

ACCIDENT

Aircraft Type and Registration:	DJI Mavic 2 Enterprise Zoom	
No & Type of Engines:	4 DJI electric engines	
Year of Manufacture:	Unknown (Serial no: 276DFB5001QU7B)	
Date & Time (UTC):	5 December 2022 at 1430 hrs	
Location:	Garstang, Lancashire	
Type of Flight:	Commercial Operations (UAS)	
Persons on Board:	Crew - N/A	Passengers - N/A
Injuries:	Crew - N/A	Passengers - N/A
Nature of Damage:	Damage to propellers and body	
Commander's Licence:	Other	
Commander's Age:	50 years	
Commander's Flying Experience:	257 hours (of which 35 were on type) Last 90 days - 26 hours Last 28 days - 9 hours	
Information Source:	Aircraft Accident Report Form submitted by the pilot	

Synopsis

During an aerial survey flight, the UAS detected a rapid loss of battery power and initiated an immediate automatic landing. Whilst descending, its flight behaviour became erratic, control was lost to the remote pilot, and the UA struck an uninvolved person before hitting the ground. It was not possible to determine a cause for the loss of battery power or the flight behaviour. There may have been an opportunity during flight control checks to consider unexpected battery discharge rate as a reason to abort the flight.

History of the flight

The UAS was planned to fly as part of a survey to monitor progress on a construction site, to take images along the front and across the site within the property boundaries agreed with the client. Weather conditions on the day were good visibility, low winds and moderate temperature.

The flight started from a location towards the rear of the construction site, approximately 300 m from the site frontage. The remote pilot then flew the UA to approximately head-height and completed flight control checks, where the battery indicator showed 95% but rapidly dropped to 88%. The pilot continued, manually flying the aircraft at a height of 50 - 60 m over the construction site towards a point approximately 50 m from the site frontage to record the imagery.

The pilot received a CRITICALLY LOW – LANDING battery notification and the UA initiated automatic landing¹.

The UA was observed to fly in an erratic manner, and the pilot stated he had limited lateral control available to enable him to fly it into a clear area. It came close to houses under construction and stopped responding to control inputs. The pilot described it as then “appearing to descend too fast, despite the propellers spinning”, before going out of sight behind some construction materials. The UA struck a site worker on their arm, dropped into some cement, and fell to the ground. The site worker was not injured.



Figure 1

UA after falling to the ground

Aircraft information

The DJI Mavic 2 Enterprise Zoom is a commercially available UAS. It comprises a UA with maximum take-off weight of 1100g, and a handheld control unit. The UA is fitted with a battery unit which has an integral charge level indicator.

Battery management

The UA was fitted with a battery that had been fully charged for the flight. It can be set up to notify the pilot with an alert at pre-set battery charge levels. This UA was configured to provide alerts for LOW BATTERY at 30%, and CRITICALLY LOW BATTERY at 20% power remaining. A battery level of 30% is intended to have enough power left for the aircraft to Return to Home (RTH) to the last recorded Home Point. However, the aircraft also self-determines whether the battery level is sufficient to RTH based upon position information, meaning that a RTH notification and action can occur independently from pre-set battery level warnings.

Footnote

¹ The aircraft will land automatically if the current battery level can only support the aircraft long enough to descend from its current altitude. The user cannot cancel the auto landing but can use the remote controller to alter the aircraft's orientation during the landing process. (Mavic 2 Enterprise Series User Manual v1.8)

When a CRITICALLY LOW BATTERY level alert is triggered, the UA will land after 10 seconds, or immediately if deemed to be an extremely critically low² battery level. Both actions cannot be cancelled by the pilot, but limited directional control should remain available for hazard avoidance.

The aircraft did not notify the pilot of low battery at 30% remaining, only CRITICALLY LOW – LANDING immediately before descending. Control of the aircraft was lost to the pilot and he was unable to avoid hazards despite applying control inputs.

Batteries for this aircraft have a manufacturer's rating of 200 cycles³; this battery had 43 recorded cycles. The operator normally replaces batteries at 100 recorded cycles.

Aircraft examination

The UA was sent to an authorised repair facility for assessment. No discrepancies could be found with the battery condition, and the battery's integral charge level indicator showed 50-75% charge. The battery appeared to have been seated correctly and no physical defects were found with the UA that could have caused the loss of control.

The flight log was analysed post-flight but there was no data that showed a loss of power or flight control.

UAS Operation Regulations

UAS operations within UK airspace are legislated by three main pieces of regulation⁴ alongside UK CAA policy and guidance *UK CAA CAP722 Unmanned Aircraft System Operations in UK*. Flight operations are further categorised using a risk-based approach and the incident flight was being operated within the 'Specific' category where the UAS operator is subject to additional oversight by the CAA due to a higher level of risk associated with the operations. To comply with the additional oversight, the operator of this UA had an operations manual⁵ and was issued with a CAA operational authorisation for Pre-Defined Risk Assessment (PDRA) UKPDRA01 which enables Visual Line of Sight (VLOS) operations within 150 m of any residential, commercial, industrial or recreational areas for UAS with a Maximum Take-Off Mass of less than 25 kg. The operator was also the remote pilot, and he held a valid Operation Authorisation - Permission for Commercial Operations (PfCO).

Regarding operational conditions and limitations of safe distances between the UA and people, structures, and objects, UKPDRA01 states:

'No flight within 50 metres of any uninvolved person⁶, except that during take-off and landing this distance may be reduced to 30 metres. Any overflight of uninvolved people must be kept to a minimum.'

Footnote

² Less than 6% battery charge (Mavic 2 Enterprise Series User Manual v1.8).

³ Mavic 2 Enterprise Series Disclaimer and Safety Guidelines v1.6, dated 01/2021.

⁴ Regulation (EU) 2019/947, Regulation (EU) 2019/945, The Air Navigation Order (ANO) 2016.

⁵ Operations Manual, Version 4.6, dated 31/01/2022.

⁶ An uninvolved person is someone not directly under control of the UA pilot, as defined within CAP722 and ANO 2016.

The operator's operations manual sets out flight parameters and safe operating distances from people, property and hazards in accordance with CAA CAP722 and UKPDRA01. The flight was planned to operate within these restrictions and a pre-flight plan and risk assessment were carried out by the pilot. The construction worker who was struck by the UA was not under the control of the remote pilot and was classed as an 'uninvolved person'.

Analysis

The flight was planned in accordance with applicable regulation and guidance for safe distances between the UA and uninvolved people and structures. Due to the erratic flight behaviour of the UA during its automatic landing, coupled with loss of flight control, the UA subsequently breached the required safe distances and then struck the construction worker.

The battery was fully charged prior to the flight, was within the manufacturer's recommended number of cycles, and no defects were found to have affected its charge. During flight the battery percentage detected by the UAS dropped at an unexpectedly high rate that resulted in an automatic landing without notifying the pilot at the pre-set charge thresholds.

The first indication of an abnormal battery discharge rate was during flight control checks. The pilot chose to continue with the planned flight as it would have been achievable using the indicated 88% battery level. Subsequently, the UAS continued to detect a high discharge rate which triggered the automatic landing.

After the flight the battery integral charge level indicator showed 50-75% charge. It was not possible to determine the difference between this charge level and the battery power displayed on the handheld controller during the flight. Flight log data did not explain the discrepancy in battery level.

Discussion

The UAS measured a high loss of battery power in a short space of time, leading to an uncontrolled landing where the distance between the UA and uninvolved people and structures was compromised. This sequence of events resulted in the UA striking an uninvolved person. It was not possible to determine a cause of the UA's detecting a loss of battery power or its flight behaviour.

Whilst the displayed level of power remaining was sufficient for the planned flight, there may have been an opportunity during flight control checks for the pilot to consider the abnormal battery discharge rate was likely to continue, and to abort the flight.