SOUTH AFRICAN CIVIL AVIATION AUTHORITY

Section/division **Accident and Incident Investigations Division** Form Number: CA 12-58

UAS LIMITED OCCURRENCE INVESTIGATION REPORT – FINAL

Reference Number	CA18/2/3/10333								
Classification	Accident		**Date**	18 June 2023			**Time**	2129Z	
Type of Operation	Unmanned Aircraft System – Surveillance (Part 101)								
Location									
Place of Departure	Beatrix West Mine in Welkom, Free State Province		Place of Intended Landing		Beatrix West Mine in Welkom, Free State Province				
Place of Occurrence	Beatrix West Mine, Welkom, Free State Province								
GPS Co-ordinates	Latitude	28º10'58.82" S	Longitude	26º42'53.55" E	Elevation	4416 ft			
Aircraft Information									
Registration	ZT-YIR		Class	3A					
Make; Model; S/N	Mavic 2 Enterprise Advanced (Serial Number: MAV128)								
Damage to Aircraft	Substantial		Total UAS Hours	296.91					
Pilot-in-command									
Licence Type	Remote Pilot Certificate		Gender	Male	Age	28			
Licence Valid	Yes	Total Hours	91.9	Total Hours on Type	91.9				
Total Hours 30 days	75.2		Total Flying on Type Past 90 days	88.38					
People Controlling	1	**Injuries (On ground)**	0	**Fatalities**	0	**Fatalities (on ground)**	0		

What Happened

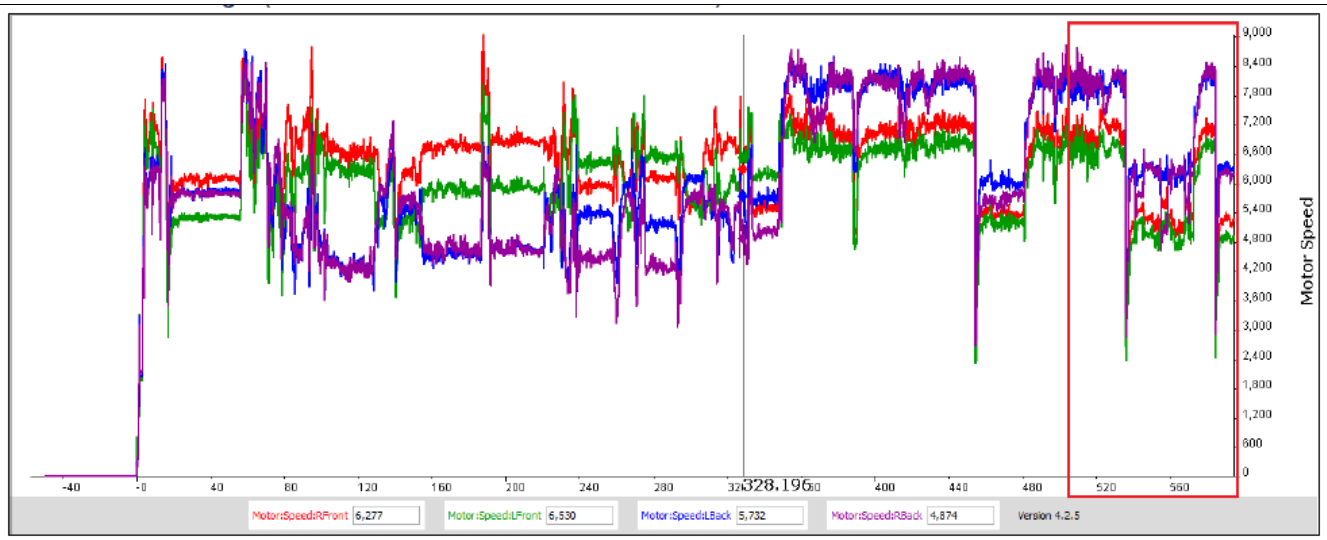
On 18 June 2023, an unmanned aircraft system (UAS) with registration ZT-YIR was launched for surveillance at Beatrix West Mine in Welkom, Free State province. The flight was conducted beyond visual line of sight (BVLOS) rules by night and under the provisions of Part 101 of the Civil Aviation Regulations (CAR) 2011 as amended.

The pilot reported that he had flown approximately ten (10) missions on the day of the accident, and during those missions, he experienced the battery depleting irregularly. The longest flight lasted approximately 18 minutes. The pilot armed the UAS for the eleventh (11) mission and ascended to a height of approximately 382.2 feet (ft) above ground level (AGL). The UAS took off with 100% battery power. Three (3) minutes into the flight and about 500 metres (m) after launch, the UAS had an “abnormal battery communication” warning. The abnormal battery communication warning continued intermittently for about seven (7) minutes and the pilot continued with his flight because there was still more than 50% battery available. Approximately ten (10) minutes into the flight, the UAS experienced multiple battery warnings and disconnected from the communication and command (C2) link. The UAS crashed approximately 1 kilometre (km) from the home location. Later, the pilot recovered the UAS which had sustained substantial damage.

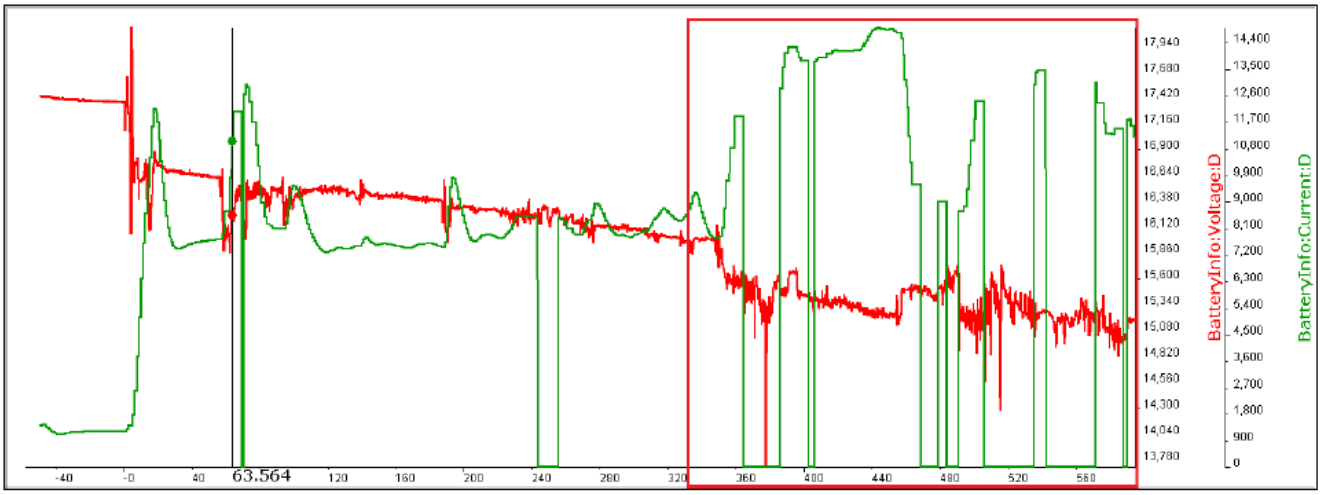
There were no injuries reported on the ground.

Figure 1: Aerial view of the accident site at Beatrix West Mine (Source: Pilot)

Figure 2: The UAS at the accident site. (Source: Pilot)



Graph 1: It is evident that the motor speed did not decrease at the end of the flight. (This indicates that the aircraft did not land, and disconnected mid-air.) (Source: Operator)



Graph 2: It is evident that the battery current (Green) dropped to zero multiple times. (This indicates that the battery terminals did not make proper contact.) (Source: Operator)

N	03m 36s	381.9 ft	336 m	Warning	Flight mode configuration: A/P/S. Current flight mode: P-GPS
O	03m 38s	381.9 ft	336 m	Warning	Recalibrate the Vision System. Use DJI Assistant on Mac or PC. Calibrate Vision Sensors with DJI Assistant on PC or Mac for higher accuracy
P	04m 04s	381.2 ft	417 m	Warning	The communication to the battery is abnormal. Please land as soon as possible and check if the battery is installed properly
	04m 51s	382.2 ft	407 m		80% Battery
Q	05m 59s	378.6 ft	557 m	Low Risk	⚠ High Wind Velocity. Fly with caution.
R	06m 06s	379.6 ft	488 m	Warning	The communication to the battery is abnormal. Please land as soon as possible and check if the battery is installed properly
S	06m 39s	379.6 ft	251 m	Low Risk	⚠ High Wind Velocity. Fly with caution.
T	06m 44s	379.6 ft	238 m	Warning	The communication to the battery is abnormal. Please land as soon as possible and check if the battery is installed properly
	06m 46s	379.9 ft	239 m		70% Battery
U	07m 50s	380.2 ft	382 m	Warning	The communication to the battery is abnormal. Please land as soon as possible and check if the battery is installed properly
V	08m 04s	380.6 ft	389 m	Warning	The communication to the battery is abnormal. Please land as soon as possible and check if the battery is installed properly
W	08m 10s	380.2 ft	425 m	Low Risk	⚠ High Wind Velocity. Fly with caution.
	08m 17s	380.2 ft	479 m		60% Battery
X	08m 26s	380.6 ft	551 m	Warning	The communication to the battery is abnormal. Please land as soon as possible and check if the battery is installed properly
Y	09m 04s	380.2 ft	786 m	Warning	The communication to the battery is abnormal. Please land as soon as possible and check if the battery is installed properly
Z	09m 34s	380.9 ft	788 m	Low Risk	⚠ High Wind Velocity. Fly with caution.
	09m 46s	381.2 ft	863 m		52% Battery at maximum distance
a	09m 48s	380.6 ft	863 m	Warning	The communication to the battery is abnormal. Please land as soon as possible and check if the battery is installed properly

Figure 3: The battery experienced an “abnormal battery communication” warning. (Source: Operator)

Sequence of Events

At 21:29 UTC: The pilot armed the aircraft and ascended to 382.2 ft AGL.
At 21:32 UTC: 3 minutes into the flight, the aircraft experienced an “abnormal battery communication” warning 500 metres from the home location.
At 21:39 UTC: 10 minutes into the flight at 800 metres from the home location, the aircraft disconnected from the C2 link.

Analysis

3.1 Findings

1. *The aircraft disconnected from the C2 link 10 minutes into the flight.*
2. *The aircraft experienced an “abnormal battery communication” warning.*
3. *The battery terminals were severely burned.*

Figure 4: Red circle shows the burnt battery terminals. (Source: Operator)

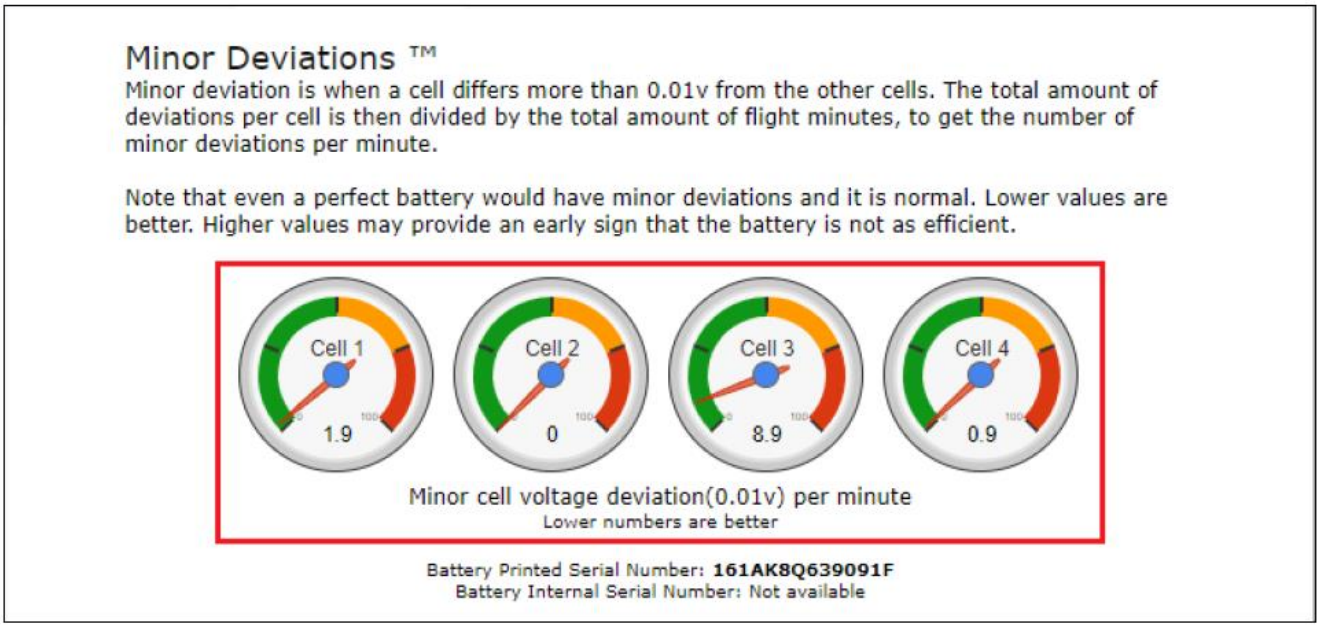


Figure 5: The battery did not have any cell damage. (Source: Operator)

Findings

1. The pilot was issued a Remote Pilot Licence (RPL) with visual line of sight (VLOS) ratings on 26 August 2022 with an expiry date of 31 August 2024. The pilot was issued a Remote Pilot Certificate (RPC) with VLOS, beyond visual line of sight (BVLOS) ratings and multirotor (MR) category on 16 May 2023 with an expiry date of 31 August 2024.
2. His Class 3 medical certificate was issued on 22 February 2022 with an expiry date of 29 February 2024 with no medical restrictions.

3. The remotely piloted aircraft systems maintenance technician (RMT) was initially issued a licence on 26 June 2021 with an expiry date of 20 June 2023.
4. The operator was issued a Remote Pilot Aircraft Systems Operating Certificate (ROC) on 31 October 2022 with an expiry date of 31 October 2023.
5. The UAS was initially issued a Remotely Piloted Aircraft Systems Letter of Approval (RLA) on 13 September 2022 with an expiry date of 12 September 2023.
6. The UAS was a class 3A and was approved to operate under BVLOS rules at a radius of 3.5km and at a height of 400 ft AGL.
7. The UAS's last inspection was conducted at 211.5 total hours. It accumulated a further 85.3 hours since the last mandatory periodic inspection (MPI).
8. The downloaded logs showed that the battery current dropped to zero multiple times, an indication that the battery terminals did not make proper contact.
9. The UAS battery did not have any cell damage, however, the battery terminals were severely burnt.

Probable Cause

The UAS disconnected from the C2 link due to a faulty battery failure warning as a result of burnt battery terminals, preventing proper contact to complete the circuit.

Contributing Factor(s)

None.

Safety Actions

The operator issued the following recommendations and possible mitigations:

1. Battery terminals should be cleaned on a regular basis.

2. Pilots should not fly with damaged batteries.

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
This report is produced without prejudice to the rights of the AIID, which are reserved.

This report is issued by:
Accident and Incident Investigations Division
South African Civil Aviation Authority
Republic of South Africa