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	CA18/2/3/10307					
Classification	Accident	**Date**	10 May 2023		**Time**	0139Z
Type of Operation	Unmanned Aircraft System – Surveillance (Part 101)					
Location						
Place of Departure	Balfour, Mpumalanga Province	Place of Intended Landing	Balfour, Mpumalanga Province			
Place of Occurrence	6nm south of Balfour, Mpumalanga Province					
GPS Co-ordinates	Latitude	26º 44’ 56” S	Longitude	28º 37’ 48” E	Elevation	5 352 feet
Aircraft Information						
Registration	ZT-YHR	Class	3A			
Make; Model; S/N	Arace Sirin (Serial Number: SIR122)					
Damage to Aircraft	Substantial	Total UAS Hours	127.16			
Pilot-in-command						
Licence Type	Remote Pilot Licence (RPL)	Gender	Male	Age	30	
Licence Valid	Yes	Total Hours	234.57	Total Hours on Type	234.57	
Total Hours 30 Days	65.03	Total Flying on Type Past 90 Days	114.32			
People Controlling	1	**Injuries (On ground)**	0	**Fatalities**	0	**Fatalities (on ground)** 0

What Happened

On Wednesday morning, 10 May 2023 at 0048Z, an unmanned aircraft system (UAS) Arace Sirin with registration ZT-YHR was launched from a launch pad in Balfour, Mpumalanga province, to conduct security surveillance in the area with the intention to return to the same take-off launch pad. The flight was conducted under 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 conducted the pre-flight checks with no anomalies noted. He then armed and launched the UAS for the mission with 95% battery power available. The UAS climbed to 410 feet (ft) above ground level (AGL) to start the mission which lasted approximately 55 minutes (see Figure 3). Whilst the UAS was on its return flight to the launch pad, the pilot noticed a fail-safe ‘EKF3 lane switch’ (estimate vehicle position, velocity and angular orientation) warning on the remote pilot station display. Shortly thereafter, the UAS disconnected from the remote pilot station. The pilot switched on the strobe lights to visually locate the UAS; he located it on the ground approximately 10 metres from the launch pad with damage to the landing legs, fuselage and camera gimbal. No injuries to persons on the ground were reported.

Figure 1: ZT-YHR at the accident site. (Source: Operator)

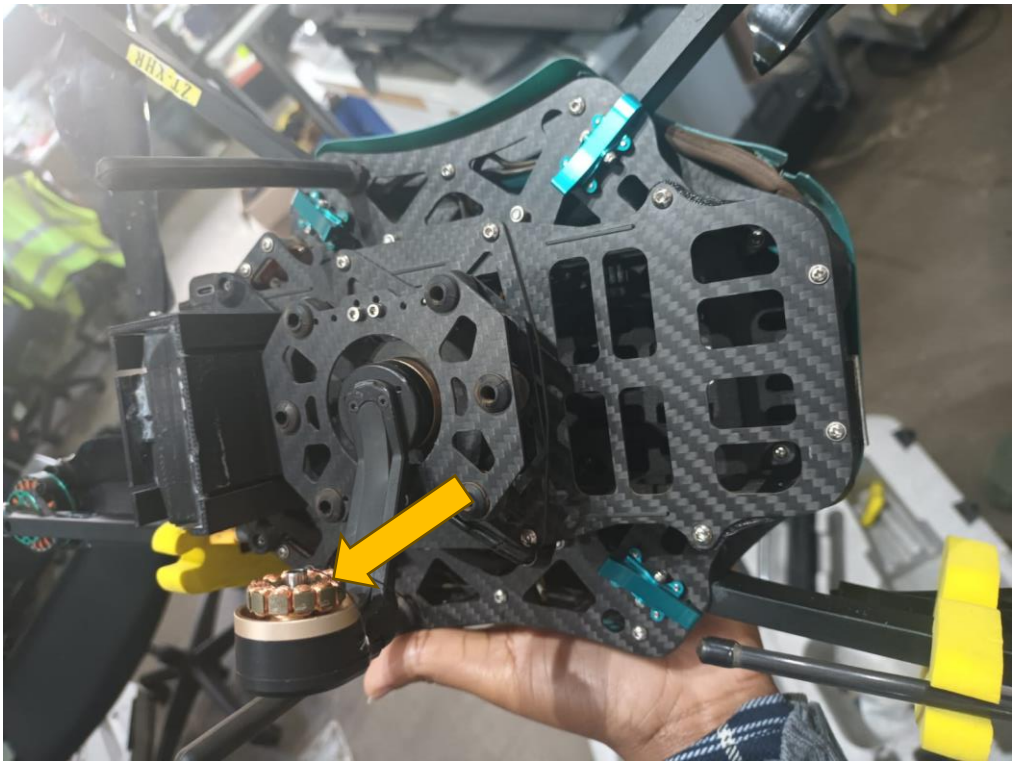


Figure 2: Damage to the camera. (Source: Operator)

Limitation	***Arace Sirin***
Operational conditions	*VLOS and BVLOS* *Day and night operations*
Operational Ceiling (as per OpSpec)	*1000ft AGL*
Maximum operating altitude	*16404ft*
Operational Endurance	*60 minutes*
Range (as per OEM)	*Bidirectional telemetry range: up to 20kms*
Range (maximum distance RPA will be flown)	*15kms* *Restriction: if wind >15kts, range is restricted to 10kms*

Figure 3: Operational endurance. (Source: Operator)

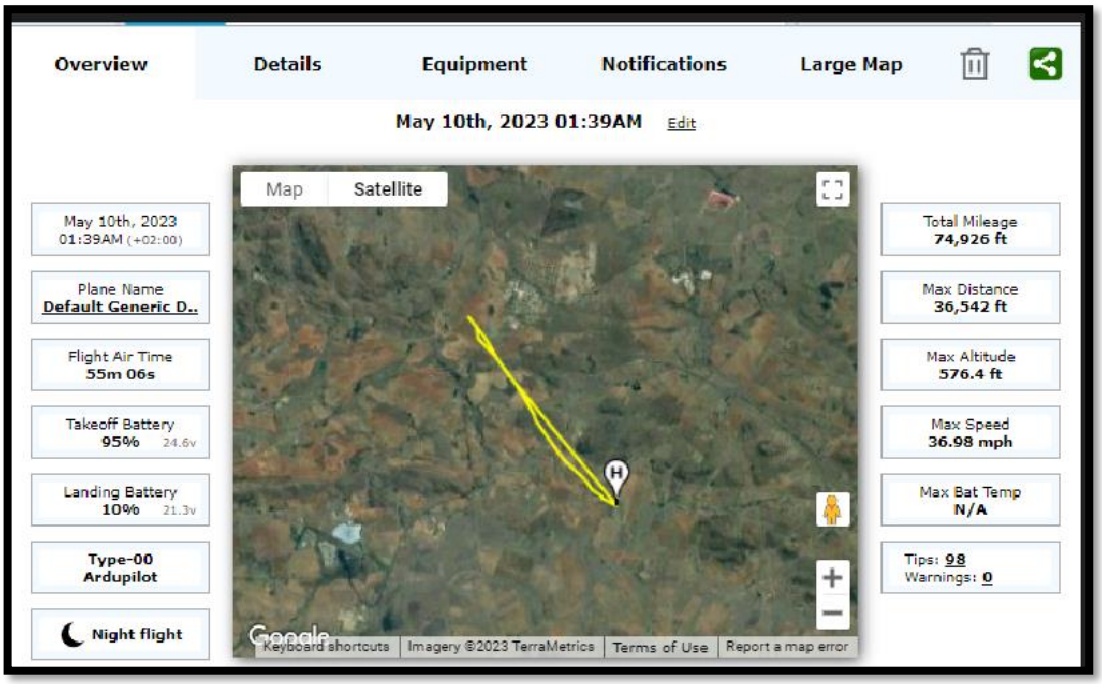
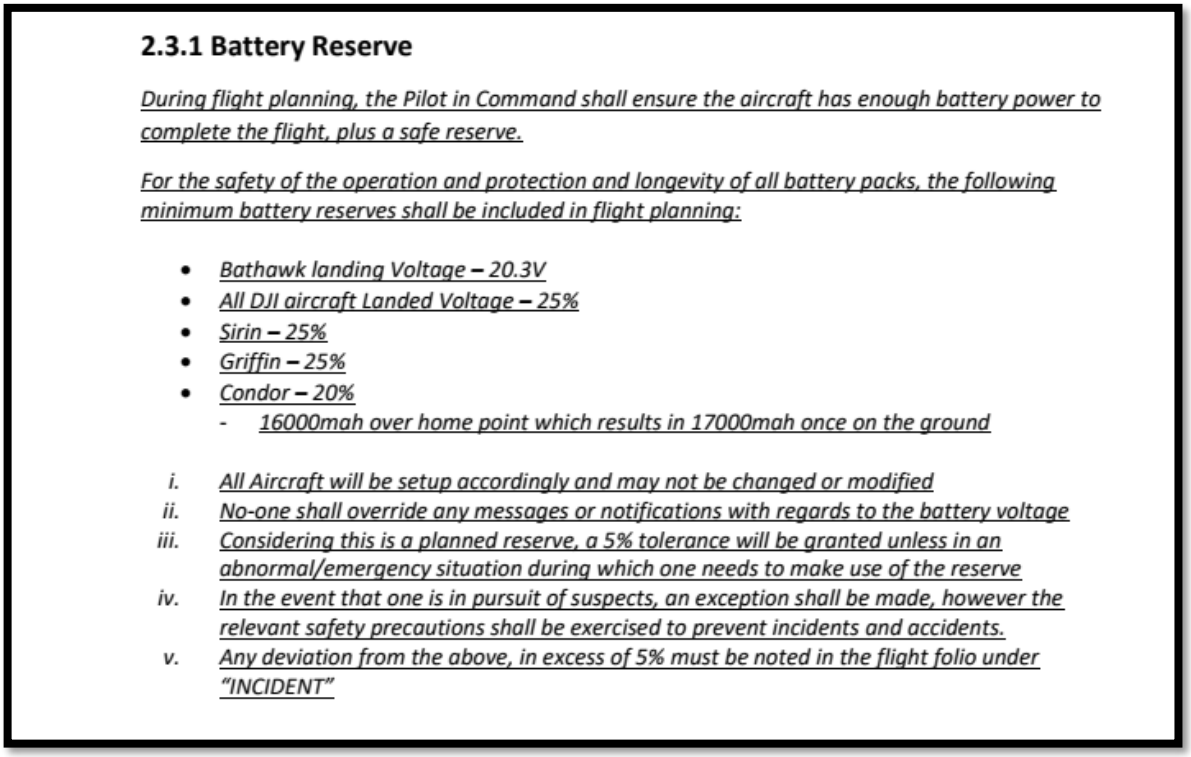


Figure 4: Total elapsed time and power, launch and landing. (Source: Operator)



2.3.1 Battery Reserve

During flight planning, the Pilot in Command shall ensure the aircraft has enough battery power to complete the flight, plus a safe reserve.

For the safety of the operation and protection and longevity of all battery packs, the following minimum battery reserves shall be included in flight planning:

- *Bathawk landing Voltage – 20.3V*
- *All DJI aircraft Landed Voltage – 25%*
- *Sirin – 25%*
- *Griffin – 25%*
- *Condor – 20%*
  - *16000mah over home point which results in 17000mah once on the ground*

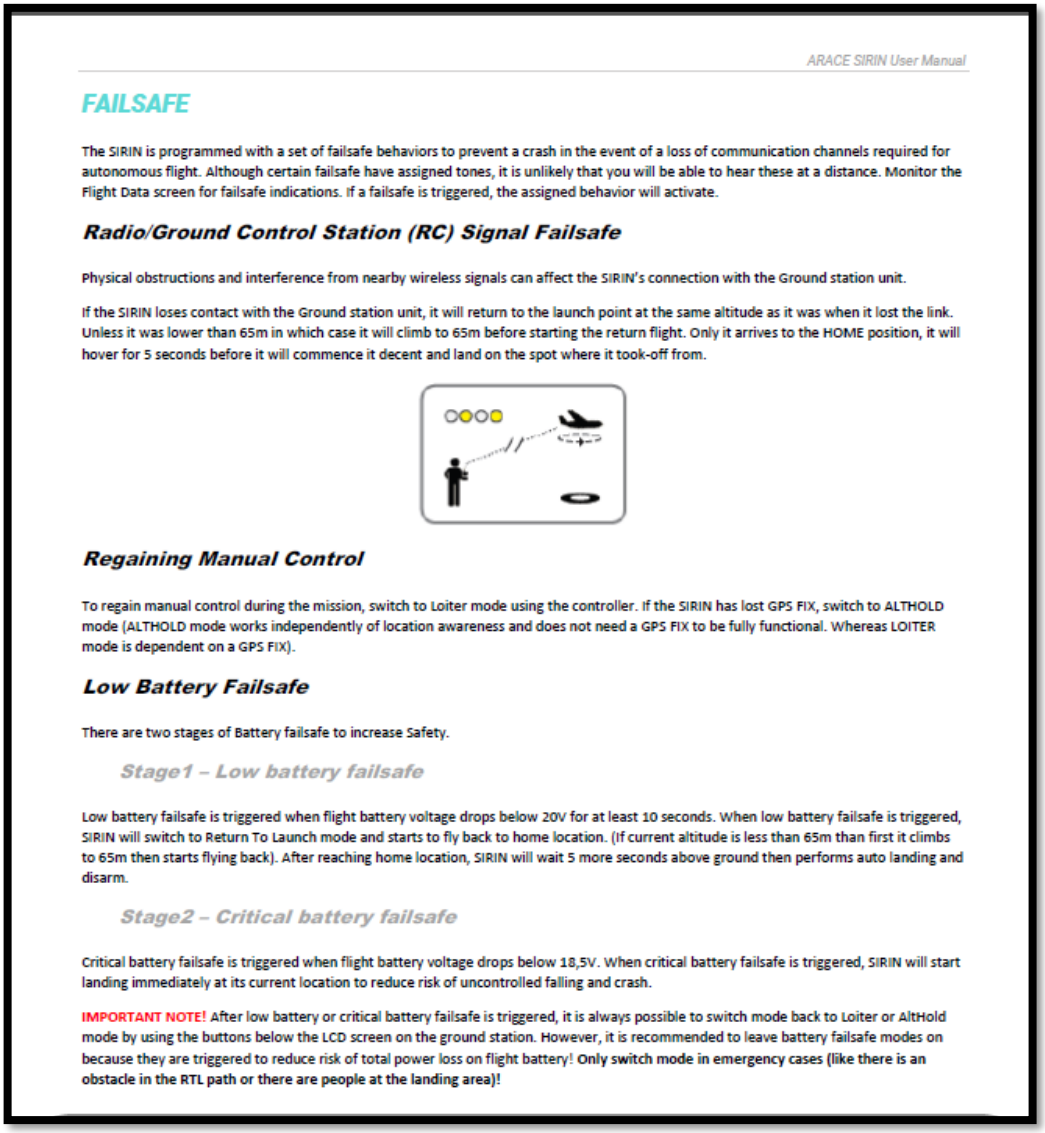
i. *All Aircraft will be setup accordingly and may not be changed or modified*
ii. *No-one shall override any messages or notifications with regards to the battery voltage*
iii. *Considering this is a planned reserve, a 5% tolerance will be granted unless in an abnormal/emergency situation during which one needs to make use of the reserve*
iv. *In the event that one is in pursuit of suspects, an exception shall be made, however the relevant safety precautions shall be exercised to prevent incidents and accidents.*
v. *Any deviation from the above, in excess of 5% must be noted in the flight folio under "INCIDENT"*

Figure 5: Battery reserve. (Source: UDS SOP)

Description: EKF3 Lane Switch: (Source: Operator)

Ekf3 lane switch is only a notification to say it is now using the secondary GPS module. During normal operation both GPS module receive Sat signal that is used to estimate the time and space at any point while the units are powered on. It happens that one GPS Sat lock will drop down more than the other. Like when you use your phone for navigation. Now and then your phone will lose some Sats and this is completely normal and soon after you will continue as normal when Sats recover.

When this happens on the craft it is just a notification to tell you what is happening. It is just that instead of it using the primary GPS for navigation it will switch to the secondary until the Sats is recovered on the primary. When this happens, then as standard, you will get a second lane switch notification stating this. EKF failsafe is equivalent to Atti. mode or altitude hold mode but it is still a failsafe. Craft will hover in on the spot until Sats is recovered and continue with normal flight very soon after. If no Sats are regained, then the craft will initiate land mode to prevent a 'fly away'.



ARACE SIRIN User Manual

FAILSAFE

The SIRIN is programmed with a set of failsafe behaviors to prevent a crash in the event of a loss of communication channels required for autonomous flight. Although certain failsafe have assigned tones, it is unlikely that you will be able to hear these at a distance. Monitor the Flight Data screen for failsafe indications. If a failsafe is triggered, the assigned behavior will activate.

Radio/Ground Control Station (RC) Signal Failsafe

Physical obstructions and interference from nearby wireless signals can affect the SIRIN's connection with the Ground station unit.

If the SIRIN loses contact with the Ground station unit, it will return to the launch point at the same altitude as it was when it lost the link. Unless it was lower than 65m in which case it will climb to 65m before starting the return flight. Only it arrives to the HOME position, it will hover for 5 seconds before it will commence it decent and land on the spot where it took-off from.

Regaining Manual Control

To regain manual control during the mission, switch to Loiter mode using the controller. If the SIRIN has lost GPS FIX, switch to ALTHOLD mode (ALTHOLD mode works independently of location awareness and does not need a GPS FIX to be fully functional. Whereas LOITER mode is dependent on a GPS FIX).

Low Battery Failsafe

There are two stages of Battery failsafe to increase Safety.

Stage1 – Low battery failsafe

Low battery failsafe is triggered when flight battery voltage drops below 20V for at least 10 seconds. When low battery failsafe is triggered, SIRIN will switch to Return To Launch mode and starts to fly back to home location. (If current altitude is less than 65m than first it climbs to 65m then starts flying back). After reaching home location, SIRIN will wait 5 more seconds above ground then performs auto landing and disarm.

Stage2 – Critical battery failsafe

Critical battery failsafe is triggered when flight battery voltage drops below 18,5V. When critical battery failsafe is triggered, SIRIN will start landing immediately at its current location to reduce risk of uncontrolled falling and crash.

IMPORTANT NOTE! After low battery or critical battery failsafe is triggered, it is always possible to switch mode back to Loiter or AltHold mode by using the buttons below the LCD screen on the ground station. However, it is recommended to leave battery failsafe modes on because they are triggered to reduce risk of total power loss on flight battery! **Only switch mode in emergency cases (like there is an obstacle in the RTL path or there are people at the landing area)!**

Figure 6: Failsafe modes. (Source: Arace User Manual)

Findings

1. The pilot was issued a Remote Pilot Licence (RPL) with multirotor and beyond visual line of sight (BVLOS) ratings on 12 April 2022 with an expiry date of 30 April 2024. His Class 2 medical certificate was issued on 12 February 2020 with an expiry date of 28 February 2025. The pilot was restricted to wear corrective lenses.

2. The UAS was issued a Remotely Piloted Aircraft Systems Letter of Approval on 18 July 2022 with an expiry date of 17 July 2023.

3. The operator was issued an UAS Operating Certificate with an endorsement of Part 101 by the Regulator (SACAA) on 31 October 2022 with an expiry date of 31 October 2023.

4. The technician who repaired the UAS was properly qualified; her Remote Maintenance Technician (RMT) licence was issued on 21 June 2021 with an expiry date of 20 June 2023.

5. A mandatory periodic inspection (MPI) at 118.58 was completed on 05 May 2023. The next MPI was due at 193.58.

6. The EFK3 lane switch activated, and the battery was at critical level to depletion at 10%, hence, the UAS defaulted to landing. The flight endurance was almost 60 minutes (Figure 3).

7. The operator's standard operating procedure (SOP) states that the UAS must be landed with at least 25% battery capacity still remaining (Figure 5).

Probable Cause(s)

The UAS initiated an unsuccessful land mode after EFK3 lane switch warning activated, and the battery was close to depletion at below the SOP recommended 25%.

Contributing Factor(s)

None.

Safety Action(s)

None.

Safety Message

UAS pilots are reminded to always adhere to the operator's SOP limitations and advisory messages.

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