| **Title: Gyroplane yaw management and effects on controls** | | |
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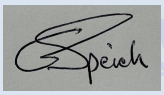
| **AG-PIL-2023-01-EN** | | **Released:** |
| **Applicability** | | |
| **Aircraft type & model:**<br><br>**All AutoGyro Gyrocopter Models** | **Affected Serial number(s):**<br>**All Models** | **January 2023** |
| The maintenance manual to be referenced is this stated or subsequent issue. | | As per AutoGyro website |

This form is the response from AutoGyro Certification Ltd and AutoGyro GmbH either against an issue experienced in the market in service requiring a containment or rectification action, or as operator/pilot information for safe aircraft operation
For help, contact AutoGyro, email: airworthiness@auto-gyro.com.

## Documentation (Pilot Information Letter Completion action)

The purpose of this document is to provide aircraft operators and pilots with information over and above that currently available in the relevant POH and training syllabi. Its compliance must be properly documented, if such procedure is required by the relevant authority

| **Document approval signatures** | |
|---|---|
| **Head of Engineering** | **Flight Test CVE** |
|  Gerald Speich<br>26-Jan-23 |  Chris Taylor<br>2023.01.26<br>09:46:37 Z |

The technical content of this document is approved under the authority of the UK CAA Design Organisation
Approval Ref: **DAI/9917/06**

**This document is issued jointly by AutoGyro Certification Ltd and AutoGyro GmbH**

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## Reason and overview of the Pilot Information Letter

The effect of excessive sideslip on gyroplane pitch and roll control, is, in general, poorly understood, which can lead to a risk to safe gyroplane operation.

AutoGyro places clear warnings within the aircraft Pilot Handbooks regarding yaw and resultant sideslip, and this document is intended to provide the background to this warning.

Whilst this is published for the safety of AutoGyro pilots, the same situation exists for all gyroplanes regardless of manufacturer.

## Manpower estimates

There are no manpower estimates associated with this PIL.

## Compliance

There is no compliance time associated with this PIL

## Customer Support

If it is unclear what is explained within this PIL then it is highly recommended that the pilot contact a gyroplane flight training organisation for further explanation and possibly additional flying training.

## Manuals affected

POH & AMM AutoGyro is not affected. Avoidance of sideslip has always been present in AutoGyro manuals

## Explanation

Excessive sideslip may be created in a gyroplane deliberately, typically using rudder pedal inputs, or as an aircraft's reaction (secondary effect) to another input such as engine power changes.

The result of either input is the same; the aircraft will yaw but the aircraft will initially continue in the original flight direction which creates sideslip. Although the aircraft's directional stability, caused by airflow over the fin, will resist the creation of sideslip, the fin is ineffective at low airspeeds and can be overpowered. Further engine thrust can be used to overpower the fin. In extremis the aircraft could be turned as much as 90 degrees to the direction of flight.

Flight Control Stops

Every aircraft has flight control limit stops to prevent over-travel and failure.

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1. Gyroplane stick pitch control stops typically range from a few degrees forward ('nose down') to around 20 degrees aft.
   During flight the stick/rotor is typically positioned around 10 degrees aft, with an in-flight stick movement of only a few degrees. The extra movement is required for take-off (stick fully back) or for stopping the rotor after landing (stick fully forward).

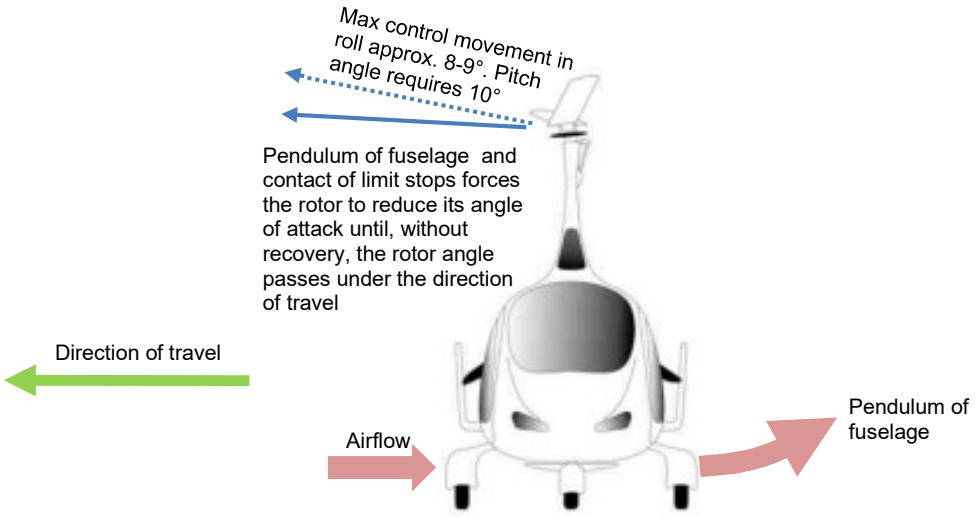
2. Gyroplane stick roll control stops range normally around 8-9 degrees either side of vertical. This amount of movement is never used in flight, it is only used on the ground for safe handling in side-winds. In-flight roll movement is only a few degrees.

3. These limit stops are always built into the rotor head, normally with secondary limit stops on the stick.

## Yaw as a result of an extreme pedal input

It is important to remember that a gyroplane body hangs 'free' under the rotating wing or rotor disc. This freedom enables the body to be moved in all axes under and with respect to the rotor.

A 90 degree yaw will place the body at 90deg to the oncoming airflow. This then means that the roll axis has effectively become the pitch axis.
The rotor disc pitch angle in the direction of travel will tend to the nominal 10 deg aft orientation typical of forward flight at normal cruise speeds. However in the roll axis the roll control stops will aim to limit the disc pitch angle to 8-9 degrees. In a light aeroplane or helicopter the wing or rotor disc would normally roll away from such sideslip. This characteristic on autogyros is very weak and easily overpowered, for example by the aerodynamic load induced on the gyroplane body in sideslip.




This sketch assumes a full 90deg yaw.

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Consider then also that the aircraft is now flying sideways and the side of the aircraft is facing the oncoming airflow. This airflow will create an increased drag force which will tend to swing the fuselage away from direction of flight. Because the rotor disc is already against the limit stops, and because the force from the body is considerable, the rotor disc is pitched down into the oncoming airflow.
With the airflow now above rather than below the rotor disc the aircraft will rapidly roll over into the direction of flight, unless urgent corrective action is taken.

Whilst this is an extreme example, AutoGyro is aware of a small number of such occurrences around the world.

**Side-slipping gyroplanes without careful control is inherently dangerous.**

**Recovery** must be made promptly using pedal yaw input (effective provided there is propeller wash over the rudder), and lowering the nose to force the body into the direction of flight and maintain airflow through the rotor disc.

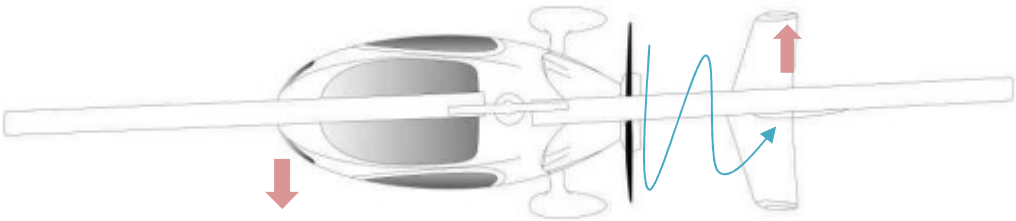
See also engine power changes below.

## Yaw as a result of engine thrust increase or reduction

There are 3 main reasons why a gyro has yaw tendencies during throttle application or reduction.

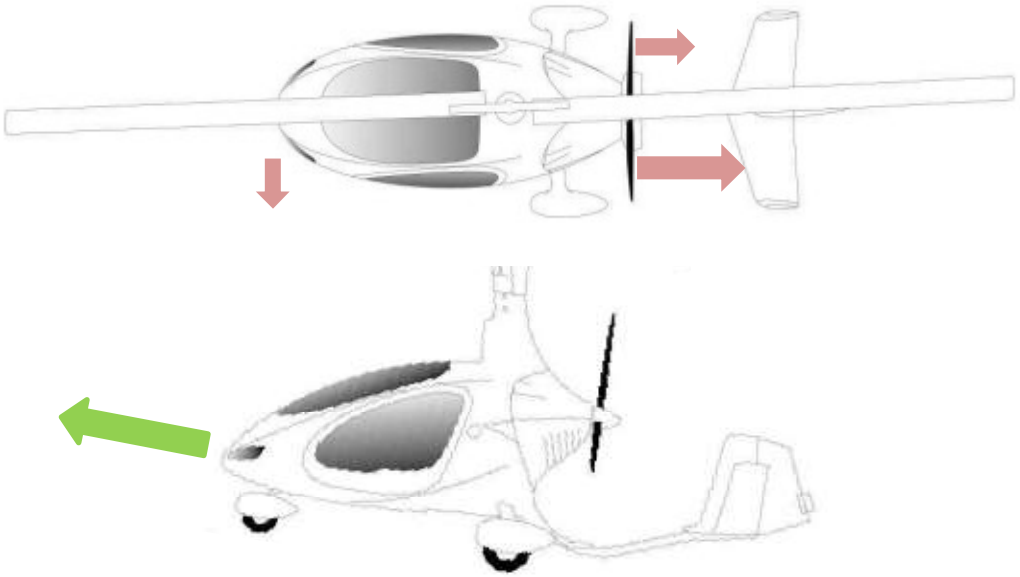
1. The corkscrew effect:

   This effect has one of the largest influences on yaw. During take-off, the air being accelerated through the propeller is rotated, and with the forward movement of the gyro, forms a corkscrew shaped flow. The spiraling air hits the centre vertical stabilizer fin and rudder on the port (left) side (on AutoGyro aircraft), exerting pressure on them and yawing the nose left. This is particularly relevant due to the close proximity of the propeller to the tail unit.



2. Asymmetric propeller loading:

   On an autogyro the airflow entering the propeller disc is modified by the airflow through the rotor disc. The downward moving propeller blade has a greater attack angle than the upward moving one. This means the downward sweeping blade creates more lift (thrust) than the upward moving one and induces a port (left) yaw effect.



3. Gyroscopic precession.

   Gyroscopic precession is what happens when force is applied to a spinning disc (gyroscope). During take-off, when the gyroplane's nose is lifted, force (airflow) is applied to the bottom of the disc (the propeller) and the resultant reactive force is felt 90° in direction of rotation. In this case with an anti-clockwise rotating propeller, on the starboard (right) side. This creates a yaw motion to the left.

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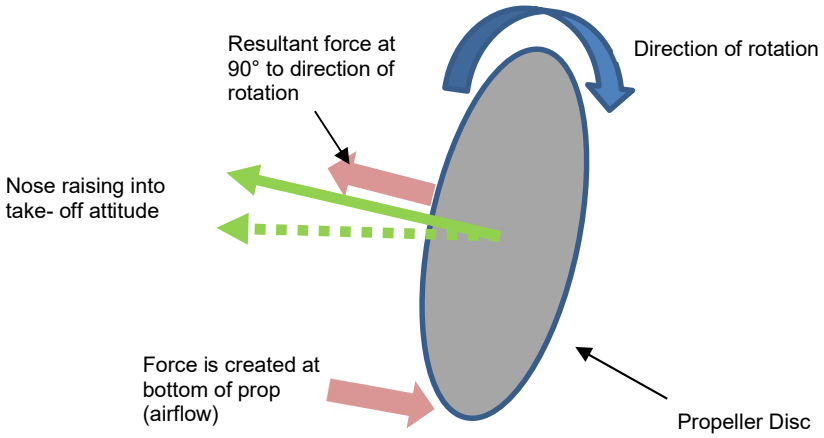


Logically then, to compensate for these effects, an appropriate amount of right rudder must be applied during take-off when applying full-power. The faster the power is applied, the quicker the required pedal input is also required.

*If the yaw is not prevented, as can be seen from the above, the aircraft will yaw to the left (eg on take-off, full power) or to the right (when reducing the throttle, eg, to land). If not corrected, the aircraft may continue to yaw to the 90 degree position described and result in an unrecoverable flight condition.*

Side-note: Yaw effect on the pitot-static system.

During yaw maneuvers the pitot tube will be angled to the oncoming airflow, and will indicate an airspeed LESS than actual.

**Summary:**

- It is important for a gyroplane pilot to understand that a deliberate or secondary yaw input may generate excessive sideslip.
- Attention should be paid to maintaining balanced flight with minimal sideslip.
- When turning a gyroplane co-ordinate use of the stick and rudder to achieve a normal balanced turn.
- Excessive sideslip will create an unsafe flight attitude.

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