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INVESTIGATION REPORT

Accident to the AIR COPTER - DJP 2000 identified 31LI

on 05 July 2020
at Sos (Lot-et-Garonne)

Time	Around 12:00[1]
Operator	Private
Type of flight	Local
Persons on board	Pilot
Consequences and damage	Pilot fatally injured, gyroplane destroyed

This is a courtesy translation by the BEA of the Final Report on the Safety Investigation published in June 2021. As accurate as the translation may be, the original text in French is the work of reference.

[1] Except where otherwise indicated, the times in this report are in local time.

Rudder struck by main rotor, loss of control in flight, collision with the ground

1 - HISTORY OF THE FLIGHT

Note: the following information is principally based on statements and on video footage recorded by a witness.

On the Saturday morning, in the scope of a weekend organised by their club at the Bretagne-d'Armagnac (Gers) microlight strip, eight gyroplanes and one fixed-wing microlight made a flight over the region.

The flight took place at an altitude of between 1,100 and 1,500 ft with a turning point at the village of Sos. The gyroplanes flew in a V-shaped formation and the fixed-wing microlight outside of the formation. 31LI was at the rear on the left side of the formation.

When passing through the turning point, the gyroplane fell practically vertically and collided with the ground.

2 - ADDITIONAL INFORMATION

2.1 Gyroplane information

2.1.1 Gyroplane involved in the accident

The DJP2000 is an amateur-built gyroplane with two seats in tandem configuration. 31LI was equipped with a Rotax 914 UL Turbo engine delivering 115 hp onto which a composite three-blade propeller was assembled. The aluminium rotor measured 8.60 m in diameter. 31LI entered into service in 2009. The pilot bought the gyroplane in May 2016.

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Source: ArthurC AIRLINERS.NET website

Figure 1: Gyroplane DJP2000 31LI

2.1.2 General information about gyroplanes

A gyroplane is an aircraft where the lift is created by a free, twin-blade teetering rotor driven by the relative wind. The blades are integral with it, are not hinged and can deform by elasticity. The power unit provides the power required for the gyroplane to fly forward but does not drive the rotor. The lever controls the orientation of the rotor plane in order to tilt its aerodynamic resultant to go nose-up, nose-down, or to make a left turn or a right turn. The tailplane[(2)] is used to control the gyroplane in yaw and to stabilize it in pitch.

[(2)] The tailplane of 31LI comprises a horizontal stabilizer, to which the rudder is attached in its middle, flanked by two vertical stabilizers.

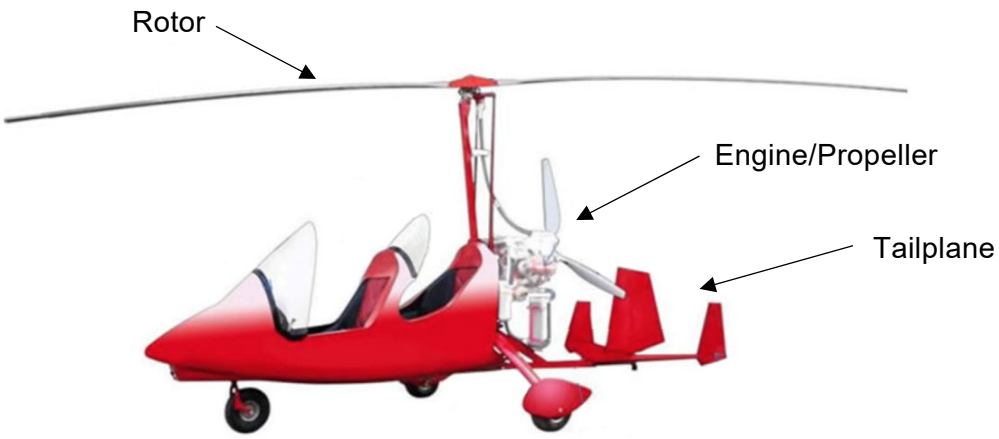
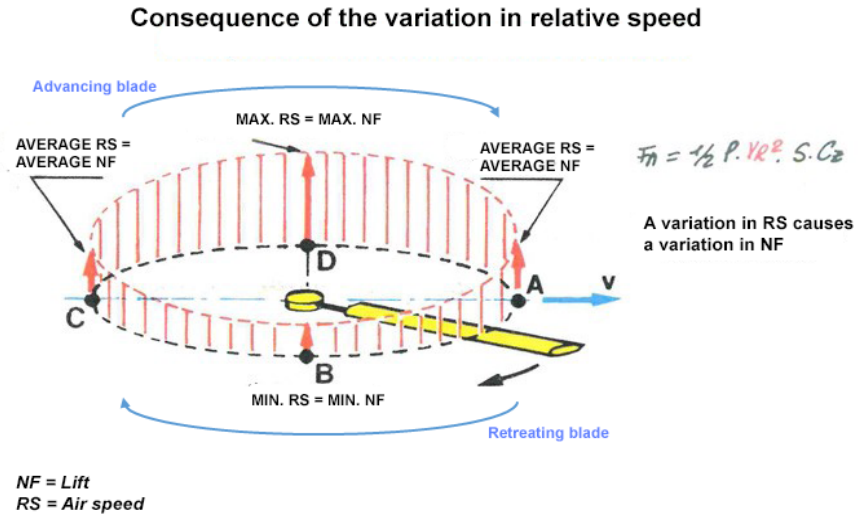


Figure 2: Gyroplane description

2.1.3 Rotor flapping[3]

During a rotor revolution, the blades flap due to the combination of loads to which they are subjected, in particular the lift force and the centrifugal force. On the teetering rotor, the balance of each blade is influenced by both its own loads and the loads of the other blade.



Source: Théorie élémentaire de l'hélicoptère, published by Cépaduès

Figure 3: Variation of lift as a function of speed

When the pilot moves the lever to modify the orientation of the rotor plane, the lift force on each blade changes, which causes flapping. In the same way, when the centrifugal force of the rotor blades changes following a change in forward speed of the gyroplane or due to an aerological phenomenon, the blades flap to find a new balance.

For gyroplanes, it is essential to maintain a forward speed to ensure lift. This way, the air speed on the advancing blade is higher than the air speed on the retreating blade. In these conditions, the flapping of the blades causes the rotor plane to pitch backwards.

The pilot must continually adjust the load on the lever to control his forward speed and to maintain a sufficient number of rotor revolutions to ensure lift, in particular during changes to the flight path.

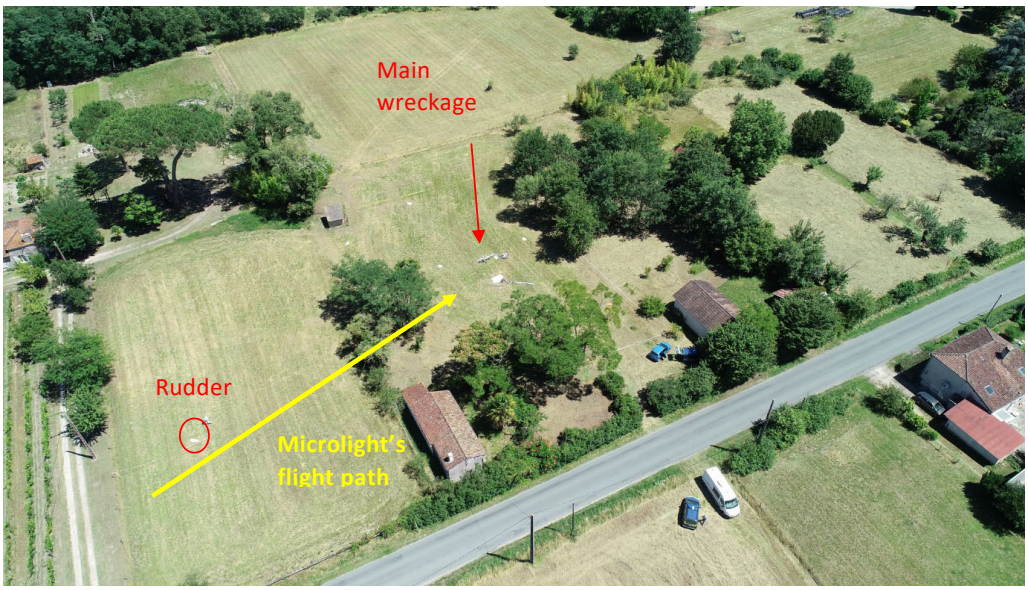
When the flapping phenomenon is significant, the retreating blade can strike the tailplane and the pusher propeller. The strike risk is heightened by the see-saw movement of the carriage under the rotor[4].

2.2 Site of the accident

The gyroplane was in several pieces spread over a radius of around 50 m around the main part of the wreckage, essentially on the axis of the path. Components of the rear section were found further back from the wreckage on the gyroplane's final flight path.

[3] The BEA's report into the accident to 31-HK on 7 June 2008 includes an appendix which explains the principles of gyroplane rotor dynamics. Available in French only.

[4] For rotary wings, rotor loads are transmitted to the airframe by the universal joint on the mast. This can cause a delay in the airframe's response following an input on the lever. The gyroplane's carriage is free to swing longitudinally or laterally like a pendulum. This phenomenon can be exacerbated by over-control.



Source: GTA

Figure 4: Accident site

2.3 Examination of the wreckage

The rotor was in position on the mast, the leading edges of both blades had white marks due to contact with exterior elements.

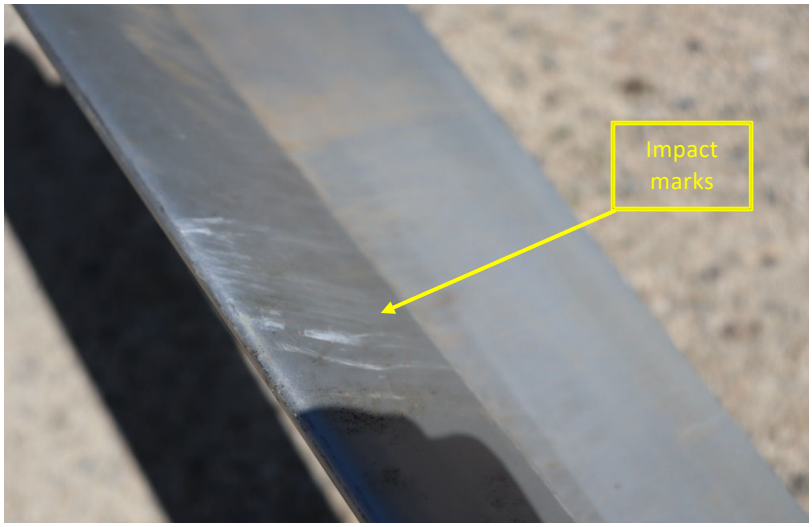


Figure 5: Marks observed on the main rotor blades

The tail fin and the rudder each had contact marks and were deformed at mid-height approximately.

With the exception of the rudder, the tailplane components had traces of sprayed oil.

Figure 6: Rudder

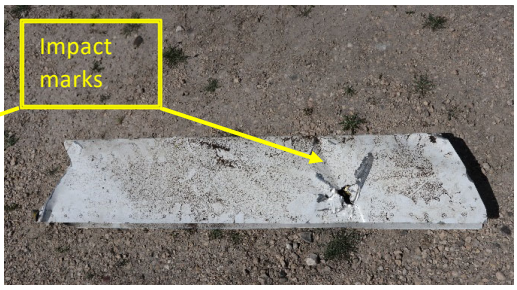


Figure 7: Tail fin covered with oil

The marks observed on the rotor blades (see Figure 5) coincide with deformations observed on the tail fin and the rudder, both in terms of deposited colour and position.

The engine was blocked in rotation and the propeller was destroyed.

The two control cables connecting the pedals to the rudder were broken perpendicular to the propeller. Damage observed on the other flight controls was consistent with the impact with the ground.

These observations showed that the main rotor entered into contact with the rudder in flight. The rudder then separated from the airframe. The control cables and the rudder probably struck the blades of the unfaired pusher propeller, which caused an engine oil leak, the reduction in rotor rotation speed then the fall of the aircraft.

2.4 Pilot information and experience

The 64-year-old pilot held a gyroplane pilot licence issued in July 2014. He also held a fixed-wing microlight pilot licence issued in August 2006, and a paramotor pilot licence issued in August 2007. The investigation was unable to determine the pilot's experience in 31LI and in gyroplanes.

2.5 Meteorological information

The conditions were anticyclonic in the south-west of France and there were no clouds in the sky. The air mass was dry, convective with a regular westerly wind of 5 to 10 kt between the ground and approximately 2,000 ft.

2.6 Statements

Of the pilots flying at that time, only one pilot saw a plume of smoke and the gyroplane fall. The other pilots were positioned in front. The various witnesses on the ground stated that, during the flight, a loud noise was heard followed by a plume of white smoke coming from the gyroplane.

2.7 Analysis of video footage

A video of the gyroplanes in flight at the time of the accident was filmed by one of the witnesses. A noise can be heard that is possibly linked to the accident of 31LI. At this time, 31LI cannot be seen on the video. When it appears on the video, a component, probably the rudder, seems to be partially separated from the rest of the gyroplane. This component appears to follow the gyroplane as if still attached to it. The rudder probably initially remained attached to the gyroplane by the rudder control cables. Changes to the rotor plane can also be seen.

31LI disappears from the camera's field of vision for a few seconds. When it reappears, a plume of white smoke can be seen and the gyroplane starts to fall towards the ground. At least two components also fall, more slowly than the gyroplane.

The white smoke visible on the video is consistent with oil being sprayed onto the engine's hot parts. The two components falling towards the ground were very likely pieces of the rudder separated from the gyroplane after the control cables broke.

3 - CONCLUSIONS

The conclusions are solely based on the information which came to the knowledge of the BEA during the investigation. They are not intended to apportion blame or liability.

Scenario

During the flight, the main rotor struck the gyroplane's rudder, causing it to break. This interaction was the result of rotor flapping that may have been caused by rapid actions on the lever along the pitch axis, a localised aerological phenomenon, wake turbulence from one or more of the aircraft ahead, or a combination of several of these phenomena. The investigation was unable to determine the exact origin of this rotor flapping. Given the extent of the damage, it was impossible for the pilot to keep control of the gyroplane and avoid collision with the ground.