



Federal Aviation Administration

Memorandum

Date: January 7, 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 §23.1326(b)(1); Pilatus PC-12/47E,
Finding No. ACE-07-14

This memorandum requests your office to review and provide concurrence with the proposed finding of Equivalent Level of Safety (ELOS) to the Probes OFF caution 14 CFR part 23, § 23.1326(b)(1).

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 23.1326(b)(1) requires:

(b) The indication provided must be designed to alert the flight crew if either of the following conditions exist:

(1) The pitot heating system is switched "off."

REGULATIONS REQUIRING AN ELOS

In considering the current design, the applicant has requested an ELOS for one specific condition of the *Pitot heat indication systems* 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-12 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. Crew alerts are displayed in a dedicated Crew Alerting System (CAS) window on the lower Multi-Function Display (MFD). One of the philosophies applied to the design of the PC-12/47E Human-Machine Interface (HMI) is the “dark and quiet cockpit” philosophy. This implies that in principle only (non-normal) system conditions that require crew action or crew awareness are annunciated to the crew. Hence, if there are no system conditions that require crew action or crew awareness, the CAS window is empty (black), representing normal operating conditions.

The PC-12/47E, just like its predecessor models, is to be certified for flight in known icing conditions. Therefore, the aircraft’s Pitot and Static probes are equipped with heating elements. The heating elements can be switched ON or OFF by the crew by means of the “PROBES” rocker switch located on the left-hand crossbar panel. In the interest of the service life of the heating elements, the normal operating procedure is to only switch the probe heaters on once the aircraft is lined up on the runway and ready for departure, thus avoiding prolonged operation of the heaters on the ground without a cooling airflow.

To ensure that the crew does not forget to switch on the probe heaters, the Primus Apex™ system will raise a caution alert (amber “Probes Off” message displayed in the CAS window accompanied by a single chime), as soon as it detects that the Outside Air Temperature (OAT) is less than 10°C and the “PROBES” switch is in the OFF position.

Pilatus is of the opinion that the implementation of the “Probes Off” caution on the PC-12/47E provides an equivalent level of safety to what is required by 14 CFR, part 23, § 23.1326(b)(1) for the following reasons:

1. The intent of the 14 CFR, part 23, § 23.1326(b)(1) rule is to protect the crew from inadvertently operating the aircraft in an environment where ice formation on the pitot probes might occur with the pitot heating system switched off.
2. It is generally accepted that icing conditions (during flight or ground operations) can occur and ice protection systems or procedures should be activated, when OAT is below 50 degrees F (10 degrees C) and visible moisture in any form is present, or when there is standing water, ice, or snow on the runway and/or taxiways.
3. The Apex systemTM will post an amber “Probes Off” caution message in the CAS window when the following condition is true:

(“Probes” switch = OFF) AND ((OAT_{LH} <= 10°C) OR (OAT_{RH} <= 10°C))

The OAT is independently sensed by both channels of the Apex Air Data Attitude Heading Reference System (ADAHRS). The temperature sensor of ADAHRS channel A is mounted under the LH wing (providing OAT_{LH}). The temperature sensor of ADAHRS channel B is mounted under the RH wing (providing OAT_{RH}). The OAT data is provided to the Modular Avionics Unit (MAU) and is processed by the Monitor Warning Function (MWF) running in each channel of the MAU. The MWF evaluates the logic expression driving the “Probes Off” caution and will activate it as required. Failure of an ADAHRS or one MAU channel is annunciated to the crew, in which case the remaining ADAHRS/MAU channel will still support the Probes Off alert function.

4. FAA Advisory Circular AC 23-17B, section 23.1326 outlines two negative issues related to the 14 CFR, part 23, § 23.1326(b)(1) rule:
 - a. It violates the “dark cockpit” where caution and warning lights only represent failure conditions.
 - b. Adherence to a “dark cockpit” philosophy will cause pitot heat operation in all environmental conditions, which will shorten the life of the system.

With the implementation outlined under item 3, Pilatus meets the intent of the 14 CFR, part 23, § 23.1326(b)(1) rule (see item 1), while addressing the negative issues associated with the rule as indicated under item 4.

Related Regulatory Material

FOCA brought the existence of FAA Policy Statement PS-ACE100-2002-007 to the attention of Pilatus. Policy Statement addresses possible misinterpretation of guidance for an ELOS for 14

CFR, part 23, § 23.1326(b)(1) contained in an earlier version of AC 23-17 (revision A). AC 23-17A states:

"An aircraft design that does not include a caution annunciation when the pitot heat is Off may be eligible for an ELOS finding that preserves a "dark cockpit" provided a placard or flight manual prescribes when to operate the pitot heat."

This Policy Statement implies that aircraft like the PC-12/47E are not eligible for an ELOS based on the guidance presented in AC 23-17A. Pilatus is of the opinion that this Policy Statement does not apply to the request for an ELOS finding contained in present memo for the following reason:

Pilatus is not using the guidance provided in AC 23-17A as the basis for the request for an ELOS finding. Pilatus will not (as the guidance suggests) eliminate the "Probes Off" caution and replace it with a Flight Manual procedure and/or a placard. Instead, Pilatus will retain the "Probes Off" caution (thus fully complying with the intent of 14 CFR, part 23, § 23.1326(b)(1)), while ensuring that the caution is not posted, when there is no requirement for crew action due to the absence of (potential) icing conditions (thereby addressing the concerns noted in revised AC 23-17B).

APPLICANT POSITION

Based on the information provided in the previous sections, Pilatus is of the opinion that the implementation of the "Probes Off" caution on the PC-12/47E Primus Apex™ system meets the intent of the 14 CFR, part 23, § 23.1326(b)(1) 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 a review with the PC-12/47E certification team for the "Probe Off" caution deactivated when the OAT is above 10°C (50°F), FOCA is of the opinion that this design chosen is compliant with the intent of 14 CFR, part 23, § 23.1326(b)(1), and that the design philosophy of "dark and quiet cockpit" is preferable in this situation. However, the applicant shall carefully design this function to ensure that the caution will be reliable enough as the failure effect might be at least hazardous due to the potential of simultaneous loss of speed, Angle-of-Attack (AOA) and altitude indications. Also, the stick shaker and pusher function might be seriously impacted.

FAA Position

The above is from the FOCA developed CRI F-12 stage 1.0. The FAA documented this FOCA CRI and coordinated FAA agreement on FAA Issue Paper S-8.

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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Manager, Project Support Office, ACE-112	Date
<u><i>Mark B. James for</i></u>	<u><i>1-7-08</i></u>
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