SOUTH AFRICAN CIVIL AVIATION AUTHORITY

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

LIMITED OCCURRENCE INVESTIGATION REPORT – FINAL

Reference Number	CA18/2/3/10275						
Classification	Accident	**Date**	3 March 2023		**Time**	2205Z	
Type of Operation	Remotely Piloted Aircraft System – Surveillance (Part 101)						
Location							
Place of Departure	African Explosives and Chemical Industries (AECI) Modderfontein, Gauteng Province		Place of Intended Landing		African Explosives and Chemical Industries (AECI) Modderfontein, Gauteng Province		
Place of Occurrence	AECI Modderfontein, Gauteng Province						
GPS Co-ordinates	Latitude	26°04'26.29" S	Longitude	28°10'16.68" E	Elevation	5 305ft	
Aircraft Information							
Registration	ZT-YHM						
Make; Model; S/N	DJI Matrice, 300 RTK (Serial Number: DOMT3-03/Class 4A)						
Damage to Aircraft	Substantial		Total Aircraft Hours	267.44			
Pilot-in-command							
Licence Type	Remote Pilot Licence (RPL)		Gender	Male	Age	25	
Licence Valid	Yes	Total Hours	238.29	Total Hours on Type	233.55		
Total Hours 30 Days	27.57		Total Flying on Type Past 90 Days	57.03			
People Controlling	1	**Injuries**	0	**Fatalities**	0	**Other (on ground)**	0

What Happened

On 3 March 2023, a remotely piloted aircraft (RPA) with registration ZT-YHM was launched from a launch pad for a surveillance operation at African Explosives and Chemical Industries (AECI) in Modderfontein, Gauteng province, with the intention to land back at the same launch pad. The surveillance flight was conducted under beyond visual line of sight (BVLOS) rules by night and under the provisions of Part 101 of the Civil Aviation Regulations (CAR) 2011 as amended.

The pilot stated that he carried out the RPA inspection prior to commencing the surveillance mission. The first seven flights were uneventful, and there were no warnings or defects encountered during these missions. The RPA was launched for the eighth mission of the evening at approximately 2200Z with 99% battery power (equating to 55 minutes of flight time) and it climbed to 656 feet (ft) above ground level (AGL). The RPA proceeded to the area to be surveyed.

Approximately 1 minute and 20 seconds into the mission, the pilot noticed an electronic speed control (ESC) error/warning message (which read ‘not enough force’) on the controller unit; the error message disappeared moments after. The pilot continued with normal operation and, after 2 minutes and 11 seconds, the unit controller displayed a ‘high wind velocity warning’ message. About 3 minutes and 30 seconds later, the controller displayed ‘pitching sharply forward’ and ‘propeller malfunction’ warning messages on the unit

controller. Thereafter, the RPA entered a spiral dive until it impacted the ground. The distance between the RPA and the pilot was approximately 400m at that time (therefore, he had visual of the RPA). Thus, the pilot observed the RPA descend uncontrollably to the ground without his input. The pilot stated that he attempted to regain control by performing an emergency landing which was unsuccessful, thereafter, he selected a return-to-home function, but the RPA crashed to the ground. The RPA sustained substantial damage and no people on the ground were reported injured.

Post-accident:

The weather information was received from the South African Weather Service (SAWS); the meteorological aerodrome report (METAR) at the time of the accident was: FAOR 032200Z 04004KT CAVOK 16/13 NOSIG=

According to the pilot questionnaire, the weather was as follows: Wind direction, south-west at 6 knots: temperature, 19°; visibility 10km.

According to the RPA manual, the maximum wind resistance for the RPA is 15 metres per second (m/s) (29kts), therefore, the weather did not play a role in this accident.

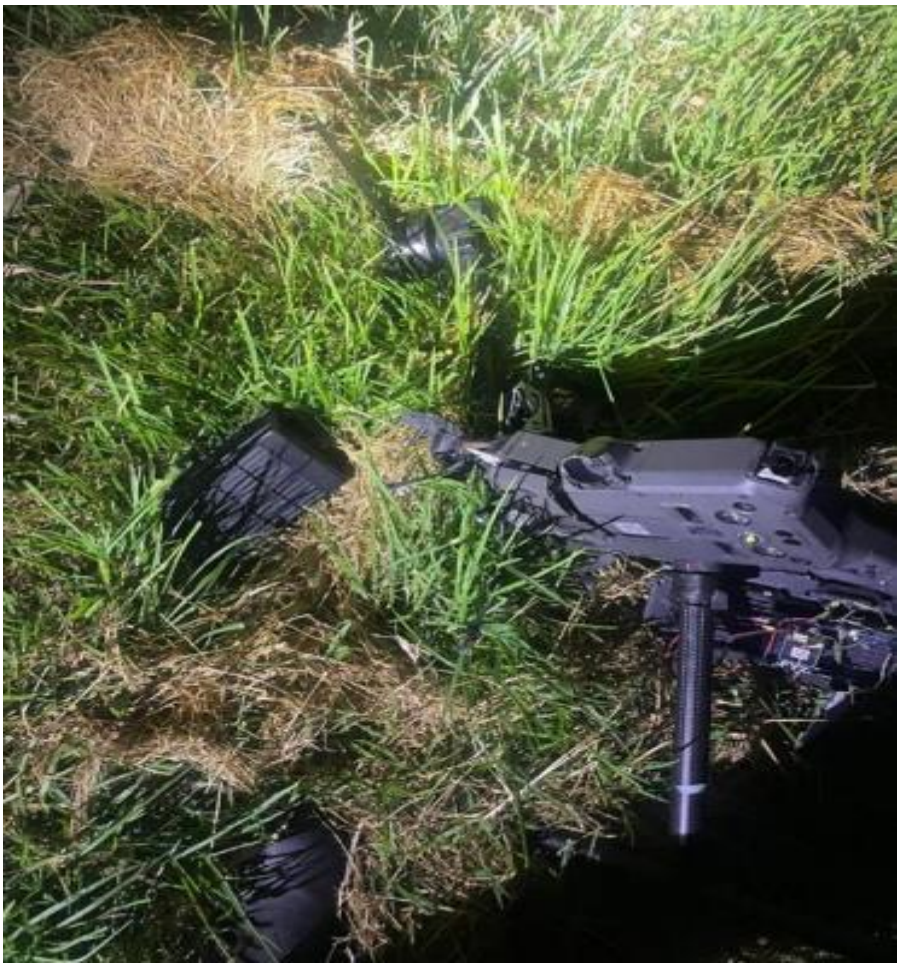


Figure 1: Final resting position of the RPA. (Source: Operator)

Description of RPA

The MATRICE 300 RTK (M300 RTK) is a powerful industrial drone platform with an advanced flight controller system. To enhance reliability and safety, it also supports CSM Radar – an additional obstacle detection component that can be mounted on top of the drone. It features several advanced flight functions including 6 directional sensing and positioning, AI spot-check, Smart Track, PinPoint, Location Sharing, Primary Flight Display and more. The built-in AirSense provides awareness of nearby aircraft within the surrounding airspace to ensure safety.

Its airframe design gives it an IP45 Ingress Protection, in accordance with the global IEC 60529 standard. The mechanical design, along with quick-release landing gears and mounted folding arms makes it easy to transport, store and prepare for the flight. The safety beacons on both the top and the bottom of the aircraft allow the aircraft to be identified at night or in low light conditions, improving aircraft take-off, landing and flight safety.

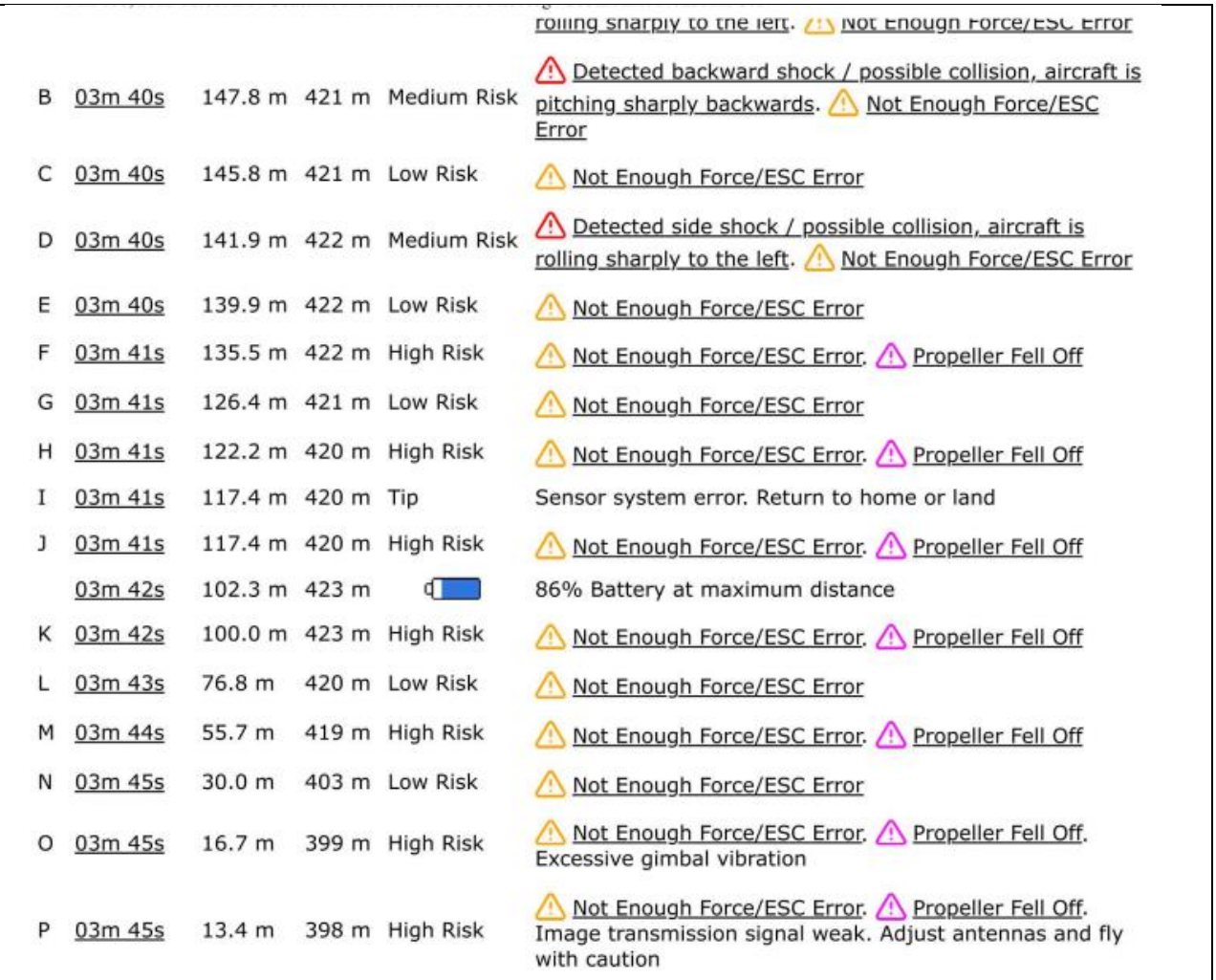
M300 RTK is compatible with many of DJI's DGC2.0 connector gimbals, supporting multi-gimbal system, which can support up to three independent gimbals to meet the needs of the different scenarios.

The Matrice 300 RTK is equipped with several expansion ports for broader applications. It has a built-in RTK module, which provides more accurate heading data for positioning. An advanced power management system along with dual batteries ensures power supply and enhances flight safety. Without a payload, the M300 RTK has a flight time of up to 55 minutes.

	Flight time	Altitude	Home Dist	Type	Notification
A	00m 00s	0.0 m	0 m	Mode	Mode changed to P-GPS
B	00m 00s	0.0 m	0 m	Mode	Mode changed to Motors Started
C	00m 00s	0.0 m	0 m	Tip	✔ Your aircraft is flying in an Altitude Zone (500m). Please fly with caution.
D	00m 00s	0.0 m	0 m	Tip	✔ Setting new Return-To-Home altitude to 200m (656 ft). ✔ Data Recorder File Index is 67. ✔ Setting new Maximum Flight Altitude to 300m (984 ft)
E	00m 02s	0.0 m	0 m	Mode	Mode changed to Assisted Takeoff
F	00m 02s	0.0 m	0 m	Mode	Mode changed to P-GPS
G	00m 02s	0.0 m	0 m	Tip	✔ Home Point recorded. ✔ Return-to-Home Altitude: 200m
H	00m 04s	6.0 m	0 m	Warning	Horizontal ambient light too low. Horizontal obstacle avoidance unavailable. Only infrared sensors available. Fly with caution
I	00m 05s	11.2 m	0 m	Warning	Downward ambient light too low. Obstacle avoidance unavailable. Fly with caution
J	01m 20s	118.2 m	203 m	Low Risk	⚠ Not Enough Force/ESC Error
K	01m 20s	119.2 m	206 m	Low Risk	⚠ Not Enough Force/ESC Error. Strong remote controller signal interference. Move away from other remote controllers or the source of interference
L	01m 20s	119.8 m	207 m	Low Risk	⚠ Not Enough Force/ESC Error
M	01m 25s	144.7 m	259 m	Low Risk	⚠ Not Enough Force/ESC Error
N	01m 39s	155.0 m	379 m	Low Risk	⚠ High Wind Velocity. Fly with caution.
O	02m 07s	173.3 m	396 m	Warning	Image transmission signal weak. Adjust antennas and fly with caution
P	02m 07s	173.2 m	396 m	Warning	Strong remote controller signal interference. Move away from other remote controllers or the source of interference
	02m 10s	173.3 m	396 m		90% Battery
Q	02m 11s	173.4 m	396 m	Warning	Strong remote controller signal interference. Move away from other remote controllers or the source of interference
R	02m 11s	173.3 m	396 m	Low Risk	⚠ High Wind Velocity. Fly with caution.
S	03m 27s	173.3 m	396 m	Low Risk	⚠ High Wind Velocity. Fly with caution.

T	03m 35s	173.3 m	401 m	Low Risk	⚠ High Wind Velocity. Fly with caution.
U	03m 37s	174.9 m	412 m	Medium Risk	⚠ Detected side shock / possible collision, aircraft is rolling sharply to the right
V	03m 37s	175.1 m	412 m	High Risk	⚠ Propeller Fell Off
W	03m 37s	175.0 m	413 m	Tip	✔ Gimbal 1 pitch axis endpoint reached
X	03m 37s	175.0 m	413 m	High Risk	⚠ Propeller Fell Off
Y	03m 37s	174.9 m	414 m	High Risk	⚠ Detected forward shock / possible collision, aircraft is pitching sharply forward. ⚠ Propeller Fell Off
Z	03m 37s	174.7 m	414 m	Tip	Motor 4 propeller detached or installed incorrectly
a	03m 37s	174.7 m	414 m	High Risk	⚠ Propeller Fell Off. Aircraft antenna satellite signal searching error. Fly with caution (0x1610008f)
b	03m 37s	174.3 m	414 m	High Risk	⚠ Propeller Fell Off
c	03m 38s	173.9 m	415 m	High Risk	⚠ Detected side shock / possible collision, aircraft is rolling sharply to the right. ⚠ Propeller Fell Off
d	03m 38s	173.7 m	415 m	High Risk	⚠ Propeller Fell Off
e	03m 38s	173.2 m	417 m	High Risk	⚠ Detected forward shock / possible collision, aircraft is pitching sharply forward. ⚠ Propeller Fell Off
f	03m 38s	172.6 m	417 m	High Risk	⚠ Propeller Fell Off
g	03m 38s	171.5 m	417 m	High Risk	⚠ Detected side shock / possible collision, aircraft is rolling sharply to the right. ⚠ Propeller Fell Off
h	03m 38s	170.7 m	417 m	High Risk	⚠ Detected forward shock / possible collision, aircraft is pitching sharply forward. ⚠ Not Enough Force/ESC Error. ⚠ Propeller Fell Off
i	03m 38s	169.9 m	418 m	Tip	✔ Gimbal 1 pan axis endpoint reached
j	03m 38s	169.9 m	418 m	High Risk	⚠ Not Enough Force/ESC Error. ⚠ Propeller Fell Off
k	03m 38s	169.1 m	418 m	High Risk	⚠ Detected backward shock / possible collision, aircraft is pitching sharply backwards. ⚠ Detected side shock / possible collision, aircraft is rolling sharply to the right. ⚠ Not Enough Force/ESC Error. ⚠ Propeller Fell Off
l	03m 38s	168.2 m	418 m	Mode	Mode changed to Emergency Landing

m	03m 38s	168.2 m	418 m	High Risk	⚠ Aircraft propulsion system error. Forced landing. Manually control the aircraft and land in an open area
n	03m 38s	168.2 m	418 m	High Risk	⚠ Not Enough Force/ESC Error. ⚠ Propeller Fell Off
o	03m 39s	166.2 m	418 m	High Risk	⚠ Detected backward shock / possible collision, aircraft is pitching sharply backwards. ⚠ Detected side shock / possible collision, aircraft is rolling sharply to the right. ⚠ Not Enough Force/ESC Error. ⚠ Propeller Fell Off
p	03m 39s	165.2 m	419 m	High Risk	⚠ Not Enough Force/ESC Error. ⚠ Propeller Fell Off
q	03m 39s	162.7 m	419 m	High Risk	⚠ Detected side shock / possible collision, aircraft is rolling sharply to the right. ⚠ Not Enough Force/ESC Error. ⚠ Propeller Fell Off
r	03m 39s	161.6 m	419 m	High Risk	⚠ Detected forward shock / possible collision, aircraft is pitching sharply forward. ⚠ Not Enough Force/ESC Error. ⚠ Propeller Fell Off
s	03m 39s	160.3 m	419 m	High Risk	⚠ Detected side shock / possible collision, aircraft is rolling sharply to the right. ⚠ Not Enough Force/ESC Error. ⚠ Propeller Fell Off
t	03m 39s	158.9 m	420 m	High Risk	⚠ Detected forward shock / possible collision, aircraft is pitching sharply forward. ⚠ Not Enough Force/ESC Error. ⚠ Propeller Fell Off
u	03m 39s	157.5 m	420 m	Tip	ESC auto-check error. Return to home or land
v	03m 39s	157.5 m	420 m	High Risk	⚠ Not Enough Force/ESC Error. ⚠ Propeller Fell Off
w	03m 39s	155.9 m	420 m	High Risk	⚠ Detected side shock / possible collision, aircraft is rolling sharply to the right. ⚠ Not Enough Force/ESC Error. ⚠ Propeller Fell Off
x	03m 40s	154.3 m	421 m	High Risk	⚠ Not Enough Force/ESC Error. ⚠ Propeller Fell Off
y	03m 40s	152.9 m	421 m	High Risk	⚠ Detected side shock / possible collision, aircraft is rolling sharply to the right. ⚠ Not Enough Force/ESC Error. ⚠ Propeller Fell Off
z	03m 40s	151.1 m	421 m	High Risk	⚠ Detected forward shock / possible collision, aircraft is pitching sharply forward. ⚠ Not Enough Force/ESC Error. ⚠ Propeller Fell Off
A	03m 40s	149.5 m	421 m	Medium Risk	⚠ Detected side shock / possible collision, aircraft is



					rolling sharply to the left. ⚠ Not Enough Force/ESC Error
B	03m 40s	147.8 m	421 m	Medium Risk	⚠ Detected backward shock / possible collision, aircraft is pitching sharply backwards. ⚠ Not Enough Force/ESC Error
C	03m 40s	145.8 m	421 m	Low Risk	⚠ Not Enough Force/ESC Error
D	03m 40s	141.9 m	422 m	Medium Risk	⚠ Detected side shock / possible collision, aircraft is rolling sharply to the left. ⚠ Not Enough Force/ESC Error
E	03m 40s	139.9 m	422 m	Low Risk	⚠ Not Enough Force/ESC Error
F	03m 41s	135.5 m	422 m	High Risk	⚠ Not Enough Force/ESC Error. ⚠ Propeller Fell Off
G	03m 41s	126.4 m	421 m	Low Risk	⚠ Not Enough Force/ESC Error
H	03m 41s	122.2 m	420 m	High Risk	⚠ Not Enough Force/ESC Error. ⚠ Propeller Fell Off
I	03m 41s	117.4 m	420 m	Tip	Sensor system error. Return to home or land
J	03m 41s	117.4 m	420 m	High Risk	⚠ Not Enough Force/ESC Error. ⚠ Propeller Fell Off
	03m 42s	102.3 m	423 m		86% Battery at maximum distance
K	03m 42s	100.0 m	423 m	High Risk	⚠ Not Enough Force/ESC Error. ⚠ Propeller Fell Off
L	03m 43s	76.8 m	420 m	Low Risk	⚠ Not Enough Force/ESC Error
M	03m 44s	55.7 m	419 m	High Risk	⚠ Not Enough Force/ESC Error. ⚠ Propeller Fell Off
N	03m 45s	30.0 m	403 m	Low Risk	⚠ Not Enough Force/ESC Error
O	03m 45s	16.7 m	399 m	High Risk	⚠ Not Enough Force/ESC Error. ⚠ Propeller Fell Off. Excessive gimbal vibration
P	03m 45s	13.4 m	398 m	High Risk	⚠ Not Enough Force/ESC Error. ⚠ Propeller Fell Off. Image transmission signal weak. Adjust antennas and fly with caution

Figure 2: Flight log data. (Source: Operator)

According to the flight log data (above), a new return-to-home altitude of 656 feet (ft) was set, and the home point was recorded at 00 minutes and 00 seconds. A 'horizontal and downward ambient light too low' message was recorded shortly thereafter. The RPA continued with surveillance over the area. At approximately 1 minute and 20 seconds, a 'not enough force/ESC error' messages appeared, followed by the 'high wind velocity' message at the altitude of 508 ft above ground level (AGL). Whilst at 567 ft, it detected a weak image transmission signal followed by a strong remote controller signal interference. At 3 minutes and 27 seconds, a 'side shock/possible collision' and 'aircraft rolling sharply to the right' messages were displayed, followed by 'propeller fell-off' warning message. Thereafter, a series of warning messages appeared (detected forward shock, motor 4 propeller detached, not enough force/ESC error and detected backward shock) on the controller unit. The mode was changed to emergency landing and the RPA altitude decreased rapidly from 567 ft to 43 ft in less than 7 seconds. The duration of the recording was 3 minutes and 45 seconds.

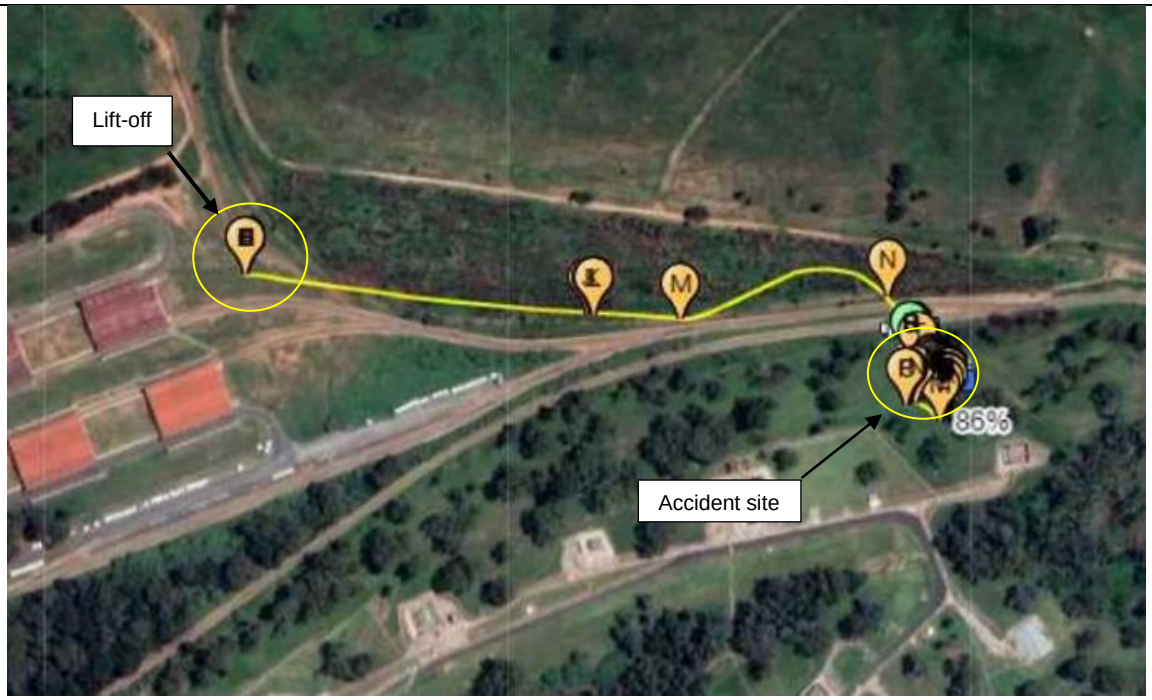


Figure 3: The flight path from lift-off until the crash. (Source: Operator)

Findings

1. The pilot was initially issued a Remote Pilot Licence (RPL) on 9 November 2022 with an expiry date of 30 November 2024. The pilot was issued a Class 3 aviation medical certificate on 17 August 2022 with an expiry date of 17 August 2026 with no medical restrictions.

2. The aircraft was registered to the present owner on 19 May 2022.

3. The last maintenance inspection on the RPA was carried out on 25 January 2023 with an expiry date of 25 January 2024.

4. The RPA was issued a Remotely Piloted Aircraft System Letter of Approval (RLA) certificate on 23 August 2022 with an expiry date of 22 August 2023.

5. The RPA maintenance was carried out by an approved person (AP) with a remote maintenance technician (RMT) certificate that was issued by the Regulator (SACAA) on 26 March 2023 with an expiry date of 6 June 2023.

6. The operator had a valid Remotely Piloted Aircraft System Operating Certificate (ROC) that was issued by the Regulator on 21 April 2022 with an expiry date of 30 April 2023.

7. Post-accident, the operator shared the flight log of the accident flight as well as the technical report with the investigator. The flight (eighth mission) lasted approximately 3 minutes and 37 seconds.

Probable Cause(s)
Failure of the ESC due to a possible battery low voltage resulted in the loss of control and an un-commanded spiral dive.
Contributing Factor(s)
None.
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 desk top 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.
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Accident and Incident Investigations Division
South African Civil Aviation Authority
Republic of South Africa