Accident

Aircraft Type and Registration:	Phoenix Wings Orca
No & Type of Engines:	8 electric motors
Year of Manufacture:	2024 (Serial no: PW54)
Date & Time (UTC):	25 March 2025 at 1450 hrs
Location:	Coombe Country Park, Warwickshire
Type of Flight:	Commercial Operations (UAS)
Persons on Board:	Crew - None Passengers - None
Injuries:	Crew - N/A Passengers - N/A
Nature of Damage:	Damaged beyond economic repair
Commander's Licence:	Other
Commander's Age:	23 years
Commander's Flying Experience:	85 hours (of which 5 were on type) Last 90 days - 16 hours Last 28 days - 7 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

The aircraft struck the ground in a wooded area whilst on approach to land at a site adjacent to Coventry Hospital. The accident occurred during the sixth consecutive flight, which was in preparation for demonstrating the aircraft being operated in accordance with the operator's Beyond Visual Line Of Sight with Visual Mitigations (BVLOS VM) authorisation.

The cause of the accident was identified as a software bug in combination with a loss of synchronisation between the Remote Pilot (RP) and the Safety Remote Pilot (SRP), whereby the SRP's hand controller had remained set to the DISARM position when the aircraft had taken off. When the aircraft came within range of the SRP's controller, this resulted in power being removed from the aircraft's electric propulsion motors, leading to the aircraft stalling, its emergency parachute system being disabled, and a subsequent uncontrolled descent from a height of 60 m.

History of the flight

A number of flights were being flown a total distance of about 1.5 nm between a farm and a field adjacent to Coventry Hospital (Figure 1). These were being performed in preparation for a BVLOS VM demonstration flight.

The flight crew consisted of a Remote Pilot (RP), Safety Remote Pilot (SRP), Pad Manager (PM), Visual Observer (VO)[1] and an Emergency Response Team (ERP). The PM was located at the farm site and had a handheld controller that allowed the aircraft to take off and land. The SRP was at the hospital landing site and had a remote controller that provided the ability to take manual flight control of the aircraft, arm and disarm it and also terminate flight in the event of an emergency (refer to the aircraft information section for further detail). The RP was at the operator's facility some miles away and was using a PC-based ground control station to control the aircraft, with the VO located about midway between the two sites and the ERP collocated with the SRP (Figure 1).

Coordination between the flight crew was made using two-way radios, with the control settings of the RP and SRP controllers being manually synchronised by each pilot, so that the aircraft was appropriately armed in preparation for flight and disarmed (shutdown) after each landing.

Five flights were successfully flown over the period of about an hour and, having completed the ground checks at the farm site, the aircraft took off to fly back to the hospital landing site. The aircraft climbed vertically to a height of about 50 m agl before transitioning to forward flight where it then climbed to its cruise height of 60 m agl. The aircraft's takeoff weight was 38.9 kg.

The aircraft was observed to follow the planned flight profile but as it approached approximately the halfway point the aircraft's motors suddenly stopped. The aircraft initially maintained altitude but subsequently stalled, before descending quickly and striking the ground within a wooded area (Figure 1). No persons were injured and there was no damage to property; the aircraft was damaged beyond repair.

The RP, SRP and PM reported that they had not made any selections on their respective controllers in the period before the aircraft departed from controlled flight.

Footnote

[1] The VO is a designated person who assists the pilot during BVLOS flights. The VO's primary responsibility is to maintain visual contact with the aircraft and its surroundings, alerting the remote pilot who may not be able to observe the aircraft to any potential hazards or conflicts. The VO provides the visual mitigations required by the BVLOS VM authorisation.

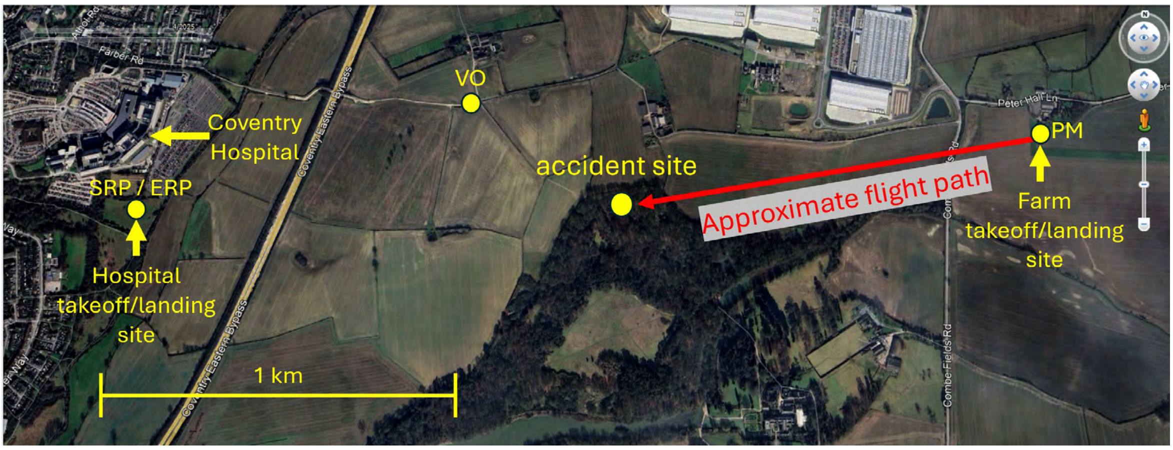

Figure 1

Relative position of takeoff, landing and accident sites
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Accident site

The aircraft struck the ground in a wooded area (Figure 2) which was accessible to the public. Approximately 250 m from the accident site was an outdoor activity centre.

Figure 2

Aircraft wreckage

Aircraft information

The aircraft (Figure 3) is an unmanned, electrically powered vertical takeoff and landing aircraft. It is equipped with eight propulsion motors. Six motors are installed under the wings, and these provide vertical takeoff and landing capability. Two motors are mounted at the front of the wings that provide propulsion during forward flight. The MTOW of the aircraft is 52 kg with a cruise speed of 60 kt and maximum range of 54 nm.

The aircraft is controlled remotely from a ground control station, and by an optional SRP controller. The ground control station to aircraft communications system provides uninterrupted signals that enable the aircraft to be operated BVLOS. The signals between the SRP controller and aircraft are limited by range and line of sight.

At the time of report publication, 26 aircraft have been manufactured, of which 20 remain in operational service. The accident aircraft had accumulated a total of 13 hours and 59 minutes flight time and had completed 119 flights prior to the accident. This was the first accident involving this type.

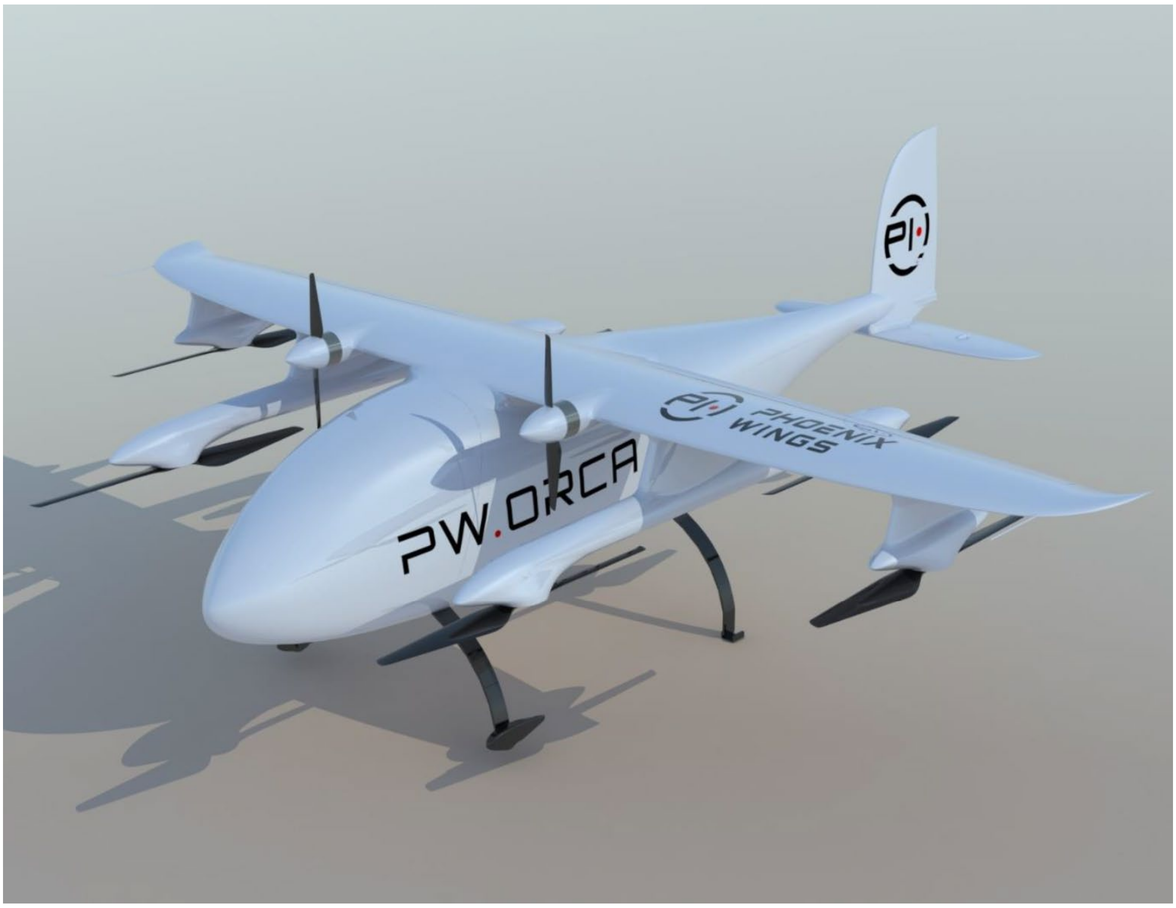

Figure 3

PW Orca
(used with permission)

Flight termination system (FTS)

The aircraft is equipped with a FTS which, when activated, removes power from its electric propulsion motors and deploys the parachute[2]. The ailerons also move to place the aircraft into a spin, which is intended to quickly reduce any forward movement of the aircraft as it descends. This system can bring the aircraft safely to the ground at a controlled rate in the event of an emergency. The aircraft manufacturer's minimum deployable height for the parachute to be fully effective is 60 m above the ground[3].

The FTS activates automatically if the aircraft's descent rate exceeds 2,000 fpm, or it can be manually triggered by selection of a TERMINATE push button on the RP ground station or switch on the SRP controller (Figure 4).

Arm and disarm function

The arm and disarm function applied or removed power to the electric propulsion motors respectively and enabled or disabled remote control of the aircraft. Upon landing the aircraft was designed to automatically disarm itself, enabling it to be safely approached by ground personnel. The design of the system also allowed the aircraft to be manually disarmed when in flight or on the ground.

The manufacturer advised that the ability to manually disarm the aircraft was provided as it was possible after an abnormal landing, a failed takeoff or entanglement on the ground that the aircraft may not always automatically disarm. It was envisaged that the manual disarm function would only be used when the aircraft was close to, or on the ground.

The aircraft is fitted with two physical switches that enable its hardware (power made available to motors and control systems) to be armed or disarmed. Once the hardware was armed, the aircraft's control software could then be armed and capable of responding to remote commands from the RP, SRP and PM controllers. It could be disarmed using a press and hold switch on the RP ground control station or by selection of a toggle switch on the SRP controller (Figure 4).

Footnote

2 The parachute manufacturer refers to the model fitted to the aircraft as a 'Tough G2 parachute system'.
3 The parachute manufacturer specified that the minimum height was 40 m, but the aircraft manufacturer provided an additional safety margin to take account of the vertical and horizontal velocity of the aircraft and time to fully deploy the parachute.

Figure 4

RP controller showing DISARM and ARM switch

The manufacturer had considered the scenario of the aircraft being in flight and the SRP controller being inadvertently set to the DISARM position when the aircraft came within range of the controller. To prevent the inadvertent in-flight shutdown of the aircraft, the system was intended so that it should require the received signal to change state from DISARM to ARM and then back to DISARM before it would respond. A description of the operation of the SRP controller arm/disarm switch was provided in the manufacturer's Flight and Ground Control Technical Manual (Figure 5).

Function	Label	Description
Arming switch	DISARM/ ARM	UP: Disarm DOWN: • Allow arming by PW.GCA or PW.PMA (when in AUTO) • Arm (when in MANUAL) The arming switch is a secure switch, meaning it can only be switched if it is pulled out at the same time. The switch only reacts to intentional changes. The current state is shown in PW.GCA and changes to the state are announced by audio message. When the aircraft is flying in AUTO, all switches except for the arming, manual override and flight termination switches are ineffective. The arming switch allows disarming of the aircraft by switching it from ARM to DISARM at **any time**. When in DISARM, the switch prevents software arming. This is also communicated by a warning message in PW.GCA. When in AUTO, switching to ARM only means that arming is now possible through PW.GCA. Also, if it is a mission with a take-off by PW.PMA, only now the aircraft starts asking for a clearance for take-off. To arm manually, the following settings must be established prior to switching the arming switch to ARM: • remote control is turned ON and the connection is good (Connection indication with bars on display) • throttle LOW • configuration switch COPTER • manual override switch MANUAL Turning on VLOS Pilot Remote Control while flying: If the arming switch is in DISARM before the transmitter connects to the aircraft, the aircraft won't disarm, since it only reacts to intentional changes of switches when the VLOS Pilot Remote Control is connected.

Figure 5

Arm/disarm switch function
(Dated 23 April 2025 Revision 1.4)

The manual also included text (emphasised in red) to draw particular attention to the operation of the aircraft in response to SRP controller selections (Figure 6).

Important: **Reaction to all switches is based on changes to the switch, not on the current state of the switch. There is one exception: The control mode switch is absolute, so its position directly dictates the mode the aircraft will be in, when flying manual.**

- This is to ensure that the switch command is intentional
- It might be needed to cycle a switch to another position and back, if the switch is already in the position of the command to be sent
- It is recommended that the VLOS pilot follows the aircraft's current state with the switches while it is flying automatically, so that in case of a manual take over, every switch action has an effect right away without the need for a switch cycle
- It is recommended to use control mode VEL for manual flying, since it is more stabilized and keeps altitude when throttle is at center
- Control mode ATT shall only be used in case of the unavailability of GNSS
- When the aircraft is flying in AUTO, all switches except for the arming switch and the manual override switch are ineffective
- Check VOLUME knob when turning on device, so audio warnings are noticeable

Figure 6

SRP controller switch operation
(Dated 23 April 2025 Revision 1.4)

After the accident, the aircraft manufacturer confirmed to the operator that if the aircraft was disarmed in flight that the FTS would also be disabled; this information was included in the aircraft's technical manual provided to the operator within the section concerning the operation of the parachute system which stated:

> *'The Tough [G]2 is unlocked and locked automatically when the aircraft is armed and disarmed with the hardware arming switches. Furthermore, all parachute activation conditions of the Tough G2 are only enabled when the aircraft is armed by software.'*

The aircraft operator stated that it had not appreciated that the FTS would be disabled in flight if the aircraft was disarmed and noted that, unlike the SRP control selections in the technical manual, the statement about the parachute arming was not similarly emphasised to draw attention to it. The operator considered the ability to disarm the aircraft in flight to pose a safety hazard and subsequently requested the manufacturer to remove this capability.

Recorded information

Recorded data was available from onboard the aircraft and the RP ground control station. The onboard data included the control signals received from the RP station. It also included those from the SRP controller[4] but only when it was in range. The SRP controller does not record any data.

Footnote

[4] The remote pilot ground station uses a command-and-control signal (C2) which is designed to provide a permanent connection with the aircraft. The remote safety pilot controller uses a 2.4 GHz radio frequency signal that will lose connection when the aircraft is either out of range or the signal is masked by terrain features or structures.

The data showed that during the flight prior to the accident, the SRP controller was correctly set to the ARM position. This signal was recorded by the aircraft for about 90 seconds until it moved out of range of the SRP controller and communication was lost. About 80 seconds later, the aircraft landed at the farm site, where the PM replaced the aircraft's battery pack. The aircraft then took off to fly back to the hospital site under automatic flight control.

The takeoff and initial cruise were normal, and when at a distance of about 0.7 nm from the hospital site, the communication link was re-established between the aircraft and SRP controller. The recorded signals showed that at this point the arm/disarm switch on the SRP controller was in the DISARM position. Almost immediately the aircraft responded by removing power to its electric propulsion motors and the aircraft's airspeed started to quickly reduce. The aircraft initially continued to maintain altitude using its elevators, but eventually stalled, after which it rolled to the right and descended. The descent rate reached about 3,000 fpm before the aircraft struck the ground. A summary of the recorded data from the aircraft is provided below:

Flight from hospital-farm-hospital (flights one and two)

- 1319:07 hrs — SRP controller signal set from DISARM to ARM
- 1311:38 hrs — takeoff from hospital
- 1313:59 hrs — aircraft out of SRP controller range
- 1315:16 hrs — lands at farm
- 1323:24 hrs — takeoff from farm
- 1324:31 hrs — aircraft in SRP range (aircraft recording shows SRP controller signal in the ARM position)
- 1326:26 hrs — lands at hospital
- 1326:36 hrs — SRP controller signal set from ARM to DISARM

Ground operation at hospital

- 1343:08 hrs — SRP controller signal set from DISARM to ARM
- 1346:10 hrs — SRP controller signal set from ARM to DISARM

Flight from hospital-farm-hospital (flights three and four)

- 1349:04 hrs — SRP controller signal set from DISARM to ARM
- 1353:09 hrs — takeoff from hospital
- 1355:11 hrs — aircraft out of SRP controller range
- 1356:13 hrs — lands at farm
- 13:58:14 to 14:00:51 — battery hot swap
- 1408:44 hrs — takeoff from farm
- 1409:40 hrs — aircraft in SRP controller range (aircraft recording shows SRP controller signal in the ARM position)
- 1411:38 hrs — lands at hospital

Flight from hospital-farm-hospital (flights five and accident flight)

- 1422:18 hrs SRP controller signal set from ARM to DISARM
- 1422:54 hrs SRP controller signal set from DISARM to ARM
- 1425:40 hrs takeoff from hospital
- 1427:07 hrs aircraft out of SRP controller range
- 1428:24 hrs lands at farm
- 1436:07 hrs takeoff from farm
- 1436:59 hrs aircraft in SRP controller range (aircraft recording shows signal has changed to DISARM at some point since 1427:07 hrs)
- 1436:59 hrs aircraft disarms in flight and power is cut to the propulsion motors

Training and operating procedures

The operator of the accident aircraft had received operational training provided by the aircraft manufacturer. This included the use of the ground control station, SRP and PM controllers. The operator stated that the training content did not include that the FTS would be disabled in flight if the aircraft was disarmed.

The operator advised that its procedure in the event of an in-flight emergency was to activate the FTS and that the disarm function would only be selected when the aircraft was on the ground.

It also advised that its normal procedure was for the SRP and RP to verbally coordinate the selection of the ARM/DISARM selections on their respective controllers. This included setting the controllers to DISARM after landing, and ARM in preparation for flight, irrespective of whether the SRP controller was in communication range of the aircraft. However, the operator's checklist did not include a 'check and challenge' of the ARM/DISARM settings.

Operational authorisation (OA)

The operator of the aircraft held an OA issued by the UK CAA. The OA did not explicitly require the use of an SRP, but it did refer to the operator's Operation Manual Volume 1 which included the use of an SRP when operating the aircraft type.

The aircraft manufacturer stated that the aircraft type was operated in eight countries, of which four were in Europe (including the UK) and four in Asia and further advised that of all the operators, only that of the accident aircraft used an SRP. The manufacturer considered that an SRP was unnecessary, with the use of a SRP controller increasing the operational complexity of the system and that a loss of SRP and RP settings could subsequently occur.

The aircraft operator stated that it was reviewing its operational procedures regarding the advantages and disadvantages of using an SRP when operating the aircraft type.

Aircraft software and testing

In November 2024, an updated version of the aircraft operating software was released by its manufacturer. This introduced a signal filter that incorporated a 200 ms delay intended to resolve infrequent 'glitches' in SRP controller signals received by the aircraft. This software was installed on the accident aircraft.

The manufacturer advised that it followed a software development process intended to encompass iterative testing prior to final release. However, after the accident the manufacturer advised that it had omitted to test the scenario of an aircraft in flight establishing communication with an SRP controller that was set to DISARM. When this scenario was then tested, the 'de-glitch' signal filter inadvertently resulted in the aircraft immediately disarming.

Analysis

When the aircraft took off from the hospital site during the fifth flight, the SRP controller's arm/disarm switch was in the ARM position. In accordance with the operator's procedures it should then have been set to the DISARM position when the aircraft landed and set back to the ARM position prior to takeoff. However, the recorded data showed that as the aircraft approached the hospital landing site, and communication with the SRP controller was established, the controller was recorded as being in the DISARM position. The SRP reported that he had not moved this switch during the flight. It is therefore most likely that the selection was synchronised correctly with the RP after the aircraft had landed at the farm, but a loss of synchronisation with the RP then occurred, with the selection remaining in the DISARM position when the aircraft took off.

The checklist used by the RP and SRP did not include a formal verification (check and challenge) of the arm/disarm switch selection. This increased the possibility that a loss of synchronisation between the two remote pilots was not detected and this risk may have been further increased by conducting a number of flights in relatively quick succession.

Although the SRP controller was inadvertently set in the DISARM position when communication was established with the aircraft, this scenario had already been considered by the manufacturer that had designed the system so that it would not disarm the aircraft in this eventuality. However, the change to the software in November 2024, which was not retested against the scenario above prior to its release, unintentionally resulted in the aircraft disarming in flight. This also disabled the FTS, which otherwise would have automatically deployed the parachute. The subsequent uncontrolled descent posed a safety hazard to people and property on the ground. Given the aircraft's weight, if it had struck a person, it is likely that serious or even fatal injuries may have occurred.

Conclusion

A change to the aircraft's operating software by its manufacturer meant that, under a particular set of circumstances, it no longer performed as intended. The SRP controller selection had remained in the DISARM position when the aircraft took off, and the software bug resulted in the unintended in-flight shutdown of the aircraft's electric propulsion motors, the disabling of the aircraft's safety parachute system from deploying, and a subsequent uncontrolled descent from a height of 60 m.

This accident highlights the importance of ensuring that change management processes include comprehensive scenario testing, particularly for safety-critical functions. While the manufacturer followed an iterative development process, this incident emphasises the need to validate software behaviour against all known operational cases.

Safety actions

Following this accident the following safety actions were taken:

The aircraft manufacturer has:

- Notified all operators about the safety critical software issue.
- Released new software to resolve the protection logic to ensure that the 'deglitch' filter does not interfere with the arm/disarm switch protection function.
- Updated the flight and ground control manuals to highlight the importance of switch state positions and to include additional information on the operation of the FTS and disarm function.

The aircraft manufacturer also stated that it is considering a change to the aircraft's software that will prevent the aircraft being manually disarmed in flight (remove power from motors and disable the FTS) using the RP ground station or SRP controller. This software change is expected to be released in August 2025.

The aircraft operator has:

- Grounded all flights of this aircraft type until such time that it completed a revalidation process to determine the aircraft's suitability for future operation following changes to the aircraft's software.
- Updated its flight reference cards to include checks that switch selections of the RP ground control station match those of the SRP controller.

The aircraft operator also advised that it is reviewing the advantages and disadvantages of continuing to operate the aircraft with an SRP.