SC1: Applicability

(a) The herein Special Conditions SC1...SC17 are applicable to turbine engines for kit helicopters, for which an application for eligibility has been made to DGAC under French regulation *"Arrêté du 22 septembre 1998 relatif au Certificat de Navigabilité Spécial d'aéronef en Kit (CNSK)"*.

(b) These Special Conditions complete the following paragraphs of CS-VLR appendix B, which are also retained as applicable to turbine engines for kit helicopters:
B.VLR.5, B.VLR.7, B.VLR.9, B.VLR.11, B.VLR.13, B.VLR.15, B.VLR.17, B.VLR.19, B.VLR.23, B.VLR.25, B.VLR.27, B.VLR.29, B.VLR.31, B.VLR.51, B.VLR.53, B.VLR.55

(c) The following assumptions are retained for the engine design and use:
- single engine;
- no bleed air;
- no emergency power ratings;
- no flight in icing or hail conditions;
- no aerobatic operation.

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: Instruction Manual:

Instruction for installing and operating the engine must be established. In particular, the following instructions must be included:

(a) The operating limitations, including any relevant limitation on temperatures for turbine outlet and oil.

(b) The power ratings and procedures for correcting for non standard atmosphere.

(c) The recommended procedures under normal and extreme ambient conditions for –
(1) Starting;
(2) Operating on the ground; and
(3) Operating during flight.

SC4: Engine Control System

(a) The engine control system must operate with the ease, smoothness, and positiveness appropriate to its functions.

(b) 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 power oscillations.

(c) 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, without inducing excessive stress in any engine part because of vibration and without imparting excessive vibration forces above the approved helicopter limitations on the structure of the helicopter.

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 endurance 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 helicopter 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 these 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 and both the physical and corrected rotational speeds far 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 power changes that may occur during the endurance test of SC10, 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 that includes 25 stages conducted according to the following sequences:

Sequence	**Duration (Minutes)**	**Operating Conditions**
1	1	Minimum test bed idle (1)
2	5	Take-off Power
3	5	Minimum test bed idle
4	5	Take-off Power
5	5	Minimum test bed idle
6	10	Maximum Continuous Power for stages 1 to 15 Take-off Power for stages 16 to 25
7	1	Minimum test bed idle (cooling run)
8	30	Maximum Continuous Power
9	50	Run covering the range in 15 approximately equal speed increments from Idling up to, but not including, Maximum Continuous Power.
10	10	Accelerations and decelerations consisting of 6 cycles from Idling to Take-off Power maintaining Take-off Power for a period 30 seconds, the remaining time being at Idling.
11	1	Minimum test bed idle (cooling run) and stop
Total:	123	

(c) Accelerations and Decelerations. During scheduled accelerations and decelerations between sequences 1 to 5 and in sequence 10 of the endurance test, the power demand shall be increased to Take-Off from the minimum test bed idle in a time not greater than one second.

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

(1) The “Minimum test bed idle” is the minimum practically possible power extraction from the engine in the test facility while the output shaft is at the governed speed.

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 over speeding 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 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 transitional 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 engine 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 effect that would be unacceptable under SC17.

SC16: B.VLR.23(c) - (Amendment to B.VLR.23):

For Turbine engines, the compliance demonstration to B.VLR.23(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).