ACCIDENT

Aircraft Type and Registration:	Aeryon Skyranger R60, (UAS) SR9112798
No & Type of Engines:	4 Electric - engines
Year of Manufacture:	(Serial no: SR9112798)
Date & Time (UTC):	18 January 2018 at 0330 hrs
Location:	Brixton, London
Type of Flight:	Aerial Work
Persons on Board:	Crew - N/A Passengers - N/A
Injuries:	Crew - N/A Passengers - N/A
Nature of Damage:	Unmanned aircraft destroyed
Commander's Licence:	CAA Permission
Commander's Age:	33 years
Commander's Flying Experience:	n/k hours (of which n/k were on type)[1] Last 90 days - 4 hours Last 28 days - 2 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and further information provided by the operator and manufacturer

Synopsis

After takeoff the unmanned aircraft (UA) experienced winds exceeding the manufacturer's stated limitations and was unable to hold its position position. A culmination of the subsequent position warning and automatic attempt to return "home" and land triggered a software error, commanding the UA to land while not over its home position. As the UA descended there was a loss of link with the ground control unit and the UA collided with a tree. The loss of signal was probably caused by the loss of radio line of sight between the UA and ground control unit when it drifted in the high wind over a five-storey building.

History of the flight

The UA was being operated in a built-up area at night, with appropriate authorization from the CAA. It was carrying a camera and was being operated by a pilot and observer. Prior to the flight, an inspection of the area was carried out to identify suitable takeoff and landing sites and to check for any local hazards. A check of the UAS was also completed with no faults identified.

Footnote

[1] The actual hours have not been determined but the pilot was reported to be inexperienced, both on UAS and on type.

Flight settings were loaded into the ground control unit, with a programmed maximum operating height of 121 m. The pilot stated he then lifted the UA into a 1.5m hover to complete calibration and safety checks, which all proved satisfactory. The UA was then climbed towards its planned operational height, but as it reached a height of about 50m it started to drift and the ground control unit displayed a 'Strong Winds [N10]' message[2]. The ground control unit also displayed two options for the pilot: 'Home and Land' and 'Ignore'. The pilot did not select either option. The UA, unable to hold position, then drifted out of sight over an adjacent five-storey building, generating a 'Position Control Warning'.

The pilot realised the UA was not following the intended flight track and changed position in an attempt to see the UA again, but without success. The ground control unit then indicated a loss of control signal. The UA camera image was lost and the control screen switched to the home screen, with no apparent connection indicated with the UA. The UA did not return to the pre-programmed home position (the takeoff point) and a search of the local area revealed the UA had impacted the ground about 30 m from the take-off site, breaking into several pieces.

Recorded information

Flight data stored on the UA's internal storage card could not be recovered due to damage sustained to the card in the impact. The flight logs recorded on the ground control unit, and video recorded to the video storage card, were however recovered. These indicated that after the control link was lost, the UA went through a number of direction and height changes before descending and impacting a tree top at a height of approximately 15 m, then falling to the ground.

UAS software information

The UAS comprised a Skyranger R60 quadcopter, controlled by a Panasonic Toughpad FZ-G1 ground control unit with an integrated Aeryon joystick controller. The system was loaded with software Version 3.6.14.54767 but on 23 December 2016 the manufacturer became aware it contained an error. The error only became evident when a 'non-fatal' message[3] was generated and the UA became unable to hold position. As a result of the pilot not selecting either the 'Home and Land' or 'Ignore' options after the strong wind message, the UAS had automatically entered the 'return home' mode. The error however resulted in the UA considering it was over its home position, regardless of its actual location, and landing. A software fix was completed on 6 June 2017, but this was not made available until the manufacturer's software Version 3.7 was released on 8 January 2018. The manufacturer was aware of only one other incidence of the error occurring operationally and believed the conditions required to trigger it were sufficiently rare that the delay would not pose an undue risk to operators.

Footnote

[2] Message displays in winds in excess of 45km/hr.

[3] Prompts to the pilot to either alter or terminate the flight when the UA encounters certain conditions, such as strong winds.

Operators had to either subscribe to an online system to receive software updates or receive these through the relevant reseller. The reseller of the UAS involved in the accident was no longer representing the manufacturer when the software update was released. In addition, the operator of the UAS involved in the accident was not its owner. The operator reported that it did not have access to the manufacturer's online service, although the manufacturer stated that the operator had an access account at the time of the accident. Nevertheless, the operator was not aware of the issue with the software, nor that there was an update available, and as a consequence Version 3.7 had not been installed.

Aircraft performance

The UAS operator's manual states that it can operate in sustained wind speeds of up to 65 km/hr (35 kt) and gusts of 90 km/hr (48 kt).

Meteorology

Forecasts for London City, Heathrow and Gatwick Airports indicated the risk of strong south-westerly winds at the time of the intended UAS flight, along with a risk of rain. The nearest airfield to Brixton that had a valid TAF at the time of the incident was London City and the TAF issued at 0306 hrs gave a risk of winds blowing from the west at 25-30 kt with gusts of 40-50 kt from 0300 hrs until 0800 hrs.

Actual conditions gave wind speeds generally increasing through the morning in the London area. London City produced METARs at the time of the incident, and at 0320 hrs the wind was from 250° at 30 kt mean with gusts of 47 kt. At Heathrow, the second closest airfield to Brixton, at 0320 hrs the wind was from 260° at 31 kt with gusts of 45 kt. Finally, at Gatwick at 0320 hrs the wind was from 240° at 17 kt with gusts of 29 kt.

The pilot and observer used the Gatwick TAF and a weather app to obtain wind speeds in planning the flight. Both provided only forecast data. The app-predicted wind speed at the time of the flight was 42 km/hr (22 kt) with gusts of 77 km/hr (41 kt) at ground level.

The UAS also recorded the wind speed experienced by the UA. This indicated that sustained wind speeds in excess of 65 km/hr were experienced approximately 75 seconds into the flight for about 20 seconds.

Personnel

Both the pilot and observer had received training on the Skyranger R60 and been issued with the appropriate permission by a CAA National Qualified Entity. They were however relatively inexperienced at operating UAS at the time of the accident.

Analysis

The pilot and observer were aware of the difficult weather conditions at the time of operation, but the sources of weather information they were relying on indicated the conditions were within the capability of the UAS. These sources provided, however, only forecast conditions and the actual conditions were somewhat different. In particular, it was not apparent to the operator that the app they were using was providing forecast, rather than the actual, conditions at the time. Had they reviewed the actual wind conditions reported by Heathrow and London City Airports they would have realised the conditions were marginal for the UAS to be operating.

The data recovered from the UA indicate that after takeoff, when the UA left the shelter of the surrounding buildings, it experienced wind speeds above its design limit and was unable to hold position.

Whilst it has not been possible to eliminate a technical failure, due to the damage sustained by the UA in the impact, the most probable cause of the loss of link between the UA and the ground station just after the wind warning occurred was the fact it drifted out of radio line of sight. Whilst the low height at which the UA was blown over the building contributed to the attenuation of the radio signal, the siting of the ground station and the height and proximity of the building would still have provided a potential issue in maintaining a strong signal between the ground station and UA had it achieved its proposed operating height.

Having lost its ability to hold position, with no command made by the pilot in response, the UA should have attempted to return to its home position, which in the strong winds would have proved difficult. The combination of the wind and position warnings, with the return home function triggered, caused the software error to make the UA attempt to land immediately, rather than to return to the home position in order to do so. The UA descending contributed to the loss of signal, after which the UA was committed to try and land, resulting in the collision with the tree and the subsequent impact with the ground. Had the UA remained in visual line of sight, not only should it have been obvious to the pilot what the UA was doing, but he should have had the ability to take over manually to try and return the UA to the home position or find an alternative safe place to land.

The manufacturer had taken six months to provide a software fix to the problem and a further six months to release it. The delay in doing so was due to the consideration by the manufacturer that the failure was unlikely to occur, and by inference was not critical to the safe operation of the UAS. The delay was further compounded by the fact the operator was not aware of the software problem or the fact that an update existed. As the UAS was not required to be certified, due to its low weight, there was no oversight of these aspects by the relevant authorities.

Safety actions

As a result of the accident, the operator carried out a comprehensive review of their procedures as well as liaising with the manufacturer on the technical aspects of the accident. As a result, the operator has introduced a number of safety actions. These include:

- Ensuring software checks and updates are integrated into the maintenance procedures.

- Ensuring at least one member of the operating team is experienced in operating the system and introducing a mentoring scheme to provide opportunities to increase experience levels with appropriate oversight.
- Providing information on the most appropriate sources of weather information to be used in planning and operating flights and ensuring these take into account actual, as well as forecast, weather conditions.
- Providing pilots and observers with training on weather effects experienced in a built-up environment, especially related to wind.
- Introducing reduced wind limits on the operation of UAS to allow a safety factor, mitigating the risk of exceeding the limits. These will also be varied to take account of each pilot's experience.
- Revised training on the assessment of ground station transmitter siting to minimise the likelihood of signal loss.
- Review of incident and accident reporting procedures.

Comment

This accident demonstrates some of the issues associated with this emerging technology. New operators with little, or no, previous aviation experience are still developing procedures whilst operating small UAS which do not require certification due to their relatively low weight. The combination presents a challenge which operators, manufacturers and regulators will continually need to monitor and develop to ensure the safe operation of this expanding area of aviation.