Federal Aviation Administration

Memorandum

Date: September 15, 2010

To: Manager, Small Airplane Directorate, ACE-100

From: Manager, Project Support Branch, ACE-112

Prepared by: Albert J. Mercado, Project Officer, ACE-112

Subject: Equivalent Level of Safety (ELOS) Finding for Liquid Cooling and Cooling Tank for Costruzioni Aeronautiche Tecnam s.r.l. P2006T, FAA Project Number CE0108AM

ELOS Memo#: ACE-10-17

Regulatory ref: 14 CFR, part 23, §§ 23.1061(b), 23.1063

This memorandum requests your office to review and provide concurrence with the proposed equivalent level of safety (ELOS) finding for the Costruzioni Aeronautiche Tecnam s.r.l. P2006T liquid cooling and cooling tank.

BACKGROUND

The P2006T is a normal category, high wing, twin engine monoplane with four seat capacity (including 1 pilot).

The aircraft is equipped with two reciprocating engines Rotax 912S3, which have liquid-cooled cylinder heads and ram air-cooled cylinders. This engine uses a closed loop liquid cooling systems with external expansion tank and overflow bottle.

The engine is certified under Title 14 Code of Federal Regulations (14 CFR) part 33. 14 CFR part 23, § 23.1061(b), requires that a coolant tank must have a capacity of at least 1 U.S. gallon. Rotax 912 engines require, in the installation manual, an expansion tank of 0.25 litres and an overflow bottle of 0.5 litres. The minimum capacity of the Rotax cooling system is not in compliance with § 23.1061(b) requirements.

The European Aviation Safety Agency (EASA) granted an Equivalent Safety Finding to the liquid cooling and cooling tank requirements identified in Certification Specifications

23.1061(b) and 23.1063 during its certification. This is documented in the EASA Type Certification Data Sheet (TCDS) and CRI E-01.

The applicant proposes a similar ELOS to 14 CFR, part 23, § 23.1061(b) for the FAA validation. The proposed ELOS will allow for the utilization of a coolant tank that has a capacity less than that required by § 23.1061(b)

The applicable regulation is 14 CFR, part 23, § 23.1061(b) which states:

> (b) *Coolant tank.* The tank capacity must be at least one gallon, plus 10 percent of the cooling system capacity. In addition—
>
> (1) Each coolant tank must be able to withstand the vibration, inertia, and fluid loads to which it may be subjected in operation;
> (2) Each coolant tank must have an expansion space of at least 10 percent of the total cooling system capacity; and
> (3) It must be impossible to fill the expansion space inadvertently with the airplane in the normal ground attitude.

The FAA has researched the origins of § 23.1061(b) with respect to the coolant tank volume requirements. The coolant tank volume requirements date from at least 1945; and have been unchanged since then. The types of liquid coolant systems in service at that time were systems utilized on lower powered gasoline engines, neither the type of engines, nor the type of system that the requirement was applicable to was envisioned when the requirement originated.

Because of this, the FAA believes that despite the prescriptive nature of this regulation, its basis in five-decade-old technology compels the FAA to review the need for the requirement.

To ensure an ELOS to the general intent of § 23.1061(b) for a safety margin in case of coolant fluid loss, the following are requirements of the design:

- The expansion tank capacity must be shown to be large enough to ensure safe operation of the cooling system in case of cooling fluid loss that could be expected in service. This needs to be demonstrated by analysis and tests. The minimum and maximum fluid levels need to be established.

- Demonstrate that the reduced thermal buffer capacity of the cooling tank does not affect the safe operation and the emergency capability adversely. This needs to be shown for both heating up and cooling down. The cooling capacity of the system needs to be shown to be able to compensate for the reduced thermal buffer capacity.

- The expansion tank must be able to withstand the vibration, inertia and fluid loads to which it may be subjected in operation, as required in § 23.1063.

APPLICABLE REGULATION(S)

The certification basis for the Costruzioni Aeronautiche Tecnam s.r.l. P2006T is 14 CFR part 23 Normal Category, as amended through Amendment 23-57. Additional Special Conditions, ELOS, and Exemptions may be incorporated during this project.

REGULATION(S) REQUIRING AN ELOS FINDING

14 CFR, part 23, §§ 23.1061(b), 23.1063

Description of compensating design features or Alternative Methods of Compliance (AMOC), which allow the granting of the ELOS (include design changes, limitations or equipment need for equivalency)

P2006T is equipped with two Engines Rotax 912S3. These engines are not provided with a coolant tank, but only with an expansion tank and an overflow bottle. The Rotax engine is only partially liquid-cooled, the cylinders are ram air cooled, while the cylinders heads are liquid cooled. The liquid provides cooling only for cylinder heads. Therefore, a large volume of liquid coolant is not necessary. The total system capacity is 1.4 lt.

The compensating features and alternate methods of compliance proposed by Costruzioni Aeronautiche Tecnam s.r.l. are provided below.

- The liquid cooling system is a closed loop with external expansion tank and overflow bottle. In normal operation a closed loop cooling system does not have loss of cooling fluid, the expansion tank ensures a proper fluid level in various temperature and pressure situations. The overflow bottle is in the non pressure area of the system and ensures that additional fluid amount is available. The overflow bottle collects surplus of coolant and returns it back into the circuit at the cooling down period. No refill of coolant prior to flight is necessary, so that no direct access of the pilot to the system for pre-flight check is necessary. The minimum and maximum fluid levels are established by analysis.

- Flight tests have demonstrated that operative temperatures in all areas of the flight envelope are always within the limits prescribed by the engine's manufacturer. Ground tests have demonstrated that operative temperatures are always within the limits prescribed by the engine's manufacturer. A low coolant fluid low level warning system is installed in order to give the pilot adequate indication.

- Expansion tank and overflow bottles are installed in a way that they are free of vibration and able to withstand the inertia and fluid loads to which it may be subjected in operation. The expansion tank and the overflow bottles have been tested as per 14 CFR, part 23, § 23.1063.

Based on the results from the tests and analysis, the Costruzioni Aeronautiche Tecnam s.r.l. proposes the design features are shown to ensure safe operation and meets the intent of the rule.

FAA APPROVAL AND DOCUMENTATION OF THE ELOS FINDING

The ELOS requested by Costruzioni Aeronautiche Tecnam s.r.l. and concurred with the EASA/ENAC for subject requirements is acceptable to the FAA.

The FAA has approved the aforementioned equivalent level of safety finding in project issue paper P-1. 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.

Equivalent Level of Safety Findings has been made for the following regulation(s):
14 CFR, part 23, §§ 23.1061(b), 23.1063.

William J. Timberlake	***9-15-10***
Acting Manager, Small Airplane Directorate Aircraft Certification Service	Date

ELOS Originated by Small Airplane Directorate:	Acting Manager, Project Support Branch, Mike Kiesov	Routing Symbol: ACE-112