SOUTH AFRICAN CIVIL AVIATION AUTHORITY

Section/division **Accident and Incident Investigations Division** Form Number: CA 12-57

LIMITED OCCURRENCE INVESTIGATION REPORT – FINAL

Reference Number	CA18/2/3/10507								
Classification	Accident		**Date**	3 October 2024		**Time**	1230Z		
Type of Operation	Private (Part 91)								
Location									
Place of Departure	Dibeng Airfield, Northern Cape Province		Place of Intended Landing	Dibeng Airfield, Northern Cape Province					
Place of Occurrence	On Runway 16 at Dibeng Airfield, Northen Cape Province								
GPS Co-ordinates	Latitude	27º35'32.25"	Longitude	22º52'03.18"E		Elevation	3 686ft		
Aircraft Information									
Registration	ZU-RHN								
Make; Model; S/N	Autogyro GMBH; Calidus (Serial Number: C00192)								
Damage to Aircraft	Destroyed		Total Aircraft Hours	432					
Pilot-in-command									
Licence Type	National Pilot Licence (NPL)		Gender	Male		Age	66		
Licence Valid	Yes	Total Hours	220	Total Hours on Type		200			
Total Hours 30 Days	6.5		Total Flying on Type Past 90 Days	11.5					
People On-board	1+0	**Injuries**	0	**Fatalities**	0	**Other (on the ground)**	0		

What Happened

On Thursday afternoon, 3 October 2024, a pilot on-board a Calidus gyrocopter with registration ZU-RHN was engaged in a private flight from Dibeng Airfield in the Northern Cape province with the intention to land back at the same airfield. Visual meteorological conditions (VMC) by day prevailed at the time of the flight which was conducted under the provisions of Part 91 of the Civil Aviation Regulations (CAR) 2011 as amended.

The pilot reported that he conducted a pre-flight inspection and no anomalies were found. Thereafter, he taxied the gyrocopter to Runway 16 and prepared for take-off. He pre-rotated the rotor blades; however, he disengaged the pre-rotator shaft before the rotor speed reached the minimum 200 revolutions per minute (RPM). This caused the pre-rotator to disengage prematurely. Despite the premature disengagement of the pre-rotator and without the required speed being reached, the pilot continued with the take-off run with the hope that the rotor would gain sufficient rotational speed. Additionally, the pilot stated that he did not pull back the control stick far enough to achieve the necessary angle-of-attack for the rotor blades. As the gyrocopter rolled forward, the rotor blade flapped due to low rotor RPM and the uneven rotation of the rotor disk which prevented the gyrocopter from lifting off. The excessive upward and downward movement of the rotor blades

(flapping) caused turbulence and, as a result, the pilot lost grip of the control stick and the gyrocopter rolled to the right. The gyrocopter was destroyed, and the pilot was not injured.

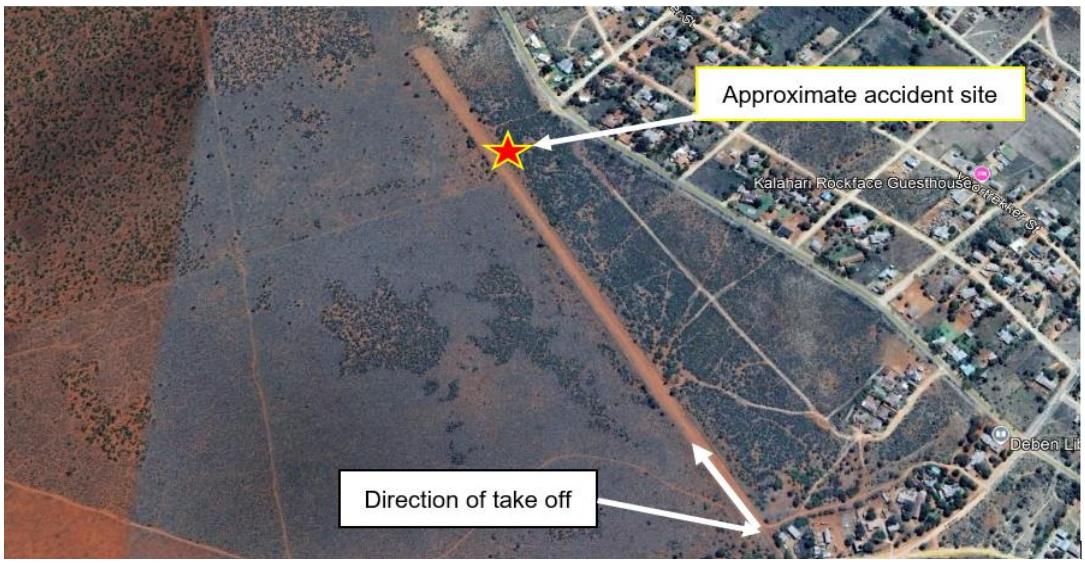

Figure 1: Aerial view of Dibeng Airfield, the take-off direction, and the accident site. (Source: Google Earth)

Figure 2: ZU-RHN at the accident site. (Source: Operator)

Post-accident investigation revealed that the tail section had separated from the gyrocopter and the propeller blades were damaged at the tips; the cockpit glass also shattered during the accident (see Figure 2).

Aircraft Performance (Source: Pilot's Operating Handbook)

The maximum required rotor pre-rotation speed is 220 RPM at a recommended pre-rotation clutch speed of 2000 RPM.

Blade Flapping (Source: Rotorcraft Flying Handbook)

On a gyroplane with a semi-rigid, teeter-head rotor system. blade flap may develop if too much airflow passes through the rotor system while it is operating at low rpm. This is most often the result of taxiing too fast for a given rotor speed. Unequal lift acting on the advancing and retreating blades can cause the blades to teeter to the maximum allowed by the rotor head design. The blades then hit the teeter stops, creating a vibration that. may be felt in the cyclic control. The frequency of the vibration corresponds to the speed of the rotor with the blades hitting the stops twice during each revolution. If the flapping is not controlled, the situation can grow worse as the blades begin to flex and bend. Because the system is operating at low rpm, there is not enough centrifugal force acting on the blades to keep them rigid. The shock of hitting the teeter stops combined with uneven lift along the length of the blade causes an undulation to begin, which can increase in severity if allowed to progress- In extreme cases, a rotor blade may strike the ground or propeller.

Pre-rotation (Source: Rotorcraft Flying Handbook)

Pre-rotation of the rotor can take many forms in a gyroplane. The most basic method is to turn the rotor blades by hand. On a typical gyroplane with a counterclockwise rotating rotor, pre-rotation by hand is done on the right side of the rotor disk. This allows body movement to be directed away from the propeller to minimize the risk of injury. Other methods of pre-rotation include using mechanical, electrical, or hydraulic means for the initial blade spin-up. Many of these systems can achieve only a portion of the rotor speed that is necessary for take-off. After the pre-rotator is disengaged, taxi the gyroplane with the rotor disk tilted aft to allow airflow through the rotor. This increases rotor speed to flight RPM. In windy conditions, facing the gyroplane into the wind during pre-rotation assists in achieving the highest possible rotor speed from the pre-rotator. A factor often overlooked that can negatively affect the pre-rotation speed is the cleanliness of the rotor blades. For maximum efficiency, it is recommended that the rotor blades be cleaned periodically. By obtaining the maximum possible rotor speed through the use of proper pre-rotation techniques, you minimise the length of the ground roll that is required to get the gyroplane airborne. The pre-rotators on certificated gyroplanes remove the possibility of blade flap during pre-rotation. Before the clutch can be engaged, the pitch must be removed from the blades. The rotor is then pre-rotated with a 0° angle of attack on the blades, which prevents lift from being produced and precludes the possibility of flapping. When the desired rotor speed is achieved, blade pitch is increased for take-off.

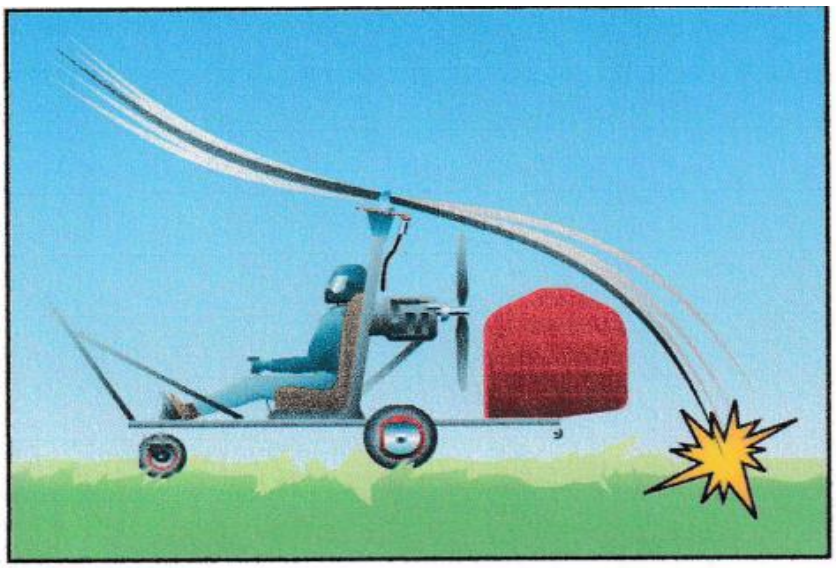

Figure 20-2. Taxiing too fast or gusting winds can cause blade flap in a slow turning rotor. If not controlled, a rotor blade may strike the ground.

Figure 3: Illustration of the blade flap.

To avoid the onset of blade flap, always taxi the gyroplane at slow speeds when the rotor system is at low RPM. Consideration must also be given to wind speed and direction. If taxiing into a 10-knot headwind, for example, the airflow through the rotor will be 10 knots faster than the forward speed of the gyroplane, so the taxi speed should be adjusted accordingly. When pre-rotating the rotor by taxiing with the rotor disc tilted aft, allow the rotor to accelerate slowly and smoothly. In the event the blade flap is encountered, apply forward cyclic to reduce the rotor disc angle and slow the gyroplane by reducing the throttle and applying the brakes, if needed.

Take-off Procedure

- *Check relative wind*
- *Maintain control stick in the forward position with right-hand*
- *Switch the pneumatic mode selector to FLIGHT and return to brake with left-hand*
- *Hold the wheel brake without having the locking pawl engaged*
- *While holding the wheel brake adjust the throttle to give 2000 RPM (1600 RPM.*
- *Activate and hold the pre-rotator. To reduce lateral stick force during pre-rotation, adjust the forward stick position by pulling it slightly aft and to the right*
- *Let the pneumatic clutch fully engage (stabilization at about 110 rotor RPM). If necessary, release the pre-rotator button momentarily and press it again to maintain engine RPM within the green arc, respectively prevent the engine from stalling!*
- *Carefully increase throttle (~ 20 R-RPM/sec) to 200 R-RPM – max. 220 R-RPM*
- *When the minimum required rotor RPM is reached, release the pre-rotator button*

- *Gently – but smartly - move control stick fully aft (stick travel ~ 1 sec.). In a strong headwind be prepared to stop movement before nose wheel rises!*
- *Release wheel brake with throttle unchanged*

Meteorological Conditions

The pilot provided the following weather information for Dibeng Airfield on 3 October 2024 through the pilot's questionnaire form.

Dibeng Airfield 261230Z 09004KT CAVOK 28/05 Q1023 NOSIG=

Wind Direction	90°	Wind Speed	4kts	Visibility	9999m
Temperature	28°C	Cloud Cover	Nil	Cloud Base	Nil
Dew Point	5°C	QNH	1028hPa		

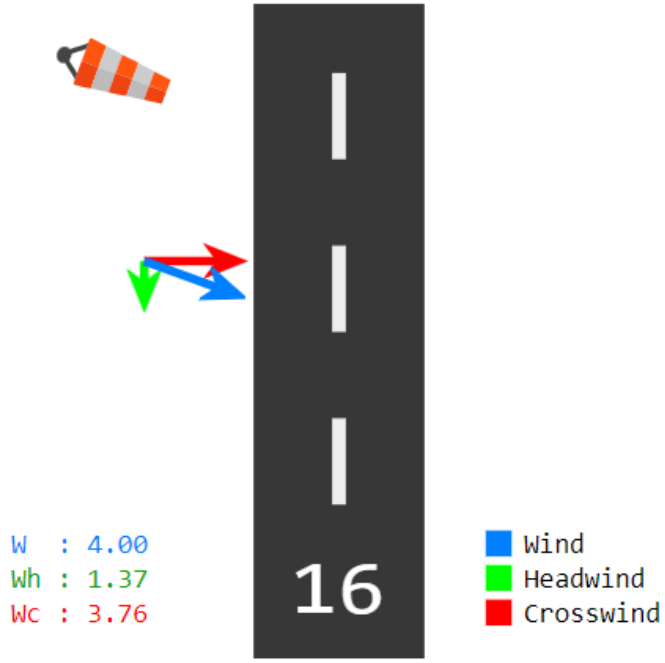

Figure 4: The crosswind component as per the weather report. (Source: https://e6bx.com)

- The meteorological conditions show a 4 knots (kts) crosswind from the left at the time of the accident. The crosswind component was calculated using https://e6bx.com website.
- According to the POH, the crosswind component which refers to the maximum crosswind velocity a gyrocopter can effectively withstand during take-off and landing is 22 knots (kts).

Findings

Pilot

1. The pilot was initially issued a National Pilot Licence (NPL) on 21 August 2018. His last validation was conducted on 10 July 2023 with an expiry date of 9 July 2025. The aircraft

type was endorsed on the pilot's licence. His Class 4 aviation medical certificate was issued on 18 November 2022 with an expiry date of 30 November 2025. The pilot was suitably qualified and authorised for the flight.

Aircraft

2. The aircraft's Certificate of Registration (C of R) was issued to the current owner on 9 September 2020. The Authority-to-Fly (ATF) was initially issued on 8 September 2019. The ATF was reissued on 28 August 2024 with an expiry date of 31 August 2025.

3. The last annual inspection of the aircraft was certified on 23 August 2024 at 432 total airframe hours. At the time of the accident, the aircraft had a total of 435 airframe hours. The aircraft was flown a further 3 hours since the last inspection.

4. The aircraft was issued a Certificate of Release to Service (CRS) on 23 August 2024 at 432 airframe hours with an expiry date of 7 August 2025 or at 532 airframe hours, whichever occurs first.

5. A pre-flight inspection was conducted, and the aircraft was deemed ready for the flight. No defects were recorded in the flight folio before the flight.

6. The pilot engaged the pre-rotator system but disengaged it before the gyrocopter reached the minimum rotor speed of 220 RPM as specified in the POH) The pilot's decision to disengage the pre-rotator prematurely before achieving the minimum rotor RPM was a critical error as it left the rotor spinning with insufficient speed for a safe take-off.

7. Despite the pre-mature disengagement of the pre-rotator, the pilot proceeded with the take-off in the hope that the rotor would accelerate to the required speed during the ground roll. This decision was dangerous and contravened the safe operating practices. Attempting a take-off with insufficient rotor RPM is risky as it reduces the effectiveness of the rotor blades and increases the likelihood of blade flapping. (Flapping is a phenomenon where the blade moves excessively due to unequal lift on the rotor disk.)

8. The rotor speed was insufficient which led to blade flapping as the gyrocopter began to roll forward. According to the POH, blade flapping occurs when there is uneven airflow through the rotor blades, especially at low RPM, which was the case in this occurrence. The combination of insufficient pre-rotation and excessive taxiing speed caused the rotor blades to "flap" due to unequal lift. This resulted in excessive upward and downward movement of the rotor blades. In a semi-rigid teeter-head rotor system, flapping is most likely when the

aircraft is moving too fast whilst the rotor is at low RPM, preventing the blades from achieving a uniform lift.

Environment

9. Good weather conditions prevailed at the time of the flight. The weather was not a contributing factor on this accident.

Probable Cause

The gyrocopter's main rotor blades flapped during take-off due to pre-mature disengagement of the pre-rotator before it reached the required rotor speed of 220 RPM.

Contributing Factor(s)

Failure to follow the manufacturer's operational procedures.

Safety Action(s)

None.

Safety Message and/or Safety Recommendation/s

None.

About this Report

The decision to conduct a limited investigation is based on factors including whether the cause is known and the evidence supporting the cause is clear, the level of safety benefit likely to be obtained from an investigation and that will determine the scope of an investigation. For this occurrence, a limited investigation has been conducted, and the Accident and Incident Investigations Division (AIID) has relied on the information submitted by the affected person/s and organisation/s to compile this limited report. The report has been compiled using information supplied in the initial notification, as well as from follow-up desktop enquiries to bring awareness of potential safety issues to the industry in respect of this occurrence, as well as possible safety action/s that the industry might want to consider in preventing a recurrence of a similar occurrence.

All times given in this report are Co-ordinated Universal Time (UTC) and will be denoted by (Z). South African Standard Time is UTC plus 2 hours.

Purpose

In terms of Regulation 12.03.1 of the Civil Aviation Regulations (CAR) 2011 and ICAO Annex 13, this report was compiled in the interest of the promotion of aviation safety and the reduction of the risk of aviation accidents or incidents and not to apportion blame or liability.

Disclaimer

This report is issued by:

Accident and Incident Investigations Division
South African Civil Aviation Authority
Republic of South Africa