

CABRI G2

SERVICE LETTER 19-002

Controllability in yaw at low rotor speed

It is recommended to keep this letter with the Flight Manual

Introduction

The Cabri G2 is fitted with a shrouded tail rotor providing the aircraft with an excellent maneuverability that has been flight tested with relative winds up to 35 kts from all directions.

Just like any helicopter with a tail rotor (shrouded or not), at a given pedal position, the tail rotor thrust will decrease when the rotor speed decreases.

Nonetheless, the Cabri main rotor is capable of producing lift at very low RPM, well below the nominal speed. This is not the case with most light helicopters whereby a significantly low rotor speed will cause the main rotor to stall.

This unique ability can lead to dangerous situations, up to loss of control in yaw.

This Service Letter intends to clarify the tail rotor behavior at low RPM, to illustrate the associated risks and to provide recommendations to avoid such situations.

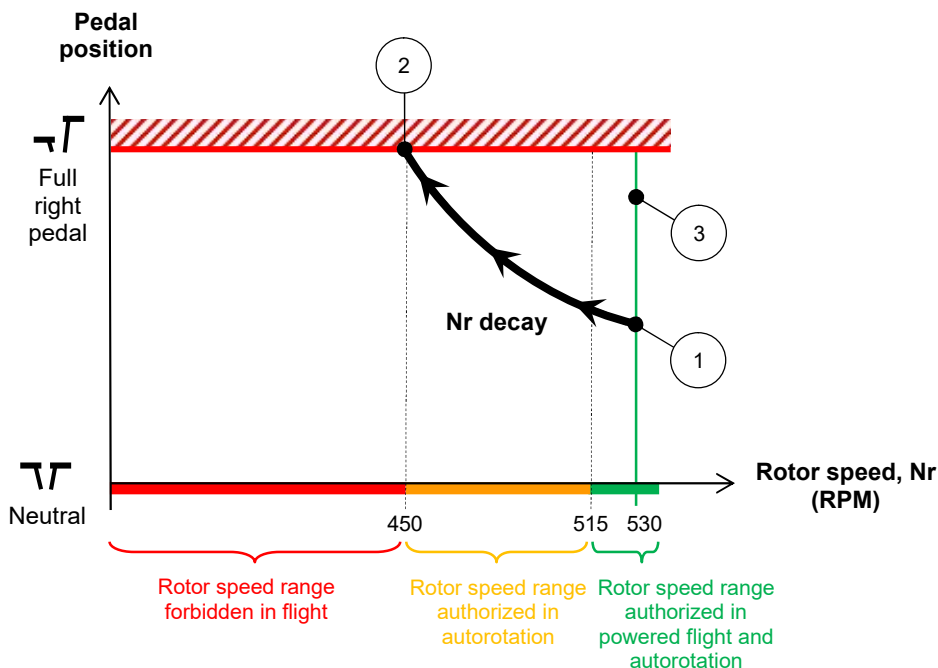
Pedal position versus rotor speed

The diagram below gives the relation between pedal position and rotor speed in the following conditions:

- IGE hover
- 700 Kg
- ISA conditions, at sea level
- Stabilized rotor speed and heading
- No wind

Points 1 and 2 are key points of the diagram, in the same conditions.

Point 3 is a stabilized point in the same conditions but with a 35-knot wind from the left.



Warning: The above data comes from flight testing and is shown here for educative purposes. Pilots should always comply with the limitations defined in the Flight Manual, notably the power-on rotor speed limits (515 – 540 RPM).

At nominal rotor speed and with no wind, the pedal position required for stabilized hover provides a large margin before reaching full right pedal (**point 1**).

In addition, the more the rotor speed decays, the more right pedal is needed. Full right pedal is reached at about 450 RPM (**point 2**).

Certification requires to maintain controllability in a hover and during take-off with a 17-knot wind from all directions, at nominal rotor speed. This was demonstrated during the flight test campaign.

The Cabri exceeds this requirement and keeps yaw controllability margin in a hover with a 35-knot wind from the left (critical direction), at nominal rotor speed.

Potential consequences and aggravating factors

The main rotor is capable of producing lift in a hover at rotor speeds well below nominal speed and even below 450 RPM. However, in such situation, the tail rotor thrust will not be sufficient and even with full right pedal, the aircraft will start spinning uncontrollably to the left.

In addition, if such loss of control in yaw occurs close to the ground, the instinctive reaction of an average pilot will be to raise the collective to regain height, which will lower the rotor speed even more and will aggravate the situation by increasing the spinning to the left.

Lastly, the above data is only applicable when rotor speed is stabilized. Due to the high inertia of the main rotor, yaw controllability is degraded if the engine torque is increased to accelerate the rotor from low speed toward nominal.

Note: Lots of publications depict the Loss of Tail rotor Effectiveness (LTE). This is a completely different phenomenon which usually happens at nominal speed and that should not be confused with decay of tail rotor thrust effectiveness at low RPM. On a side note, extensive flight testing has proven that the Cabri was not subject to LTE.

Typical situations of low rotor speed

Situation 1: Power limitation at high altitude

When the MLI is in FLO mode, if the pilot raises the collective once 100% power reading is reached (full throttle), rotor speed will decrease. The instinctive reaction of an average pilot will be to raise the collective more, since the previous control input had no effect, which will decrease the rotor speed even further.

This situation can be avoided by maintaining an adequate power margin.

When attempting to land at high altitude, the pilot must always check that available power is sufficient for IGE hover, taking the wind into account.

Situation 2: Power recovery during autorotation exercise

It is common practice on certain helicopter types to end an autorotation with a power recovery during, or just after, the flare.

This practice is not recommended on the Cabri. When performing a power recovery, the engine governor will re-engage as soon as the engine speed reaches 2000 RPM and will open the throttle fully. The engine torque will then be maximum, which can lead to loss of control in yaw, as described above.

The safest way to perform an autorotation with power recovery is to not rotate the twist grip during the maneuver. Lowering the collective to the lower stop will be enough to desynchronize the rotor and the engine. The Cabri engine governor is then capable of keeping the engine speed within the green arc even when the rotor is desynchronized at a higher speed than nominal. Smooth resynchronization will occur when the collective is raised and the pilot will have full authority to control yaw.

It is also possible to perform an autorotation with the engine idling, by rotating the twistgrip against the idle mechanical stop. In this case, power recovery must be carried out early, no lower than 300 ft AGL, as described in the OSD Flight Crew. As soon as the pilot will increase the engine speed above 2000 RPM, the engine governor will re-engage:

- If rotor speed is above 530 RPM, the engine governor will keep the engine speed within the green arc and the rotor will remain desynchronized. Smooth resynchronization will occur when the collective is raised and the pilot will have full authority to control yaw.
- If rotor speed is below 530 RPM, the engine governor will increase the engine speed enough to resynchronize the rotor and the engine. The pilot will need to counteract the torque with a right pedal input, the lower the rotor speed the larger the input will be required.

Finally, if the conditions and the pilot's skills are appropriate, performing a full down autorotation will prevent the risk of loss control in yaw.

Power recovery during or after the flare of an autorotation using the twist grip is risky and must be avoided.

Situation 3: Incorrect throttle management during simulated engine failure

See Service Letter **SL 19-001**.

Situation 4: In-flight tail rotor control failure simulation

Some instructors use the twist grip to control yaw during in-flight tail rotor control failure simulation.

This procedure must not be followed because it can lead to low rotor speed and loss of control. In such case, yaw must only be controlled using the collective.

During in-flight tail rotor control failure simulation, pilots should never use the twist grip to control yaw.

Note: Nonetheless, as indicated page 3-8 of the Flight Manual, it is acceptable to use the twist grip to control yaw during a tail rotor control failure in IGE hover.

Situation 5: Full down autorotation with crosswind

If a full down autorotation is performed with high crosswind, the pilot will fly the aircraft with a sideslip at the end of the maneuver in order to keep the nose aligned with the runway. This requires significant pedal inputs.

Consequently, there is a risk that the tail rotor thrust becomes insufficient at the end of the maneuver, since the rotor speed will decay due to raising the collective. The aircraft will then turn into the wind (weathervaning), regardless of the pedal position. In case forward speed has not been completely stopped during the flare, the aircraft will slide sideways on the runway, which can lead to runway excursion or rolling over in case of a grass strip.

Note: Risk is higher with crosswind from the right.

Full down autorotation training with high crosswind is hazardous and is not recommended.

Recommendations summary

Low rotor speed situations can always be avoided by taking adequate precautionary measures.

Nonetheless, in case of a low rotor speed, if full right pedal is applied, or is close to being applied, the following recommendations must be used:

Do not raise the collective, it would aggravate the situation

Lower the collective as much as possible:

- If height is sufficient, increase airspeed using forward cyclic input
- If height is low, manage the contact with the ground

Do not try to increase the rotor speed by turning the twist grip, it can only aggravate the situation

Overall, always consider that excessive right pedal input cannot hurt.

"Keep it to the right, or get fright!"

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