SOUTH AFRICAN CIVIL AVIATION AUTHORITY

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

LIMITED OCCURRENCE INVESTIGATION REPORT – FINAL

Reference Number	CA18/3/2/1409					
Classification	Serious Incident	**Date**	28 February 2023		**Time**	2328Z
Type of Operation	Remotely Piloted Aircraft System – Aerial Survey (Part 101)					
Location						
Place of Departure	Paulpietersburg (Dumbe), KwaZulu-Natal Province		Place of Intended Landing		Paulpietersburg (Dumbe), KwaZulu-Natal Province	
Place of Occurrence	Near Paulpietersburg (Dumbe), Kwa Zulu Natal Province					
GPS Co-ordinates	Latitude	27° 27' 54" S	Longitude	030° 49' 55" E	Elevation	3773ft
Aircraft Information						
Registration	ZT-YPH					
Make; Model; S/N	DJI; Mavic 2 Enterprise (Serial Number: Mav112)					
Damage to Aircraft	None		Total Aircraft Hours	150.34		
Pilot-in-command						
Licence Type	Remote Pilot Licence (RPL)		Gender	Male	Age	32
Licence Valid	Yes	Total Hours	176.79	Total Hours on Type		176.79
Total Hours 30 Days	16.04		Total Flying on Type Past 90 Days	105		
People Controlling	1	**Injuries** 0	**Fatalities**	0	**Other (on ground)**	0

What Happened

On Tuesday morning, 28 February 2023, a remotely piloted aircraft (RPA) Mavic 2 Enterprise with registration ZT-YPH was engaged in an aerial survey at Paulpietersburg in Mpumalanga province when the serious incident occurred. Visual meteorological conditions (VMC) by night prevailed at the time of the flight. The flight was conducted beyond visual line of sight (BVLOS) rules and under the provisions of Part 101 of the Civil Aviation Regulations (CAR) 2011 as amended.

The pilot commenced the standard aerial survey operation at 2130Z for Transnet railway patrol after conducting pre-flight checks. He then performed four (4) successful aerial survey operations which lasted approximately 18 minutes each. On the fifth (5) flight at approximately 2315Z, he launched the RPA with 99% battery power and the RPA climbed to approximately 115 metres (m) above ground level (AGL). Once the RPA stability was maintained, the pilot continued with the flight to the intended area. Upon reaching the end of the area to be surveyed (turning point), the pilot began to fly the RPA back for a full-stop landing at the launch site. At approximately 2328Z as the RPA was on its return flight, the controller unit display screen blacked out, and the pilot immediately activated a return-to-home (RTH) button. However, the screen remained blank. A few moments later whilst scanning the area towards the RPA's direction, the pilot identified the RPA by its flashing navigational lights as it descended towards the ground.

The pilot made his way to the RPA's last known position but could not locate it. The search for the RPA was continued the next day, but it was still not found. Thirty (30) days after the incident (30 March 2023), the RPA was located by Transnet security personnel at a different location from which the initial search was conducted. The RPA was found not damaged.

The operator reported the meteorological conditions on the day of the incident as follows: wind direction: south-west; wind speed: 4kts gusting 9kts; visibility: clear; air temperature: 21°C. Also, caution was issued that the weather conditions were “not good to fly”.

Figure 1: Circle on the left indicate launch position and on the right it shows the accident site. (Source: Google)

Figure2: Mavic 2 Enterprise remotely piloted aircraft (RPA) type. (Source: Operator)

The information below is an extract from the Mavic 2 Enterprise User’s Manual:

The Remotely Piloted Aircraft

The DJI Mavic 2 Enterprise advanced drone is the latest commercial RPA with an advanced flight control system, featuring omnidirectional Vision System and Infrared Sensing System. It is constructed with a magnesium aluminium composite shell and carbon fibre arms that hold the motors and landing struts. During the flight, these arms are raised to allow unobstructed view from the camera that is suspended by the gimbal below the RPA. DJI technologies such as obstacle sensing and the advance pilot assistance system help to capture complex shots effortlessly. Additional features like the built-in air sense makes the pilot aware of their surrounding airspace, and password protection helps maintain secure access to aircraft and protect data. The RPA features a fully stabilized 3-axis gimbal camera that shoots 4k video, 12-megapixel photos, supports 2x optical zoom, 24-48 mm lens and supports filters.

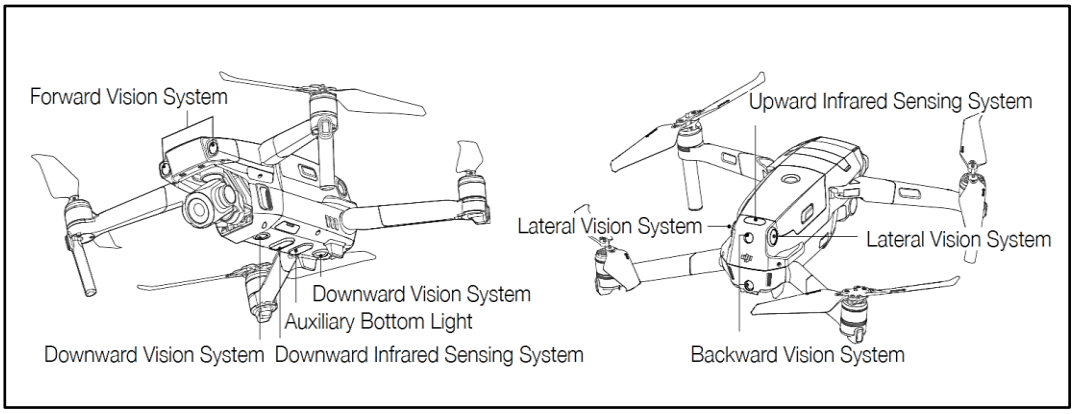

Diagram 1: An illustration of the DJI Mavic 2 Enterprise RPA. (Source: DJI Mavic 2 User Manual)

The RPA comprises several advanced flight functions including:

- *P-mode (Positioning) which works best when the GPS signal is strong. The aircraft utilizes GPS and the Vision System to locate itself to locate itself, stabilize and navigate between obstacles.*
- *S-mode (Sport): the obstacle sensing function is disabled, and the RPA uses GPS and vision system for positioning. The maximum flight speed is 44.7mph(72kph). The RPA cannot sense or avoid obstacle. Note: In S-mode, the RPA responses are optimized for agility and speed making it more responsive to stick movements.*
- *T-mode (Tripod): The mode is based on P-mode and the flight speed is limited, which makes the RPA more stable during shooting. The maximum flight speed, maximum ascend speed and maximum descend speed are 1m/s.,*
- *Return-to-Home (RTH), the function brings the RPA to the last recorded Home Point. There are three types of RTH namely Smart RTH, Low Battery RTH and Failsafe RTH. The accident RPA, with serial number MAV0037, had a maximum take-off weight (MTOW) of 1 100 kilograms (g). It also had a maximum flight time of 31 minutes with batteries fully charged. The RPA could be operated18 kilometres (km) away from the launch position.*

Built into the remote controller is DJI's long-range transmission technology OCUSYNC 2.0 offering a maximum transmission range of 6.2 miles (10km) and displaying video from the aircraft to DJI pilot on your mobile device at up to 1080pixel. The remote controller works at both 2.4GHz and 5.8GHz, and it can select the best transmission channel automatically without any latency. The RPA and camera can easily be controlled using the onboard buttons. An onboard LCD screen gives real-time RPA data information, and the detachable control

sticks make the remote controller easier to store. The maximum run time is 2 hours and 15 minutes. The Mavic 2 Enterprise boast a maximum flight speed of 44.7 mph and a maximum flight time of 31minutes. The maximum flight time was tested in an environment with no wind while flying at a consistent speed of 15.5mph (25kph) at sea level altitude. (Note: These values are for reference only). The remote controller reaches its maximum transmission distance (FCC) in a wide-open area with no electromagnetic interference at an altitude of about 400feet(ft) (120m) above ground level (AGL). The remote controller uses its own separate battery source. To check the power level, an operator is required to press the power button once to check the current battery level. Press once and then again and hold to turn on/off the remote controller. The battery has a capacity of 3950mAh and a maximum run time of 2 hours and 15minutes. The remote controller is equipped with a LCD Screen that displays various system statuses including real-time flight telemetry and battery levels.

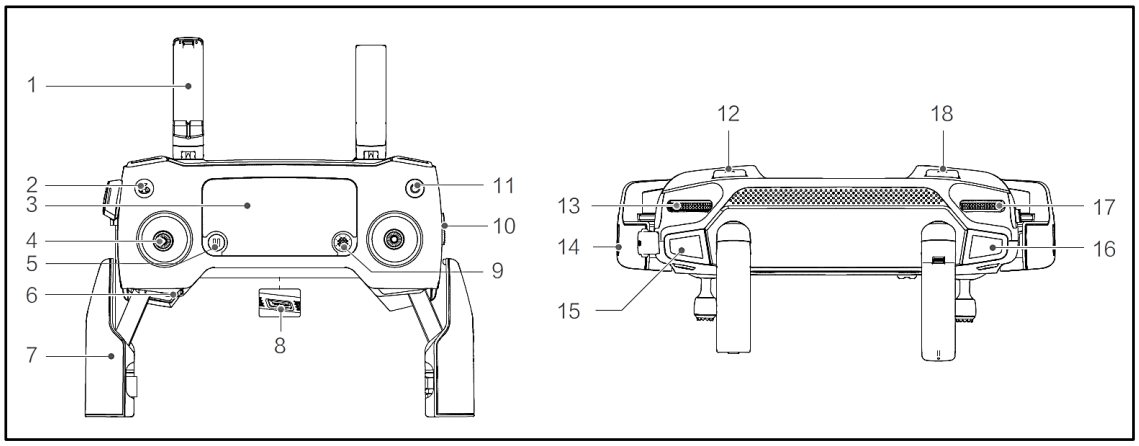

Diagram 1: Schematic of the remote controller.

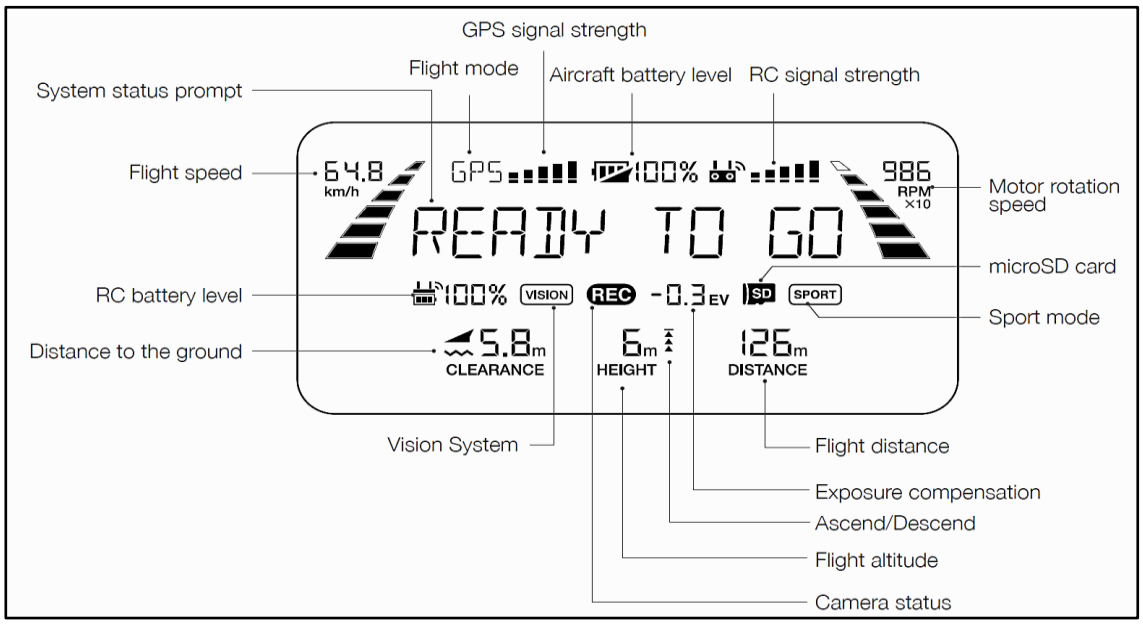

Diagram 2: The LCD screen display.

According to the operator, post-incident investigation revealed that the remote controller unit's battery depleted during operation, hence, the blacked out screen.

The information below is an extract from the RPA User Manual.

Failsafe (RTH) Return-to-Home function

The forward vision system allows the RPA to create a real time map of its flight route as it flies. If the Home Point was successfully recovered and the compass is functioning normally, Failsafe RTH automatically activates after the remote-control signal is lost more than two (2) seconds. When Failsafe RTH is activated, the RPA starts to retrace its original flight route home. If the remote-control signal is re-established within 60 seconds of failsafe RTH being activated, the RPA hovers at its present location for 10 seconds and waits for pilot commands. The user may press the RTH button on the remote controller to cancel Failsafe RTH and retake control. If no pilot command is given, the RPA flies to the Home Point in a straight line. If the remote-control signal is still lost 60 seconds after activating Failsafe RTH, the RPA stops retracing its original flight route and flies to Home Point in a straight line.

Note: The remote controller will unlink itself from an RPA if a new remote controller links to the same RPA.

- *Fully charge the remote controller before each flight.*
- *If the remote controller is powered on and is not in use for five minutes, an alert will sound.*
- *After 10 minutes, it will automatically power off. Move the sticks to cancel the alert.*
- *Adjust the mobile device clamp to ensure the mobile device is secure.*
- *Ensure the antennas of the remote controller are unfolded and adjusted to the proper position to achieve optimal transmission quality.*
- *Repair or replace the remote controller if damaged. A damaged remote controller antenna greatly decreases performance.*
- *Fully charge the battery at least once every three months to maintain health.*
- *Ensure the control stick is mounted securely.*

Findings

1. The pilot was issued a Remote Pilot Licence by the Regulator (SACAA) on 10 November 2022 with an expiry date of 30 June 2024. The pilot's Class 3 medical certificate was issued on 7 December 2021 with an expiry date of 31 December 2026. The pilot had a visual line of site (VLOS) and beyond visual line of site (BVLOS) multirotor (MR) ratings endorsed on his licence.

2. The operator was issued a Remotely Piloted Aircraft System Letter of Approval (ROA) by the Regulator on 22 September 2022 at 0.5 hours with an expiry date of 21 September 2023. The last periodic maintenance conducted on the RPA was carried out on 4 February 2023 at 106.17 hours. The RPA's Certificate of Registration was issued by the Regulator on 24 August 2022.

3. The RPA was maintained by an approved person (AP) with a Remote Maintenance Technician (RMT) certificate that was issued by the Regulator on 20 September 2022 with an expiry date of 3 September 2024.

4. The operator had a valid Remotely Piloted Aircraft Operating Certificate (ROC) that was issued by the Regulator on 31 October 2022 with an expiry date of 31 October 2023. The ROC had the RPA type and operation specifications endorsed on it with validity from 10 November 2022 to 30 November 2023.

5. According to the pilot, after the RPA reached the end of the area to be surveyed (turning point) approximately 13 minutes into the flight and whilst returning to home position for a full stop landing, the RPA screen blacked out. The pilot identified the RPA by its flashing navigational lights as it descended to the ground. A post-investigation conducted by the operator on the remote controller (RC) revealed that the battery depleted during operation, which led to the remote controller unit transmission disconnecting and the screen blacked out. According to the RPA User Manual, the remote controller unit battery requires charging during flight or before each flight. The RPA's User Manual also states that a failsafe RTH automatically activates after the remote controller unit signal is lost for more than two (2) seconds. When the failsafe RTH is activated, the RPA retraces its original flight route to home position. If the RTH option is disabled, the RPA lands immediately.

6. Following the controller unit disconnection, the pilot made his way to the last known location but could not locate it. The search was continued the next day with no success. The RPA was found 30 days later in the vicinity of its operation and in good condition.

   It is evident that the pilot might have misjudged the position where the RPA descended to the ground (place of incident). It is likely that the RTH function was disengaged when the RPA signal was lost. The RPA landed safely as per the pilot's observation; however, he misjudged the place of the incident, and the search was initiated at an incorrect location.

7. According to the weather report, the prevailing conditions were not conducive for a safe flight operation; however, the weather is likely to have contributed to the battery power depleting too fast. The RPA would then require more battery power to propel against the head winds.

8. The RPA was operated with low battery in the remote controller unit, and the battery depleted during operation. Following the control signal disconnection, the RPA landed immediately as the RTH function was disabled.

Probable Cause

The RPA landed immediately from its position following a disconnection from the remote controller unit. Both the remote controller unit and the RPA batteries depleted during operation.

Contributing Factor(s)

Strong weather conditions are likely to have contributed to battery power to deplete faster than under normal favourable weather conditions.

Safety Action(s)

None.

Safety Message and/or Safety Recommendation/s

Pilots should ensure sufficient battery power during operation for both the remote controller unit and the RPA.

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