SOUTH AFRICAN CIVIL AVIATION AUTHORITY

Section/division **Accident and Incident Investigations Division** Form Number: CA 12-58

RPAS/UAS LIMITED OCCURRENCE INVESTIGATION REPORT – FINAL

Reference Number	CA18/2/3/10308					
Classification	Accident	**Date**	19 April 2023	**Time**	2013Z	
Type of Operation	Remotely Piloted Aircraft System – Surveillance (Part 101)					
Location						
Place of Departure	Nottingham Road, KwaZulu-Natal Province	Place of Intended Landing	Nottingham Road, KwaZulu-Natal Province			
Place of Occurrence	Nottingham Road, on the ground approximately 20 metres from the launch pad, KwaZulu-Natal (KZN) Province					
GPS Co-ordinates	Latitude	29°22'37.1" S	Longitude	030°00'37.8" E	Elevation	4631 ft
Aircraft Information						
Registration	ZT-YAA	Class	3A			
Make; Model; S/N	Arace Sirin (Serial Number: SIR0081)					
Damage to Aircraft	Substantial	Total UAS Hours	621.14			
Pilot-in-command						
Licence Type	Remote Pilot Licence (RPL)	Gender	Male	Age	22	
Licence Valid	Yes	Total Hours	142.8	Total Hours on Type	142.4	
Total Hours 30 Days	47.46	Total Flying on Type Past 90 Days	142.4			

People controlling	1	**Injuries**	0	**Injuries (On ground)**	0	**Fatalities**	0	**Fatalities (on ground)**	0

What Happened

On 19 April 2023, an ARACE Sirin unmanned aircraft system (RPA) with registration ZT-YAA was launched for surveillance over railway tracks at Nottingham Road, KwaZulu-Natal province. The flight was operated 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 stated that after conducting the pre-flight checks with no anomalies detected, he launched the UAS with 92% battery power at 1945Z to begin the mission. At 1946Z, the UAS reached an altitude of 22.2 feet (ft) above ground level (AGL) and the pilot selected 'loiter' flight mode and the UAS continued to climb to 330ft AGL. Approximately 28 minutes into the flight at 2012Z, the pilot engaged a hover abeam the launch pad. The UAS experienced a potential thrust loss from motors 2 and 4 (Figure 2) and, thereafter, rolled sharply to the right (Figure 3). This was followed by a rapid loss of altitude and, thus, the subsequent crash to the ground. The UAS sustained damage to three of the four legs, and two propellers (Figure 4). There were no reported injuries. The pilot recovered the RPA which was approximately 20 metres (m) from the launch pad.

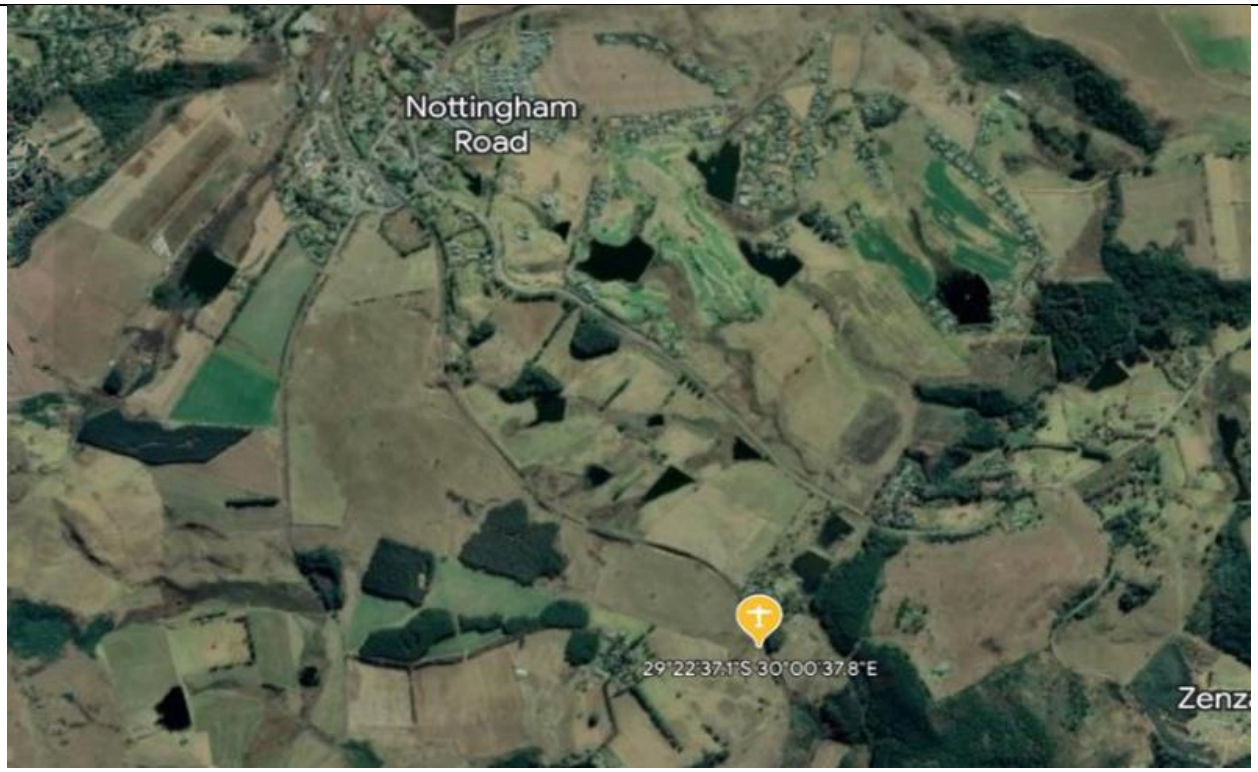

Figure 1: A view of the accident site. (Source: Google Earth)

R	20m 03s	313.5 ft	2,522 m	Tip	Radio Failsafe
	20m 07s	329.1 ft	2,531 m		53% Battery at maximum distance
S	20m 16s	330.3 ft	2,476 m	Tip	Radio Failsafe Cleared
T	20m 26s	329.4 ft	2,376 m	Tip	14 mins remaining before RTL
U	20m 30s	331.1 ft	2,334 m	Tip	Mode change to AUTO failed: initialisation failed
V	20m 31s	330.8 ft	2,320 m	Mode	Mode changed to Loiter
	21m 17s	331.7 ft	2,008 m		50% Battery
W	25m 26s	329.9 ft	599 m	Tip	4 mins remaining before RTL
	26m 01s	330.4 ft	483 m		40% Battery
X	28m 38s	188.4 ft	15 m	Tip	Potential Thrust Loss (2)
Y	28m 40s	119.6 ft	21 m	Tip	Potential Thrust Loss (4)
Z	28m 40s	105.8 ft	22 m	Mode	Mode changed to RTL
a	28m 44s	1.8 ft	28 m	Tip	EKF3 lane switch 1. EKF primary changed:1
b	28m 45s	2.3 ft	28 m	Tip	Vibration compensation ON
c	28m 45s	4.3 ft	28 m	Tip	Crash: Disarming: AngErr=52>30, Accel=0.1<3.0. EKF primary changed:0
d	28m 51s	4.0 ft	28 m	Tip	PreArm: Need Alt Estimate. PreArm: GPS positions differ by 4597555.m. PreArm: Battery 1 below minimum arming voltage
e	28m 56s	3.6 ft	28 m	Tip	CAN[124] GPS 1: detected as u-blox at 230400 baud
f	29m 00s	3.3 ft	27 m	Tip	Vibration compensation OFF

Figure 2: The flight log with X and Y showing potential thrust loss from motors 2 and 4. (Source: Operator)

Figure 3: The UAS rolling to the right. (Source: Operator)

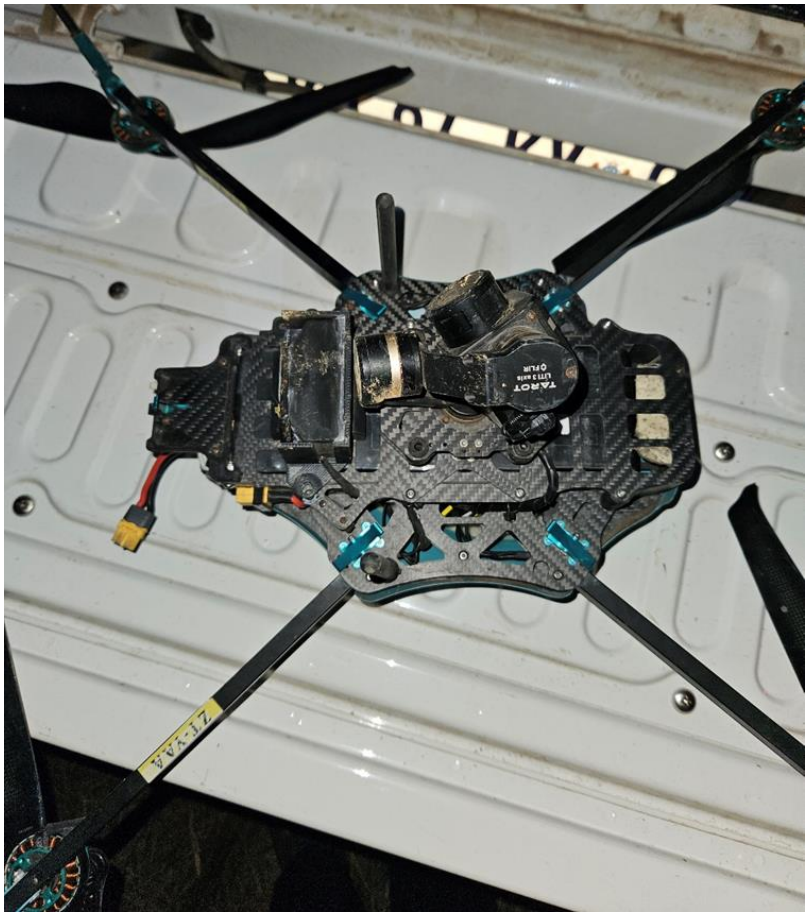

Figure 4: The UAS being recovered from the accident site. (Source: Operator)

Arace RPA description (Source: www.araceuas.com/sirin/)

The Sirin can be airborne up to 85mins and cover more than 40km in a single flight.

Field deployment takes less than 1 minute and requires no assembly.

Folds into a compact size for easy storage and transportation (including backpack options).

Li-ion battery which can be recharged 3-4x as much a traditional LiPo batteries which is what is used on most commercially available drones. Also, it only needs a single battery to fly.

Multiple redundancy for safe operation:

- *Triple IMUs*
- *Dual Compass*
- *Dual GNSS/GPS (multi constellation)*
- *No pre-flight calibration is required.*
- *Numerous built-in failsafe features.*

It can be equipped with various state-of-the-art, single, or dual sensor payload. Long range, optical zooming daylight cameras, as well as thermal cameras.

Operational radius of up to 20 km and can act as a relay with ARACE point to multi-point Mobile Remote Viewing Terminal (MRVT).

Figure 5: An example of the Arace Sirin UAS. (Source: araceuas.com)

The following information was provided by the operator from the flight Log Analysis Report.

Sequence of events:

1. *At 1945Z: The pilot armed the aircraft and started the operation.*
2. *At 1946Z: The aircraft reached an altitude of 22.2 ft AGL. The pilot switched to 'Loiter' mode and continued climbing to 330 ft AGL.*
3. *At 2012Z: 28 minutes into the flight the pilot hovered above his home location when the aircraft experienced a potential thrust loss on motor 2 and the aircraft started to roll sharply to the left as it lost altitude rapidly.*
4. *At 2013Z: The aircraft hit the ground hard resulting in damage to the aircraft.*

Original Equipment Manufacturer (OEM):

1. The OEM's facility is in Páty, Hungary, where the elevation is approximately 656ft (200m).

2. According to the OEM's website (www.araceaus.com) the maximum take-off weight (MTOW) for the Sirin is 2.98kg (EU RPAS Class 2) with a maximum payload of 500 grams (g).

3. The operator engaged the OEM after encountering several incidents related to the "potential thrust loss" over a short period.

   The OEM's feedback raised several factors:

   (i) The atmospheric conditions in which the UASs are being flown in South Africa differ substantially from the European conditions. The density altitude conditions in South Africa, especially in the Highveld areas, is approximately eight times higher than in the European regions.

   (ii) The OEM uses UASs fitted with new batteries and new motors. Battery power (voltage) is of paramount importance to ensure optimal effectiveness of the four motors at all times. The OEM recommended that the operator limit their flight time to levels above 50% battery power.

   (iii) Pilots must avoid flying in strong wind conditions.

   (iv) The OEM is continuously monitoring data provided to them by operators around the world and is constantly striving to improve reliability. Several of the components (i.e., the motors) are obtained from vendors, and the reliability of these components are only tested during operation (flying). One of the critical parts of the motor is the bearing, which is also sourced from different vendors although the OEM strives to use only one supplier which they have found (since they have been in production) to have quality bearings.

   (v) The four motors fitted to the UAS have a service life of 500 hours and should be replaced thereafter.

Findings

1. The pilot was initially issued a Remote Pilot Licence (RPL) by the Regulator (SACAA) on 26 September 2022 with an expiry date of 30 September 2024. The pilot had a beyond visual line of sight (BVLOS) rating which was endorsed on his licence.

2. The pilot's Class 3 medical certificate was issued on 27 August 2022 with an expiry date of 31 August 2026.

3. The UAS was issued a Remotely Piloted Aircraft Systems Letter of Approval (RLA) by the Regulator on 6 May 2022 with an expiry date of 5 May 2023. The UAS mandatory periodic inspection was conducted on 8 April 2023 at 607.49. The UAS was operated for a further 13.65 minutes at the time of the accident. The UAS's Certificate of Registration (CRS) was issued to the current owner on 17 February 2022.

4. The remote maintenance technician who conducted the last inspection was issued a Remote Maintenance Technician (RMT) licence by the Regulator (SACAA) on 30 September 2022 with an expiry date of 29 September 2024.

5. The operator had a Remotely Piloted Aircraft System Operating Certificate (ROC) No: CAA/G1291D that was issued by the Regulator on 31 October 2022 with an expiry date of 31 October 2023. The operational specification of the UAS type was endorsed on the ROC with an effective date of 10 November 2022.

6. The flight logs recorded potential thrust loss from the number 2 and 4 motors, which is consistent with vortex ring state. This caused the aircraft to roll sharply to the right and lose altitude rapidly before it crashed to the ground.

7. It is likely that the loss of control was because of a rapid depletion of the battery below 50% which caused the loss of thrust on the number 2 and 4 motors, therefore, caused an imbalance of the motors and a loss of control before the UAS crashed.

Probable Cause(s)

It is likely that loss of control was due to the rapid depletion of the battery below 50% which caused the loss of thrust on the number 2 and 4 motors, and therefore, led to an imbalance of the motors and a loss of control before the UAS crashed.

Contributing Factor(s)

None.

Safety Action(s)

None.

Safety Message

A substantial number of accidents and serious incidents was reported by the operator since the beginning of the year. The SACAA and the operator are to find common ground for a joint corrective action plan to reduce the high accident/serious incident rate at this operation.

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