AIRCRAFT ACCIDENT REPORT AND EXECUTIVE SUMMARY

		Reference:		CA18/2/3/10061	
Aircraft Registration	ZS-UKU	**Date of Accident**	28 October 2021	**Time of Accident**	1035Z
Type of Aircraft	Rand KR-2		**Type of Operation**	Private (Part 94)	
Pilot-in-command Licence Type	Private Pilot Licence		**Age** 53	**Licence Valid**	Yes
Pilot-in-command Flying Experience	**Total Flying Hours**		1809.5	**Hours on Type**	40
Last Point of Departure	Kitty Hawk Aerodrome (FAKT), Gauteng Province				
Next Point of Intended Landing	Kitty Hawk Aerodrome (FAKT), Gauteng Province				
Damage to Aircraft	Destroyed				

Location of the accident site with reference to easily defined geographical points (GPS readings if possible)

On higher ground at Tierpoort farm, approximately 0.57 nautical miles (nm) south of FAKT Runway 01 at Global Positioning System (GPS) co-ordinates determined to be S25° 52' 22.6" E28° 27' 13.1" at an elevation of approximately 4 708ft.

Meteorological Information	Wind direction: 140°; Wind speed: 5 knots; Temperature: 20°C; Dew point: 13ºC; Visibility: 10km; QNH:1026hPa						
Number of People On-board	1 + 0	**Number of People Injured**	0	**Number of People Killed**	1	**Other (On Ground)**	0

Synopsis

On Thursday afternoon, 28 October 2021, a pilot on-board a Rand KR-2 two-seat high-performance aircraft with registration ZS-UKU took off on a private flight from Kitty Hawk Aerodrome (FAKT), located south-east of Pretoria in Boschkop, Gauteng province, with the intention to return to the same aerodrome. Visual meteorological conditions (VMC) prevailed at the time of the flight. According to the first eyewitness, the aircraft entered the aerobatic box situated west of FAKT; thereafter, the pilot executed a few aerobatic-type manoeuvres before flying towards the south. The second eyewitness saw the aircraft overhead his house flying at an estimated height of 500 feet (ft) above ground level (AGL). The aircraft then made a high-speed left turn during which the right wing broke off in-flight. As a result, the pilot lost control of the aircraft and crashed at Tierpoort farm, approximately 0.57 nautical miles (nm) south of FAKT Runway 01. The aircraft was destroyed and the pilot was fatally injured during the accident. Post-accident examination of the failed right-wing aileron indicated that the right-wing separation was triggered by the aileron aerodynamic flutter which was caused by the aileron that was not balanced in accordance with (IAW) the Rand Robinson Engineering Build Manual.

Probable Cause

The pilot lost control of the aircraft after the right-wing broke off in-flight due to the aileron aerodynamic flutter.

Contributing Factor:

The aileron was under balanced to the extent of 60 kilograms per millimetre (kg/mm) residual moment.

SRP Date	10 May 2022	Publication Date	13 May 2022

ABBREVIATION	DESCRIPTION
AGL	Above Ground Level
ARCC	Aeronautical Rescue and Coordination Centre
AAIB	Air Accidents Investigation Branch
AMSL	Above Mean Sea Level
AIID	Accident and Incident Investigations Division
ATF	Authority to Fly
AP	Approved Person
CRS	Certificate of Release to Service
C of G	Centre of Gravity
CVR	Cockpit Voice Recorder
CAR	Civil Aviation Regulations
ARCC	Aeronautical Rescue and Coordination Centre
EMS	Emergency Medical Services
FAOR	O.R. Tambo International Airport
FAWB	Wonderboom Aerodrome
FAKT	Kitty Hawk Aerodrome
FDR	Flight Data Recorder
FL	Flight Level
Ft	Feet
GPS	Global Positioning System
L	Litres
Lbs	Pounds
MHz	Megahertz
NM	Nautical Mile
IAW	In Accordance With
Hp	Horsepower
USA	United States of America
VW	Volkswagen
RPM	Revolutions per Minute
SAWS	South African Weather Service
SAPS	South African Police Service
VMC	Visual Meteorological Conditions
PPL	Private Pilot Licence
POH	Pilot's Operating Handbook

Reference Number	**:** CA18/2/3/10061
Name of Owner/Operator	**:** Dick Jacobs
Manufacturer	**:** Rand Robinson Engineering
Model	**:** Rand KR-2
Nationality	**:** South African
Registration Marks	**:** ZS-UKU
Place	**:** Tierpoort farm, Pretoria east
Date	**:** 28 October 2021
Time	**:** 1035Z

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 of the Investigation:

In terms of Regulation 12.03.1 of the Civil Aviation Regulations (CAR) 2011, 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**.

Investigations Process:

On Thursday afternoon, 28 October 2021, the Accident and Incident Investigations Division (AIID) was notified of an accident involving a Rand KR-2 aircraft with registration ZS-UKU which occurred on a farm approximately 0.57 nautical miles (nm) south of Kitty Hawk Aerodrome (FAKT) in Gauteng province. The AIID appointed an investigator-in-charge (IIC) and a co-investigator. Notifications were sent to the State of Registry, State of Operator, and the State of Manufacture and Design. No accredited representatives were appointed.

The AIID reports are made available to the public at:
http://www.caa.co.za/Pages/Accidents%20and%20Incidents/Aircraft-accident-reports.aspx

Notes:

1. *Whenever the following words are mentioned in this report, they shall mean the following:*

- *Accident – this investigated accident*
- *Aircraft – the Rand KR-2 involved in this accident*
- *Investigation – the investigation into the circumstances of this accident*
- *Pilot – the pilot involved in this accident*
- *Report – this accident report*

2. *Photos and figures used in this report were taken from different sources and may be adjusted from the original for the sole purpose of improving clarity of the report. Modifications to images used in this report are limited to cropping, magnification, file compression; or enhancement of colour, brightness, contrast; or addition of text boxes, arrows or lines.*

Disclaimer:

This report is produced without prejudice to the rights of AIID, which are reserved.

1. FACTUAL INFORMATION

1.1. History of Flight

1.1.1 On Thursday afternoon, 28 October 2021, a pilot on-board a Rand KR-2 high-performance sport aircraft with registration ZS-UKU took off on a private flight from Kitty Hawk Aerodrome (FAKT), located south-east of Pretoria in Boschkop, Gauteng province, with the intention to return to the same aerodrome. According to the weather forecast from the South African Weather Service (SAWS), visual meteorological conditions (VMC) prevailed around the time of the flight. On the morning of 28 October 2021, the pilot drove to FAKT to pay a friend a visit at his hangar at FAKT. The friend was the owner of the ZS-UKU aircraft. The hangar is located close to a restaurant. *The owner of the aircraft had informed the investigators during an interview that he had approved of the pilot to fly his aircraft.* The pilot had not flown an aircraft since 10 October 2021 because his aircraft, a Kopke GK-1, with registration ZU-BLJ was undergoing maintenance. The ZS-UKU aircraft was pulled out of the hangar, whereafter a detailed pre-flight inspection was conducted with no abnormalities found.

1.1.2 According to the owner, the aircraft's fuel tank had about 22 litres of mixed Avgas LL100 and Mogas fuel. Approximately 10 minutes after the pre-flight inspection, the pilot boarded the aircraft and fastened his safety harness. Thereafter, he started the engine and waited until all the indications were within the green arch before taxiing the aircraft to the threshold of Runway 01. At about 1020Z, the aircraft rolled on the runway in a northerly direction before it rotated and climbed to a height of approximately 500 feet (ft) above ground level (AGL); thereafter, it made a right turn to the east, and then to the south. The pilot later made another right turn to the west and flew over the runway towards the aerobatic box area. The aerobatic box limits are (from the ground up) a minimum of 7500ft and a maximum of flight level (FL) 090. The first eyewitness, who was standing outside a hangar at FAKT stated that he saw the aircraft entering the aerobatic box area, whereafter the pilot executed a few aerobatic-type manoeuvres. The pilot did not spend much time in the aerobatic box area; he soon flew the aircraft to the south of FAKT.

1.1.3 The second eyewitness, a local farmer who was located south of FAKT, stated that he observed the aircraft overhead his house flying at an estimated height of 500ft AGL. The aircraft then made a high-speed left turn (*which the investigators assumed was the final approach flight path for Runway 01*) during which the right wing broke off in-flight. The aircraft subsequently entered a high-speed descent towards the ground with no visible sign of recovery. The aircraft disappeared from the second eyewitness' line of sight; following that, a loud bang was heard. The second eyewitness alerted the South African Police Service (SAPS) and the Emergency Medical Services (EMS) about the accident. The Aeronautical Rescue and Coordination Centre (ARCC) initiated a search and rescue mission after being notified of the accident. Moreover, a helicopter was dispatched from

Pretoria West SAPS Airwing Unit to the area where the aircraft was last seen. The helicopter crew spotted the wreckage on higher ground at Tierpoort farm, approximately 0.57 nautical miles (nm) south of FAKT Runway 01.

1.1.4 The helicopter landed on an open area close to the accident site and the crew made their way to the accident scene where they discovered that the pilot had succumbed to his injuries.

1.1.5 The flight lasted about 15 minutes; it was conducted under the provisions of Part 94 of the Civil Aviation Regulations (CAR) 2011 as amended.

1.1.6 The accident occurred during daylight at Global Positioning System (GPS) co-ordinates determined to be S25° 52’ 22.6” E28° 27’ 13.1” at an elevation of approximately 4 708ft.

Figure 1: The accident site with GPS co-ordinates. (Source: Google Earth Map)

1.2. Injuries to Persons

Injuries	Pilot	Crew	Pass.	Total On-board	Other
Fatal	1	-	-	1	
Serious	-	-	-	-	
Minor	-	-	-	-	
None	-	-	-	-	
Total	1	-	-	1	

1.3. Damage to Aircraft

1.3.1 The aircraft was destroyed during the accident sequence.

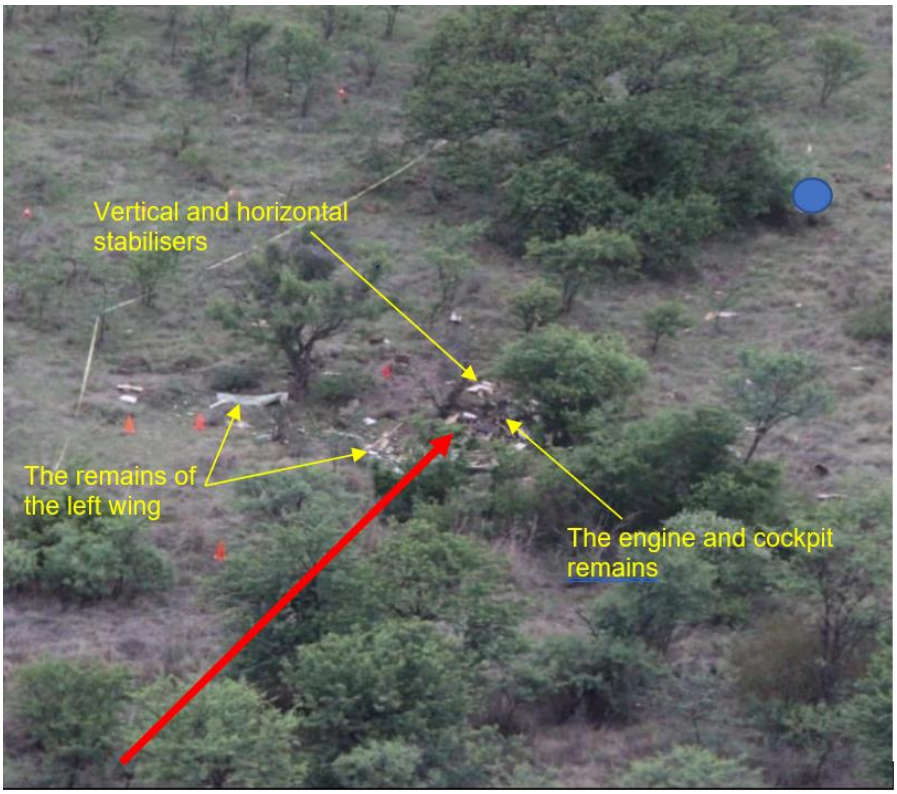

Figure 2: An aerial view of the accident site and the aircraft's approximate flight path (red line).

1.4. Other Damage

1.4.1 None.

1.5. Personnel Information

Nationality	South African	Gender	Male	Age	53
Licence Number	0270479652	Licence Type	Private Pilot Licence		
Licence Valid	Yes	Type Endorsed	Yes		
Ratings	Night Rating, Test Pilot Rating (Class 2) and Aerobatic Rating				
Medical Issue Date	31 October 2020				
Medical Expiry Date	31 October 2021				
Restrictions	Suitable corrective lenses				
Previous Accidents	None				

Flying Experience:

Total Hours	1809.5
Total Past 24 Hours	0.25
Total Past 7 Days	0.25
Total Past 90 Days	20.6
Total on Type Past 90 Days	0
Total on Type	40

The hours reflected on the table above were obtained from the pilot's logbook hard copies that were made available to the investigators. The last entry in the logbook was dated 10 October 2021. The pilot had a valid Class 2 aviation medical certificate issued on 31 October 2020 with an expiry date of 31 October 2021. According to available information, the pilot had flown his practical flight test to obtain his Private Pilot Licence (PPL) on 28 January 2000. On 2 February 2000, proof of training was submitted to the South African Civil Aviation Authority (SACAA); thereafter, the pilot was issued a PPL on 20 March 2000. The pilot had aerobatics flight activity endorsement rating on his licence. The instructor who carried out his aerobatic competency test made remarks on the pilot's report that he had exceptional aerobatic flying skills and an outstanding knowledge of the aircraft.

On 13 August 2020, the pilot completed his Rand KR-2 type conversion training at FAKT and had submitted his "Flight Crew Licence Conversion" form CA61-01.3 to the Regulating Authority (SACAA) on 25 August 2020. His application form showed that he had a dual flight training during his type conversion to a Rand KR-2 aircraft. A copy of the aircraft type

syllabus as well as the practical flight test report on the Rand KR-2 were found in the pilot's file. The instructor who carried out his type conversion did not identify any issues with the pilot. The pilot's profile showed a history of satisfactory performance on all proficiency checks. The database at the SACAA showed that the Rand KR-2 aircraft was endorsed on the pilot's licence. Scrutiny of the pilot's logbook showed that he had accumulated approximately 40 hours on type. The pilot had 20 different types of smaller general aviation aircraft endorsement ratings on his licence.

1.6. Aircraft Information

1.6.1 Aircraft description (Source: Pilot's Operating Handbook [POH]):

The Rand KR-2 is a two-seat, low-wing high performance sport aircraft with an enclosed cockpit designed in the United States of America (USA). The ZS-UKU aircraft was equipped with retractable cast aluminium alloy mainwheel legs and a steerable tailwheel. The structure of the aircraft is a wooden frame with polyurethane foam which was formed to the shapes required and then covered by Dynel fabric which was filled with resin. The wings have two wooden spars with polyurethane ribs which are also covered with resin filled Dynel fabric. The aircraft has a wingspan of 23ft, 6 inches and a length of 14ft, 6 inches. The primary flying control in the cockpit were connected via a series of push-pull rods and bell cranks to their respective control surfaces. The flaps are cut out of the trailing edge of the inboard wing skins and the aerodynamic fairing is bonded on to fair the flaps for cruise. The aircraft is powered with a Volkswagen (VW) 2180 CC 4-cylinder horizontally opposed air-cooled engine modified for aircraft use and fitted with a dual ignition system comprising 1 magneto fired sparkplug and 1 electronic fired sparkplug per cylinder. The engine is rated at 3 800 revolutions per minute (RPM) and is driving a fixed-pitch two-bladed wooden propeller. The aircraft comprises a 12 gallons header fuel tank located in the nose-section between the engine firewall and the forward instruments panel. The aircraft design stress loading is ±7g at 800 pounds (lbs) gross weight and the redline is [never exceed speed (V_{NE})] is 200 miles per hour (mph). The aerobatic operation within the flight load factor on the aircraft type is limited to full aft stick manoeuvres at minimum controllable airspeed, lazy eights, chandelles, and steep turns.

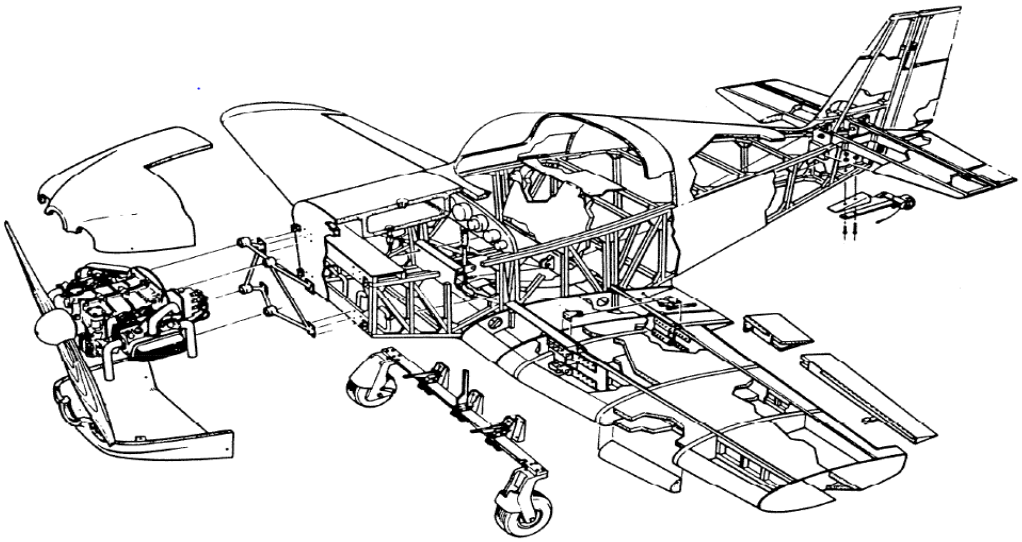

Illustration 1: The Rand RK-2 standard construction. (Source: POH)

Figure 3: File picture of the ZS-UKU aircraft. (Source: https://www.jetphotos.com)

Airframe:

Type	Rand KR-2
Serial number	IJH-1
Manufacturer	Rand Robinson Engineering
Service Ceiling	15 000ft
Year of manufacture	1980
Total airframe hours at the time of accident	899.1

Last Annual Inspection (Hours & Date)	869.1	23 August 2021
Hours Since Last Annual Inspection	30	
Authority to Fly (Issue Date)	20 June 2016	
Authority to Fly (Expiry Date)	31 July 2022	
C of R (Issue Date) (Present owner)	29 July 2021	
Maximum take-off weight	408.2 kg	
Type of fuel recommended	Mogas and Avgas LL 100	
Fuel used	Mogas and Avgas LL 100 mixed	
Operating categories	Part 94	

*NOTE: The exact airframe hours of the aircraft at the time of the accident could not be determined because the aircraft (including the instrument panel) was destroyed during the accident sequence. After consultation with the owner of the aircraft, he stated that he (the owner) had flown the aircraft approximately 30 hours since the last 100-hour annual inspection was completed. The flight folio page serial number 20560 revealed that a 100-hour annual inspection was carried out on 23 August 2021 at 869.1 total airframe hours. The Certificate of Release to Service (CRS) was issued by the approved person (AP) number 222 on 23 August 2021 with an expiry date of 22 August 2022 or at 969.1 airframe hours, whichever comes first. The aircraft was initially issued an Authority to Fly (ATF) certificate on 20 June 2016; the latest reissued ATF had an expiry date of 31 July 2022.

Post-accident interview with the owner of the aircraft revealed that the aircraft was airworthy prior to the accident flight.

Examination of the aircraft's technical records indicated that the aircraft was properly certificated and maintained IAW the SACAA regulations. There were no open or deferred maintenance items listed in the aircraft's flight folio before the accident flight.

Examination of the AP file at the SACAA facility showed that he had a maintenance licence issued IAW CAR Part 66.04 with an expiry date of 25 May 2023. The AP had A, C, X and W ratings endorsed on his licence. It was stated in the AP's licence that he was authorised to maintain aircraft manufactured from composites, metal, wood, tube and fabric material.

Engine:

Type	Volkswagen 2180 CC
Serial Number	SFCUR 237865
Hours Since New	230
Hours Since Overhaul	Not reached

Propeller:

Type	Dunbar DC138
Serial Number	N1230
Hours Since New	230
Hours Since Overhaul	Not reached

1.7. Meteorological Information

1.7.1 An official weather report was obtained from the South African Weather Service (SAWS) for FAKT for 28 October 2021.

i. Upper Air Analysis:

No turbulence was forecasted below FL100 at 1200Z (Chart 1) which was the closest to the time of the accident.

ii. Satellite Images:

The satellite image (Figure 5) reflects broken clouds around the accident area between 1015Z and 1145Z and 'fair' meteorological aerodrome report (METAR) reported the cloud base of 2000ft AGL.

Wind direction	040°	Wind speed	05kts	Visibility	≥10KM
Temperature	20°C	Cloud cover	BKN 5-6 octas	Cloud base	2000 ft
Dew point	13°C	QNH	1026 hPa		

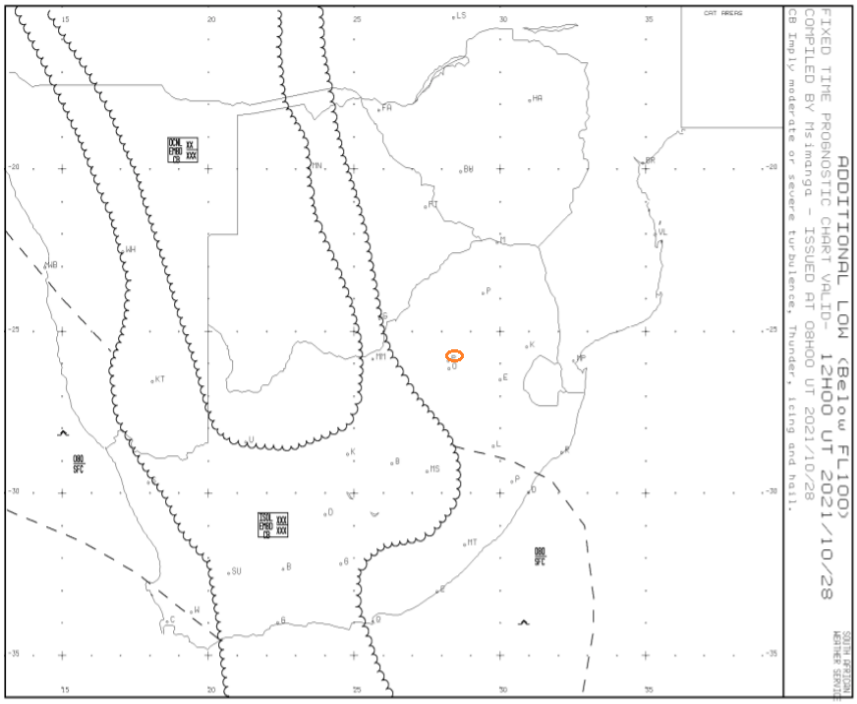

Chart 1: A weather chart indicating the absence of turbulence below FL100.

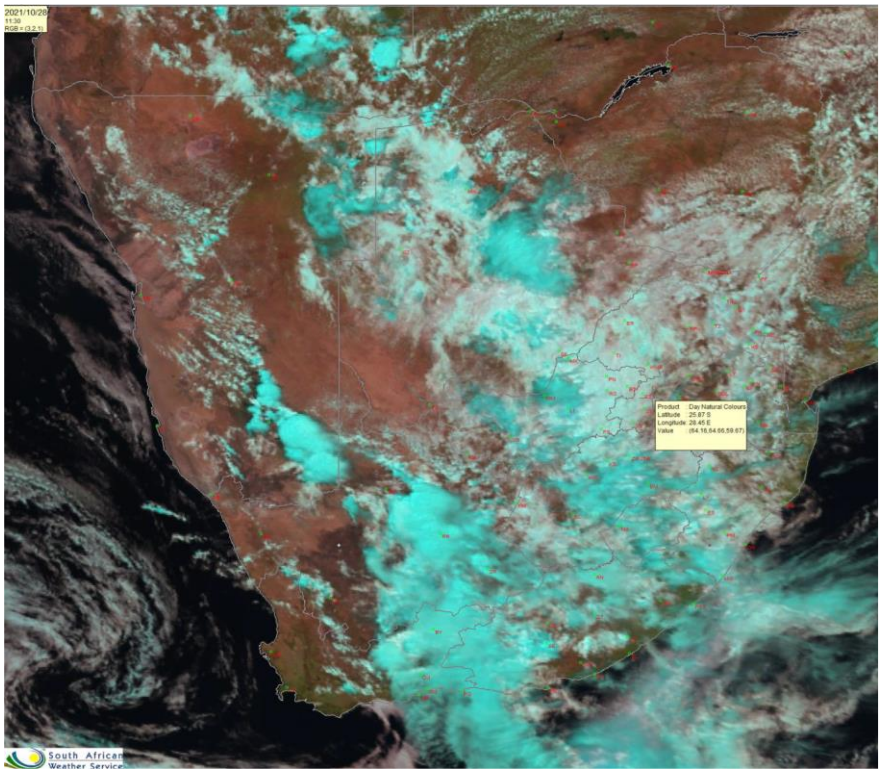

Figure 4: A satellite image of the accident area between 1015Z and 1145Z on the day of the accident.

1.8. Aids to Navigation

1.8.1 The aircraft was equipped with standard navigational equipment as approved by the Regulator (SACAA) for the aircraft type. There was no record indicating that the navigation system was unserviceable prior to or during the flight.

1.9. Communication

1.9.1 The aircraft was equipped with standard communication equipment as approved by the Regulator for the aircraft type. There were no recorded defects with the communication equipment prior to the flight.

1.9.2 No record could be found that the aircraft broadcasted any communication on the common traffic advisory frequency for the Kitty Hawk area on the very high frequency (VHF) 120.65-Megahertz (MHz).

1.9.3 No distress call was received by any station from the accident aircraft pilot at any stage of the flight.

1.10. Aerodrome Information

1.10.1 The accident occurred south of FAKT, approximately 0.57 nautical miles (nm) from Runway 01 at GPS co-ordinates determined to be S25° 52’ 22.6” E28° 27’ 13.1” at an elevation of approximately 4 708ft.

Aerodrome Location	Kitty Hawk Aerodrome (FAKT), Pretoria East	
Aerodrome Co-ordinates	S25°51'.42" E028°26'.49”	
Aerodrome Elevation	4586ft	
Runway Dimensions	810m x 18m	
Runway Designations	01/19	RH 01, LH 19
Runway Used	01	
Runway Surface	Asphalt	
Aerodrome Status	Licensed	
Approach Facilities	None	

*NOTE: The aerodrome has the licence No. 0200 that was renewed by the Regulating Authority from 1 August 2011 to 31 July 2022. The traffic patterns at FAKT are located to the east to ensure that air traffic is flown into and out of the aerodrome safely — that is, Runway 01 right-side circuits and Runway 19 left-side circuits. This was established based on the local conditions, including the direction and placement of the patterns, the altitude at which the aircraft are flown, and the procedures for entering and exiting the patterns. The

aerobatic box limits of FAKT are from ground to a minimum of 7 500ft and a maximum of FL090.

1.11. Flight Recorders

1.11.1 The aircraft was not equipped with a cockpit voice recorder (CVR) or a flight data recorder (FDR), nor was it required by regulation to be fitted to this aircraft.

1.12 Wreckage and Impact Information

1.12.1 Examination of the accident site indicated that the aircraft's right wing broke off in-flight, resulting in the pilot's inability to maintain control of the aircraft. The accident scene indicated that the aircraft impacted the ground at high speed in a nose-down left-wing high attitude. After impact, the aircraft flipped over and the pilot was ejected from the cockpit; he was found about 45 metres to the far-right end of the accident scene. The aircraft's enclosed cockpit/cabin area was destroyed, and the Perspex windshield shattered into multiple pieces. Because the structure of the aircraft is made of mainly wood with foam and composite coverings, substantial disintegration occurred on impact. The debris was projected sideways and upwards and about 60m forward from the first point of impact. All major components such as the flight control surface and the wood structure components were present at the accident site, except for the right wing that broke off in-flight. The pilot's four-point safety harness failed from overload; however, the buckle was still latched into position. The wooden instrument panel was destroyed, and the throttle and mixture control levers provided no reliable information. The turn and bank co-ordinator indicator showed that the left wing was high on impact.

Figure 5: The turn and bank co-ordinator indicator showing the attitude of the aircraft prior to impact.

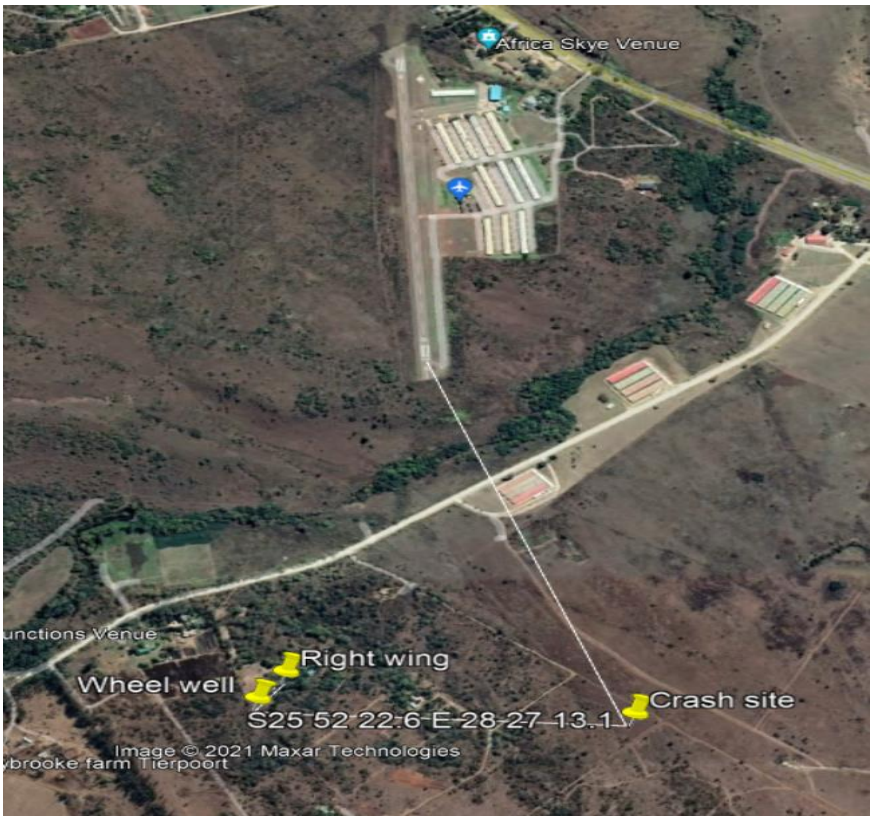

Figure 6: The right wing and the right gear wheel well/fairing positions, as well as the accident site.

1.12.2 The failed right wing and the right main landing gear wheel well/fairing were found at two different locations on the farm, approximately 750 metres south of the accident site. The failure occurred at the forward wing spar area underneath the pilot's seat outboard right main gear mount.

Figures 7/8: The right wing was found in an inverted position (left picture). The right gear wheel well/fairing at the accident site (right picture).

Figures 9/10: The outboard gear mount area showing where the failure occurred (left picture). The right wing and the right gear wheel well/fairing after they were reconstructed post-accident (right picture).

1.12.3 The right-wing aileron had minor damages but was still attached to the wing's rear trailing edge. The aileron control cable and turnbuckles were examined and were found attached to the control column and were properly wire-locked. The aileron bell crank had remained mounted to the aft spar on the right wing. The horizontal and vertical stabilisers were found about 4m from the first point of impact. The steerable tailwheel had remained attached to the tailwheel arm and the main landing gear wheels were found close to each other on the right-side of the wreckage trail. Rudder cables were found attached to the rudder bar, and the cables were still attached to fragments of the rudder horn.

1.12.4 The left wing and the aileron were destroyed by impact forces during the accident sequence; however, the aileron remains revealed no evidence of failure prior to impact. The left-wing aileron bell crank had remained mounted to the aft spar on the left wing. The control surfaces, pulleys, turnbuckles and cables were all in good condition before impact.

1.12.5 The VW 2180 CC 4-cylinder engine had broken into fragments due to high-impact force. The two-blade fixed pitch wooden propeller had remained attached to the hub and the hub had remained attached to the crankshaft. One propeller blade was severely splintered, which was consistent with the engine producing a substantial amount of power on impact.

Figures 11/12: The fragmented VW 2180 CC engine (left picture). Wooden blade remnant indicates an engine that was operating prior to impact (right picture).

1.13 Medical and Pathological Information

1.13.1 Post-mortem examination determined that the pilot succumbed from blunt force injuries, consistent with high energy impact.

1.14 Fire

1.14.1 There was no evidence of a pre- or post-impact fire.

1.15 Survival Aspects

1.15.1 The accident was considered not survivable due to the high kinetic energy associated with impact that was well above that of human tolerance.

1.15.2 The pilot had made use of the aircraft's safety harness which was fitted to his seat. The pilot had succumbed to his injuries. The pilot's body was handed over to the care of the Forensic Pathology Services, and the police have opened an inquest docket.

1.16 Tests and Research

1.16.1 The on-site examination of the wreckage indicated that the aircraft was intact prior to the failure of the right-wing in-flight. The aircraft's flight folio indicated no outstanding snags/defects recorded. The severely splintered propeller blades found at the accident scene were an indication that the engine was operational at the time of impact, however,

the amount of power it was producing could not be determined because the aircraft was not equipped with the FDR or an engine monitor.

1.16.2 Scrutiny into the manufacturer's (Rand Robinson Engineering, Inc) Build Manual revealed that the accident aircraft was constructed IAW an approved design. Visual examination of the wood used to build the aircraft's wing spars indicated no pre-existing damage or inherent defects. The bonding on the wood/main spars was of good quality. The left wing/aileron was destroyed on impact during the accident.

1.16.3 The right wing was recovered from FAKT to Wonderboom Aerodrome (FAWB) for a detailed engineering examination. The aileron operation was restricted by the distortion which resulted from ground impact. The aileron was removed from the wing and glued together on the bell crank attachment side where it had separated. After it had dried up, it was hung using a fine wire in a flying position and checked for mass balancing.

Figures 13/14: The aileron after it was removed from the failed right-wing (left picture). The aileron after it was glued together (right picture).

1.16.4 The residual moment was obtained by multiplying the scale reading of 0.415 kilograms (kg) with the moment arm of 145 millimetres (mm). The cord line was placed horizontally level and the hinge line was properly supported when the static line was measured. It was then discovered that the aileron was not balanced IAW the Build Manual (see attached Appendices). The aileron was under balanced to the extent of 60kg/mm residual moment. This contributed to the aileron flutter (explained in paragraph 1.18.1) which further caused the separation of the aileron and its bell crank. The aircraft was manufactured in 1980 and

the control surfaces were initially balanced during that period to make sure they were within the tolerances required for safe and stable aircraft control over the full range of anticipated operating conditions. Control surfaces are checked for the condition and security during inspections; it is not a requirement that they be checked for balancing unless there were alterations made on them.

1.16.5 Available records showed no evidence of alterations made on the ailerons; however, this cannot be verified with certainty as some records of prior years could not be traced. Post-accident visual examination of the right-wing spars was an indication of structural overload in both a positive and negative direction.

Figure 15: View of the aileron on a calibrated scale.

Figure 16: View of the aileron with the moment measured using a tape.

Figure 17: The aileron and bell crank separation caused by flutter.

1.17 Organisational and Management Information

1.17.1 The flight was conducted IAW the provisions of Part 94 of the South African Civil Aviation Regulations 2011 as amended.

1.17.2 The AP who carried out the last 100-hour annual inspection prior to the accident flight had an approved AP certificate number 222, valid until 25 May 2023.

1.18 Additional Information

1.18.1 Causes of flutter in aircraft structures and control systems – (Source: SB-5E Glider, G-DEJH Accident report by Air Accidents Investigation Branch [AAIB] Bulletin 4/2021)

Flutter is defined as an oscillation of a structure under the interaction of aerodynamic and aeroelastic forces. It occurs when aerodynamic loads cause the deflection of a structure in bending and/or twist and is typically seen in cantilevered aerofoil structures such as wings and vertical and horizontal stabilisers on the tail. The frequency of oscillation can become very rapid and, in some cases, divergent where the amplitude (maximum deflection) of the oscillation increases with each cycle. Divergent flutter can very rapidly result in structural failure due to overload.

Several factors can contribute to the susceptibility of an aircraft structure to flutter, the most significant being structural stiffness with susceptibility reducing as stiffness increases. Flutter can also be induced by the combination of an aerodynamic structure and a control surface, such as a wing and aileron, or vertical stabiliser and rudder. Turbulent airflow can induce deflection of the fixed structure which is not immediately matched by the control surface. If the centre of Gravity (CG) of the control surface is behind the hinge line when the structure deflects, for example due to an aerodynamic disturbance or turbulent airflow, the control surface will lag behind in its response due to inertia. To counteract this effect, control surfaces can be mass balanced with weights to bring the CG of the control surface in-line with or forward of the hinge line.

1.19 Useful or Effective Investigation Techniques

1.19.1 None.

2. ANALYSIS

2.1 General

From the available evidence, the following analysis was made with respect to this accident. This shall not be read as apportioning blame or liability to any particular organisation or individual.

2.2 Analysis

2.2.1 Examination of the pilot's file held at the SACAA indicated that the pilot was appropriately qualified and certified to conduct the flight. The pilot had a valid Class 2 aviation medical certificate issued on 31 October 2020 with an expiry date of 31 October 2021. The performance of the pilot was not a factor in the accident and had an aircraft type endorsed on his licence.

2.2.2 Prevailing weather conditions at the time and place of the accident were associated with VMC. The possibility of the aircraft encountering severe turbulence was eliminated. The accident was non-survivable because of the severe impact forces.

2.2.3 Examination of the aircraft documentation revealed that the aircraft was airworthy to undertake the flight on 28 October 2021. The flight folio page serial number 20560 revealed that a 100-hour annual inspection was carried out on 23 August 2021 at 869.1 total airframe hours. The Certificate of Release to Service (CRS) was issued by the AP number 222 on 23 August 2021 with an expiry date of 22 August 2022 or at 969.1 airframe hours, whichever comes first. The aircraft was initially issued an Authority to Fly (ATF) certificate on 20 June 2016; the latest reissued ATF had an expiry date of 31 July 2022. Scrutiny of the aircraft flight folio revealed that there were no snags pending on the aircraft prior to the accident flight.

2.2.4 The on-site investigation confirmed that the aircraft had experienced an in-flight break-up. Evidence to support this conclusion includes the area where the right-wing failure occurred underneath the pilot's seat outboard right main landing gear mount. The failed right wing was recovered for engineering examination. Visual examination of the wood used to build the aircraft's wings showed no inherent defects. The investigation revealed that the right-wing aileron was not balanced in accordance with the Build Manual. The aileron was under balanced to the extent of 60kg/mm residual moment. This could have led to the aerodynamic flutter, resulting in structural overload of the right-wing spar.

3 CONCLUSION

3.1. General

From the available evidence, the following findings, causes and contributing factors were made with respect to this accident. These shall not be read as apportioning blame or liability to any particular organisation or individual.

To serve the objective of this investigation, the following sections are included in the conclusion heading:

- **Findings —** are statements of all significant conditions, events or circumstances in this accident. The findings are significant steps in this accident sequence, but they are not always causal or indicate deficiencies.
- **Causes —** are actions, omissions, events, conditions, or a combination thereof, which led to this accident.
- **Contributing factors —** are actions, omissions, events, conditions, or a combination thereof, which, if eliminated, avoided or absent, would have reduced the probability of the accident or incident occurring, or mitigated the severity of the consequences of the accident or incident. The identification of contributing factors does not imply the assignment of fault or the determination of administrative, civil or criminal liability.

3.2. Findings

3.2.1 The flight was conducted IAW the provisions of Part 94 of the South African Civil Aviation Regulations 2011 as amended.

3.2.2 Moderate weather conditions prevailed at the time of flight and accident; and the weather had no bearing to this accident.

3.2.3 No turbulence was forecasted below FL100 at 1200Z, which was the closest to the time of the accident.

3.2.4 The pilot had a PPL and the aircraft type was endorsed on his licence. He also had a Class 2 aviation medical certificate issued on 31 October 2020 with an expiry date of 31 October 2021.

3.2.5 The pilot had a restriction to wear suitable corrective lenses.

3.2.6 The pilot performed the Rand KR-2 type conversion training at FAKT on 13 August 2020 and had submitted his “Flight Crew Licence Conversion” form CA61-01.3 to the Regulating Authority on 25 August 2020. His application form reflected that he had dual flight training during his type conversion to a Rand KR-2 aircraft. A copy of the aircraft type syllabus as well as a practical flight test report on the Rand KR-2 were available on his SACAA pilot file.

3.2.7 The AP who performed the last 100-hour annual inspection had the maintenance licence issued IAW CAR Part 66.04 with an expiry date of 25 May 2023.

3.2.8 The aircraft was issued an ATF on 20 June 2016 with an expiry date of 31 July 2022.

3.2.9 The aircraft was issued a Certificate of Registration on 29 July 2021.

3.2.10 Examination of the aircraft’s technical records indicated that the aircraft was properly certificated and maintained IAW the SACAA regulations. There were no open or differed maintenance items listed in the aircraft’s flight folio before the accident flight.

3.2.11 Examination of the aircraft’s documentation revealed that the aircraft was airworthy to undertake the flight on 28 October 2021. The flight folio page serial number 20560 revealed that a 100-hour annual inspection was carried out on 23 August 2021 at 869.1 total airframe hours. The CRS was issued by the AP number 222 on 23 August 2021 with an expiry date of 22 August 2022 or at 969.1 airframe hours, whichever comes first.

3.2.12 The investigation showed that the aileron was not balanced IAW the Build Manual. The aileron was under balanced to the extent of 60kg/mm residual moment. This could have led to aerodynamic flutter, resulting in structural overload on the right-wing spar.

3.3 Probable Cause/s

3.3.1 The pilot lost control of the aircraft after the right wing broke off in-flight due to aileron aerodynamic flutter.

3.4 Contributory Factors

3.4.1 The aircraft ailerons were not balanced IAW the Rand Robinson Engineering Build Manual.

4. SAFETY RECOMMENDATIONS

4.1 General

The safety recommendations listed in this report are proposed according to paragraph 6.8 of Annex 13 to the Convention on International Civil Aviation and are based on the conclusions listed in heading 3 of this report; the AIID expects that all safety issues identified by the investigation are addressed by the receiving States and organisations.

4.2 Safety Recommendations

4.2.1 The safety recommendations were issued to the Director of Civil Aviation on 26 November 2021.

1) During every annual inspection, the mass balancing of all control surfaces must be checked against the limits set by the manufacturer/designer.
2) If maintenance is performed on any control surface that may add weight to that control surface/s, then mass balancing must also be checked at that time and before further flights; this includes paint jobs.

5. APPENDICES

5.1 Aileron Balancing Manual.

Appendix 1: Aileron Balancing

AILERON BALANCING

10.64 The ailerons must be balanced to prevent flutter. Large lead fishing line weights melted down into a solid block work well.

Make a cardboard container approximately 1½ x 2 x 3. Use an old pot and on the stove melt down about 3 lbs of lead. Pour the melted lead into the cardboard container (It will smoke and singe the board but it does hold.) Be sure you've taped all the corners with several layers of tape to prevent the lead from running out. When cool, peel off the cardboard to leave a solid block of lead. This will be easily carved down with a surform until balance is attained. With two long pipe clamps attached to the aileron hinge, temporarily fasten the aileron to a level work bench. See drawing no. 72 . Be sure aileron swings freely over edge of work bench. By placing counterweight at proper mounting position on weight arm, carve down until the aileron suspends in a slight trailing edge high position - the weight of primer and paint will pull it down to level.

10.65 The weight should be drilled and bolted securely to the arm. (Allow for the weight decrease due to the drilled hole.)

10.66 Position the aileron on wing and cut a hole in the bottom of wing for the weight travel range. The ¼" spar will also require slight notching. Epoxy 1" foam into the sides of this cavity and lay in one BID. Recheck for smooth, full travel. Aileron travel is 20° T.E.U. and 10° T.E.D.

The aileron may now be permanently mounted to the wing.

AILERON BALANCING
DRAWING NO. 72

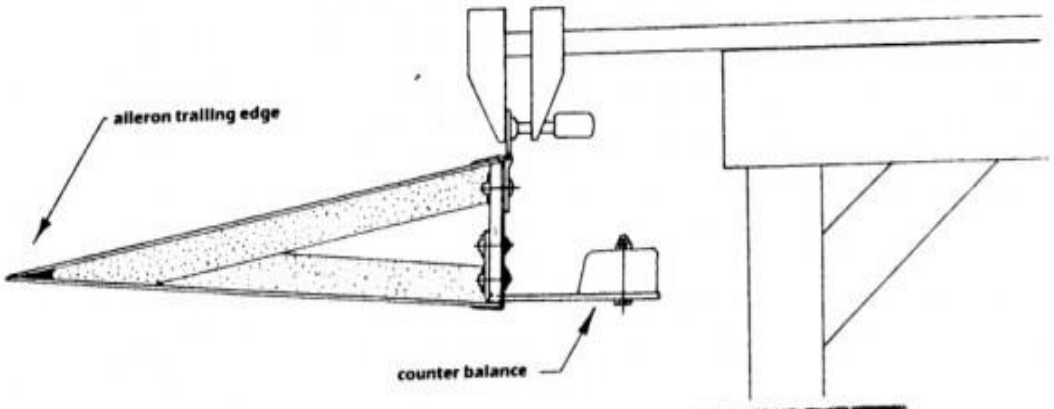

Photo No. 52: Aileron counter balance on underside of aileron.

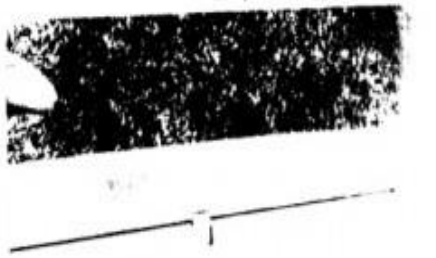

Photo No. 53: Aileron counter balance installation.

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