SOUTH AFRICAN CIVIL AVIATION AUTHORITY

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

LIMITED OCCURRENCE INVESTIGATION REPORT – FINAL

Reference Number	CA18/2/3/10269										
Classification	Accident		**Date**	20 February 2023			**Time**	2310Z			
Type of Operation	Remotely Piloted Aircraft System – Surveillance (Part 101)										
Location											
Place of Departure	Welverdiend Pump Station, Springbok, Mpumalanga Province			Place of Intended Landing			Welverdiend Pump Station, Springbok, Mpumalanga Province				
Place of Occurrence	Mining area at Welverdiend Pump Station, Springbok, Mpumalanga Province										
GPS Co-ordinates	Latitude	26° 02' 39" S		Longitude	29° 24' 45" E		Elevation	5 246 ft			
Aircraft Information											
Registration	ZT-YIT										
Make; Model; S/N	DJI, Mavic 2 Enterprise Advanced (Serial Number: MAV130)										
Damage to Aircraft	Unknown (Missing)			Total Aircraft Hours	221.25						
Pilot-in-command											
Licence Type	Remote Pilot Licence (RPL)			Gender	Male		Age	21			
Licence Valid	Yes	Total Hours	1 259.43		Total Hours on Type	1 259.43					
Total Hours 30 Days	± 17.00			Total Flying on Type Past 90 Days	51.43						
People Controlling	1	**Injuries**	0	**Fatalities**	0	**Other (on ground)**	0				

What Happened

On Monday evening, 20 February 2023, a DJI Mavic 2 Enterprise Advanced Remotely Piloted Aircraft (RPA) with registration ZT-YIT was launched from Welverdiend Pump Station in Springbok, Mpumalanga province, for aerial surveillance around the mine. The flight was conducted 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 the pre-flight checks were carried out on the RPA with no anomalies observed. The battery voltage indicated full capacity (100%) during the pre-flight checks. The pilot launched the RPA using an application (APP) installed on a mobile device. The RPA climbed steadily and proceeded to the designated surveillance area. After three minutes into the flight, the pilot received an error message on the controller unit screen which indicated low battery voltage. The pilot cleared the error message on the controller unit screen; however, it reappeared within seconds. The pilot then activated the return-to-launch (RTL) position function, but the screen powered out (turned black). Thus, the RPA failed to return-to-launch.

After the controller unit lost connection with the RPA, the pilot launched another RPA to the last recorded location of ZT-YIT to search for it, however, the RPA could not be found. There were no reported injuries on the ground.

Figure 1: Red circle indicates the last recorded location of ZT-YIT RPA using Google Earth. (Source: Operator)

Figure 2: The DJI Mavic 2 Enterprise Advanced RPA type similar to the lost ZT-YIT. (Source: https://www.dji.com/mavic-2-enterprise-advanced)

Findings

1. The pilot was initially issued a Remote Pilot Licence (RPL) on 10 March 2021 with an expiry date of 31 March 2023. The pilot had beyond visual line of sight (BVLOS), visual line of sight (VLOS) and multirotor (MR) ratings and endorsements on his licence. A Class 3 medical certificate was issued to the pilot on 29 January 2021 with an expiry date of 31 January 2026 with no restrictions. The pilot was properly licensed and medically fit for the flight in accordance with the existing regulations.

2. The operator was issued a Remotely Piloted Aircraft System Letter of Approval (RLA) by the Regulator (South African Civil Aviation Authority) on 1 September 2022 with an expiry date of 31 August 2023. The last inspection conducted on the RPA prior to the accident flight was on 20 February 2023 at 218.67 hours. The RPA recorded 221.25 total hours at the time of the accident, meaning that it was flown a further 2.58 hours since the last inspection was conducted. According to the RPA's maintenance records, ZT-YIT was maintained in compliance with the regulations and was airworthy when it dispatched for the surveillance flight.

3. The operator was issued a Remotely Piloted Aircraft System Operating Certificate (ROC) by the Regulator on 31 October 2022 with an expiry date of 31 October 2023. The ZT-YIT RPA type was endorsed on the ROC and approved for BVLOS operations, issued on 25 January 2023 with an expiry date of 31 January 2024.

4. According to the operator's pre- and post-flight check sheets, pilots are required to check the amount (number) of battery cycles (*once exceeded/if greater than 250 cycles, please document, stating serial number, in flight folio*) and replace them during pre-flight inspections.

5. Post-accident investigation carried out by the operator:

   The RPAs AIRDATA and Mission Planner was used to determine the cause of the accident. Bin file 2023-01-01 21-27-44.bin was analysed to determine the root cause of the accident. The operator reported the following observations based on the AIRDATA flight logbook and CSV-View information:

   - *The battery's current dropped while the RPA was at 400 feet (ft) above ground level (AGL).*
   - *As the battery's current dropped, the RPA lost communication.*
   - *There was a drop in the cells of the battery between two and three minutes into the flight.*
   - *There was a warning of a faulty battery at the end of the flight. (See Figure 3)*

	Flight time	Altitude	Home Dist	Type	Notification
A	00m 10s	40.4 ft	0 m	Mode	Mode changed to P-GPS
B	00m 10s	39.7 ft	6 m	Tip	✓ Setting new Return-To-Home altitude to 120m (394 ft). ✓ Data Recorder File Index is 89. ✓ Setting new Maximum Flight Altitude to 30m (98 ft)
	00m 10s	39.7 ft	6 m		100% Battery
C	00m 12s	54.5 ft	13 m	Tip	✓ Setting new Maximum Flight Altitude to 500m (1640 ft)
D	00m 13s	64.0 ft	15 m	Tip	SDCard Tip: SD card speed is slow, cannot record 4K/SEQ video. ✓ To take off in non-P mode, toggle Flight Mode Switch to another mode and then toggle it back
E	01m 56s	395.0 ft	284 m	Warning	SDCard Tip: SD card speed is slow, cannot record 4K/SEQ video
F	01m 56s	395.0 ft	284 m	Tip	✓ To take off in non-P mode, toggle Flight Mode Switch to another mode and then toggle it back.
G	01m 57s	395.3 ft	284 m	Warning	Flight mode configuration: A/P/S. Current flight mode: P-GPS
	02m 31s	395.7 ft	319 m		90% Battery
H	02m 58s	394.4 ft	587 m	Warning	The communication to the battery is abnormal. Please land as soon as possible and check if the battery is installed properly
I	03m 34s	395.3 ft	719 m	Low Risk	⚠ High Wind Velocity. Fly with caution.
J	04m 23s	395.3 ft	1,083 m	Data Loss	⚠ Downlink data connection lost for 1.2 seconds
	05m 27s	392.7 ft	1,199 m		89% Battery at maximum distance

Figure 3: A snapshot of the flight log information for ZT-YIT which was downloaded after the accident. (Source: Operator)

Sequence of Events (UCT Time):

At 2254Z: The pilot armed the RPA and switched to GPS mode.
At 2256Z: The transmitter gave a battery warning to the pilot.
At 2257Z: 3 minutes into the flight the RPA lost communication with the battery.
At 2259Z: The screen on the transmitter turned black and gave a warning that the RPA disconnected.
At 2310Z: The pilot realised something was wrong when the aircraft never returned home.
At 2311Z: The pilot used the flight record to locate the aircraft and realised it fell in a "red zone" of the mine (where access is prohibited).

Conclusion:

Hardware failure in that the battery failed during flight.

Probable Cause

Battery failure during flight caused the loss of communication between the RPA and the controller unit (C2-Link) after reaching 400 ft AGL; the RPA was not recovered.

Contributing Factor

The battery exceeded the 250 life cycles (life span) recommended by the manufacturer (battery's end-of-life limit).

Safety Action

The operator has urged pilots to check battery cycles regularly as stated in the Pre- and Between-Flight checklists.

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.

Disclaimer

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