Transport Canada Aviation Transports Canada Aviation

AMA: **549.201**

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AIRWORTHINESS MANUAL ADVISORY (AMA)

Subject: Evaluation Of Amateur-Built Helicopters

1. Purpose.

This advisory information provides criteria, but not the only criteria, for the evaluation of helicopter types for the purpose of issuing a Special of Airworthiness (CofA) for Amateur-Built Aircraft. Like all advisory material, this AMA is not mandatory and does not constitute a regulation. As a guidance document, its purpose is to outline a method of compliance with existing standards. The applicant may elect to follow an alternate which must be acceptable to the Department of Transport as a means of compliance with the requirements of Chapter 549 of the Airworthiness Manual. Hence the term "shall" used herein applies only to an applicant who chooses to follow this particular method without deviations.

2. Reference Airworthiness Standards

Chapter 549, Amateur-Built Aircraft, Subchapters A and C.

3. Background and Discussion.

Due to the uniqueness of design and construction (compared with amateur-built fixed-wing aircraft), amateur-built helicopters will be evaluated on an individual basis for structural integrity, weight and balance, flutter, flight limitations and handling qualities. The main object of this evaluation is to ensure safe flight. In this regard, the following outlines acceptable requirements and procedures:

(a) To thoroughly inform the amateur-builder of the limitations of the aircraft, the designer of the kit manufacturer shall provide in the form of manuals, information relating to structural integrity, rigging, weight and balance, flight limitations, and maintenance.

(b) The information specified in sub paragraph 3(a) shall be provided to a person (or group) acceptable to the Minister, conducting the type evaluation before it is started. The appraisal of this information will be based on the requirements of Chapters 549 and 527 (Normal Category Rotorcraft) of the Airworthiness Manual, and will clear the aircraft for flight test.

(c) The flight test program will encompass the performance and handling quality aspects of the design to ensure that the aircraft is safe and controllable in all regimes of flight including the case of power unit failure.

4. Structural Requirements

(a) Manoeuvring Loads. The rotorcraft shall withstand the maximum loads which arise from the most severe movements of the controls which it is anticipated will occur during operational flight

including the emergency condition after engine failure. The most adverse combinations of flight speed, rotor rotational speed and control movements shall be included. The values of limit load factors to be assumed for design purposes are:

(1) Limit Positive Factor: 3.5: and

(2) Limit Negative Factor: -1.0

(b) Safety Factor. The structure shall have an ultimate safety factor of 1.5 under the loads arising during balanced flight at all points on or within the flight envelope.

(c) Structural Fatigue. Due to the fluctuating loads and vibratory stresses inherent in rotorcraft, structural fatigue strength is a necessary consideration. The strength and fabrication of the rotocraft shall be such as to ensure that the possibility of catastrophic fatigue failure of the primary structure under the action of the repeated loads of variable magnitude expected in service, is extremely remote throughout its operational life.

(1) A list of parts of the primary structure which may be critical from the fatigue aspect shall be provided together with satisfactory substantiation of a demonstrated safe fatigue life, or that such part(s) or structure are fail-safe.

(2) In addition, vibrating stresses shall be kept low by attention to detail design, conceptual design, materials specified, freedom from stress concentrations and correct tolerances. Critical parts shall be easily inspected and the designer shall provide the constructor with a pre- and post-flight inspection procedure in the Flight and Maintenance Manuals.

(3) Operational limitations may be established until sufficient knowledge of the rotorcraft has been accumulated in order to establish that the rotocraft will have safe qualities in service.

5. Flutter

(a) The designer's/kit manufacturer's structural testing, flight testing, and/or operational flight experience shall be reviewed to determined that it can be reasonably assured that:

(1) all rotor blades are free from any dangerous characteristics, including flutter and resonance; and

(2) the natural frequency of any parts of the rotorcraft which may be excited by rotor vibration (in particular the rotor mounting) is remote from the fundamental rotor frequency and its higher harmonics.

(b) In addition, the rotorcraft shall be:

(1) ground tested at rotor speeds up to 1.05 times the rotor never-exceed-RPM (taking into account any engine condition likely to be critical during power-on operation); and

(2) flight tested at speed up to 1.10 times the rotorcraft never-exceed speed (V_{NE}).

6. Mechanical Systems

(a) Rotor Blade Clearance. There shall be enough clearance between the rotor blades and other parts of the structure to prevent the blades from striking any parts of the structure during any operating condition.

(b) Rotor Drive Systems. The rotor drive system shall incorporate a free-wheel unit to automatically disengage the power unit from the main and auxiliary rotors in the event of power unit failure. Each rotor drive system shall be arranged so that each rotor necessary for control in autorotation will continue to be driven by the main rotor system after disengagement of the power

unit. All universal joints, slip joints, and other shafting joints where lubrication is necessary for operation shall have provision for lubrication even in the event of power unit failure.

(c) Clutch. A clutch shall be incorporated between the free-wheel unit and the power unit transmission where it is deemed necessary to avoid dangerously high stresses in the rotor system whilst starting the power unit.

(d) Fuel and Oil Systems. The systems shall be designed and manufactured in accordance with accepted aircraft practice.

7. Cockpit Layout

(a) *View.* The field of view shall be sufficiently extensive, clear and undistorted for safe operation of the rotorcraft in all regimes of flight.

(b) *Cockpit Controls*. Essential cockpit controls shall be conventional in layout and operation and compatible with current industry practice. All controls shall be easily reached and operable in all regimes of flight. There shall be minimal coupling between the longitudinal and other control planes. There shall be no overbalance of controls.

8. Rotorcraft Weight And Balance.

Longitudinal and lateral centre-of-gravity (C.G.) limits shall be prescribed by the designer. These limits shall not be impracticably small and any ballast requirements, if necessary, shall be clearly stated and placarded in the aircraft, according to section 549.215.

9. Limitations

(a) A flight envelope shall be provided by the designer and this shall cover the limiting conditions, including the emergency conditions following engine failure, of flight speed and rotor rotational speed at which the rotorcraft will be permitted to fly at the design maximum weight.

(b) A range of main rotor speeds shall be established that -

(1) With power on, provides adequate margin to accommodate the variations in rotor speed occurring in any appropriate manoeuvre;

(2) With power off, allows each appropriate autorotative manoeuvre to be performed throughout the ranges of established airspeeds and weights; and,

(3) The maximum (never-exceed) rotor RPM does not exceed 95 percent of the maximum design RPM.

(c) Rotor pitch limits shall be set such that at the upper limit, unsafe low main rotor speeds are unlikely. At the lower pitch limit sufficient rotor speed shall be possible for any autorotative condition under the most critical combinations of weight and airspeed without the recourse to exceptional piloting skills being necessary to prevent overspeeding of the rotor.

(d) A maximum safe engine power limit shall be established.

10. Pilot Techniques.

Flight test pilot techniques shall conform as closely as possible to normal operating procedures so that they will be readily repeatable.

11. Handling Qualities

(a) *Controllability and Manoeuvrability*. The rotorcraft shall be safely controllable and manoeuverable during steady flight and any manoeuvre expected in normal operations without undue pilot fatigue or straim.

(b) *Stability.* It shall be possible to maintain any required flight condition without exceptional pilot skill, fatigue or strain.

(c) *Transitions*. It shall be possible to make a smooth transition from any normal flight condition to any other normal flight condition without exceptional pilot skill, fatigue or strain. This includes the transition from powered to unpowered flight following a sudden complete power failure.

(d) *Autorotation*. The rotorcraft shall be controllable in autorotative flight so that survivable power off landings are possible following engine failure without requiring exceptional pilot skill. The designer shall alert the rotorcraft builder/operator to any flight conditions which will preclude execution of a survivable landing in the event of a sudden complete power failure.

(e) *Trim.* It should be possible to reduce any steady longitudinal and lateral control forces to zero in level flight at any appropriate speed.

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