus Apex™ system will alert the crew by changing the color of the digital airspeed readout.

### APPLICANT POSITION

Based on the information provided in the previous sections, Pilatus is of the opinion that display of the safe Flaps operating speeds as implemented in the PC-12E Primus Apex™ system fully meets the intent of the 14 CFR, part 23, § 23.1545 (b)(4) rule and provides an equivalent level of safety. FOCA is kindly requested to issue a CRI to allow an ELOS finding to this extent to be recorded.

### FOCA/EASA POSITION

After an analysis with the PC-12/47E certification team for the Flaps speed range markings on linear vertical Airspeed Indicator, FOCA is of the opinion that the design chosen should be equivalent, or should exceed the intent of 14 CFR, part 23, §1545(b)(4). However, the applicant will have to demonstrate through the Human Factors ground and flight test evaluations planned in the program that this design is effectively equivalent in safety. This means that the awareness of speed, speed dynamic behaviour in relation to the setting of the Flaps is ensured for all phase of flight under adverse flight conditions. FOCA would also make sure that the speed bugs for VR (rotation),  $V_x$  (Best angle of climb),  $V_y$  (Best rate of climb), VAPP (approach), or any other indication do not clutter these primary essential cues.

### FAA Position

The above is from the FOCA developed CRI F-11 stage 1.0. The FAA documented this FOCA CRI and coordinated FAA agreement on FAA Issue Paper S-9.

The FAA is in full agreement with FOCA/EASA position on this issue.

There have been no unsafe conditions documented to this data that would warrant not issuing this ELOS for this airplane.

## RECOMMENDATION

The FAA recommends approval of the applicant's proposal.

## CONCURRED BY

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| <i>Doug Rudolph for</i>                           | <i>1-7-08</i> |
| _____<br>Manager, Project Support Office, ACE-112 | _____<br>Date |

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|---|---------------|
| <i>Mark B. James for</i>                    | <i>1-8-08</i> |
| _____<br>Manager, Standards Office, ACE-110 | _____<br>Date |

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| <i>John Colomy for</i>                                | <i>1-8-08</i> |
| _____<br>Manager, Small Airplane Directorate, ACE-100 | _____<br>Date |