PROPOSED SPECIAL CONDITION

for

Gyroplane - Road Vehicle Use

INTRODUCTORY NOTE:

The following Special Condition (SC) has been classified as important and as such shall be subject to public consultation in accordance with EASA Management Board decision 12/2007 dated 11 September 2007, Article 3 (2.) which states:

"*2. Deviations from the applicable airworthiness codes, environmental protection certification specifications and/or acceptable means of compliance with Part 21, as well as important special conditions and equivalent safety findings, shall be submitted to the panel of experts and be subject to a public consultation of at least 3 weeks, except if they have been previously agreed and published in the Official Publication of the Agency. The final decision shall be published in the Official Publication of the Agency.*"

IDENTIFICATION OF ISSUE

The Agency has received an application for the type certification of a two seat gyroplane, powered by two reciprocating engines. The Maximum Take Off Mass (MTOM) of this vehicle is approximately 910 kg, including the pilot and passenger.
Being a gyroplane, which is a particular kind of rotorcraft, the certification requirements for this product need to differ in certain aspects from those of helicopters. In particular, a part of the CS 27 technical specifications are not directly applicable to gyroplanes. This CS is also more helicopters oriented. It is therefore necessary to address the particularities of a gyroplane by establishing specific technical specifications in the form of a SC.
Additionally a set of SCs is necessary due to the double functionality of the product as gyroplane/road vehicle. This SC addresses those interfaces or aspects of the road vehicle affecting the flying mode as a gyroplane, but not any requirement affecting only the road functionality.

BACKGROUND/SCOPE

The Agency considers that the current certification specifications in CS-27 for rotorcraft are not fully adequate to prescribe the certification basis for a gyroplane to comply with the essential requirements of the Basic Regulation. Therefore there is a need to complement the applicable CS-27 with appropriate technical specifications in the form of special conditions that can be used to establish the certification basis for this gyroplane, in accordance with EASA Part 21.B.75 (a).1.

The SCs have been established taking into account the unique characteristics of this product and prescribe the set of technical specifications for the issuance of the type certificate, and changes to this type certificate, for a gyroplane of 1000 kg MTOM in the small category, including multiengine designs, as well as the road use of such aircraft when interfacing with the airworthiness of the gyroplane.

In order to enhance the readability of this document as well as to provide the visibility of the complete certification basis, it also shows the applicable CS-27 requirements. However, existing CS-27 requirements or already consulted Notices of Proposed Amendments are not part of the current consultation process.

The Special Conditions are identified by the prefix “SC” and any change to existing specifications adopted for gyroplanes is highlighted in grey. The set of technical specifications presented here for public consultation (*) are divided in two parts:
The first part addresses the technical specifications due to the particular characteristics of a gyroplane and not addressed in the current CS-27 (SC GP XXXX).
The second part addresses those technical specifications due to the road use of the vehicle which might interface with the airworthiness of the gyroplane (SC XXXX).

(*) Explanatory Note:
The SCs in this document have been established as far as possible on the basis of existing regulatory or standards material related to gyroplanes or aircraft of similar MTOW like from CS-27 Amendment 3, (11 December 2012), CS-23 Amendment 3 (13/July 2012) and from UK CAA tailored to small gyroplanes CAP643 BCAR T Issue 5 (British Civil Airworthiness Requirements Section T Light Gyroplanes). The text that differs from these airworthiness specifications has been shadowed as well in the relevant SCs to facilitate the review.

An example of the process made in tailoring this special condition to a gyroplane is provided hereafter.
While addressing some certification specifications, it was taken into account the gyroplane characteristics and the similarity with a small airplane or a small helicopter. For instance, for some performance aspects, as the engine installation losses determination, a gyroplane is more similar to a small airplane. Therefore, it was so decided that CS 23.45, adequately adapted, would be more appropriate to be used.
For a typical rotorcraft requirement such as height velocity diagram (CS27.79) the BCAR T79 text seems more appropriate for a gyroplane. In addition and more importantly, the conventional CS-27 approach that sets 7000 ft density altitude as a reference for determining the maximum certificated weight has been substituted with an approach that allows to determine the maximum certificated weight at sea level and the maximum take-off as a function of the altitude.
This approach has been considered more in line with the way a gyroplane is going to be operated.

Once the Agency has gained more experience with this type of product, the Agency might transpose the applicable parts of this special condition into a dedicated certification specification to gyroplanes of similar weight and flying characteristics, supplemented by CS-27 where necessary.

ABBREVIATIONS AND DEFINITIONS

Gyroplane: For the purpose of this SC a gyroplane is defined as rotorcraft with a non-power-driven rotor/s rotating about an axis which is vertical or nearly so, when the aircraft is in horizontal flight.

C_N:	Aerodynamic normal force coefficient.
EAS:	Equivalent airspeed. True airspeed x (p /po)½ where p is the air density and po is the air density in standard sea-level conditions.
IAS:	Indicated airspeed. The readings of the pitot-static airspeed indicator as installed in the rotorcraft, corrected only for instrument error.
ISA	International Standard Atmosphere.
V_D:	The Maximum Design Speed, EAS.
V_{DF}:	The Maximum Demonstrated Flight Speed, EAS. This must not exceed V_D.
V_H:	Maximum speed in level flight with the engine at maximum continuous power, IAS.
VMC:	Visual Meteorological Conditions.
$V_{MC\ (power\text{-}off)}$:	The minimum power-off control airspeed (IAS) at which control of the aircraft is assured in all axes following failure of the engine, including transient effects experienced at the point of failure.
$V_{MC\ (power\text{-}on)}$:	The minimum power-on control airspeed (IAS) at which control of the aircraft is assured in all axes with the engine producing the power required to maintain the flight condition.
V_{MIN}:	Minimum Level Flight Speed, IAS**,** limited by either power or controllability considerations.
V_{NE}:	The Never Exceed Speed, IAS.
V_Y:	Best Rate of Climb Speed, IAS

Considering all the above, the following Special Condition is proposed:

Proposed Special Conditions for Gyroplane combined with Road Vehicle use

SPECIAL CONDITION - Gyroplane - Issue 01 – May 2020

Subpart A - GENERAL

SC GP 27.1 Applicability

(a) This SC is applicable to a small gyroplane with a maximum weights of 1000 kg or less and 2 or less seats.

Subpart B - FLIGHT

GENERAL

CS 27.21 Proof of compliance

Each requirement of this Subpart must be met at each appropriate combination of weight and centre of gravity within the range of loading conditions for which certification is requested. This must be shown:

(a) By tests upon a rotorcraft of the type for which certification is requested or by calculations based on, and equal in accuracy to, the results of testing; and

(b) By systematic investigation of each required combination of weight and centre of gravity if compliance cannot be reasonably inferred from combinations investigated.

SC GP 27.25 Weight limits

(a) Maximum weight. The maximum weight, for each altitude and for each operating conditions, such as take off, enroute and landing, must be established so that it is:

(1) Not more than:

(i) The highest weight selected by the applicant;

(ii) The design maximum weight, the highest weight at which compliance with each applicable structural loading condition of this special condition is shown;

(iii) The highest weight at which compliance with each applicable flight requirement of this special condition is shown; or

(iv) reserved

(2) Not less than the sum of:

(i) The empty weight determined under CS 27.29;

(ii) The weight of usable fuel appropriate to the intended operation with full payload;

(iii) The weight of full oil capacity; and

(iv) For each seat, an occupant weight of 77 kg (170 lbs) or any lower weight for which certification is requested.

(b) Minimum weight. The minimum weight, the lowest weight at which compliance with each applicable requirement of this special condition is shown, must be established so that it is:

(1) Not more than the sum of:

(i) The empty weight determined under CS 27.29; and

(ii) The weight of the minimum crew necessary to operate the rotorcraft, assuming for each crew member a weight no more than 77 kg (170 lbs), or any lower weight selected by the applicant or included in the loading instructions; and

(2) Not less than:

(i) The lowest weight selected by the applicant;

(ii) The design minimum weight, the lowest weight at which compliance with each applicable structural loading condition of this special condition is shown; or

(iii) The lowest weight at which compliance with each applicable flight requirement of this special condition is shown.

CS 27.27 Centre of Gravity limits

The extreme forward and aft centres of gravity and, where critical, the extreme lateral centres of gravity must be established for each weight established under CS 27.25. Such an extreme may not lie beyond:

(a) The extremes selected by the applicant;

(b) The extremes within which the structure is proven; or

(c) The extremes within which compliance with the applicable flight requirements is shown.

CS 27.29 Empty weight and corresponding centre of gravity

(a) The empty weight and corresponding centre of gravity must be determined by weighing the rotorcraft without the crew and payload but with:

(1) Fixed ballast;

(2) Unusable fuel; and

(3) Full operating fluids, including:

(i) Oil;

(ii) Hydraulic fluid; and

(iii) Other fluids required for normal operation of rotorcraft systems, except water intended for injection in the engines.

(b) The condition of the rotorcraft at the time of determining empty weight must be one that is well defined and can be easily repeated, particularly with respect to the weights of fuel, oil, coolant, and installed equipment.

CS 27.31 Removable ballast

Removable ballast may be used in showing compliance with the flight requirements of this Subpart.

SC GP 27.33 Rotor speed limits

a) A range of rotor speed limits must be established which permits any manoeuvre appropriate to the type to be performed safely over the ranges of airspeed, all-up weight and altitude within which it is intended that the gyroplane must be operated.

b) At the critical combinations of weight, altitude and airspeed for any manoeuvre appropriate to the type the rotor speed must remain within the established safe range.

PERFORMANCE

SC GP 27.45 General

(a) Unless otherwise prescribed, the performance requirements of this subpart must be met for:

(1) Still air and standard atmosphere;

(2) reserved

(b) Performance data must be determined over the range of pressure altitude and temperatures for which certification is requested.

(c) Performance data must be determined with the cowl flaps or other means for controlling the engine cooling air supply in the position used in the cooling tests required by CS 27.1041 to 27.1045.

(d) The available propulsive thrust must correspond to engine power, not exceeding the approved power, less –

(1) Installation losses; and

(2) The power absorbed by the accessories and services appropriate to the particular ambient atmospheric conditions and the particular flight condition.

(e) The performance as affected by engine power must be based on a relative humidity of –

(1) 80% at and below standard temperature; and

(2) 34% at and above standard temperature plus 28°C (plus 50°F).

Between the two temperatures listed in subparagraphs (e) (1) and (e) (2) the relative humidity must vary linearly.

(f) Unless otherwise prescribed in determining the take-off and landing distances, changes in the aeroplane's configuration, speed and power must be made in accordance with procedures established by the applicant for

operation in service. These procedures must be able to be executed consistently by pilots of average skill in atmospheric conditions reasonably expected to be encountered in service.

(g) The following, as applicable, must be determined –

(1) Take-off distance of SC GP 27.51(c)

(2) reserved

(3) reserved

(4) Landing distance of SC GP 27.77.

The effect on these distances of operation on other types of surface (e.g. grass, gravel) when dry, may be determined or derived and these surfaces listed in accordance with CS 27.1585.

SC GP 27.47 Minimum control speed

The following minimum control speeds must be determined:

a) minimum power-off control speed, VMC (power-off);

b) minimum power-on control speed, VMC (power-on).

SC GP 27.49 Performance at minimum operating speed

The minimum airspeed for level flight, V_{MIN}, must be determined. This speed must not be less than the minimum control speed, $V_{MC\ (power\text{-}on)}$.

SC GP 27.51 Take-off

The take-off, with take-off power at the most critical centre of gravity, and with weight from the maximum weight at sea-level to the weight for which take-off certification is requested for each altitude covered by this paragraph:

(a) May not require exceptional piloting skill or exceptionally favourable conditions throughout the ranges of altitude from standard sea-level conditions to the maximum altitude for which take-off and landing certification is requested, and

(b) Must be made in such a manner that a landing can be made safely at any point along the flight path if an engine fails. This must be demonstrated up to the maximum altitude for which take-off and landing certification is requested or an altitude agreed with the Agency, whichever is less.

(c) The distance(s) required from rest, to take-off from, and climb to 15 m above, a dry, level surface, with zero wind, must be determined using flight technique(s) selected by the Applicant.

SC GP 27.65 Climb

(a) The time for climb from leaving the ground up to 1000 ft above the field must be determined and when corrected to the international standard day conditions at sea level, must not exceed four minutes with not more than take-off power and without exceeding temperature limits established under CS 27.1041.

(b)The conditions are: airspeed as selected by the applicant (Vy), most unfavourable cg, and the maximum weight for each take off altitude for which certification is requested.

SC GP 27.67 Climb: one engine inoperative

For multi-engine rotorcraft, the steady rate of climb (or descent), at V_Y (or at the speed for minimum rate of descent), must be determined with:

(a) Maximum weight;

(b) The critical engine inoperative and the remaining engines at either:

(1) Maximum continuous power and, for rotorcraft for which certification for the use of 30-minute one engine inoperative (OEI) power is requested, at 30-minute OEI power, or

(2) Continuous OEI power for rotorcraft for which certification for the use of continuous OEI power is requested.

SC GP 27.71 Rate of descent

The minimum rate of descent, and the associated airspeed, in a power-off, en-route configuration at maximum weight and minimum practicable operating weight must be determined.

CS 27.75 Landing

(a) The rotorcraft must be able to be landed with no excessive vertical acceleration, no tendency to bounce, nose over, ground loop, porpoise, or water loop, and without exceptional piloting skill or exceptionally favourable conditions, with:

(1) Approach or autorotation speeds appropriate to the type of rotorcraft and selected by the applicant;

(2) The approach and landing made with:

(i) Power off, for single-engine rotorcraft and entered from steady state autorotation; or

(ii) One-engine inoperative (OEI) for multi-engine rotorcraft with each operating engine within approved operating limitations, and entered from an established OEI approach.;

(b) Multi-engine rotorcraft must be able to be landed safely after complete power failure under normal operating conditions.

SC GP 27.77 Landing distance

The distance required to land and come to rest from a point 15 m above the landing surface, with zero wind, must be determined, for standard temperatures at each weight and altitude within the operational limits established for landing. An approach speed must be specified.

SC GP 27.79 Limiting height-speed envelope

(a) If there are any combinations of height and forward speed of V_{MIN} and greater, from which a safe landing cannot be made following engine failure, a limiting height-speed envelope must be established, throughout a range of

(1) Altitude, from standard sea level conditions to the maximum take-off and landing altitude capability of the rotorcraft, or an altitude to be agreed with the Agency, whichever is less, and

(2) Weight from the maximum weight at sea level to the weight selected by the applicant for each altitude covered by subparagraph (a)(1) of this paragraph.

(b) The applicable power failure conditions are the ones appropriate to the type.

FLIGHT CHARACTERISTICS

SC GP 27.141 General

The rotorcraft must:

(a) Except as specifically required in the applicable paragraph, meet the flight characteristics requirements of this Subpart:

(1) At the altitudes and temperatures for which certification is requested;

(2) Under any critical loading condition within the range of weights and centres of gravity for which certification is requested;

(3) For power-on operations, under any condition of speed, power, and rotor rpm for which certification is requested; and

(4) For power-off operations, under any condition of speed and rotor rpm for which certification is requested that is attainable with the controls rigged in accordance with the approved rigging instructions and tolerances;

(b) reserved

(c) Have any additional characteristic required for night or instrument operation, if certification for those kinds of operation is requested. Requirements for rotorcraft instrument flight are contained in appendix B.

SC GP 27.143 Controllability and manoeuvrability

a) The gyroplane must be safely controllable and manoeuvrable with sufficient margin of control movement and rotor clearance to correct for atmospheric turbulence and to permit control of the attitude of the gyroplane at all power settings at the critical weight and c.g., at sea level and at the maximum altitude for which certification is requested:

1) during steady flight at speeds between V_{MC} (power-on) or V_{MC} (power-off), whichever is the lowest, and V_{DF}.

2) during speed changes;

3) during changes of engine power, (including sudden loss of engine power); and

4) during any manoeuvre appropriate to the type, including:

i) take-off;

ii) climb;

iii) turning flight;

iv) descent (power-on and power-off) including vertical and spiral descents;

v) landing (power-on and power-off);

vi) recovery to power-on flight from a balked approach; and

vii) during dynamic manoeuvres including steep turns, straight pull-outs, and roll reversals.

b) It must be possible to maintain any required flight condition and make a smooth transition from one flight condition to another (including turns, slips and reversal of turns) with no more than average piloting skill, alertness or strength, and without danger of exceeding the limit manoeuvring load-factor, under any operating condition probable for the type, with the engine running at all possible associated power settings within the allowable range, including the effect of power changes and sudden engine failure.

If V_{MC} (power-on) is less than V_{MC} (power-off) (see SC GP 27.49B), it must be demonstrated that it is possible, without exceptional pilot skill or strength, to recover the aircraft to V_{MC} (power-off) after the engine has been made inoperative at V_{MC} (power-on).

Likely variations from any recommended techniques must not cause unsafe flight conditions.

c) reserved

d) Control Characteristics

1) The controls must not exhibit excessive breakout force, friction or free play.

2) There must be no overbalance of the directional, pitching and rolling controls.

e) reserved

f) The gyroplane must not exhibit any tendency to enter undesirable Pilot-Induced Oscillations (PIO) at all power settings at the critical weight and c.g., at sea level and at the maximum altitude for which certification is requested:

1) during steady flight at speeds between V_{MC} (power-on) or V_{MC} (power-off), whichever is the lowest, and V_{DF};

2) during speed changes;

3) during changes of engine power, (including sudden loss of engine power); and

4) during any manoeuvre appropriate to the type, including:

i) take-off;

ii) climb;

iii) turning flight;

iv) descent (power-on and power-off) including vertical and spiral descents;

v) landing (power-on and power-off);

vi) recovery to power-on flight from a balked approach; and

vii) during dynamic manoeuvres including steep turns, straight pull-outs, and roll reversals.

SC GP 27.145 Longitudinal lateral and directional control

a) It must be possible at any speed below 1.3 V_{MIN} to pitch nose downwards so that a speed equal to 1.3 VMIN can be reached promptly. This must be shown at all possible configurations and engine powers when trimmed at 1.3 VMIN (where trim control is fitted).

b) It must be possible to pitch the nose upwards at VDF at all permitted c.g. positions and engine powers.

c) If marginal conditions exist with regard to pilot effort, the control forces must be assessed by quantitative tests, with the engine running at all allowable powers.

d) The maximum wind velocity, maximum cross wind and maximum tail wind (if applicable), must be established in which the gyroplane can be operated, without the loss of control, on or near the ground in any manoeuvre appropriate to the type (such as cross wind take-off).

These wind velocities must be specified in the Rotorcraft Flight Manual.

CS 27.151 Flight controls

(a) Longitudinal, lateral, directional, and collective controls may not exhibit excessive breakout force, friction or preload.

(b) Control system forces and free play may not inhibit a smooth, direct rotorcraft response to control system input.

SC GP 27.155 Pitch control force in manoeuvres

The pitch control forces during turns, or during transition between manoeuvres, must be such that at constant speed an increase in load factor is associated with an increase in control force.

CS 27.161 Trim control

The trim control:

(a) Must trim any steady longitudinal, lateral, and collective control forces to zero in level flight at any appropriate speed; and

(b) May not introduce any undesirable discontinuities in control force gradients.

CS 27.171 Stability: General

The rotorcraft must be able to be flown, without undue pilot fatigue or strain, in any normal manoeuvre for a period of time as long as that expected in normal operation. At least three landings and take-offs must be made during this demonstration.

SC GP 27.172 Stability in turns

a) There must be no tendency for the gyroplane to rapidly increase the turn rate during a turn with normal accelerations of up to 1.5 g at all allowable power settings.

b) There must be no tendency for the gyroplane to rapidly pitch up during a turn, with normal accelerations of up to 1.5 g, at all allowable power settings.

SC GP 27.173 Static Longitudinal Stability

a) The longitudinal control must be designed so that a rearward movement of the control is necessary to obtain an airspeed less than the trim speed, and a forward movement of the control is necessary to obtain an airspeed more than the trim speed.

b) Throughout the full range of altitude for which certification is requested, with the throttle held constant during the manoeuvres specified in SC GP 27.175 a) through d), the slopes of

1) the control force versus airspeed curve and

2) the control position versus airspeed curve must be positive or neutral (not unstable).

c) Where a pitch trim system is provided for use in flight, the gyroplane must be trimmed at the datum conditions specified in SC GP 27.175. Where such a pitch trim system is not provided, the stability characteristics must be assessed by the change of control position with speed compared to the control position at the datum condition. In all cases, the stability characteristics must be assessed over changes of speed of approximately ±15% from the datum speed.

SC GP 27.175 Demonstration of static longitudinal stability

The demonstration of static stability must be done in the following conditions:

a) Climb at:

1) the best climb speed, VY; and

2) maximum continuous power.

b) Cruise at:

1) the best climb speed, VY, and at the lower of VNE or VH; and

2) power for level flight.

c) Descent at:

1) the minimum rate of descent speed (see SC GP 27.71); and

2) power off.

d) Approach at:

1) the recommended approach speed; and

2) approach power

SC GP 27.177 Lateral and directional stability

a) Following an initial yaw disturbance, with controls held fixed, the gyroplane must tend to correct automatically. With the directional controls free a yaw disturbance or sideslip must not result in a dangerous condition.

b) The directional and lateral stability must be sufficient to prevent dangerous flight conditions following abrupt pedal displacements considered appropriate for the aircraft type.

c) In a sideslip, any control force must increase progressively with sideslip; the gradient need not be linear but must not reverse. Pedal deflection should be limited to the maximum allowed for the flight condition. Sufficient cues must accompany sideslip to alert the pilot when approaching sideslip limits.

d) The characteristics detailed in SC GP 27.177a) to c) must be met under the following conditions:

1) In the climb, at maximum continuous power, at VY;

2) In level flight at power for level flight, at:

i) the best climb speed VY; and

ii) the lower of VNE or VH.

3) At the minimum rate of descent speed (see SC 27.71) with and without the engine operating, and

4) At the recommended approach speed.

SC GP 27.181 Dynamic stability

a) Any oscillations occurring under any permissible flight condition must be damped both with the primary controls fixed and free for longitudinal and lateral controls but fixed for the directional control.

b) The gyroplane, under smooth air conditions, must exhibit no dangerous behaviour at any speed between the speed for best rate of climb and VNE, when all controls are fixed or free for a period of five seconds.

GROUND AND WATER HANDLING CHARACTERISTICS

CS 27.231 General

The rotorcraft must have satisfactory ground and water handling characteristics, including freedom from uncontrollable tendencies in any condition expected in operation.

CS 27.235 Taxying condition

The rotorcraft must be designed to withstand the loads that would occur when the rotorcraft is taxied over the roughest ground that may reasonably be expected in normal operation.

SC GP 27.241 Ground resonance

The gyroplane must have no dangerous tendency to oscillate on the ground with the rotor turning. This must be shown for all intended combinations of rotor speed and gyroplane forward speed on the ground, including use of any rotor spin-up system.

MISCELLANEOUS FLIGHT REQUIREMENTS

SC GP 27.251 Vibration

Each part of the gyroplane must be free from excessive vibration under each appropriate speed and power condition, throughout the flight envelope at speeds up to V_{DF}.

Subpart C - STRENGTH REQUIREMENTS

GENERAL

CS 27.301 Loads

(a) Strength requirements are specified in terms of limit loads (the maximum loads to be expected in service) and ultimate loads (limit loads multiplied by prescribed factors of safety). Unless otherwise provided, prescribed loads are limit loads.

(b) Unless otherwise provided, the specified air, ground, and water loads must be placed in equilibrium with inertia forces, considering each item of mass in the rotorcraft. These loads must be distributed to closely approximate or conservatively represent actual conditions.

(c) If deflections under load would significantly change the distribution of external or internal loads, this redistribution must be taken into account.

CS 27.303 Factor of safety

Unless otherwise provided, a factor of safety of 1.5 must be used. This factor applies to external and inertia loads unless its application to the resulting internal stresses is more conservative.

CS 27.305 Strength and deformation

(a) The structure must be able to support limit loads without detrimental or permanent deformation. At any load up to limit loads, the deformation may not interfere with safe operation.

(b) The structure must be able to support ultimate loads without failure. This must be shown by:

(1) Applying ultimate loads to the structure in a static test for at least 3 seconds; or

(2) Dynamic tests simulating actual load application.

CS 27.307 Proof of structure

(a) Compliance with the strength and deformation requirements of this Subpart must be shown for each critical loading condition accounting for the environment to which the structure will be exposed in operation. Structural analysis (static or fatigue) may be used only if the structure conforms to those structures for which experience has shown this method to be reliable. In other cases, substantiating load tests must be made.

(b) Proof of compliance with the strength requirements of this Subpart must include:

(1) Dynamic and endurance tests of rotors, rotor drives, and rotor controls;

(2) Limit load tests of the control system, including control surfaces;

(3) Operation tests of the control system;

(4) Flight stress measurement tests;

(5) Landing gear drop tests; and

(6) Any additional tests required for new or unusual design features.

SC GP 27.309 Design limitations

The following values and limitations must be established to show compliance with the structural requirements of this Subpart:

(a) The design maximum weight.

(b) The rotor rpm range.

(c) Forward speeds up to V_D.

(d) The centre of gravity limitations; and

(e) The positive and negative limit manoeuvring load factors.

FLIGHT LOADS

CS 27.321 General

(a) The flight load factor must be assumed to act normal to the longitudinal axis of the rotorcraft, and to be equal in magnitude and opposite in direction to the rotorcraft inertia load factor at the centre of gravity.

(b) Compliance with the flight load requirements of this Subpart must be shown:

(1) At each weight from the design minimum weight to the design maximum weight; and

(2) With any practical distribution of disposable load within the operating limitations in the Rotorcraft Flight Manual.

CS 27.337 Limit manoeuvring load factor

The rotorcraft must be designed for:

(a) A limit manoeuvring load factor ranging from a positive limit of 3.5 to a negative limit of – 1.0.

CS 27.339 Resultant limit manoeuvring loads

The loads resulting from the application of limit manoeuvring load factors are assumed to act at the centre of each rotor hub and at each auxiliary lifting surface, and to act in directions, and with distributions of load among the rotors and auxiliary lifting surfaces, so as to represent each critical manoeuvring condition, including power-on and power-off flight with the maximum design rotor tip speed ratio. The rotor tip speed ratio is the ratio of the rotorcraft flight velocity component in the plane of the rotor disc to the rotational tip speed of the rotor blades, and is expressed as follows:

$$\mu = \frac{V \cos a}{\Omega R}$$

where:

V = The airspeed along the flight path;

α = The angle between the projection, in the plane of symmetry, of the axis of no feathering and a line perpendicular to the flight path (positive when the axis is pointing aft);

Ω = The angular velocity of rotor; and

R = The rotor radius.

CS 27.341 Gust loads

The rotorcraft must be designed to withstand at each critical airspeed the loads resulting from a vertical gust of 9.1 m/s (30 ft/s).

SC GP 23.351 Yawing conditions

The gyroplane must be designed for yawing loads on the vertical surfaces resulting from the loads specified in SC GP 23.441 to SC GP 23.445

SC GP 23.441 Manoeuvring loads

(a) At speeds up to VA the vertical surfaces must be designed to withstand the following conditions. In computing the loads, the yawing velocity may be assumed to be zero:

(1) With the aeroplane in unaccelerated flight at zero yaw, it is assumed that the rudder control is suddenly displaced to the maximum deflection, as limited by the control stops or by limit pilot forces.

(2) With the rudder deflected as specified in sub-paragraph (1), it is assumed that the aeroplane yaws to the overswing sideslip angle. In lieu of a rational analysis, an overswing angle equal to 1·5 times the static sideslip angle of sub-paragraph (3) may be assumed.

(3) A yaw angle of 15° with the rudder control maintained in the neutral position (except as limited by pilot strength).

(b) The yaw angles specified in subparagraph (a) (3) may be reduced if the yaw angle chosen for a particular speed cannot be exceeded in –

(1) Steady slip conditions;

(2) Uncoordinated rolls from steep banks; or

(3) Sudden failure of the critical engine with delayed corrective action.

SC GP 23.443 Gust loads

(a) Vertical surfaces must be designed to withstand, in unaccelerated flight at speed VC, lateral gusts of the values prescribed in CS 27.341.

(c) In the absence of a more rational analysis, the gust load must be computed as follows:

$$L_{vt} = \frac{\rho_o K_{gt} U_{de} V a_{vt} S_{vt}}{2}$$

where –

L_{vt} = Vertical surface loads (N);

$K_{gt} = \frac{0{\cdot}88\,\mu_{gt}}{5{\cdot}3 + \mu_{gt}}$ = gust alleviation factor;

$\mu_{gt} = \frac{2W}{\rho \bar{C}_t g a_{vt} S_{vt}} \left(\frac{K}{l_{vt}}\right)^2$ lateral mass ratio;

ρ_o = Density of air at sea-level (kg/m^3)

U_{de} = Derived gust velocity (m/s);

ρ = Air density (Kg/m^3);

W = the applicable weight of the aeroplane in the particular load case (N);

S_{vt} = Area of vertical surface (m^2);

$\bar{C}_t$ = Mean geometric chord of vertical surface (m);

a_{vt} = Lift curve slope of vertical surface (per radian);

K = Radius of gyration in yaw (m);

l_{vt} = Distance from aeroplane c.g. to lift centre of vertical surface (m);

g = Acceleration due to gravity (m/sec^2); and

V = Aeroplane equivalent speed (m/s)

SC GP 23.445 Outboard fins or winglets

(a) If outboard fins or winglets are included on the horizontal surfaces or wings, the horizontal surfaces or wings must be designed for their maximum load in combination with loads induced by the fins or winglets and moment or forces exerted on horizontal surfaces or wings by the fins or winglets.

(b) If outboard fins or winglets extend above and below the horizontal surface, the critical vertical surface loading (the load per unit area as determined under SC 23.441 and SC 23.443) must be applied to –

(1) The part of the vertical surfaces above the horizontal surface with 80% of that loading applied to the part below the horizontal surface; and

(2) The part of the vertical surfaces below the horizontal surface with 80% of that loading applied to the part above the horizontal surface;

(c) The endplate effects of outboard fins or winglets must be taken into account in applying the yawing conditions of SC 23.441 and SC 23.443 to the vertical surfaces in sub-paragraph (d).

(d) When rational methods are used for computing loads, the manoeuvring loads of SC 23.441 on the vertical surfaces and the one-g horizontal surface load, including induced loads on the horizontal surface and moments or forces exerted on the horizontal surfaces by the vertical surfaces, must be applied simultaneously for the structural loading condition.

CS 27.361 Engine torque

(b) For reciprocating engines, the limit torque may not be less than the mean torque for maximum continuous power multiplied by:

(2) Two, three, and four, for engines with four, three, and two cylinders, respectively.

CONTROL SURFACES AND SYSTEM LOADS

CS 27.391 General

Each auxiliary rotor, each fixed or movable stabilising or control surface, and each system operating any flight control must meet the requirements of CS 27.395, 27.397, 27.399, 27.411 and 27.427.

CS 27.395 Control system

(a) The part of each control system from the pilot's controls to the control stops must be designed to withstand pilot forces of not less than –

(1) The forces specified in CS 27.397; or

(b) Each primary control system including its supporting structure, must be designed as follows:

(1) The system must withstand loads resulting from the limit pilot forces prescribed in CS 27.397.

(3) If the system design or the normal operating loads are such that a part of the system cannot react to the limit forces prescribed in CS 27.397, that part of the system must be designed to withstand the maximum loads that can be obtained in normal operation. The minimum design loads must, in any case, provide a rugged system for service use, including consideration of fatigue, jamming, ground gusts, control inertia and friction loads. In the absence of rational analysis, the design loads resulting from 0.60 of the specified limit pilot forces are acceptable minimum design loads.

(4) If operational loads may be exceeded through jamming, ground gusts, control inertia, or friction, the system must withstand the limit pilot forces specified in CS 27.397, without yielding.

CS 27.397 Limit pilot forces and torques

(a) Except as provided in sub-paragraph (b) the limit pilot forces are as follows:

(1) For foot controls, 578 N (130 lbs).

(2) For stick controls, 445 N (100 lbs) fore and aft, and 298 N (67 lbs) laterally.

CS 27.399 Dual control system

Each dual primary flight control system must be designed to withstand the loads that result when pilot forces of 0.75 times those obtained under CS 27.395 are applied –

(a) In opposition; and

(b) In the same direction.

SC GP 27.411 Ground clearance: tail guard

(a) It must be impossible for the tail to contact the landing surface during a normal landing.

(b) If a tail guard is required to show compliance with sub-paragraph (a):

(1) Suitable design loads must be established for the guard; and

(2) The guard and its supporting structure must be designed to withstand those loads.

SC GP 27.413 Control Surface Loads

a) Each stabilizing and control surface (other than the rotor blades), and its supporting structure, must be designed so that limit loads are not less than the greater of:

1) 720 N/m2 (evenly distributed over the control surface); or

2) the aerodynamic load resulting where the normal force coefficient CN equals 1.5 at the maximum design speed.

b) Compliance with sub-paragraph a) of this paragraph must be shown with realistic or conservative load distributions with allowance for any relative slipstream effects.

CS 27.427 Unsymmetrical loads

(a) Horizontal tail surfaces and their supporting structure must be designed for unsymmetrical loads arising from yawing and rotor wake effects in combination with the prescribed flight conditions.

(b) To meet the design criteria of sub-paragraph (a), in the absence of more rational data, both of the following must be met:

(1) 100% of the maximum loading from the symmetrical flight conditions acts on the surface on one side of the plane of symmetry and no loading acts on the other side.

(2) 50% of the maximum loading from the symmetrical flight conditions acts on the surface on each side of the plane of symmetry but in opposite directions.

(c) For empennage arrangements where the horizontal tail surfaces are supported by the vertical tail surfaces, the vertical tail surfaces and supporting structure must be designed for the combined vertical and horizontal surface loads resulting from each prescribed flight condition, considered separately. The flight conditions must be selected so the maximum design loads are obtained on each surface. In the absence of more rational data, the unsymmetrical horizontal tail surface loading distributions described in this paragraph must be assumed.

GROUND LOADS

CS 27.471 General

(a) Loads and equilibrium. For limit ground loads –

(1) The limit ground loads obtained in the landing conditions in this Subpart must be considered to be external loads that would occur in the rotorcraft structure if it were acting as a rigid body; and

(2) In each specified landing condition, the external loads must be placed in equilibrium with linear and angular inertia loads in a rational or conservative manner.

(b) Critical centres of gravity. The critical centres of gravity within the range for which certification is requested must be selected so that the maximum design loads are obtained in each landing gear element.

CS 27.473 Ground loading conditions and assumptions

(a) For specified landing conditions, a design maximum weight must be used that is not less than the maximum weight. A rotor lift may be assumed to act through the centre of gravity throughout the landing impact. This lift may not exceed two-thirds of the design maximum weight.

(b) Unless otherwise prescribed, for each specified landing condition, the rotorcraft must be designed for a limit load factor of not less than the limit inertia load factor substantiated under CS 27.725.

CS 27.475 Tyres and shock absorbers

Unless otherwise prescribed, for each specified landing condition, the tyres must be assumed to be in their static position and the shock absorbers to be in their most critical position.

CS 27.477 Landing gear arrangement

Paragraphs CS 27.235, 27.479 to 27.485, and CS 27.493 apply to landing gear with two wheels aft, and one or more wheels forward, of the centre of gravity.

CS 27.479 Level landing conditions

(a) Attitudes. Under each of the loading conditions prescribed in sub-paragraph (b), the rotorcraft is assumed to be in each of the following level landing attitudes:

(1) An attitude in which all wheels contact the ground simultaneously.

(2) An attitude in which the aft wheels contact the ground with the forward wheels just clear of the ground.

(b) Loading conditions. The rotorcraft must be designed for the following landing loading conditions:

(1) Vertical loads applied under CS 27.471.

(2) The loads resulting from a combination of the loads applied under sub- paragraph (b)(1) with drag loads at each wheel of not less than 25% of the vertical load at that wheel.

(c) Pitching moments. Pitching moments are assumed to be resisted by:

(1) In the case of the attitude in sub-paragraph (a)(1), the forward landing gear, and

(2) In the case of the attitude in sub-paragraph (a)(2), the angular inertia forces.

CS 27.481 Tail-down landing conditions

(a) The rotorcraft is assumed to be in the maximum nose-up attitude allowing ground clearance by each part of the rotorcraft.

(b) In this attitude, ground loads are assumed to act perpendicular to the ground.

CS 27.483 One-wheel landing conditions

For the one-wheel landing condition, the rotorcraft is assumed to be in the level attitude and to contact the ground on one aft wheel. In this attitude:

(a) The vertical load must be the same as that obtained on that side under CS 27.479(b)(1); and

(b) The unbalanced external loads must be reacted by rotorcraft inertia.

CS 27.485 Lateral drift landing conditions

(a) The rotorcraft is assumed to be in the level landing attitude, with:

(1) Side loads combined with one-half of the maximum ground reactions obtained in the level landing conditions of CS 27.479(b)(1); and

(2) The loads obtained under sub- paragraph (a)(1) applied:

(i) At the ground contact point; or

(ii) For full-swivelling gear, at the centre of the axle.

(b) The rotorcraft must be designed to withstand, at ground contact –

(1) When only the aft wheels contact the ground, side loads of 0.8 times the vertical reaction acting inward on one side, and 0,6 times the vertical reaction acting outward on the other side, all combined with the vertical loads specified in sub-paragraph (a); and

(2) When all wheels contact the ground simultaneously:

(i) For the aft wheels, the side loads specified in sub-paragraph (b)(1); and

(ii) For the forward wheels, a side load of 0.8 times the vertical reaction combined with the vertical load specified in sub-paragraph (a).

CS 27.493 Braked roll conditions

Under braked roll conditions with the shock absorbers in their static positions:

(a) The limit vertical load must be based on a load factor of at least:

(1) 1.33, for the attitude specified in CS 27.479(a)(1); and

(2) 1.0 for the attitude specified in CS 27.479(a)(2); and

(b) The structure must be designed to withstand at the ground contact point of each wheel with brakes, a drag load at least the lesser of:

(1) The vertical load multiplied by a coefficient of friction of 0.8; and

(2) The maximum value based on limiting brake torque.

MAIN COMPONENT REQUIREMENTS

SC GP 27.547 Main rotor structure

(a) Each main rotor assembly (including rotor hubs and blades) must be designed as prescribed in this paragraph.

(b) The main rotor structure must be designed to withstand the following loads prescribed in CS 27.337 to 27.341:

(1) Critical flight loads.

(2) Limit loads occurring under normal conditions of autorotation. For this condition, the rotor rpm must be selected to include the effects of altitude.

(c) The main rotor structure must be designed to withstand loads simulating:

(1) For the rotor blades, hubs, and flapping hinges, the impact force of each blade against its stop during ground operation; and

(2) Any other critical condition expected in normal operation.

(d) The main rotor structure must be designed to withstand the limit torque at any rotational speed, including zero. In addition:

(1) The limit torque need not be greater than the torque defined by a torque limiting device (where provided), and may not be less than the greater of:

(i) The maximum torque likely to be transmitted to the rotor structure in either direction; and

(ii) The limit pre-rotator torque.

(2) The limit torque must be distributed to the rotor blades in a rational manner.

CS 27.549 Fuselage, landing gear, and rotor pylon structures

(a) Each fuselage, landing gear, and rotor pylon structure must be designed as prescribed in this paragraph. Resultant rotor forces may be represented as a single force applied at the rotor hub attachment point.

(b) Each structure must be designed to withstand:

(1) The critical loads prescribed in CS 27.337 to 27.341;

(2) The applicable ground loads prescribed in CS 27.235, 27.471 to 27.485, CS 27.493, 27.497, 27.501, 27.505, and 27.521; and

(3) The loads prescribed in CS 27.547 (c)(2) and (d).

(c) Auxiliary rotor thrust, and the balancing air and inertia loads occurring under accelerated flight conditions, must be considered.

(d) Each engine mount and adjacent fuselage structure must be designed to withstand the loads occurring under accelerated flight and landing conditions, including engine torque.

EMERGENCY LANDING CONDITIONS

CS 27.561 General

(a) The rotorcraft, although it may be damaged in emergency landing conditions on land or water, must be designed as prescribed in this paragraph to protect the occupants under those conditions.

(b) The structure must be designed to give each occupant every reasonable chance of escaping serious injury in a crash landing when:

(1) Proper use is made of seats, belts, and other safety design provisions;

(2) The wheels are retracted (where applicable); and

(3) Each occupant and each item of mass inside the cabin that could injure an occupant is restrained when subjected to the following ultimate inertial load factors relative to the surrounding structure:

(i) Upward – 4 g

(ii) Forward – 16 g

(iii) Sideward – 8 g

(iv) Downward – 20 g, after the intended displacement of the seat device

(v) Rearward – 1.5 g

(c) The supporting structure must be designed to restrain, under any ultimate inertial load up to those specified in this paragraph, any item of mass above and/or behind the crew and passenger compartment that could injure an occupant if it came loose in an emergency landing. Items of mass to be considered include, but are not limited to, rotors, transmissions, and engines. The items of mass must be restrained for the following ultimate inertial load factors:

(1) Upward – 1.5 g

(2) Forward – 12 g

(3) Sideward – 6 g

(4) Downward – 12 g

(5) Rearward – 1.5 g

(d) Any fuselage structure in the area of internal fuel tanks below the passenger floor level must be designed to resist the following ultimate inertial factors and loads and to protect the fuel tanks from rupture when those loads are applied to that area:

(1) Upward – 1.5 g

(2) Forward – 4.0 g

(3) Sideward – 2.0 g

(4) Downward – 4.0 g.

SC GP 27.562 Emergency landing conditions

The gyroplane must be capable, in an emergency landing, to reduce its forward airspeed to near zero and subsequently contact the ground in a near vertical direction in a near level attitude, thereby minimizing load factors in the forward direction.

FATIGUE EVALUATION

CS 27.571 Fatigue evaluation of flight structure

(a) General. Each portion of the flight structure (the flight structure includes rotors, rotor drive systems between the engines and the rotor hubs, controls, fuselage, landing gear, and their related primary attachments) the failure of which could be catastrophic, must be identified and must be evaluated under sub-paragraph (b), (c), (d), or (e). The following apply to each fatigue evaluation:

(1) The procedure for the evaluation must be approved.

(2) The locations of probable failure must be determined.

(3) In-flight measurement must be included in determining the following:

(i) Loads or stresses in all critical conditions throughout the range of limitations in CS 27.309, except that manoeuvring load factors need not exceed the maximum values expected in operation.

(ii) The effect of altitude upon these loads or stresses.

(4) The loading spectra must be as severe as those expected in operation including, but not limited to, external cargo operations, if applicable, and ground-air-ground cycles. The loading spectra must be based on loads or stresses determined under sub-paragraph (a)(3).

(b) Fatigue tolerance evaluation. It must be shown that the fatigue tolerance of the structure ensures that the probability of catastrophic fatigue failure is extremely remote without establishing replacement times, inspection intervals or other procedures under paragraph A27.4 of appendix A.

(c) Replacement time evaluation. It must be shown that the probability of catastrophic fatigue failure is extremely remote within a replacement time furnished under paragraph A27.4 of appendix A.

(d) Fail-safe evaluation. The following apply to fail-safe evaluation:

(1) It must be shown that all partial failures will become readily detectable under inspection procedures furnished under paragraph A27.4 of appendix A.

(2) The interval between the time when any partial failure becomes readily detectable under sub-paragraph (d)(1), and the time when any such failure is expected to reduce the remaining strength of the structure to limit or maximum attainable loads (whichever is less), must be determined.

(3) It must be shown that the interval determined under sub-paragraph (d)(2) is long enough, in relation to the inspection intervals and related procedures furnished under paragraph A27.4 of appendix A, to provide a probability of detection great enough to ensure that the probability of catastrophic failure is extremely remote.

(e) Combination of replacement time and fail-safe evaluations. A component may be evaluated under a combination of sub-paragraphs (c) and (d). For such component it must be shown that the probability of catastrophic failure is extremely remote with an approved combination of replacement time, inspection intervals, and related procedures furnished under paragraph A27.4 of appendix A.

CS 27.573 Damage tolerance and fatigue evaluation of composite structures

(a) Composite rotorcraft structure must be evaluated under the damage tolerance requirements of sub-paragraph (d) unless the applicant establishes that a damage tolerance evaluation is impractical within the limits of geometry, inspectability, and good design practice. In such a case, the composite rotorcraft structure must undergo a fatigue evaluation in accordance with sub-paragraph (e).

(d) Damage Tolerance Evaluation:

(1) Damage tolerance evaluations of composite structures must show that Catastrophic Failure due to static and fatigue loads is avoided throughout the operational life or prescribed inspection intervals of the rotorcraft.

(2) The damage tolerance evaluation must include PSEs of the airframe, main and tail rotor drive systems, main and tail rotor blades and hubs, rotor controls, fixed and movable control surfaces, engine and transmission mountings, landing gear, and any other detail design points or parts whose failure or detachment could prevent continued safe flight and landing.

(3) Each damage tolerance evaluation must include:

(i) The identification of the structure being evaluated;

(ii) A determination of the structural loads or stresses for all critical conditions throughout the range of limits in CS 27.309 (including altitude effects), supported by in-flight and ground measurements, except that manoeuvring load factors need not exceed the maximum values expected in service;

(iii) The loading spectra as severe as those expected in service based on loads or stresses determined under sub-paragraph (d)(3)(ii), including external load operations, if applicable, and other operations including high torque events;

(iv) A Threat Assessment for all structure being evaluated that specifies the locations, types, and sizes of damage, considering fatigue, environmental effects, intrinsic and discrete flaws, and impact or other accidental damage (including the discrete source of the accidental damage) that may occur during manufacture or operation;

(v) An assessment of the residual strength and fatigue characteristics of all structure being evaluated that supports the replacement times and inspection intervals established under sub-paragraph (d)(4); and

(vi) allowances for the detrimental effects of material, fabrication techniques, and process variability.

(4) Replacement times, inspections, or other procedures must be established to require the repair or replacement of damaged parts to prevent Catastrophic Failure. These replacement times, inspections, or other procedures must be included in the Airworthiness Limitations Section of the Instructions for Continued Airworthiness required by CS 27.1529.

(i) Replacement times must be determined by tests, or by analysis supported by tests to show that throughout its life the structure is able to withstand the repeated loads of variable magnitude expected in service. In establishing these replacement times, the following items must be considered:

(A) Damage identified in the Threat Assessment required by subparagraph (d)(3)(iv);

(B) Maximum acceptable manufacturing defects and in service damage (i.e., those that do not lower the residual strength below ultimate design loads and those that can be repaired to restore ultimate strength); and

(C) Ultimate load strength capability after applying repeated loads.

(ii) Inspection intervals must be established to reveal any damage identified in the Threat Assessment required by sub-paragraph (d)(3)(iv) that may occur from fatigue or other in service causes before such damage has grown to the extent that the component cannot sustain the required residual strength capability. In establishing these inspection intervals, the following items must be considered:

(A) The growth rate, including no-growth, of the damage under the repeated loads expected in service determined by tests or analysis supported by tests; and

(B) The required residual strength for the assumed damage established after considering the damage type, inspection interval, detectability of damage, and the techniques adopted for damage detection. The minimum required residual strength is limit load.

(5) The effects of damage on stiffness, dynamic behaviour, loads and functional performance must be taken into account when substantiating the maximum assumed damage size and inspection interval.

(e) Fatigue Evaluation:

If an applicant establishes that the damage tolerance evaluation described in sub-paragraph (d) is impractical within the limits of geometry, inspectability, or good design practice, the applicant must do a fatigue evaluation of the particular composite rotorcraft structure and:

(1) Identify structure considered in the fatigue evaluation;

(2) Identify the types of damage considered in the fatigue evaluation;

(3) Establish supplemental procedures to minimise the risk of Catastrophic Failure associated with damage identified in subparagraph (e)(2); and

(4) Include these supplemental procedures in the Airworthiness Limitations section of the Instructions for Continued Airworthiness required by CS 27.1529.

Subpart D - DESIGN AND CONSTRUCTION

GENERAL

CS 27.601 Design

(a) The rotorcraft may have no design features or details that experience has shown to be hazardous or unreliable.

(b) The suitability of each questionable design detail and part must be established by tests.

CS 27.602 Critical parts

(a) Critical part - A critical part is a part, the failure of which could have a catastrophic effect upon the rotorcraft, and for which critical characteristics have been identified which must be controlled to ensure the required level of integrity.

(b) If the type design includes critical parts, a critical parts list shall be established. Procedures shall be established to define the critical design characteristics, identify processes that affect those characteristics, and identify the design change and process change controls necessary for showing compliance with the quality assurance requirements of Part-21.

CS 27.603 Materials

The suitability and durability of materials used for parts, the failure of which could adversely affect safety, must:

(a) Be established on the basis of experience or tests;

(b) Meet approved specifications that ensure their having the strength and other properties assumed in the design data; and

(c) Take into account the effects of environmental conditions, such as temperature and humidity, expected in service.

CS 27.605 Fabrication methods

(a) The methods of fabrication used must produce consistently sound structures. If a fabrication process (such as gluing, spot welding, or heat-treating) requires close control to reach this objective, the process must be performed according to an approved process specification.

(b) Each new aircraft fabrication method must be substantiated by a test program.

CS 27.607 Fasteners

(a) Each removable bolt, screw, nut, pin, or other fastener whose loss could jeopardise the safe operation of the rotorcraft must incorporate two separate locking devices. The fastener and its locking devices may not be adversely affected by the environmental conditions associated with the particular installation.

(b) No self-locking nut may be used on any bolt subject to rotation in operation unless a non-friction locking device is used in addition to the self-locking device.

CS 27.609 Protection of structure

Each part of the structure must:

(a) Be suitably protected against deterioration or loss of strength in service due to any cause, including:

(1) Weathering;

(2) Corrosion; and

(3) Abrasion; and

(b) Have provisions for ventilation and drainage where necessary to prevent the accumulation of corrosive, flammable, or noxious fluids.

CS 27.610 Lightning and static electricity protection

(d) The electrical bonding and protection against lightning and static electricity must:

(1) Minimise the accumulation of electrostatic charge;

(2) Minimise the risk of electric shock to crew, passengers, and service and maintenance personnel using normal precautions;

(3) Provide an electrical return path, under both normal and fault conditions, on rotorcraft having grounded electrical systems; and

(4) Reduce to an acceptable level the effects of lightning and static electricity on the functioning of essential electrical and electronic equipment.

CS 27.611 Inspection provisions

There must be means to allow the close examination of each part that requires:

(a) Recurring inspection;

(b) Adjustment for proper alignment and functioning; or

(c) Lubrication.

CS 27.613 Material strength properties and design values

(a) Material strength properties must be based on enough tests of material meeting specifications to establish design values on a statistical basis.

(b) Design values must be chosen to minimise the probability of structural failure due to material variability. Except as provided in sub-paragraphs (d) and (e), compliance with this paragraph must be shown by selecting design values that assure material strength with the following probability:

(1) Where applied loads are eventually distributed through a single member within an assembly, the failure of which would result in loss of structural integrity of the component, 99% probability with 95% confidence; and

(2) For redundant structure, those in which the failure of individual elements would result in applied loads being safely distributed to other load carrying members, 90% probability with 95% confidence.

(c) The strength, detail design, and fabrication of the structure must minimise the probability of disastrous fatigue failure, particularly at points of stress concentration.

(d) Material specifications must be those contained in documents accepted by the Agency.

(e) Other design values may be used if a selection of the material is made in which a specimen of each individual item is tested before use and it is determined that the actual strength properties of that particular item will equal or exceed those used in design.

CS 27.619 Special factors

(a) The special factors prescribed in CS 27.621 to 27.625 apply to each part of the structure whose strength is:

(1) Uncertain;

(2) Likely to deteriorate in service before normal replacement; or

(3) Subject to appreciable variability due to:

(i) Uncertainties in manufacturing processes; or

(ii) Uncertainties in inspection methods.

(b) For each part to which CS 27.621 to 27.625 apply, the factor of safety prescribed in CS 27.303 must be multiplied by a special factor equal to:

(1) The applicable special factors prescribed in CS 27.621 to 27.625; or

(2) Any other factor great enough to ensure that the probability of the part being understrength because of the uncertainties specified in sub-paragraph (a) is extremely remote.

CS 27.621 Casting factors

(a) General. The factors, tests, and inspections specified in sub-paragraphs (b) and (c) must be applied in addition to those necessary to establish foundry quality control. The inspections must meet approved specifications. Sub-paragraphs (c) and (d) apply to structural castings except castings that are pressure tested as parts of hydraulic or other fluid systems and do not support structural loads.

(b) Bearing stresses and surfaces. The casting factors specified in sub-paragraphs (c) and (d):

(1) Need not exceed 1.25 with respect to bearing stresses regardless of the method of inspection used; and

(2) Need not be used with respect to the bearing surfaces of a part whose bearing factor is larger than the applicable casting factor.

(c) Critical castings. For each casting whose failure would preclude continued safe flight and landing of the rotorcraft or result in serious injury to any occupant, the following apply:

(1) Each critical casting must –

(i) Have a casting factor of not less than 1.25; and

(ii) Receive 100% inspection by visual, radiographic, and magnetic particle (for ferromagnetic materials) or penetrant (for non-ferromagnetic materials) inspection methods or approved equivalent inspection methods.

(2) For each critical casting with a casting factor less than 1.50, three sample castings must be static tested and shown to meet –

(i) The strength requirements of CS 27.305 at an ultimate load corresponding to a casting factor of 1.25; and

(ii) The deformation requirements of CS 27.305 at a load of 1.15 times the limit load.

(d) Non-critical castings. For each casting other than those specified in sub-paragraph (c), the following apply:

(1) Except as provided in sub-paragraphs (d)(2) and (3), the casting factors and corresponding inspections must meet the following table:

Casting factor	Inspection
2.0 or greater.........	100% visual
Less than 2.0 greater than 1.5	100% visual and magnetic particle (ferromagnetic materials), penetrant (nonferromagnetic materials), or approved equivalent inspection methods.
1.25 through 1.50......	100% visual, and magnetic particle (ferromagnetic materials), penetrant non-ferromagnetic materials), and radiographic or approved equivalent inspection methods.

(2) The percentage of castings inspected by nonvisual methods may be reduced below that specified in sub-paragraph (d)(1) when an approved quality control procedure is established.

(3) For castings procured to a specification that guarantees the mechanical properties of the material in the casting and provides for demonstration of these properties by test of coupons cut from the castings on a sampling basis:

(i) A casting factor of 1.0 may be used; and

(ii) The castings must be inspected as provided in sub-paragraph (d)(1) for casting factors of 1.25 to 1.50 and tested under sub-paragraph (c)(2).

CS 27.623 Bearing factors

(a) Except as provided in sub-paragraph (b), each part that has clearance (free fit), and that is subject to pounding or vibration, must have a bearing factor large enough to provide for the effects of normal relative motion.

(b) No bearing factor need be used on a part for which any larger special factor is prescribed.

CS 27.625 Fitting factors

For each fitting (part or terminal used to join one structural member to another) the following apply:

(a) For each fitting whose strength is not proven by limit and ultimate load tests in which actual stress conditions are simulated in the fitting and surrounding structures, a fitting factor of at least 1.15 must be applied to each part of:

(1) The fitting;

(2) The means of attachment; and

(3) The bearing on the joined members.

(b) No fitting factor need be used:

(1) For joints made under approved practices and based on comprehensive test data (such as continuous joints in metal plating, welded joints, and scarf joints in wood); and

(2) With respect to any bearing surface for which a larger special factor is used.

(c) For each integral fitting, the part must be treated as a fitting up to the point at which the paragraph properties become typical of the member.

(d) Each seat, berth, litter, safety belt, and harness attachment to the structure must be shown by analysis, tests, or both, to be able to withstand the inertia forces prescribed in CS 27.561(b)(3) multiplied by a fitting factor of 1.33.

CS 27.629 Flutter

Each aerodynamic surface of the rotorcraft must be free from flutter under each appropriate speed and power condition.

ROTORS

CS 27.653 Pressure venting and drainage of rotor blades

(a) For each rotor blade:

(1) There must be means for venting the internal pressure of the blade;

(2) Drainage holes must be provided for the blade; and

(3) The blade must be designed to prevent water from becoming trapped in it.

(b) Sub-paragraphs (a)(1) and (2) do not apply to sealed rotor blades capable of withstanding the maximum pressure differentials expected in service.

CS 27.659 Mass balance

(a) The rotors and blades must be mass balanced as necessary to –

(1) Prevent excessive vibration; and

(2) Prevent flutter at any speed up to the maximum forward speed.

(b) The structural integrity of the mass balance installation must be substantiated.

CS 27.661 Rotor blade clearance

There must be enough clearance between the rotor blades and other parts of the structure to prevent the blades from striking any part of the structure during any operating condition.

CS 27.663 Ground resonance prevention means

(a) The reliability of the means for preventing ground resonance must be shown either by analysis and tests, or reliable service experience, or by showing through analysis or tests that malfunction or failure of a single means will not cause ground resonance.

(b) The probable range of variations, during service, of the damping action of the ground resonance prevention means must be established and must be investigated during the test required by CS 27.241.

CONTROL SYSTEMS

CS 27.671 General

(a) Each control and control system must operate with the ease, smoothness, and positiveness appropriate to its function.

(b) Each element of each flight control system must be designed, or distinctively and permanently marked, to minimise the probability of any incorrect assembly that could result in the malfunction of the system.

CS 27.673 Primary flight control

Primary flight controls are those used by the pilot for immediate control of pitch, roll, yaw, and vertical motion of the rotorcraft.

CS 27.674 Interconnected controls

Each primary flight control system must provide for safe flight and landing and operate independently after a malfunction, failure, or jam of any auxiliary interconnected control.

CS 27.675 Stops

(a) Each control system must have stops that positively limit the range of motion of the pilot's controls.

(b) Each stop must be located in the system so that the range of travel of its control is not appreciably affected by:

(1) Wear;

(2) Slackness; or

(3) Take-up adjustments.

(c) Each stop must be able to withstand the loads corresponding to the design conditions for the system.

(d) For each main rotor blade:

(1) Stops that are appropriate to the blade design must be provided to limit travel of the blade about its hinge points; and

(2) There must be means to keep the blade from hitting the droop stops during any operation other than starting and stopping the rotor.

SC GP 27.677 Trim system

If a trim system is fitted which is operable in flight, proper precautions must be taken to prevent improper, or abrupt trim operation. Inadvertent operation must be prevented as well unless the specific design allows for inadvertent operation without leading to unsafe conditions.

a) There must be means near the trim control to indicate to the pilot (when strapped in), the direction of trim control movement relative to the gyroplane.

b) There must be some means to indicate to the pilot the position of the trim device, with respect to the range of adjustment. This means must be visible to the pilot (when strapped in) and must be located and designed to prevent confusion. A trim position indication that only shows the trim off (zero trim) position would be acceptable when this does not generate unsafe conditions during normal, abnormal, or emergency operations.

CS 27.679 Control system locks

If there is a device to lock the control system with the rotorcraft on the ground or water, there must be means to:

(a) Give unmistakable warning to the pilot when the lock is engaged; and

(b) Prevent the lock from engaging in flight.

CS 27.681 Limit load static tests

(a) Compliance with the limit load requirements of this CS–27 must be shown by tests in which:

(1) The direction of the test loads produces the most severe loading in the control system; and

(2) Each fitting, pulley, and bracket used in attaching the system to the main structure is included.

(b) Compliance must be shown (by analyses or individual load tests) with the special factor requirements for control system joints subject to angular motion.

CS 27.683 Operation tests

It must be shown by operation tests that, when the controls are operated from the pilot compartment with the control system loaded to correspond with loads specified for the system, the system is free from:

(a) Jamming;

(b) Excessive friction; and

(c) Excessive deflection.

CS 27.685 Control system details

(a) Each detail of each control system must be designed to prevent jamming, chafing, and interference from cargo, passengers, loose objects or the freezing of moisture.

(b) There must be means in the cockpit to prevent the entry of foreign objects into places where they would jam the system.

(c) There must be means to prevent the slapping of cables or tubes against other parts.

(d) Cable systems must be designed as follows:

(1) Cables, cable fittings, turnbuckles, splices and pulleys must be of an acceptable kind.

(2) The design of the cable systems must prevent any hazardous change in cable tension throughout the range of travel under any operating conditions and temperature variations.

(3) No cable smaller than 2.4 mm (3/32 inch) diameter may be used in any primary control system.

(4) Pulley kinds and sizes must correspond to the cables with which they are used.

(5) Pulleys must have close fitting guards to prevent the cables from being displaced or fouled.

(6) Pulleys must lie close enough to the plane passing through the cable to prevent the cable from rubbing against the pulley flange.

(7) No fairlead may cause a change in cable direction of more than 3°.

(8) No clevis pin subject to load or motion and retained only by cotter pins may be used in the control system.

(9) Turnbuckles attached to parts having angular motion must be installed to prevent binding throughout the range of travel.

(10) There must be means for visual inspection at each fairlead, pulley, terminal and turnbuckle.

(e) Control system joints subject to angular motion must incorporate the following special factors with respect to the ultimate bearing strength of the softest material used as a bearing:

(1) 3.33 for push-pull systems other than ball and roller bearing systems.

(2) 2.0 for cable systems.

(f) For control system joints, the manufacturer's static, non-Brinell rating of ball and roller bearings must not be exceeded.

CS 27.687 Spring devices

(a) Each control system spring device where failure could cause flutter or other unsafe characteristics must be reliable.

(b) Compliance with sub-paragraph (a) must be shown by tests simulating service conditions.

LANDING GEAR

CS 27.723 Shock absorption tests

The landing inertia load factor and the reserve energy absorption capacity of the landing gear must be substantiated by the tests prescribed in CS 27.725 and 27.727, respectively. These tests must be conducted on the complete rotorcraft or on units consisting of wheel, tyre, and shock absorber in their proper relation.

CS 27.725 Limit drop test

The limit drop test must be conducted as follows:

(a) The drop height must be –

(1) 0.33 m (13 inches) from the lowest point of the landing gear to the ground; or

(2) Any lesser height, not less than 0.20 m (8 in), resulting in a drop contact velocity equal to the greatest probable sinking speed likely to occur at ground contact in normal power-off landings.

(b) If considered, the rotor lift specified in CS 27.473(a) must be introduced into the drop test by appropriate energy absorbing devices or by the use of an effective mass.

(c) Each landing gear unit must be tested in the attitude simulating the landing condition that is most critical from the standpoint of the energy to be absorbed by it.

(d) When an effective mass is used in showing compliance with sub-paragraph (b) the following formula may be used instead of more rational computations:

$$W_e = W \frac{h + (1 - L)d}{h + d} \text{: and } n = n_j \frac{W_e}{W} + L$$

where:

We = the effective weight to be used in the drop test.

W = WM for main gear units , equal to the static reaction on the particular unit with the rotorcraft in the most critical attitude. A rational method may be used in computing a main gear static reaction, taking into consideration the moment arm between the main wheel reaction and the rotorcraft centre of gravity.

W = WN for nose gear units , equal to the vertical component of the static reaction that would exist at the nose wheel, assuming that the mass of the rotorcraft acts at the centre of gravity and exerts a force of 1.0 g downward and 0.25 g forward.

W = WT for tailwheel units equal to whichever of the following is critical:

(1) The static weight on the tailwheel with the rotorcraft resting on all wheels; or

(2) The vertical component of the ground reaction that would occur at the tailwheel, assuming that the mass of the rotorcraft acts at the centre of gravity and exerts a force of 1 g downward with the rotorcraft in the maximum nose-up attitude considered in the nose-up landing conditions.

h = specified free drop height.

L = ratio of assumed rotor lift to the rotorcraft weight.

d = deflection under impact of the tyre (at the proper inflation pressure) plus the vertical component of the axle travel relative to the drop mass.

n = limit inertia load factor.

nj = the load factor developed, during impact, on the mass used in the drop test (i.e., the acceleration dv/dt in g recorded in the drop test plus 1.0).

CS 27.727 Reserve energy absorption drop test

The reserve energy absorption drop test must be conducted as follows:

(a) The drop height must be 1.5 times that specified in CS 27.725(a).

(b) Rotor lift, where considered in a manner similar to that prescribed in CS 27.725(b), may not exceed 1.5 times the lift allowed under that paragraph.

(c) The landing gear must withstand this test without collapsing. Collapse of the landing gear occurs when a member of the nose, tail, or main gear will not support the rotorcraft in the proper attitude or allows the rotorcraft structure, other than the landing gear and external accessories, to impact the landing surface.

CS 27.731 Wheels

(a) Each landing gear wheel must be approved.

(b) The maximum static load rating of each wheel may not be less than the corresponding static ground reaction with:

(1) Maximum weight; and

(2) Critical centre of gravity.

(c) The maximum limit load rating of each wheel must equal or exceed the maximum radial limit load determined under the applicable ground load requirements of this CS–27.

CS 27.733 Tyres

(a) Each landing gear wheel must have a tyre:

(1) That is a proper fit on the rim of the wheel; and

(2) Of the proper rating.

(b) The maximum static load rating of each tyre must equal or exceed the static ground reaction obtained at its wheel, assuming:

(1) The design maximum weight; and

(2) The most unfavourable centre of gravity.

CS 27.735 Brakes

For rotorcraft with wheel-type landing gear, a braking device must be installed that is:

(a) Controllable by the pilot;

(b) Usable during power-off landings; and

(c) Adequate to:

(1) Counteract any normal unbalanced torque when starting or stopping the rotor; and

(2) Hold the rotorcraft parked on a 10° slope on a dry, smooth pavement.

PERSONNEL AND CARGO ACCOMODATIONS

CS 27.771 Pilot compartment

For each pilot compartment:

(a) The compartment and its equipment must allow each pilot to perform his duties without unreasonable concentration or fatigue;

(b) If there is provision for a second pilot, the rotorcraft must be controllable with equal safety from either pilot seat; and

(c) The vibration and noise characteristics of cockpit appurtenances may not interfere with safe operation.

CS 27.773 Pilot compartment view

(a) Each pilot compartment must be free from glare and reflections that could interfere with the pilot's view, and designed so that:

(1) Each pilot's view is sufficiently extensive, clear, and undistorted for safe operation; and

(2) Each pilot is protected from the elements so that moderate rain conditions do not unduly impair his view of the flight path in normal flight and while landing.

(b) If certification for night operation is requested, compliance with sub-paragraph (a) must be shown in night flight tests.

CS 27.775 Windshields and windows

Windshields and windows must be made of material that will not break into dangerous fragments.

CS 27.777 Cockpit controls

Cockpit controls must be:

(a) Located to provide convenient operation and to prevent confusion and inadvertent operation; and

(b) Located and arranged with respect to the pilots' seats so that there is full and unrestricted movement of each control without interference from the cockpit structure or the pilot's clothing when pilots from 1.57 m (5 ft 2 inches) to 1.83 m (6 ft) in height are seated.

SC GP 27.779 Motion and effect of cockpit controls and switches

Cockpit controls must be designed so that they operate as follows:

Controls	**Motion and effect**
Roll	Right (clockwise) for "right wing" down
Pitch	Rearward for nose up
Yaw	Right pedal forward for nose right
Trim	Corresponding to sense of motion and axis of the controls (See AMC T 779.)
Throttle control	Forward, or clockwise, to increase power (See AMC T 779.)
Propeller pitch	Forward to decrease pitch and/or increase rpm
Mixture	Forward, or up, for rich
Switches	Down for off

CS 27.783 Doors

(a) Each closed cabin must have at least one adequate and easily accessible external door.

(b) Each external door must be located where persons using it will not be endangered by the rotors, propellers, engine intakes and exhausts when appropriate operating procedures are used. If opening procedures are required, they must be the marked inside, on or adjacent to the door opening device.

SC GP 27.785 Seats, berths, safety belts, and harnesses

(a) Each seat, safety belt, harness, and adjacent part of the rotorcraft at each station designated for occupancy during take-off and landing must be free of potentially injurious objects, sharp edges, protuberances, and hard surfaces and must be designed so that a person making proper use of these facilities will not suffer serious injury in an emergency landing as a result of the static inertial load factors specified in CS 27.561(b).

(b) Each occupant must be protected from serious head injury by a safety belt plus a shoulder harness that will prevent the head from contacting any injurious object. A shoulder harness (upper torso restraint), in combination with the safety belt, constitutes a torso restraint system as described in ETSO-C114.

(c) Each occupant's seat must have a combined safety belt and shoulder harness with a single-point release. Each pilot's combined safety belt and shoulder harness must allow each pilot when seated with safety belt and shoulder harness fastened, to perform all functions necessary for flight operations. There must be a means to secure belts and harnesses when not in use, to prevent interference with the operation of the rotorcraft and with rapid egress in an emergency.

(e) Each projecting object that could injure persons seated or moving about in the rotorcraft in normal flight must be padded.

(f) Each seat and its supporting structure must designed for an occupant weight of at least 77 kg (170 lbs) considering the maximum load factors, inertial forces, and reactions between the occupant, seat, and safety belt or harness corresponding with the applicable flight and ground-load conditions, including the emergency landing conditions of CS 27.561(b). In addition:

(1) Each pilot seat must be designed for the reactions resulting from the application of the pilot forces prescribed in CS 27.397; and

(2) The inertial forces prescribed in CS 27.561(b) must be multiplied by a factor of 1.33 in determining the strength of the attachment of:

(i) Each seat to the structure; and

(ii) Each safety belt or harness to the seat or structure.

(g) When the safety belt and shoulder harness are combined, the rated strength of the safety belt and shoulder harness may not be less than that corresponding to the inertial forces specified in CS 27.561(b), considering the occupant weight of at least 77 kg (170 lbs), considering the dimensional characteristics of the restraint system installation, and using a distribution of at least a 60% load to the safety belt and at least a 40% load to the shoulder harness. If the safety belt is capable of being used without the shoulder harness, the inertial forces specified must be met by the safety belt alone.

(h) When a headrest is used, the headrest and its supporting structure must be designed to resist the inertia forces specified in CS 27.561, with a 1.33 fitting factor and a head weight of at least 5.9 kg (13 lbs).

(i) Each seating device system includes the device such as the seat, the cushions, the occupant restraint system, and attachment devices.

(j) Each seating device system may use design features such as crushing or separation of certain parts of the seats to reduce occupant loads for emergency landing conditions; otherwise, the system must remain intact and must not interfere with rapid evacuation of the rotorcraft.

CS 27.787 Cargo and baggage compartments

(a) Each cargo and baggage compartment must be designed for its placarded maximum weight of contents and for the critical load distributions at the appropriate maximum load factors corresponding to the specified flight and ground load conditions, except the emergency landing conditions of CS 27.561.

(b) There must be means to prevent the contents of any compartment from becoming a hazard by shifting under the loads specified in sub-paragraph (a).

(c) Under the emergency landing conditions of CS 27.561, cargo and baggage compartments must:

(1) Be positioned so that if the contents break loose they are unlikely to cause injury to the occupants or restrict any of the escape facilities provided for use after an emergency landing; or

(2) Have sufficient strength to withstand the conditions specified in CS 27.561 including the means of restraint, and their attachments, required by sub-paragraph (b). Sufficient strength must be provided for the maximum authorised weight of cargo and baggage at the critical loading distribution.

CS 27.807 Emergency exits

(a) Number and location.

(1) There must be at least one emergency exit on each side of the cabin readily accessible to each passenger. One of these exits must be usable in any probable attitude that may result from a crash;

(2) Doors intended for normal use may also serve as emergency exits, provided that they meet the requirements of this paragraph; and

(b) Type and operation. Each emergency exit prescribed by sub-paragraph (a) must:

(1) Consist of a moveable window or panel, or additional external door, providing an unobstructed opening that will admit a 0.48 m by 0.66 m (19 inch by 26 inch) ellipse;

(2) Have simple and obvious methods of opening, from the inside and from the outside, which do not require exceptional effort;

(3) Be arranged and marked so as to be readily located and operated even in darkness; and

(4) Be reasonably protected from jamming by fuselage deformation.

(c) Tests. The proper functioning of each emergency exit must be shown by test.

CS 27.831 Ventilation

(a) The ventilating system for the pilot and passenger compartments must be designed to prevent the presence of excessive quantities of fuel fumes and carbon monoxide.

(b) The concentration of carbon monoxide may not exceed one part in 20 000 parts of air during forward flight or hovering in still air. If the concentration exceeds this value under other conditions, there must be suitable operating restrictions.

FIRE PROTECTION

CS 27.853 Compartment interiors

For each compartment to be used by the crew or passengers:

(a) The materials must be at least flame resistant;

(c) If smoking is to be prohibited, there must be a placard so stating, and if smoking is to be allowed:

(1) There must be an adequate number of self-contained, removable ashtrays; and

(2) Where the crew compartment is separated from the passenger compartment, there must be at least one illuminated sign (using either letters or symbols) notifying all passengers when smoking is prohibited. Signs which notify when smoking is prohibited must:

(i) When illuminated, be legible to each passenger seated in the passenger cabin under all probable lighting conditions; and

(ii) Be so constructed that the crew can turn the illumination on and off.

CS 27.855 Cargo and baggage compartments

(a) Each cargo and baggage compartment must be constructed of, or lined with, materials that are at least:

(1) Flame resistant, in the case of compartments that are readily accessible to a crew member in flight; and

(2) Fire resistant, in the case of other compartments.

(b) No compartment may contain any controls, wiring, lines, equipment, or accessories whose damage or failure would affect safe operation, unless those items are protected so that:

(1) They cannot be damaged by the movement of cargo in the compartment; and

(2) Their breakage or failure will not create a fire hazard.

CS 27.859 Heating systems

(b) Heat exchangers. Each heat exchanger must be:

(1) Of suitable materials;

(2) Adequately cooled under all conditions; and

(3) Easily disassembled for inspection.

(d) Ventilating air ducts. Each ventilating air duct passing through any heater region must be fireproof.

(1) Unless isolation is provided by fire-proof valves or by equally effective means, the ventilating air duct downstream of each heater must be fireproof for a distance great enough to ensure that any fire originating in the heater can be contained in the duct.

(f) Heater control. General. There must be means to prevent the hazardous accumulation of water or ice on or in any heater control component, control system tubing, or safety control.

(h) Air intakes. Each combustion and heat-ventilating air intake must be located so that no flammable fluids or vapours can enter the heater system:

(1) During normal operation; or

(2) As a result of the malfunction of any other component.

CS 27.861 Fire protection of structure, controls, and other parts

Each part of the structure, controls, rotor mechanism, and other parts essential to a controlled landing that would be affected by powerplant fires must be fireproof or protected so they can perform their essential functions for at least 5 minutes under any foreseeable powerplant fire conditions.

CS 27.863 Flammable fluid fire protection

(a) In each area where flammable fluids or vapours might escape by leakage of a fluid system, there must be means to minimise the probability of ignition of the fluids and vapours, and the resultant hazards if ignition does occur.

(b) Compliance with sub-paragraph (a) must be shown by analysis or tests, and the following factors must be considered:

(1) Possible sources and paths of fluid leakage, and means of detecting leakage.

(2) Flammability characteristics of fluids, including effects of any combustible or absorbing materials.

(3) Possible ignition sources, including electrical faults, over-heating of equipment, and malfunctioning of protective devices.

(4) Means available for controlling or extinguishing a fire, such as stopping flow of fluids, shutting down equipment, fireproof containment, or use of extinguishing agents.

(5) Ability of rotorcraft components that are critical to safety of flight to withstand fire and heat.

(c) If action by the flight crew is required to prevent or counteract a fluid fire (e.g. equipment shutdown or actuation of a fire extinguisher) quick acting means must be provided to alert the crew.

(d) Each area where flammable fluids or vapours might escape by leakage of a fluid system must be identified and defined.

MISCELLANEOUS

CS 27.871 Levelling marks

There must be reference marks for levelling the rotorcraft on the ground.

Subpart E - POWERPLANT

GENERAL

SC GP 27.901 Installation

(a) For the purpose of this certification basis, the powerplant installation includes each part of the rotorcraft (other than the main and auxiliary rotor structures) that:

(1) Is necessary for propulsion;

(2) Affects the control of the major propulsive units; or

(3) Affects the safety of the major propulsive units between normal inspections or overhauls.

(b) For each powerplant installation:

(1) Each component of the installation must be constructed, arranged, and installed to ensure its continued safe operation between normal inspections or overhauls for the range of temperature and altitude for which approval is requested.

(2) Accessibility must be provided to allow any inspection and maintenance necessary for continued airworthiness;

(3) Electrical interconnections must be provided to prevent differences of potential between major components of the installation and the rest of the rotorcraft;

(5) Design precautions must be taken to minimise the possibility of incorrect assembly of components and equipment essential to safe operation of the rotorcraft, except where operation with the incorrect assembly can be shown to be extremely improbable.

(c) The installation must comply with:

(1) The installation instructions provided under the engine type certificate, and the propeller type certificate; and

(2) The applicable provisions of this Subpart.

CS 27.903 Engines

(b) Engine or drive system cooling fan blade protection.

(1) If an engine or rotor drive system cooling fan is installed, there must be means to protect the rotorcraft and allow a safe landing if a fan blade fails. This must be shown by showing that:

(i) The fan blades are contained in case of failure;

(ii) Each fan is located so that a failure will not jeopardise safety; or

(iii) Each fan blade can withstand an ultimate load of 1.5 times the centrifugal force resulting from operation limited by the following:

(2) Unless a fatigue evaluation under CS 27.571 is conducted, it must be shown that cooling fan blades are not operating at resonant conditions within the operating limits of the rotorcraft.

(d) Restart capability: A means to restart any engine in flight must be provided.

(1) Except for the in-flight shutdown of all engines, engine restart capability must be demonstrated throughout a flight envelope for the rotorcraft.

(2) Following the in-flight shutdown of all engines, in-flight engine restart capability must be provided.

SC GP 27.905 Propeller

(a) Engine power and propeller shaft rotational speed may not exceed the limits for which the propeller is certificated.

(b) Each pusher propeller must be marked so that the disc is conspicuous under normal daylight ground conditions.

(c) If the engine exhaust gases are discharged into the pusher propeller disc, it must be shown by tests, or analysis supported by tests, that the propeller is capable of continuous safe operation.

(d) All engine cowlings, access doors, and other removable items must be designed to ensure that they will not separate from the aeroplane and contact the pusher propeller.

SC GP 27.907 Propeller and Engine vibration

(a) Each engine must be installed to prevent the harmful vibration of any part of the engine or rotorcraft.

(b) The addition of the propeller and the propeller drive system to the engine may not subject the principal rotating parts of the engine to excessive vibration stresses. This must be shown by a vibration investigation.

(c) No part of the propeller and propeller drive system may be subjected to excessive vibration stresses.

ROTOR DRIVE SYSTEM

SC GP 27.917A Propeller and Road Drive System Design

(a) The propeller drive system includes any part necessary to transmit power from the engines to the propeller. This includes gearboxes, shafting, universal joints, couplings, clutches, supporting bearings for shafting, any attendant accessory pads or drives, and any cooling fans that are a part of, attached to, or mounted on the propeller drive system.

(c) Each Propeller drive system must incorporate a unit for each engine to automatically disengage that engine from the propeller if that engine fails, unless it is demonstrated that a propeller stoppage following sudden engine blockage does not affect safe flight and landing.

(e) If a torque limiting device is used in the Propeller drive system, it must be located so as to allow continued control of the engine when the device is operating.

SC GP 27.917B Pre-rotating Drive System Design

(a) The pre-rotating drive system includes any part necessary to transmit the power from pre-rotating motor to the rotor hub. This includes gearboxes, shafting, universal joints, couplings, clutches, supporting bearings for shafting, any attendant accessory pads or drives mounted on the pre-rotating drive system.

(b) The pre-rotating drive system must incorporate a unit to automatically disengage that power source from the rotor above the maximum pre-rotating rotor speed.

(c) A safety assessment must be performed to ensure that the pre-rotating drive system functions safely over the full range of conditions for which certification is sought. The safety assessment must include a detailed failure analysis and identify any pre-rotating drive system parts driven by the rotor in flight. The assessment must identify means to prevent the likelihood of pre-rotating drive system damages, which might affect continued safe flight and landing.

SC GP 27.921 Rotor spin-up and brake systems

a) The rotor spin-up and brake system must be designed to prevent:

1) It remaining engaged on take-off;

2) It becoming engaged in flight.

b) Limitations on the use of any rotor spin-up or brake systems must be specified.

SC GP 27.923 Propeller drive system endurance test programme

a) Each part tested as prescribed in this paragraph must be in a serviceable condition at the end of the tests. No intervening disassembly which might affect test results must be conducted.

b) The propeller drive system, rotor and rotating control mechanism must be tested for not less than 100 hours. A minimum of 25 hours must be conducted on the gyroplane. The torque must be absorbed by the propeller and the rotor loaded with flight loads. Other ground or flight test facilities with other acceptable methods may be used for completing the 100 hours if the conditions of support and vibration closely simulate the conditions that would exist during a test on the gyroplane.

c) A 60-hour part of the test prescribed in subparagraph (b) must be run for the propeller drive system at maximum continuous power.

d) A 20-hour part of the test prescribed in subparagraph (b) must be run for the propeller drive system with not less than 75% of maximum continuous power.

e) For multi engine gyroplanes, the test for propeller drive system must include a minimum of 5 hours OEI for each engine, representative of flight conditions which could be faced in operation with remaining engine at the maximum power. The test cycles should simulate a normal descent in autorotation with the remaining engine inoperative.

f) A 10-hours part of the test prescribed in sub-paragraph (b) must be run for the propeller drive system at not less than maximum take-off power.

g) The cycle profile for the rotor and rotating control mechanism must be representative of normal flight, including take-off, climb, cruise, descent and landing. It should also integrate under operating conditions, 500 complete cycles of lateral control, 500 complete cycles of longitudinal control of the rotor. A 'complete cycle' involves movement of the controls from the neutral position, through both extreme positions, and back to the neutral position, except that control movements need not produce loads or flapping motions exceeding the maximum loads or motions encountered in flight.

h) At least 200 engagements of each clutch mechanism of the propeller drive system should be performed to establish a level of reliability.

i) During test requirement under paragraph (b), rotor parts in test should be accelerated using the pre-rotating system and slowed down using its braking function. Any parts being in rotation or participating in the isolating function of the main rotor after the pre-rotating drive system is switched off should be considered in test as per paragraph (a). A minimum of 100 accelerations and 100 decelerations should be considered with confirmed disengagement of the pre-rotating system.

j) The isolation means of the of the Road drive system as required by paragraph 27.917 1(A)(d) must be activated as often as possible during the tests required under paragraph (b) with a minimum of 200 applications.

SC GP 27.925 Propeller clearance

Propeller clearances at maximum weight, with the most adverse c.g., with the propeller in the most adverse pitch position and taking account of likely airframe flexibility, must not be less than the following:

a) Ground clearance. There must be adequate ground clearance between the propeller and the ground, with the landing gear statically deflected and in the level normal, take-off, landing or taxiing attitude, whichever is most critical. In addition, there must be positive clearance between the propeller and the ground in the level take-off attitude, with:

1) the critical tyre completely deflated and the corresponding landing gear strut statically deflected; and

2) the critical landing gear strut bottomed and the corresponding tyre statically deflected.

b) Clearance from other parts of the gyroplane. There must be positive clearance between all rotating parts of the propeller and spinner and other parts of the gyroplane under all operating conditions with due allowance for airframe and propeller flexibility.

c) Clearance from occupant(s). There must be adequate clearance between the occupant(s) and the propeller(s) so that it is not possible for the occupant(s), when seated and strapped in, to contact the propeller(s) inadvertently. It must be possible for either occupant to enter and leave the gyroplane on the ground without passing dangerously close to the propeller disc.

SC GP 27.927 Additional tests

Any additional dynamic, endurance, and operational tests, and vibratory investigations necessary to determine that the propeller drive system or, and the pre-rotating drive system are safe, must be performed.

CS 27.931 Shafting critical speed

(a) The critical speeds of any shafting must be determined by demonstration except that analytical methods may be used if reliable methods of analysis are available for the particular design.

(b) If any critical speed lies within, or close to, the operating ranges for idling, power on, and autorotative conditions, the stresses occurring at that speed must be within safe limits. This must be shown by tests.

(c) If analytical methods are used and show that no critical speed lies within the permissible operating ranges, the margins between the calculated critical speeds and the limits of the allowable operating ranges must be adequate to allow for possible variations between the computed and actual values.

CS 27.935 Shafting joints

Each universal joint, slip joint, and other shafting joints whose lubrication is necessary for operation must have provision for lubrication.

FUEL SYSTEM

CS 27.951 General

(a) Each fuel system must be constructed and arranged to ensure a flow of fuel at a rate and pressure established for proper engine functioning under any likely operating condition, including the manoeuvres for which certification is requested.

(b) Each fuel system must be arranged so that:

(1) No fuel pump can draw fuel from more than one tank at a time; or

(2) There are means to prevent introducing air into the system.

CS 27.952 Fuel system crash resistance

Unless other means acceptable to the Agency are employed to minimise the hazard of fuel fires to occupants following an otherwise survivable impact (crash landing), the fuel systems must incorporate the design features of this paragraph. These systems must be shown to be capable of sustaining the static and dynamic deceleration loads of this paragraph, considered as ultimate loads acting alone, measured at the system component's centre of gravity without structural damage to system components, fuel tanks, or their attachments that would leak fuel to an ignition source.

(a) Drop test requirements. Each tank, or the most critical tank, must be drop-tested as follows:

(1) The drop height must be at least 15.2 m (50 ft).

(2) The drop impact surface must be non-deforming.

(3) The tank must be filled with water to 80% of the normal, full capacity.

(4) The tank must be enclosed in a surrounding structure representative of the installation unless it can be established that the surrounding structure is free of projections or other design features likely to contribute to rupture of the tank.

(5) The tank must drop freely and impact in a horizontal position ±10°.

(6) After the drop test there must be no leakage.

(b) Fuel tank load factors. Except for fuel tanks located so that tank rupture with fuel release to either significant ignition sources, such as engines, heaters, and auxiliary power units, or occupants is extremely remote, each fuel tank must be designed and installed to retain its contents under the following ultimate inertial load factors, acting alone.

(1) For fuel tanks in the cabin:

(i) Upward – 4 g.

(ii) Forward – 16 g.

(iii) Sideward – 8 g.

(iv) Downward – 20 g.

(2) For fuel tanks located above or behind the crew or passenger compartment that, if loosened, could injure an occupant in an emergency landing:

(i) Upward – 1.5 g.

(ii) Forward – 8 g.

(iii) Sideward – 2 g.

(iv) Downward – 4 g.

(3) For fuel tanks in other areas:

(i) Upward – 1.5 g.

(ii) Forward – 4 g.

(iii) Sideward – 2 g.

(iv) Downward – 4 g.

(c) Fuel line self-sealing breakaway couplings. Self-sealing breakaway couplings must be installed unless hazardous relative motion of fuel system components to each other or to local rotorcraft structure is demonstrated to be extremely improbable or unless other means are provided. The couplings or equivalent devices must be installed at all fuel tank-to-fuel line connections, tank-to-tank interconnects, and at other points in the fuel system where local structural deformation could lead to release of fuel.

(1) The design and construction of self-sealing breakaway couplings must incorporate the following design features:

(i) The load necessary to separate a breakaway coupling must be between 25 and 50% of the minimum ultimate failure load (ultimate strength) of the weakest component in the fluid-carrying line. The separation load must in no case be less than 1334 N (300 lb), regardless of the size of the fluid line.

(ii) A breakaway coupling must separate whenever its ultimate load (as defined in sub-paragraph (c)(1)(i)) is applied in the failure modes most likely to occur.

(iii) All breakaway couplings must incorporate design provisions to visually ascertain that the coupling is locked together (leak-free) and is open during normal installation and service.

(iv) All breakaway couplings must incorporate design provisions to prevent uncoupling or unintended closing due to operational shocks, vibrations, or accelerations.

(v) No breakaway coupling design may allow the release of fuel once the coupling has performed its intended function.

(2) All individual breakaway couplings, coupling fuel feed systems, or equivalent means must be designed, tested, installed and maintained so that inadvertent fuel shut-off in flight is improbable in accordance with CS 27.955(a) and must comply with the fatigue evaluation requirements of CS 27.571 without leaking.

(3) Alternate, equivalent means to the use of breakaway couplings must not create a survivable impact-induced load on the fuel line to which it is installed greater than 25 to 50% of the ultimate load (strength) of the weakest component of the line and must comply with the fatigue requirements of CS 27.571 without leaking.

(d) Frangible or deformable structural attachments. Unless hazardous relative motion of fuel tanks and fuel system components to local rotorcraft structure is demonstrated to be extremely improbable in an otherwise survivable impact, frangible or locally deformable attachments of fuel tanks and fuel system components to local rotorcraft structure must be used. The attachment of fuel tanks and fuel system components to local rotorcraft structure, whether frangible or locally deformable, must be designed such that its separation or relative local deformation will occur without rupture or local tear-out of the fuel tank and fuel system components that will cause fuel leakage. The ultimate strength of frangible or deformable attachments must be as follows:

(1) The load required to separate a frangible attachment from its support structure, or to deform a locally deformable attachment relative to its support structure, must be between 25 and 50% of the minimum ultimate load (ultimate strength) of the weakest component in the attached system. In no case may the load be less than 1330 N (300 lbs).

(2) A frangible or locally deformable attachment must separate or locally deform as intended whenever its ultimate load (as defined in sub-paragraph (d) (1)) is applied in the modes most likely to occur.

(3) All frangible or locally deformable attachments must comply with the fatigue requirements of CS 27.571.

(e) Separation of fuel and ignition sources. To provide maximum crash resistance, fuel must be located as far as practicable from all occupiable areas and from all potential ignition sources.

(f) Other basic mechanical design criteria. Fuel tanks, fuel lines, electrical wires, and electrical devices must be designed, constructed and installed, as far as practicable, to be crash resistant.

(g) Rigid or semi-rigid fuel tanks. Rigid or semi-rigid fuel tank or bladder walls must be impact and tear resistant.

CS 27.953 Fuel system independence

(a) Each fuel system for multi-engine rotorcraft must allow fuel to be supplied to each engine through a system independent of those parts of each system supplying fuel to other engines. However, separate fuel tanks need not be provided for each engine.

(b) If a single fuel tank is used on a multi-engine rotorcraft, the following must be provided:

(1) Independent tank outlets for each engine, each incorporating a shut-off valve at the tank. This shut-off valve may also serve as the firewall shut-off valve required by CS 27.995 if the line between the valve and the engine compartment does not contain a hazardous amount of fuel that can drain into the engine compartment.

(2) At least two vents arranged to minimise the probability of both vents becoming obstructed simultaneously.

(3) Filler caps designed to minimise the probability of incorrect installation or in-flight loss.

(4) A fuel system in which those parts of the system from each tank outlet to any engine are independent of each part of each system supplying fuel to other engines.

CS 27.954 Fuel system lightning protection

The fuel system must be designed and arranged to prevent the ignition of fuel vapour within the system by:

(c) Corona and streamering at fuel vent outlets.

CS 27.955 Fuel flow

(a) General. The fuel system for each engine must be shown to provide the engine with at least 100% of the fuel required under each operating and manoeuvring condition to be approved for the rotorcraft including, as applicable, the fuel required to operate the engine(s) under the test conditions required by CS 27.927. Unless equivalent methods are used, compliance must be shown by test during which the following provisions are met except that combinations of conditions which are shown to be improbable need not be considered:

(1) The fuel pressure, corrected for critical accelerations, must be within the limits specified by the engine type certificate data sheet.

(2) The fuel level in the tank may not exceed that established as unusable fuel supply for the tank under CS 27.959, plus the minimum additional fuel necessary to conduct the test.

(3) The fuel head between the tank outlet and the engine inlet must be critical with respect to rotorcraft flight attitudes.

(4) The critical fuel pump (for pump-fed systems) is installed to produce (by actual or simulated failure) the critical restriction to fuel flow to be expected from pump failure.

(5) Critical values of engine rotation speed, electrical power, or other sources of fuel pump motive power must be applied.

(6) Critical values of fuel properties which adversely affect fuel flow must be applied.

(7) The fuel filter required by CS 27.997 must be blocked to the degree necessary to simulate the accumulation of fuel contamination required to activate the indicator required by CS 27.1305(q).

CS 27.959 Unusable fuel supply

The unusable fuel supply for each tank must be established as not less than the quantity at which the first evidence of malfunction occurs under the most adverse fuel feed condition occurring under any intended operations and flight manoeuvres involving that tank.

SC GP 27.961 Fuel system hot weather operation

Each suction lift fuel system and other fuel systems with features conducive to vapour formation must be shown by test to operate satisfactorily (within certification limits) when using fuel at a temperature of 43°C (110°F) under critical operating conditions including, if applicable, the engine operating conditions defined by SC GP 27.927.

CS 27.963 Fuel tanks: general

(a) Each fuel tank must be able to withstand, without failure, the vibration, inertia, fluid, and structural loads to which it may be subjected in operation.

(b) Each fuel tank of 38 litres (8.3 Imperial gallons/10 US gallons) or greater capacity must have internal baffles, or must have external support to resist surging.

(c) Each fuel tank must be separated from the engine compartment by a firewall. At least one-half inch of clear airspace must be provided between the tank and the firewall.

(d) Spaces adjacent to the surfaces of fuel tanks must be ventilated so that fumes cannot accumulate in the tank compartment in case of leakage. If two or more tanks have interconnected outlets, they must be considered as one tank, and the airspaces in those tanks must be interconnected to prevent the flow of fuel from one tank to another as a result of a difference in pressure between those airspaces.

(e) The maximum exposed surface temperature of any component in the fuel tank must be less, by a safe margin, than the lowest expected auto-ignition temperature of the fuel or fuel vapour in the tank. Compliance with this requirement must be shown under all operating conditions and under all failure or malfunction conditions of all components inside the tank.

(g) Each flexible fuel tank bladder or liner must be approved or shown to be suitable for the particular application and must be puncture resistant. Puncture resistance must be shown by meeting the ETSO-C80, paragraph 16.0, requirements using a minimum puncture force of 1646 N (370 lbs).

CS 27.965 Fuel tank tests

(a) Each fuel tank must be able to withstand the applicable pressure tests in this paragraph without failure or leakage. If practicable, test pressures may be applied in a manner simulating the pressure distribution in service.

(b) Each conventional metal tank, non-metallic tank with walls that are not supported by the rotorcraft structure, and integral tank must be subjected to a pressure of 24 kPa (3.5 psi) unless the pressure developed during maximum limit acceleration or emergency deceleration with a full tank exceeds this value, in which case a hydrostatic head, or equivalent test, must be applied to duplicate the acceleration loads as far as possible. However, the pressure need not exceed 24 kPa (3.5 psi) on surfaces not exposed to the acceleration loading.

(c) Each non-metallic tank with walls supported by the rotorcraft structure must be subjected to the following tests:

(1) A pressure test of at least 14 kPa (2.0 psi). This test may be conducted on the tank alone in conjunction with the test specified in sub-paragraph (c)(2).

(2) A pressure test, with the tank mounted in the rotorcraft structure, equal to the load developed by the reaction of the contents, with the tank full, during maximum limit acceleration or emergency deceleration. However, the pressure need not exceed 14 kPa (2.0 psi) on surfaces not exposed to the acceleration loading.

(d) Each tank with large unsupported or unstiffened flat areas, or with other features whose failure or deformation could cause leakage, must be subjected to the following test or its equivalent:

(1) Each complete tank assembly and its support must be vibration tested while mounted to simulate the actual installation.

(2) The tank assembly must be vibrated for 25 hours while two-thirds full of any suitable fluid. The amplitude of vibration may not be less than 0.8 mm (1/32 inch), unless otherwise substantiated.

(3) The test frequency of vibration must be as follows:

(i) If no frequency of vibration resulting from any rpm within the normal operating range of engine or rotor system speeds is critical, the test frequency of vibration, in number of cycles per minute must, unless a frequency based on a more rational calculation is used, be the number obtained by averaging the maximum and minimum power-on engine speeds (rpm) for reciprocating engine-powered rotorcraft or 2000 rpm for turbine engine-powered rotorcraft.

(ii) If only one frequency of vibration resulting from any rpm within the normal operating range of engine or rotor system speeds is critical, that frequency of vibration must be the test frequency.

(iii) If more than one frequency of vibration resulting from any rpm within the normal operating range of engine or rotor system speeds is critical, the most critical of these frequencies must be the test frequency.

(4) Under sub-paragraphs (d)(3)(ii) and (iii), the time of test must be adjusted to accomplish the same number of vibration cycles as would be accomplished in 25 hours at the frequency specified in sub-paragraph (d)(3)(i).

(5) During the test, the tank assembly must be rocked at the rate of 16 to 20 complete cycles per minute through an angle of 15° on both sides of the horizontal (30° total), about the most critical axis, for 25 hours. If motion about more than one axis is likely to be critical, the tank must be rocked about each critical axis for 12½ hours.

CS 27.967 Fuel tank installation

(a) Each fuel tank must be supported so that tank loads are not concentrated on unsupported tank surfaces. In addition:

(1) There must be pads, if necessary, to prevent chafing between each tank and its supports;

(2) The padding must be non-absorbent or treated to prevent the absorption of fuel;

(3) If flexible tank liners are used, they must be supported so that it is not necessary for them to withstand fluid loads; and

(4) Each interior surface of tank compartments must be smooth and free of projections that could cause wear of the liner unless:

(i) There are means for protection of the liner at those points; or

(ii) The construction of the liner itself provides such protection.

(b) Any spaces adjacent to tank surfaces must be adequately ventilated to avoid accumulation of fuel or fumes in those spaces due to minor leakage. If the tank is in a sealed compartment, ventilation may be limited to drain holes that prevent clogging and excessive pressure resulting from altitude changes. If flexible tank liners are installed, the venting arrangement for the spaces between the liner and its container must maintain the proper relationship to tank vent pressures for any expected flight condition.

(c) The location of each tank must meet the requirements of CS 27.1185 (a) and (c).

(d) No rotorcraft skin immediately adjacent to a major air outlet from the engine compartment may act as the wall of the integral tank.

CS 27.969 Fuel tank expansion space

Each fuel tank or each group of fuel tanks with interconnected vent systems must have an expansion space of not less than 2% of the tank capacity. It must be impossible to fill the fuel tank expansion space inadvertently with the rotorcraft in the normal ground attitude.

CS 27.971 Fuel tank sump

(a) Each fuel tank must have a drainable sump with an effective capacity in any ground attitude to be expected in service of 0.25% of the tank capacity or 0.24 litres (0.05 Imperial gallons/one sixteenth US gallon), whichever is greater, unless:

(1) The fuel system has a sediment bowl or chamber that is accessible for pre-flight drainage and has a minimum capacity of 30 ml (l ounce) for every 76 litres (16.7 Imperial gallons/20 US gallons) of fuel tank capacity; and

(2) Each fuel tank drain is located so that in any ground attitude to be expected in service, water will drain from all parts of the tank to the sediment bowl or chamber.

(b) Each sump, sediment bowl, and sediment chamber drain required by the paragraph must comply with the drain provisions of CS 27.999 (b).

CS 27.973 Fuel tank filler connection

(a) Each fuel tank filler connection must prevent the entrance of fuel into any part of the rotorcraft other than the tank itself during normal operations and must be crash resistant during a survivable impact in accordance with CS 27.952 (c). In addition:

(1) Each filler must be marked as prescribed in CS 27.1557 (c)(1);

(2) Each recessed filler connection that can retain any appreciable quantity of fuel must have a drain that discharges clear of the entire rotorcraft; and

(3) Each filler cap must provide a fuel-tight seal under the fluid pressure expected in normal operation and in a survivable impact.

(b) Each filler cap or filler cap cover must warn when the cap is not fully locked or seated on the filler connection.

CS 27.975 Fuel tank vents

(a) Each fuel tank must be vented from the top part of the expansion space so that venting is effective under all normal flight conditions. Each vent must minimise the probability of stoppage by dirt or ice.

(b) The venting system must be designed to minimise spillage of fuel through the vents to an ignition source in the event of a rollover during landing, ground operation, or a survivable impact.

CS 27.977 Fuel tank outlet

(a) There must be a fuel strainer for the fuel tank outlet or for the booster pump. This strainer must:

(1) For reciprocating engine-powered rotorcraft have 3 to 6 meshes per cm (8 to 16 meshes per inch); and

(b) The clear area of each fuel tank outlet strainer must be at least 5 times the area of the outlet line.

(c) The diameter of each strainer must be at least that of the fuel tank outlet.

(d) Each finger strainer must be accessible for inspection and cleaning.

FUEL SYSTEM COMPONENTS

CS 27.991 Fuel pumps

Compliance with CS 27.955 may not be jeopardised by failure of:

(a) Any one pump except pumps that are approved and installed as parts of a type certificated engine; or

(b) Any component required for pump operation except, for engine driven pumps, the engine served by that pump.

CS 27.993 Fuel system lines and fittings

(a) Each fuel line must be installed and supported to prevent excessive vibration and to withstand loads due to fuel pressure and accelerated flight conditions.

(b) Each fuel line connected to components of the rotorcraft between which relative motion could exist must have provisions for flexibility.

(c) Flexible hose must be approved.

(d) Each flexible connection in fuel lines that may be under pressure or subjected to axial loading must use flexible hose assemblies.

(e) No flexible hose that might be adversely affected by high temperatures may be used where excessive temperatures will exist during operation or after engine shutdown.

CS 27.995 Fuel valves

(a) There must be a positive, quick-acting valve to shut-off fuel to each engine individually.

(b) The control for this valve must be within easy reach of appropriate crew members.

(c) Where there is more than one source of fuel supply there must be means for independent feeding from each source.

(d) No shut-off valve may be on the engine side of any firewall.

CS 27.997 Fuel strainer or filter

There must be a fuel strainer or filter between the fuel tank outlet and the inlet of the first fuel system component which is susceptible to fuel contamination, including but not limited to the fuel metering device or an engine positive displacement pump, whichever is nearer the fuel tank outlet. This fuel strainer or filter must:

(a) Be accessible for draining and cleaning and must incorporate a screen or element which is easily removable;

(b) Have a sediment trap and drain except that it need not have a drain if the strainer or filter is easily removable for drain purposes;

(c) Be mounted so that its weight is not supported by the connecting lines or by the inlet or outlet connections of the strainer or filter itself, unless adequate strength margins under all loading conditions are provided in the lines and connections; and

(d) Provide a means to remove from the fuel any contaminant which would jeopardise the flow of fuel through rotorcraft or engine fuel system components required for proper rotorcraft fuel system or engine fuel system operation.

CS 27.999 Fuel system drains

(a) There must be at least one accessible drain at the lowest point in each fuel system to completely drain the system with the rotorcraft in any ground attitude to be expected in service.

(b) Each drain required by sub-paragraph (a) must:

(1) Discharge clear of all parts of the rotorcraft;

(2) Have manual or automatic means to assure positive closure in the off position; and

(3) Have a drain valve:

(i) That is readily accessible and which can be easily opened and closed; and

OIL SYSTEM

CS 27.1011 Engines: general

(a) Each engine must have an independent oil system that can supply it with an appropriate quantity of oil at a temperature not above that safe for continuous operation.

(b) The usable oil capacity of each system may not be less than the product of the endurance of the rotorcraft under critical operating conditions and the maximum oil consumption of the engine under the same conditions, plus a suitable margin to ensure adequate circulation and cooling. Instead of a rational analysis of endurance and consumption, a usable oil capacity of 3.8 litres (0.83 Imperial gallon /l US gallon) for each 151 litres (33.3 Imperial gallons/40 US gallons) of usable fuel may be used.

(c) The oil cooling provisions for each engine must be able to maintain the oil inlet temperature to that engine at or below the maximum established value. This must be shown by flight tests.

SC GP 27.1013 Oil tanks

Each oil tank must be designed and installed so that:

(a) It can withstand, without failure, each vibration, inertia, fluid, and structural load expected in operation;

(c) Where used with a reciprocating engine, it has an expansion space sufficient to allow oil expansion under all foreseeable operating conditions.

(d) It is impossible to fill the tank expansion space inadvertently with the rotorcraft in the normal ground attitude;

(e) Adequate venting is provided; and

(f) There are means in the filler opening to prevent oil overflow from entering the oil tank compartment.

CS 27.1015 Oil tank tests

Each oil tank must be designed and installed so that it can withstand, without leakage, an internal pressure of 34 kPa (5 psi), except that each pressurised oil tank used with a turbine engine must be designed and installed so that it can withstand, without leakage, an internal pressure of 34 kPa (5 psi), plus the maximum operating pressure of the tank.

CS 27.1017 Oil lines and fittings

(a) Each oil line must be supported to prevent excessive vibration.

(b) Each oil line connected to components of the rotorcraft between which relative motion could exist must have provisions for flexibility.

(c) Flexible hose must be approved.

(d) Each oil line must have an inside diameter of not less than the inside diameter of the engine inlet or outlet. No line may have splices between connections.

CS 27.1019 Oil strainer or filter

(b) Each oil strainer or filter in a powerplant installation using reciprocating engines must be constructed and installed so that oil will flow at the normal rate through the rest of the system with the strainer or filter element completely blocked.

CS 27.1021 Oil system drains

A drain (or drains) must be provided to allow safe drainage of the oil system. Each drain must:

(a) Be accessible; and

(b) Have manual or automatic means for positive locking in the closed position.

CS 27.1027 Transmissions and gearboxes: general

(a) The lubrication system for components of the rotor drive system that require continuous lubrication must be sufficiently independent of the lubrication systems of the engine(s) to ensure lubrication during autorotation.

(b) Pressure lubrication systems for transmissions and gear-boxes must comply with the engine oil system requirements of CS 27.1013 (except sub-paragraph (c)), CS 27.1015, 27.1017, 27.1021, and 27.1337 (d).

(c) Each pressure lubrication system must have an oil strainer or filter through which all of the lubricant flows and must:

(1) Be designed to remove from the lubricant any contaminant which may damage transmission and drive system components or impede the flow of lubricant to a hazardous degree;

(2) Be equipped with a means to indicate collection of contaminants on the filter or strainer at or before opening of the bypass required by sub-paragraph (c)(3); and

(3) Be equipped with a bypass constructed and installed so that:

(i) The lubricant will flow at the normal rate through the rest of the system with the strainer or filter completely blocked; and

(ii) The release of collected contaminants is minimised by appropriate location of the bypass to ensure that collected contaminants are not in the bypass flow path.

(d) For each lubricant tank or sump outlet supplying lubrication to rotor drive systems and rotor drive system components, a screen must be provided to prevent entrance into the lubrication system of any object that might obstruct the flow of lubricant from the outlet to the filter required by sub-paragraph (c). The requirements of sub-paragraph (c) do not apply to screens installed at lubricant tank or sump outlets.

COOLING

CS 27.1041 General

(a) Each powerplant cooling system must be able to maintain the temperatures of powerplant components within the limits established for these components under critical surface (ground or water) and flight operating conditions for which certification is required and after normal shutdown. Powerplant components to be considered include but may not be limited to engines, rotor drive system components, auxiliary power units, and the cooling or lubricating fluids used with these components.

(b) Compliance with sub-paragraph (a) must be shown in tests conducted under the conditions prescribed in that paragraph.

CS 27.1043 Cooling tests

(a) General. For the tests prescribed in CS 27.1041 (b), the following apply:

(1) If the tests are conducted under conditions deviating from the maximum ambient atmospheric temperature specified in sub-paragraph (b), the recorded powerplant temperatures must be corrected under sub-paragraphs (c) and (d) unless a more rational correction method is applicable.

(2) No corrected temperature determined under sub-paragraph (a)(1) may exceed established limits.

(3) For reciprocating engines, the fuel used during the cooling tests must be of the minimum grade approved for the engines, and the mixture settings must be those normally used in the flight stages for which the cooling tests are conducted.

(4) The test procedures must be as prescribed in CS 27.1045.

(b) Maximum ambient atmospheric temperature. A maximum ambient atmospheric temperature corresponding to sea-level conditions of at least 38°C (100°F) must be established. The assumed temperature lapse rate is 1.98°C (3.6°F) per 305 m (1000 ft) of altitude above sea-level until a temperature of -56.5°C (-69.7°F) is reached, above which altitude the temperature is considered constant at -56.5°C (-69.7°F). However, for winterization installations, the applicant may select a maximum ambient atmospheric temperature corresponding to sea-level conditions of less than 38°C (100°F).

(c) Correction factor (except cylinder barrels). Unless a more rational correction applies, temperatures of engine fluids and powerplant components (except cylinder barrels) for which temperature limits are established, must be corrected by adding to them the difference between the maximum ambient atmospheric temperature and the temperature of the ambient air at the time of the first occurrence of the maximum component or fluid temperature recorded during the cooling test.

(d) Correction factor for cylinder barrel temperatures. Cylinder barrel temperatures must be corrected by adding to them 0.7 times the difference between the maximum ambient atmospheric temperature and the temperature of the ambient air at the time of the first occurrence of the maximum cylinder barrel temperature recorded during the cooling test.

CS 27.1045 Cooling test procedures

(a) General. For each stage of flight, the cooling tests must be conducted with the rotorcraft:

(1) In the configuration most critical for cooling; and

(2) Under the conditions most critical for cooling.

(b) Temperature stabilisation. For the purpose of the cooling tests, a temperature is 'stabilised' when its rate of change is less than 1°C (2°F) per minute. The following component and engine fluid temperature stabilisation rules apply:

(1) For each rotorcraft, and for each stage of flight:

(i) The temperatures must be stabilised under the conditions from which entry is made into the stage of flight being investigated; or

(ii) If the entry condition normally does not allow temperatures to stabilise, operation through the full entry condition must be conducted before entry into the stage of flight being investigated in order to allow the temperatures to attain their natural levels at the time of entry.

(c) Duration of test. For each stage of flight the tests must be continued until:

(1) The temperatures stabilise or 5 minutes after the occurrence of the highest temperature recorded, as appropriate to the test condition;

(2) That stage of flight is completed; or

(3) An operating limitation is reached.

SC GP 27.1061 Liquid Cooling - Installation

(a) General. Each liquid-cooled engine must have an independent cooling system (including coolant tank) installed so that –

(1) Each coolant tank is supported so that tank loads are distributed over a large part of the tank surface;

(2) There are pads or other isolation means between the tank and its supports to prevent chafing; and

(3) Pads or any other isolation means that is used must be non-absorbent or must be treated to prevent absorption of flammable fluids; and

(4) No air or vapour can be trapped in any part of the system, except the coolant tank expansion space, during filling or during operation.

(b) Coolant tank. The tank capacity must be adapted to the cooling system capacity with margin. 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 sufficient to allow cooling fluid expansion and overflow under all foreseeable operating conditions; and

(3) It must be impossible to fill the expansion space inadvertently with the aeroplane in the normal ground attitude.

(c) Filler connection. Each coolant tank filler connection must be marked as specified in CS 27.1557 (c). In addition –

(1) Spilled coolant must be prevented from entering the coolant tank compartment or any part of the aeroplane other than the tank itself; and

(2) Each recessed coolant filler connection must have a drain that discharges clear of the entire aeroplane.

(d) Lines and fittings. Each coolant system line and fitting must meet the requirements of CS 27.993, except that the inside diameter of the engine coolant inlet and outlet lines may not be less than the diameter of the corresponding engine inlet and outlet connections.

(e) Radiators. Each coolant radiator must be able to withstand any vibration, inertia and coolant pressure load to which it may normally be subjected. In addition –

(1) Each radiator must be supported to allow expansion due to operating temperatures and prevent the transmittal of harmful vibration to the radiator; and

(2) If flammable coolant is used, the air intake duct to the coolant radiator must be located so that (in case of fire) flames from the nacelle cannot strike the radiator.

(f) Drains. There must be an accessible drain that –

(1) Drains the entire cooling system (including the coolant tank, radiator and the engine) when the aeroplane is in the normal ground attitude;

(2) Discharges clear of the entire aeroplane; and

(3) Has means to positively lock it closed.

SC GP 27.1063 Liquid Cooling - Coolant tank tests

Each coolant tank, unless already demonstrated as part of the engine Type Certificate, must be tested under CS 27.965, except that:

(a) The test required by CS 27.965 (b) must be replaced with a similar test using the sum of the pressure developed during the maximum ultimate acceleration with a full tank or a pressure of 24 kPa (3·5 psi), whichever is greater, plus the maximum working pressure of the system; and

(b) For a tank with a non-metallic liner the test fluid must be coolant rather than fuel as specified in CS 27.965 (d) and the slosh test on a specimen liner must be conducted with the coolant at operating temperature.

INDUCTION SYSTEM

CS 27.1091 Air induction

(a) The air induction system for each engine must supply the air required by that engine under the operating conditions and manoeuvres for which certification is requested.

(b) Each cold air induction system opening must be outside the cowling if backfire flames can emerge.

(c) If fuel can accumulate in any air induction system, that system must have drains that discharge fuel:

(1) Clear of the rotorcraft; and

(2) Out of the path of exhaust flames.

CS 27.1093 Induction system icing protection

(a) Reciprocating engines. Each reciprocating engine air induction system must have means to prevent and eliminate icing. Unless this is done by other means, it must be shown that, in air free of visible moisture at a temperature of –1°C (30°F) and with the engines at 75% of maximum continuous power.

EXHAUST SYSTEM

CS 27.1121 General

For each exhaust system:

(a) There must be means for thermal expansion of manifolds and pipes;

(b) There must be means to prevent local hot spots;

(c) Exhaust gases must discharge clear of the engine air intake, fuel system components, and drains;

(d) Each exhaust system part with a surface hot enough to ignite flammable fluids or vapours must be located or shielded so that leakage from any system carrying flammable fluids or vapours will not result in a fire caused by impingement of the fluids or vapours on any part of the exhaust system including shields for the exhaust system;

(e) Exhaust gases may not impair pilot vision at night due to glare;

CS 27.1123 Exhaust piping

(a) Exhaust piping must be heat and corrosion resistant and must have provisions to prevent failure due to expansion by operating temperatures.

(b) Exhaust piping must be supported to withstand any vibration and inertia loads to which it would be subjected in operations.

(c) Exhaust piping connected to components between which relative motion could exist must have provisions for flexibility.

POWERPLANT CONTROLS AND ACCESSORIES

CS 27.1141 Powerplant controls: general

(a) Powerplant controls must be located and arranged under CS 27.777 and marked under CS 27.1555.

(b) Each flexible powerplant control must be approved.

(c) Each control must be able to maintain any set position without:

(1) Constant attention; or

(2) Tendency to creep due to control loads or vibration.

(d) Controls of powerplant valves required for safety must have:

(1) For manual valves, positive stops or in the case of fuel valves suitable index provisions, in the open and closed position.

CS 27.1143 Engine controls

(a) There must be a separate power control for each engine.

(b) Power controls must be grouped and arranged to allow:

(1) Separate control of each engine; and

(2) Simultaneous control of all engines.

(c) Each power control must provide a positive and immediately responsive means of controlling its engine.

CS 27.1145 Ignition switches

(a) There must be means to quickly shut off all ignition by the grouping of switches or by a master ignition control.

(b) Each group of ignition switches, except ignition switches for turbine engines for which continuous ignition is not required, and each master ignition control must have a means to prevent its inadvertent operation.

SC GP 27.1149 Propeller speed

a) Propeller speed and pitch must be limited to values that ensure safe operation under normal operating conditions.

b) During take-off and climb at the recommended best-rate-of-climb speed, the propeller must limit the engine rotational speed at full throttle to a value not greater than the maximum allowable rotational speed.

c) During a descent at VNE with throttle closed or the engine inoperative, the propeller must not permit a rotational speed to be achieved that is greater than 110% of the maximum allowable rotational speed of the engine or propeller, whichever is the lower.

CS 27.1151 Rotor brake controls

(a) It must be impossible to apply the rotor brake inadvertently in flight.

(b) There must be means to warn the crew if the rotor brake has not been completely released before take-off.

CS 27.1163 Powerplant accessories

(a) Each engine-mounted accessory must:

(1) Be approved for mounting on the engine involved;

(2) Use the provisions on the engine for mounting; and

(3) Be sealed in such a way as to prevent contamination of the engine oil system and the accessory system.

(b) Unless other means are provided, torque limiting means must be provided for accessory drives located on any component of the transmission and rotor drive system to prevent damage to these components from excessive accessory load.

POWERPLANT FIRE PROTECTION

CS 27.1183 Lines, fittings, and components

(a) Except as provided in sub-paragraph (b), each line, fitting, and other component carrying flammable fluid in any area subject to engine fire conditions must be fire resistant, except that flammable fluid tanks and supports which are part of and attached to the engine must be fireproof or be enclosed by a fireproof shield unless damage by fire to any non-fireproof part will not cause leakage or spillage of flammable fluid. Components must be shielded or located so as to safeguard against the ignition of leaking flammable fluid. An integral oil sump of less than 24 litres (5.2 Imperial gallons/25 US quart) capacity on a reciprocating engine need not be fireproof nor be enclosed by a fireproof shield.

(b) Sub-paragraph (a) does not apply to:

(1) Lines, fittings, and components which are already approved as part of a type certificated engine; and

(2) Vent and drain lines, and their fittings, whose failure will not result in, or add to, a fire hazard.

(c) Each flammable fluid drain and vent must discharge clear of the induction system air inlet.

CS 27.1185 Flammable fluids

(a) Each fuel tank must be isolated from the engines by a firewall or shroud.

(b) Each tank or reservoir, other than a fuel tank, that is part of a system containing flammable fluids or gases must be isolated from the engine by a firewall or shroud unless the design of the system, the materials used in the tank and its supports, the shutoff means, and the connections, lines and controls provide a degree of safety equal to that which would exist if the tank or reservoir were isolated from the engines.

(c) There must be at least 13 mm (½ in) of clear airspace between each tank and each firewall or shroud isolating that tank, unless equivalent means are used to prevent heat transfer from each engine compartment to the flammable fluid.

(d) Absorbent materials close to flammable fluid system components that might leak must be covered or treated to prevent the absorption of hazardous quantities of fluids.

CS 27.1187 Ventilation and drainage

Each compartment containing any part of the powerplant installation must have provision for ventilation and drainage of flammable fluids. The drainage means must be:

(a) Effective under conditions expected to prevail when drainage is needed; and

(b) Arranged so that no discharged fluid will cause an additional fire hazard.

CS 27.1189 Shut-off means

(a) There must be means to shut off each line carrying flammable fluids into the engine compartment, except:

(1) Lines, fittings, and components forming an integral part of an engine;

(2) For oil systems for which all components of the system, including oil tanks, are fireproof or located in areas not subject to engine fire conditions; and

(3) For reciprocating engine installations only, engine oil system lines in installations using engines of less than 8195 cm3 (500 cubic inches) displacement.

(b) There must be means to guard against inadvertent operation of each shutoff, and to make it possible for the crew to reopen it in flight after it has been closed.

(c) Each shut-off valve and its control must be designed, located, and protected to function properly under any condition likely to result from an engine fire.

CS 27.1191 Firewalls

(a) Each engine, including the combustor, turbine, and tailpipe sections of turbine engines must be isolated by a firewall, shroud or equivalent means, from personnel compartments, structures, controls, rotor mechanisms, and other parts that are:

(1) Essential to a controlled landing; and

(2) Not protected under CS 27.861.

(c) In meeting sub-paragraphs (a) and (b), account must be taken of the probable path of a fire as affected by the airflow in normal flight and in autorotation.

(d) Each firewall and shroud must be constructed so that no hazardous quantity of air, fluids, or flame can pass from any engine compartment to other parts of the rotorcraft.

(e) Each opening in the firewall or shroud must be sealed with close-fitting, fireproof grommets, bushings, or firewall fittings.

(f) Each firewall and shroud must be fireproof and protected against corrosion.

CS 27.1193 Cowling and engine compartment covering

(a) Each cowling and engine compartment covering must be constructed and supported so that it can resist the vibration, inertia, and air loads to which it may be subjected in operation.

(b) There must be means for rapid and complete drainage of each part of the cowling or engine compartment in the normal ground and flight attitudes.

(c) No drain may discharge where it might cause a fire hazard.

(d) Each cowling and engine compartment covering must be at least fire resistant.

(e) Each part of the cowling or engine compartment covering subject to high temperatures due to its nearness to exhaust system parts or exhaust gas impingement must be fireproof.

(f) A means of retaining each openable or readily removable panel, cowling, or engine or rotor drive system covering must be provided to preclude hazardous damage to rotors or critical control components in the event of structural or mechanical failure of the normal retention means, unless such failure is extremely improbable.

CS 27.1194 Other Surfaces

All surfaces aft of, and near, powerplant compartments, other than tail surfaces not subject to heat, flames, or sparks emanating from a powerplant compartment, must be at least fire resistant.

SC GP 27.1195 Fire detector systems

Each gyroplane with a fully enclosed rear engine compartment, must have a means to detect fire in the engine compartment in flight.

Subpart F - EQUIPMENT

GENERAL

CS 27.1301 Function and installation

Each item of installed equipment must:

(a) Be of a kind and design appropriate to its intended function;

(b) Be labelled as to its identification, function, or operating limitations, or any applicable combination of these factors;

(c) Be installed according to limitations specified for that equipment; and

(d) Function properly when installed.

CS 27.1303 Flight and navigation instruments

The following are the required flight and navigation instruments:

(a) An airspeed indicator.

(b) An altimeter.

(c) A magnetic direction indicator.

CS 27.1305 Powerplant instruments

The following are the required powerplant instruments:

(b) A cylinder head temperature indicator, for each:

(3) Rotorcraft for which compliance with CS 27.1043 is shown in any condition other than the most critical flight condition with respect to cooling.

(c) A fuel pressure indicator, for each pump-fed engine.

(d) A fuel quantity indicator, for each fuel tank.

(h) An oil pressure indicator for each engine.

(i) An oil quantity indicator for each oil tank.

(j) An oil temperature indicator for each engine.

(k) At least one tachometer to indicate the rpm of each engine and, as applicable:

(1) The rpm of the single main rotor;

(l) A low fuel warning device for each fuel tank which feeds an engine. This device must:

(1) Provide a warning to the flight crew when approximately 10 minutes of usable fuel remains in the tank; and

(2) Be independent of the normal fuel quantity indicating system.

(m) Means to indicate to the flight crew the failure of any fuel pump installed to show compliance with CS 27.955.

(n) An indicator to indicate propeller speed unless other displayed parameters allow a self determination that the propeller speed cannot exceed the limitations required for compliance with SC GP 27.901 (C)(1)(b)

(q) An indicator for the fuel filter required by CS 27.997 to indicate the occurrence of contamination of the filter at the degree established by the applicant in compliance with CS 27.955.

CS 27.1307 Miscellaneous equipment

The following is the required miscellaneous equipment:

(a) An approved seat for each occupant.

(b) An approved safety belt for each occupant.

(c) A master switch arrangement.

(d) An adequate source of electrical energy, where electrical energy is necessary for operation of the rotorcraft.

(e) Electrical protective devices.

CS 27.1309 Equipment, systems, and installations

(a) The equipment, systems, and installations whose functioning is required by this CS–27 must be designed and installed to ensure that they perform their intended functions under any foreseeable operating condition.

(b) The equipment, systems, and installations of a multi-engine rotorcraft must be designed to prevent hazards to the rotorcraft in the event of a probable malfunction or failure.

INSTRUMENTS: INSTALLATION

CS 27.1321 Arrangement and visibility

(a) Each flight, navigation, and powerplant instrument for use by any pilot must be easily visible to him.

(b) For each multi-engine rotorcraft, identical powerplant instruments must be located so as to prevent confusion as to which engine each instrument relates.

(c) Instrument panel vibration may not damage, or impair the readability or accuracy of, any instrument.

(d) If a visual indicator is provided to indicate malfunction of an instrument, it must be effective under all probable cockpit lighting conditions.

CS 27.1322 Warning, caution and advisory lights

If warning, caution or advisory lights are installed in the cockpit, they must, unless otherwise approved the Agen

(a) Red, for warning lights (lights indicating a hazard which may require immediate corrective action);

(b) Amber, for caution lights (lights indicating possible need for future corrective action);

(c) Green, for safe operation lights; and

(d) Any other colour, including white, for lights not described in sub-paragraphs (a) to (c), provided the colour di
colours prescribed in sub-paragraphs (a) to (c) to avoid possible confusion.

CS 27.1323 Airspeed indicating system

(a) Each airspeed indicating instrument must be calibrated to indicate true airspeed (at sea-level with a standard atmosphere) with a minimum practicable instrument calibration error when the corresponding pitot and static pressures are applied.

(b) The airspeed indicating system must be calibrated in flight at forward speeds of 37 km/h (20 knots) and over.

(c) At each forward speed above 80% of the climbout speed, the airspeed indicator must indicate true airspeed, at sea-level with a standard atmosphere, to within an allowable installation error of not more than the greater of:

(1) ±3% of the calibrated airspeed; or

(2) 9.3 km/h (5 knots).

CS 27.1325 Static pressure systems

(a) Each instrument with static air case connections must be vented so that the influence of rotorcraft speed, the opening and closing of windows, airflow variation, and moisture or other foreign matter does not seriously affect its accuracy.

(b) Each static pressure port must be designed and located in such a manner that the correlation between air pressure in the static pressure system and true ambient atmospheric static pressure is not altered when the rotorcraft encounters icing conditions. An anti-icing means or an alternate source of static pressure may be used in showing compliance with this requirement. If the reading of the altimeter, when on the alternate static pressure system, differs from the reading of the altimeter when on the primary static system by more than 15 m (50 feet), a correction card must be provided for the alternate static system.

(c) Except as provided in sub-paragraph (d), if the static pressure system incorporates both a primary and an alternate static pressure source, the means for selecting one or the other source must be designed so that:

(1) When either source is selected, the other is blocked off, and

(2) Both sources cannot be blocked off simultaneously.

(d) For unpressurised rotorcraft, sub-paragraph (c)(1) does not apply if it can be demonstrated that the static pressure system calibration, when either static pressure source is selected is not changed by the other static pressure source being open or blocked.

CS 27.1327 Magnetic direction indicator

(a) Except as provided in sub-paragraph (b):

(1) Each magnetic direction indicator must be installed so that its accuracy is not excessively affected by the rotorcraft's vibration or magnetic fields; and

(2) The compensated installation may not have a deviation, in level flight, greater than 10° on any heading.

CS 27.1337 Powerplant instruments

(a) Instruments and instrument lines

(1) Each powerplant instrument line must meet the requirements of CS 27.961 and 27.993.

(b) Fuel quantity indicator. Each fuel quantity indicator must be installed to clearly indicate to the flight crew the quantity of fuel in each tank in flight. In addition:

(1) Each fuel quantity indicator must be calibrated to read 'zero' during level flight when the quantity of fuel remaining in the tank is equal to the unusable fuel supply determined under CS 27.959;

SC GP 27.1337 Powerplant instruments

(a) Oil quantity indicator. There must be means to indicate the quantity of oil in each tank, unless it is demonstrated that a loss of lubrication has no detrimental influence on rotor and or propeller performances.

(b) Propeller drive system and pre-rotating drive system gearboxes utilising ferromagnetic materials must be equipped with magnetic chip detectors designed to indicate the presence of ferromagnetic particles resulting from damage or excessive wear, unless it is demonstrated that a mechanical degradations and failures have no detrimental influence on rotor and or propeller performances.

ELECTRICAL SYSTEMS AND EQUIPMENT

CS 27.1351 General

(a) Electrical system capacity. Electrical equipment must be adequate for its intended use. In addition:

(1) Electric power sources, their transmission cables, and their associated control and protective devices must be able to furnish the required power at the proper voltage to each load circuit essential for safe operation; and

(2) Compliance with paragraph (a)(1) must be shown by an electrical load analysis, or by electrical measurements that take into account the electrical loads applied to the electrical system, in probable combinations and for probable durations.

(b) Function. For each electrical system the following apply:

(1) Each system, when installed, must be:

(i) Free from hazards in itself, in its method of operation, and in its effects on other parts of the rotorcraft; and

(ii) Protected from fuel, oil, water, other detrimental substances, and mechanical damage.

(2) Electric power sources must function properly when connected in combination or independently.

(3) No failure or malfunction of any source may impair the ability of any remaining source to supply load circuits essential for safe operation.

(4) Each electric power source control must allow the independent operation of each source.

(c) Generating system. There must be at least one generator if the system supplies power to load circuits essential for safe operation. In addition:

(1) Each generator must be able to deliver its continuous rated power;

(2) Generator voltage control equipment must be able to dependably regulate each generator output within rated limits;

(3) Each generator must have a reverse current cut-out designed to disconnect the generator from the battery and from the other generators when enough reverse current exists to damage that generator; and

(4) Each generator must have an over voltage control designed and installed to prevent damage to the electrical system, or to equipment supplied by the electrical system, that could result if that generator were to develop an over voltage condition.

(d) Instruments. There must be means to indicate to appropriate crew members the electric power system quantities essential for safe operation of the system. In addition –

(1) For direct current systems, an ammeter that can be switched into each generator feeder may be used; and

(2) If there is only one generator, the ammeter may be in the battery feeder.

(e) External power. If provisions are made for connecting external power to the rotorcraft, and that external power can be electrically connected to equipment other than that used for engine starting, means must be provided to ensure that no external power supply having a reverse polarity, or a reverse phase sequence, can supply power to the rotorcraft's electrical system.

SC GP NPA 2011-09, AC 20-184 Li Ion battery

Li-Ion batteries and battery installations (including Lithium Polymer batteries) must be designed and installed as follows:

(a) Safe cell temperatures and pressures must be maintained during any probable charging or discharging condition, or during any failure of the charging or battery monitoring system not shown to be extremely remote. The Li-Ion battery installation must be designed to preclude explosion in the event of those failures.

(b) Batteries must be designed to preclude the occurrence of self-sustaining, uncontrolled increases in temperature or pressure.

(c) No explosive or toxic gases emitted by any Li-Ion battery in normal operation or as the result of any failure of the battery charging or monitoring system, or battery installation not shown to be extremely remote, may accumulate in hazardous quantities within the aeroplane.

(d) Li-Ion battery installations must meet CS 27.863.

(e) No corrosive fluids or gases that may escape from any Li-Ion battery may damage surrounding structure or any adjacent systems, equipment or EWIS, of the aeroplane in such a way as to cause a major or more severe failure condition.

(f) Each battery installation must have provisions to prevent any hazardous effect on structure or essential systems that may be caused by the maximum amount of heat the battery can generate during a short circuit of the battery or of its individual cells.

(g) Battery installations must have a system to control the charging rate of the battery automatically so as to prevent battery overheating or overcharging, and

(1) A battery temperature sensing and over-temperature warning system with a means for automatically disconnecting the battery from its charging source in the event of an over-temperature condition, or

(2) A battery failure sensing and warning system with a means for automatically disconnecting the battery from its charging source in the event of battery failure.

(h) Any Li-Ion battery installation whose function is required for the safe operation of the aeroplane, must incorporate a monitoring and warning feature that will provide an indication to the flight crew members whenever the state of charge of the batteries has fallen below the levels considered acceptable for dispatch of the gyroplane.

(i) The Instructions for Continued Airworthiness required by CS 27.1529 must contain maintenance instructions for measurements of battery capacity at appropriate intervals to ensure that batteries whose function is required for the safe operation of the gyroplane will perform their intended function as long as the batteries are installed in the aeroplane. The Instructions for Continued Airworthiness must also contain maintenance procedures for Li-Ion batteries in spares storage to prevent the replacement of batteries whose function is required for safe operation of the gyroplane, with batteries that have experienced degraded charge retention ability or other damage due to prolonged storage at low state of charge.

CS 27.1357 Circuit protective devices

(a) Protective devices, such as fuses or circuit breakers, must be installed in each electrical circuit other than:

(1) The main circuits of starter motors; and

(2) Circuits in which no hazard is presented by their omission.

(b) A protective device for a circuit essential to flight safety may not be used to protect any other circuit.

(c) Each resettable circuit protective device ('trip free' device in which the tripping mechanism cannot be overridden by the operating control) must be designed so that:

(1) A manual operation is required to restore service after tripping; and

(2) If an overload or circuit fault exists, the device will open the circuit regardless of the position of the operating control.

(d) If the ability to reset a circuit breaker or replace a fuse is essential to safety in flight, that circuit breaker or fuse must be located and identified so that it can be readily reset or replaced in flight.

(e) If fuses are used, there must be one spare of each rating, or 50% spare fuses of each rating, whichever is greater.

CS 27.1361 Master switch

(a) There must be a master switch arrangement to allow ready disconnection of each electric power source from the main bus. The point of disconnection must be adjacent to the sources controlled by the switch.

(b) Load circuits may be connected so that they remain energised after the switch is opened, if they are protected by circuit protective devices, rated at five amperes or less, adjacent to the electric power source.

(c) The master switch or its controls must be installed so that the switch is easily discernible and accessible to a crew member in flight.

CS 27.1365 Electric cables

(a) Each electric connecting cable must be of adequate capacity.

(b) Each cable that would overheat in the event of circuit overload or fault must be at least flame resistant and may not emit dangerous quantities of toxic fumes.

(c) Insulation on electrical wire and cable installed in the rotorcraft must be self-extinguishing when tested in accordance with CS–25, appendix F, part I (a)(3).

CS 27.1367 Switches

Each switch must be:

(a) Able to carry its rated current;

(b) Accessible to the crew; and

(c) Labelled as to operation and the circuit controlled.

LIGHTS

CS 27.1385 Position light system installation

(a) General. Each part of each position light system must meet the applicable requirements of this paragraph, and each system as a whole must meet the requirements of CS 27.1387 to 27.1397.

(b) Forward position lights. Forward position lights must consist of a red and a green light spaced laterally as far apart as practicable and installed forward on the rotorcraft so that, with the rotorcraft in the normal flying position, the red light is on the left side and the green light is on the right side. Each light must be approved.

(c) Rear position light. The rear position light must be a white light mounted as far aft as practicable, and must be approved.

(d) Circuit. The two forward position lights and the rear position light must make a single circuit.

(e) Light covers and colour filters. Each light cover or colour filter must be at least flame resistant and may not change colour or shape or lose any appreciable light transmission during normal use.

CS 27.1387 Position light system dihedral angles

(a) Except as provided in sub-paragraph (e), each forward and rear position light must, as installed, show unbroken light within the dihedral angles described in this paragraph.

(b) Dihedral angle L (left) is formed by two intersecting vertical planes, the first parallel to the longitudinal axis of the rotorcraft, and the other at 110° to the left of the first, as viewed when looking forward along the longitudinal axis.

(c) Dihedral angle R (right) is formed by two intersecting vertical planes, the first parallel to the longitudinal axis of the rotorcraft, and the other at 110° to the right of the first, as viewed when looking forward along the longitudinal axis.

(d) Dihedral angle A (aft) is formed by two intersecting vertical planes making angles of 70° to the right and to the left, respectively, to a vertical plane passing through the longitudinal axis, as viewed when looking aft along the longitudinal axis.

(e) If the rear position light, when mounted as far aft as practicable in accordance with 27.1385 (c), cannot show unbroken light within dihedral angle A (as defined in sub-paragraph (d)), a solid angle or angles of obstructed visibility totalling not more than 0.04 steradians is allowable within that dihedral angle, if such solid angle is within a cone whose apex is at the rear position light and whose elements make an angle of 30° with a vertical line passing through the rear position light.

CS 27.1389 Position light distribution and intensities

(a) General. The intensities prescribed in this paragraph must be provided by new equipment with light covers and colour filters in place. Intensities must be determined with the light source operating at a steady value equal to the average luminous output of the source at the normal operating voltage of the rotorcraft. The light distribution and intensity of each position light must meet the requirements of sub-paragraph (b).

(b) Forward and rear position lights. The light distribution and intensities of forward and rear position lights must be expressed in terms of minimum intensities in the horizontal plane, minimum intensities in any vertical plane, and maximum intensities in overlapping beams, within dihedral angles L, R, and A, and must meet the following requirements:

(1) Intensities in the horizontal plane. Each intensity in the horizontal plane (the plane containing the longitudinal axis of the rotorcraft and perpendicular to the plane of symmetry of the rotorcraft) must equal or exceed the values in CS 27.1391.

(2) Intensities in any vertical plane. Each intensity in any vertical plane (the plane perpendicular to the horizontal plane) must equal or exceed the appropriate value in CS 27.1393, where I is the minimum intensity prescribed in CS 27.1391 for the corresponding angles in the horizontal plane.

(3) Intensities in overlaps between adjacent signals. No intensity in any overlap between adjacent signals may exceed the values in CS 27.1395, except that higher intensities in overlaps may be used with main beam intensities substantially greater than the minima specified in CS 27.1391 and 27.1393, if the overlap intensities in relation to the main beam intensities do not adversely affect signal clarity. When the peak intensity of the forward position lights is greater than 100 candelas, the maximum overlap intensities between them may exceed the values in CS 27.1395 if the overlap intensity in Area A is not more than 10% of peak position light intensity and the overlap intensity in Area B is not more than 2.5% of peak position light intensity.

CS 27.1391 Minimum intensities in the horizontal plane of forward and rear position lights

Each position light intensity must equal or exceed the applicable values in the following table:

Dihedral angle (light included)	Angle from right or left of longitudinal axis, measured from dead ahead	Intensity (candelas)
L and R (forward red and green)	0° to 10° 10° to 20° 20° to 110°	40 30 5
A (rear white)	110° to 180°	20

CS 27.1393 Minimum intensities in any vertical plane of forward and rear position lights

Each position light intensity must equal or exceed the applicable values in the following table:

Angle above or below the horizontal plane –	Intensity
0	1.0 I
0° to 5°	0.90 I
5° to 10°	0.80 I
10° to 15°	0.70 I
15° to 20°	0.50 I
20° to 30°	0.30 I
30° to 40°	0.10 I
40° to 90°	0.05 I

CS 27.1395 Maximum intensities in overlapping beams of forward and rear position lights

No position light intensity may exceed the applicable values in the following table, except as provided in CS 27.1389(b)(3):

Overlaps	Maximum intensity	
	Area A (candelas)	Area B (candelas)
Green in dihedral angle L	10	1
Red in dihedral angle R	10	1
Green in dihedral angle A	5	1
Red in dihedral angle A	5	1
Rear white in dihedral angle L	5	1
Rear white in dihedral angle R	5	1

Where:

(a) Area A includes all directions in the adjacent dihedral angle that pass through the light source and intersect the common boundary plane at more than 10° but less than 20°; and

(b) Area B includes all directions in the adjacent dihedral angle that pass through the light source and intersect the common boundary plane at more than 20°.

CS 27.1397 Colour specifications

Each position light colour must have the applicable International Commission on Illumination chromaticity co-ordinates as follows:

(a) Aviation red:

'y' is not greater than 0.335; and

'z' is not greater than 0.002.

(b) Aviation green:

'x' is not greater than 0.440–0.320y;

'x' is not greater than y–0.170; and

'y' is not less than 0.390–0.170x.

(c) Aviation white:

'x' is not less than 0.300 and not greater than 0.540;

'y' is not less than 'x–0.040' or 'yo–0.010', whichever is the smaller; and

'y' is not greater than 'x + 0.020' nor '0.636–0.400x';

Where 'yo' is the 'y' co-ordinate of the Planckian radiator for the value of 'x' considered.

CS 27.1401 Anti-collision light system

(a) General. If certification for night operation is requested, the rotorcraft must have an anti-collision light system that:

(1) Consists of one or more approved anti-collision lights located so that their emitted light will not impair the crew's vision or detract from the conspicuity of the position lights; and

(2) Meets the requirements of sub-paragraphs (b) to (f).

(b) Field of coverage. The system must consist of enough lights to illuminate the vital areas around the rotorcraft, considering the physical configuration and flight characteristics of the rotorcraft. The field of coverage must extend in each direction within at least 30° above and 30° below the horizontal plane of the rotorcraft, except that there may be solid angles of obstructed visibility totalling not more than 0.5 steradians.

(c) Flashing characteristics. The arrangement of the system, that is, the number of light sources, beam width, speed of rotation, and other characteristics, must give an effective flash frequency of not less than 40, nor more than 100, cycles per minute. The effective flash frequency is the frequency at which the rotorcraft's complete anti-collision light system is observed from a distance, and applies to each sector of light including any overlaps that exist when the system consists of more than one light source. In overlaps, flash frequencies may exceed 100, but not 180, cycles per minute.

(d) Colour. Each anti-collision light must be aviation red and must meet the applicable requirements of CS 27.1397.

(e) Light intensity. The minimum light intensities in any vertical plane, measured with the red filter (if used) and expressed in terms of 'effective' intensities, must meet the requirements of sub-paragraph (f). The following relation must be assumed:

$$I_e = \frac{\int_{t_1}^{t_2} I(t)dt}{0 \cdot 2 + (t_2 - t_1)}$$

where:

Ie = effective intensity (candelas).

I(t) = instantaneous intensity as a function of time.

t2–t1 = flash time interval (seconds).

Normally, the maximum value of effective intensity is obtained when t2 and t1 are chosen so that the effective intensity is equal to the instantaneous intensity at t2 and t1.

(f) Minimum effective intensities for anti-collision light. Each anti-collision light effective intensity must equal or exceed the applicable values in the following table:

Angle above or below the horizontal plane	Effective intensity (candelas)
0° to 5°	150
5° to 10°	90
10° to 20°	30
20° to 30°	15

SAFETY EQUIPMENT

CS 27.1411 General

(a) Required safety equipment to be used by the crew in an emergency, such as flares and automatic life raft releases, must be readily accessible.

(b) Stowage provisions for required safety equipment must be furnished and must:

(1) Be arranged so that the equipment is directly accessible and its location is obvious; and

(2) Protect the safety equipment from damage caused by being subjected to the inertia loads specified in CS 27.561.

CS 27.1413 Safety belts

Each safety belt must be equipped with a metal to metal latching device.

CS 27.1435 Hydraulic systems

(a) Design. Each hydraulic system and its elements must withstand, without yielding, any structural loads expected in addition to hydraulic loads.

(b) Tests. Each system must be substantiated by proof pressure tests. When proof tested, no part of any system may fail, malfunction, or experience a permanent set. The proof load of each system must at least 1.5 times the maximum operating pressure of that system.

(c) Accumulators. No hydraulic accumulator or pressurised reservoir may be installed on the engine side of any firewall unless it is an integral part of an engine.

CS 27.1461 Equipment containing high energy rotors

(a) Equipment containing high energy rotors must meet sub-paragraphs (b), (c), or (d).

(b) High energy rotors contained in equipment must be able to withstand damage caused by malfunctions, vibration, abnormal speeds, and abnormal temperatures. In addition:

(1) Auxiliary rotor cases must be able to contain damage caused by the failure of high energy rotor blades; and

(2) Equipment control devices, systems, and instrumentation must reasonably ensure that no operating limitations affecting the integrity of high energy rotors will be exceeded in service.

(c) It must be shown by test that equipment containing high energy rotors can contain any failure of a high energy rotor that occurs at the highest speed obtainable with the normal speed control devices inoperative.

(d) Equipment containing high energy rotors must be located where rotor failure will neither endanger the occupants nor adversely affect continued safe flight.

Subpart G - OPERATING LIMITATIONS AND INFORMATION

GENERAL

CS 27.1501 General

(a) Each operating limitation specified in CS 27.1503 to 27.1525 and other limitations and information necessary for safe operation must be established.

(b) The operating limitations and other information necessary for safe operation must be made available to the crew members as prescribed in CS 27.1541 to 27.1589.

OPERATING LIMITATIONS

CS 27.1503 Airspeed limitations: general

(a) An operating speed range must be established.

(b) When airspeed limitations are a function of weight, weight distribution, altitude, rotor speed, power, or other factors, airspeed limitations corresponding with the critical combinations of these factors must be established.

SC GP 27.1505 Never-exceed speed

(a) The never-exceed speed, V_{NE}, must be established so that it is:

(1) Not less than 74 km/h (40 knots) (CAS); and

(2) Not more than the lesser of:

(i) 0.9 times the maximum forward speeds established under CS 27.309;

(ii) 0.9 times the maximum speed shown under SC GP 27.251 and 27.629; or

(iii) 0.9 times the maximum speed substantiated for advancing blade tip mach number effects;

(iiii) 0.9 times VDF.

(b) V_{NE} may vary with altitude, rpm, temperature, and weight, if:

(1) No more than two of these variables (or no more than two instruments integrating more than one of these variables) are used at one time; and

(2) The ranges of these variables (or of the indications on instruments integrating more than one of these variables) are large enough to allow an operationally practical and safe variation of VNE.

CS 27.1519 Weight and centre of gravity

The weight and centre of gravity limitations determined under CS 27.25 and 27.27, respectively, must be established as operating limitations.

SC GP 27.1521 Powerplant limitations

(a) General. The powerplant limitations prescribed in this paragraph must be established so that they do not exceed the corresponding limits for which the engines and propeller(s) are type certificated.

(b) Take-off operation. The powerplant take-off operation must be limited by:

(1) The maximum rotational speed, which may not be greater than:

(i) The maximum value determined by the propeller design; or

(ii) The maximum value shown during the type tests;

(2) The maximum allowable manifold pressure (for reciprocating engines);

(3) The time limit for the use of the power corresponding to the limitations established in sub-paragraphs (b)(1) and (2);

(4) If the time limit in sub-paragraph (b)(3) exceeds 2 minutes, the maximum allowable cylinder head, coolant outlet, or oil temperatures;

(c) Continuous operation. The continuous operation must be limited by:

(1) The maximum rotational speed which may not be greater than:

(i) The maximum value determined by the propeller design; or

(ii) The maximum value shown during the type tests;

(d) Fuel grade or designation. The minimum fuel grade (for reciprocating engines), or fuel designation (for turbine engines), must be established so that it is not less than that required for operation of the engines within the limitations in sub-paragraphs (b) and (c).

CS 27.1523 Minimum flight crew

The minimum flight crew must be established so that it is sufficient for safe operation, considering:

(a) The workload on individual crew members;

(b) The accessibility and ease of operation of necessary controls by the appropriate crew member; and

(c) The kinds of operation authorised under CS 27.1525.

CS 27.1525 Kinds of operations

The kinds of operations (such as VFR, IFR, day, night, or icing) for which the rotorcraft is approved are established by demonstrated compliance with the applicable certification requirements and by the installed equipment.

CS 27.1527 Maximum operating altitude

The maximum altitude up to which operation is allowed, as limited by flight, structural, powerplant, functional, or equipment characteristics, must be established.

CS 27.1529 Instructions for continued airworthiness

Instructions for Continued Airworthiness in accordance with Appendix A must be prepared.

MARKINGS AND PLACARDS

CS 27.1541 General

(a) The rotorcraft must contain:

(1) The markings and placards specified in CS 27.1545 to 27.1565, and

(2) Any additional information, instrument markings, and placards required for the safe operation of rotorcraft with unusual design, operating or handling characteristics.

(b) Each marking and placard prescribed in sub-paragraph (a):

(1) Must be displayed in a conspicuous place; and

(2) May not be easily erased, disfigured, or obscured.

CS 27.1543 Instrument markings: general

For each instrument:

(a) When markings are on the cover glass of the instrument, there must be means to maintain the correct alignment of the glass cover with the face of the dial; and

(b) Each arc and line must be wide enough, and located, to be clearly visible to the pilot.

CS 27.1545 Airspeed indicator

(a) Each airspeed indicator must be marked as specified in sub-paragraph (b), with the marks located at the corresponding indicated airspeeds.

(b) The following markings must be made:

(1) A red radial line:

(i) For rotorcraft other than helicopters, at VNE; and

(3) For the caution range, a yellow arc.

(4) For the safe operating range, a green arc.

CS 27.1547 Magnetic direction indicator

(a) A placard meeting the requirements of this paragraph must be installed on or near the magnetic direction indicator.

(b) The placard must show the calibration of the instrument in level flight with the engines operating.

(c) The placard must state whether the calibration was made with radio receivers on or off.

(d) Each calibration reading must be in terms of magnetic heading in not more than 45° increments.

(e) If a magnetic non-stabilised direction indicator can have a deviation of more than 10° caused by the operation of electrical equipment, the placard must state which electrical loads, or combination of loads, would cause a deviation of more than 10° when turned on.

CS 27.1549 Powerplant instruments

For each required powerplant instrument, as appropriate to the type of instrument:

(a) Each maximum and, if applicable, minimum safe operating limit must be marked with a red radial or a red line;

(b) Each normal operating range must be marked with a green arc or green line, not extending beyond the maximum and minimum safe limits;

(c) Each take-off and precautionary range must be marked with a yellow arc or yellow line;

(d) Each engine or propeller range that is restricted because of excessive vibration stresses must be marked with red arcs or red lines; and

CS 27.1551 Oil quantity indicator

Each oil quantity indicator must be marked with enough increments to indicate readily and accurately the quantity of oil.

CS 27.1553 Fuel quantity indicator

If the unusable fuel supply for any tank exceeds 3.8 litres (0.8 Imperial gallon/1 US gallon), or 5% of the tank capacity, whichever is greater, a red arc must be marked on its indicator extending from the calibrated zero reading to the lowest reading obtainable in level flight.

CS 27.1555 Control markings

(a) Each cockpit control, other than primary flight controls or control whose function is obvious, must be plainly marked as to its function and method of operation.

(b) For powerplant fuel controls:

(3) Each valve control for any engine of a multi-engine rotorcraft must be marked to indicate the position corresponding to each engine controlled.

(c) Usable fuel capacity must be marked as follows:

(1) For fuel systems having no selector controls, the usable fuel capacity of the system must be indicated at the fuel quantity indicator.

(d) For accessory, auxiliary, and emergency controls:

(1) Each essential visual position indicator, such as those showing rotor pitch or landing gear position, must be marked so that each crew member can determine at any time the position of the unit to which it relates; and

(2) Each emergency control must be red and must be marked as to method of operation.

SC GP 27.1557 Miscellaneous markings and placards

(a) Baggage and cargo compartments, and ballast location. Each baggage and cargo compartment and each ballast location must have a placard stating any limitations on contents, including weight, that are necessary under the loading requirements.

(b) Seats. If the maximum allowable weight to be carried in a seat is less than 77 kg (170 lbs), a placard stating the lesser weight must be permanently attached to the seat structure.

(c) Fuel and oil filler openings. The following apply:

(1) Fuel filler openings must be marked at or near the filler cover with:

(i) The word 'fuel';

(ii) For reciprocating engine-powered rotorcraft, the minimum fuel grade;

(2) Oil filler openings must be marked at or near the filler cover with the word 'oil'.

(d) Emergency exit placards. Each placard and operating control for each emergency exit must be red. A placard must be near each emergency exit control and must clearly indicate the location of that exit and its method of operation.

(e) Coolant filler openings must be marked at or near the filler cover with the word "Coolant".

CS 27.1559 Limitations placard

There must be a placard in clear view of the pilot that specifies the kinds of operations (such as VFR, IFR, day, night or icing) for which the rotorcraft is approved.

CS 27.1561 Safety equipment

(a) Each safety equipment control to be operated by the crew in emergency, such as controls for automatic life raft releases, must be plainly marked as to its method of operation.

(b) Each location, such as a locker or compartment, that carries any fire extinguishing, signalling, or other life-saving equipment, must be so marked.

ROTORCRAFT FLIGHT MANUAL AND APPROVED MANUAL MATERIAL

CS 27.1581 General

(a) Furnishing information. A rotorcraft flight manual must be furnished with each rotorcraft, and it must contain the following:

(1) Information required by CS 27.1583 to 27.1589.

(2) Other information that is necessary for safe operation because of design, operating, or handling characteristics.

(b) Approved information. Each part of the manual listed in CS 27.1583 to 27.1589, that is appropriate to the rotorcraft, must be furnished, verified, and approved, and must be segregated, identified, and clearly distinguished from each unapproved part of that manual.

(d) Table of contents. Each rotorcraft flight manual must include a table of contents if the complexity of the manual indicates a need for it.

SC GP 27.1583 Operating limitations

(a) Airspeed and rotor limitations. Information necessary for the marking of airspeed and rotor limitations on, or near, their respective indicators must be furnished. The significance of each limitation and of the colour coding must be explained.

(b) Powerplant limitations. The following information must be furnished:

(1) Limitations required by CS 27.1521.

(2) Explanation of the limitations, when appropriate.

(3) Information necessary for marking the instruments required by CS 27.1549 to 27.1553.

(c) Weight and loading distribution. The weight and centre of gravity limits required by CS 27.25 and 27.27, respectively, must be furnished. If the variety of possible loading conditions warrants, instructions must be included to allow ready observance of the limitations.

(e) Kinds of operation. Each kind of operation for which the rotorcraft and its equipment installations are approved must be listed.

(f) No aerobatic manoeuvers are authorised.

(g) Altitude. The altitude established under CS 27.1527 and an explanation of the limiting factors must be furnished.

SC GP 27.1585 Operating procedures

(a) Parts of the manual containing operating procedures must have information concerning any normal and emergency procedures and other information necessary for safe operation, including take-off and landing procedures and associated airspeeds. The manual must contain any pertinent information including:

(1) The kind of take-off surface used in the tests and each appropriate climb out speed; and

(2) The kind of landing surface used in the tests and appropriate approach and glide airspeeds.

(b) For multi-engine rotorcraft, information identifying each operating condition in which the fuel system independence prescribed in CS 27.953 is necessary for safety must be furnished, together with instructions for placing the fuel system in a configuration used to show compliance with that paragraph.

(e) If the unusable fuel supply in any tank exceeds 5% of the tank capacity, or 3.8 litres (0.8 Imperial gallon/1 US gallon), whichever is greater, information must be furnished which indicates that when the fuel quantity indicator reads 'zero' in level flight, any fuel remaining in the fuel tank cannot be used safely in flight.

(f) Information on the total quantity of usable fuel for each fuel tank must be furnished.

(g) The airspeeds for minimum rate of descent and best glide angle as prescribed in CS 27.71 must be provided.

(h) The minimum speed for level flight V_{MIN} established in accordance with SC GP 27.49; and

i) The minimum control airspeeds V_{MC} (power-off) and V_{MC} (power-on) established in accordance with SC GP 27.47.

j) In accordance with SC GP 27.145(d) a statement must be made of the maximum crosswind components in which take-off and landing have been demonstrated and whether control was found to be limiting.

k) The procedure(s) for abandoning a take-off due to engine failure or other cause must be provided.

SC GP 27.1587 Performance information

(a) The Rotorcraft Flight Manual must contain the following information, determined in accordance with SC GP 27.49 through SC GP 27.79.

(1) Enough information to determine the limiting height-speed envelope.

(2) Information relative to:

(i) The steady rates of climb and descent together with the corresponding airspeeds and other pertinent information including the calculated effects of altitude and temperatures;

(iii) For reciprocating engine-powered rotorcraft, the maximum atmospheric temperature at which compliance with the cooling provisions of CS 27.1041 to 27.1045 is shown; and

(iv) Glide distance as a function of altitude when descending at the speeds and conditions for minimum rate of descent and best glide as determined in SC GP 27.71.

(b) The rotorcraft flight manual must contain:

(1) In its performance information section any pertinent information concerning the take-off weights and altitudes used in compliance with SC GP 27.51; and

(2) The horizontal take-off distance determined in accordance with SC GP 27.51.

(3) The landing distance determined in accordance with SC GP 27.77.

CS 27.1589 Loading information

There must be loading instructions for each possible loading condition between the maximum and minimum weights determined under CS 27.25 that can result in a centre of gravity beyond any extreme prescribed in CS 27.27, assuming any probable occupant weights.

SPECIAL CONDITION - Road Vehicle Use - Issue 01 – May 2020

Subpart C - STRENGTH REQUIREMENTS

FATIGUE EVALUATION

SC 27.571 A ("AMC 20-29") Damage Threat Assessment for road use

All damages to flight structures and the vehicle (including landing gears, shock absorbers, wheels, tyres and brakes) that could occur in service during road use must be properly categorized and taken into account for the substantiation of the structural parts, systems and definition of the pre-flight inspections.

SC 27.901A Installation

(b) For each powerplant installation:

(1) Each component of the installation must be constructed, arranged, and installed to ensure its continued safe operation between normal inspections or overhauls for the range of temperature and altitude for which approval is requested. For powerplant parts participating in road related functions, the operational and road related environment must be considered even if not part of the rotorcraft type certified envelope.

ROTOR DRIVE SYSTEM

SC 27.917A Propeller and Road Drive System Design

(b) The road drive system includes any part necessary to transmit the power from the engine to the wheels and not participating in any ground or flight related functions of the gyroplane.

(d) The road drive system must incorporate a means of disengagement to isolate that system for transition in gyroplane mode. It must be not be possible to activate the road drive system mode once in flight mode.

(f) A safety assessment must be performed to ensure that the propeller drive system functions safely over the full range of conditions for which certification is sought. The safety assessment must include a detailed failure analysis and identify any propeller drive system parts also functioning while in road mode. The assessment must identify means to prevent the likelihood of damages, including road operation related, which might affect continued safe flight and landing.

SC 27.1301A Safety of Conversion from Car to Gyroplane

Safety of the conversion from Drive mode to “Fly Mode” and vice versa must be demonstrated by analysis and tests. The hazard analysis must show which possible hazardous mistakes or damages.