Subject : Special Condition - Airworthiness Standard for CS-22H - Turbine Engine to be operated in Powered Sailplanes

Status : closed

Requirement reference : Commission Regulation (EC) No. 1702/2003, 21A.16B(a)(1); CS-22,Subpart H

Statement of issue:

Since the Turbine Engine design is not yet covered by CS-22 Subpart H, a Special condition in accordance with para. 21A.16B(a)(1) is required to address this specific design.

Discussion

Because of the intended use of this engine, i.e. installation in self-sustaining sailplanes only and no usage for take-off operation, it is considered an undue burden for the applicant to base the EASA Certification for this engine on the Certification Specifications of CS-E. Therefore, between EASA, CAA-CZ and LBA a set of Special Conditions has been developed in order to address the turbine engine design. The general approach of this CRI is to change/amend Subpart H of CS-22 by introducing 17 Special Conditions which specifically address the Turbine Engine Design.
Accordingly, the following paragraphs of CS-22 Subpart H have been replaced by individual Special Conditions: CS 22.1801, CS 22.1825, CS 22.1833, CS 22.1835, CS 22.1839, CS 22.1843, CS 22.1845, CS 22.1849, CS 22.1851.
The following paragraphs of Subpart H are retained as being applicable for turbine engines as well:
CS 22.1805, CS 22.1807, CS 22.1808, CS 22.1815, CS 22.1817, CS 22.1819, CS 22.1821, CS 22.1823, CS 22.1853, CS 22.1855, CS 22.1857.

EASA Position:

1. EASA Special Conditions :

SC1: Applicability

The Special Conditions SC1...SC17 are applicable to turbine engines for powered sailplanes.

Because of the use of these engines in sailplanes, there are several assumptions, to simplify the requirements for certification.

The assumptions are:

- engines will be used for self-sustaining sailplanes only, not intended for take-off
- no bleed air, no reverse functions
- no flight in icing or hail conditions
- no aerobatic operation
- the turbine engine is not used to drive accessories that are essential for any other means than the turbine engine itself
- the strike and ingestion of foreign matter can be treated as extremely remote, because the engine is started and shut down in flight. Ground operation will only take place for maintenance purpose.

SC2: Functioning

The engine must be free from dangerous surge and instability throughout its operating range of ambient and running conditions within the air intake pressure and temperature conditions declared by the constructor.

SC3: Accessory Attachment

Each accessory drive and mounting attachment must be designed and constructed so that the engine will operate properly with the accessories attached. The design of the engine must allow the examination, adjustment or removal of each engine accessory. The engine shall not provide accessory drives other than used for essential engine equipment which is part of the engine Type Design.

SC4: Engine Control System

(a) Engine Control System Operation. It must be substantiated by tests, analysis or a combination thereof that the Engine Control System performs the intended functions in a manner which –

(1) Enables selected values of relevant control parameters to be maintained and the Engine kept within the approved operating limits over changing atmospheric conditions throughout the declared flight envelope, and

(2) Does not create unacceptable thrust or power oscillations.

b) It must also be demonstrated that the engine is capable of functioning properly in case of exposure to electromagnetic interference. The demonstrated levels have to be included in the Installation Instructions.

SC5: Vibration
The engine must be designed and constructed to function throughout its declared flight envelope of rotational speeds and power/thrust, without inducing excessive stress in any Engine part because of vibration and without imparting excessive vibration forces above the approved aircraft limitations on the structure of the powered sailplane.

SC6: Fuel and induction system
(a) The fuel system of the engine must be designed and constructed to supply the appropriate fuel throughout the complete operating range of the engine under all starting, flight and atmospheric conditions. It should also keep the rotational speed in the range, defined by the manufacturer.

(b) The engine intake shall be designed and constructed to minimise ice accretion.

(c) The type and degree of fuel filtering necessary for protection of the engine fuel system against foreign particles in the fuel must be specified. The applicant must show (e.g. within the 50-hour run prescribed in SC10(a) that foreign particles passing through the prescribed filtering means will not critically impair engine fuel system functioning.

(d) The engine design has to prevent situations in which fuel may accumulate inside the engine while not in use. This applies to all attitudes that the applicant establishes as those the engine can have when the powered sailplane in which it is installed is in the static ground attitude.

SC7: Lubrication system
(a) The design of the oil system must be such as to ensure its proper functioning under all intended flight attitudes, installation, atmospheric and operating conditions, including oil temperature and expansion factors.
(b) If required by the engine design, provisions shall be provided to allow for the installation of means for cooling the lubricant.
(c) The oil system including the oil tank expansion space must be adequately vented.

SC8: Vibration Test

(a) The engine must undergo a vibration survey to establish that the vibration characteristics of those components that may be subject to mechanically or aerodynamically induced vibratory excitations are acceptable throughout the declared flight envelope. The engine surveys and their extent must be based upon an appropriate combination of experience, analysis and component test and must address, as a minimum, blades, vanes, rotor discs, spacers and rotor shafts.

(b) The surveys must cover the ranges of power or thrust and both the physical and corrected rotational speeds for each rotor system, corresponding to operations throughout the range of ambient conditions in the declared flight envelope, from the minimum rotational speed up to 103% of the maximum physical and corrected rotational speed permitted for rating periods of two minutes or longer and up to 100% of all other permitted physical and corrected rotational speeds, including those that are Over-speeds. If there is any indication of a stress peak arising at the highest of those required physical or corrected rotational speeds, the surveys must be extended sufficiently to reveal the maximum stress values present, except that the extension need not cover more than a further two percentage points increase beyond those speeds.

SC9: Calibration Test

In order to identify the engine thrust or power changes that may occur during the endurance test of SC10, thrust or power calibration curves of the test engine must be established either by specific tests accomplished immediately before and after the endurance test or by measurements obtained during the first and final stages of the endurance, up to the highest rated power.

SC 10: Endurance test

(a) The engine must be subjected to an endurance test (with a representative propeller for turbo-prop) that includes a total of 50 hours of operation and consists of the cycles specified below:

Sequence	Duration (Minutes)	Operating Conditions
1	1	Starting Idle
2	10	Maximum power / Thrust
3	1	Cooling run (idle)
4	5	Maximum power / Thrust
5	1	Cooling run (idle)
6	30	Maximum continuous power / Thrust
7	1	Cooling run
8	10	Acceleration and deceleration consists of 6 cycles from Ground Idling to Maximum Power / Thrust, maintaining Maximum Power / Thrust for a period of 30 seconds, the remaining time being at Ground Idling
9	1-3	Cooling run (idle) and stop
Total:		60-62

(b) During or following the endurance test the fuel and if applicable oil and gas consumption must be determined.

SC11: Operation test
The operation test shall include the demonstration of characteristics in case of idling, transitional characteristics among operational stages, characteristics of acceleration of design load, characteristics in case of overspeeding as well as any other operational characteristics of the engine.

SC12: Cyclic Endurance Test
Depending on the results of the tests prescribed in SC8, additional endurance testing may be required at one or more particular rotational speed(s) to find out whether the engine may be operated without fatigue failure.

SC 13: Rotor Containment
For each high-energy engine rotor, the engine must be designed to provide containment of the Maximum kinetic energy fragments from the hub failure as specified in SC14(c).

SC 14: Containment
(a) Compliance with SC13 of each high-energy rotor, critical and non-critical[1)], must be substantiated by test, analysis or combination thereof as specified in SC14(a)(1) and (a)(2), under the conditions of SC14(b), (c) and (d).
(1) The critical rotor of each compressor and turbine rotor assembly must be substantiated by engine test.
Analyses and / or component or rig tests may be substituted only if they are validated by engine test.
(2) Non-critical rotors may be substantiated by validated analysis.

(b) Containment must be demonstrated at the following speed and temperature conditions:
(1) The highest speed which would result from either:
(i) Any single failure of the Engine Control System, or

(ii) Any single failure or likely combination of failures not considered to be Extremely Remote.
(2) The temperature of the containing components must not be lower than the temperature during operation of the engine at maximum power/thrust rating.

(c) Containment must be substantiated as hub containment under the following condition: for all types of compressors and turbines, fragments resulting from a failure which produces the maximum translational kinetic energy.
Note: The containment tests have to be performed with the engine fitted to a representative mounting system intended to be used for the typical aircraft installation.

(d) It must be shown that the following specifications were met:
(1) The engine did not experience a sustained external fire
(2) The engine did not release high-energy fragments radially through the engine casings
(3) The engine did not axially release any substantially whole rotors with residual high energy.
(4) If debris were ejected from the engine inlet or exhaust, the approximate reported maximum size, weight, energy and trajectory of the debris must be estimated and provided in the engine instructions for installation.

1) A critical Rotor is a Rotor for which the engine design provides the smallest margin for containment in the defined conditions. The margin for containment addresses the direct containment of the failed part as well as potential secondary effects which could produce an end effect identified under SC17.

SC15: Continued Rotation
If the engines rotating system will continue to rotate after the engine is shutdown for any reason while in flight, and means to prevent that continued rotation are not provided, any continued rotation during the maximum period of flight and in flight conditions expected to occur with that engine inoperative must not result in effects that would be unacceptable under SC17.

SC16: CS22.1823 (c) - (Amendment to CS22.1823):
For Turbine engines, the compliance demonstration to CS 22.1823(b) has to address engine seizure and blade off loads.

SC17: Safety Analysis
An analysis of the engine including its control system must be carried out in order to assess at least those failures that could result in hazardous engine effects such as non-containment of high energy debris, uncontrolled fire, failure of the engine mount system leading to inadvertent engine separation, complete inability to shut the engine down.
It must be shown that Hazardous Engine Effects are predicted to occur at a rate not in excess of that defined as Extremely Remote (probability less than 1E-05 per engine flight hour).

SC18: CS 22.1808 Selection of engine power and/or thrust ratings
(adjustment to the headline for consistency with terminology in this CRI)

AMT Netherlands b.v. Position:

Agreed

Conclusion:
Closed