AIRCRAFT ACCIDENT REPORT AND EXECUTIVE SUMMARY

				Reference:		CA18/2/3/10361	
Aircraft Registration	ZU-EIB	**Date of Accident**		29 August 2023		**Time of Accident**	1055Z
Type of Aircraft	Tri Cubby			**Type of Operation**		Private (Part 94)	
Pilot-in-command Licence Type	Private Pilot Licence			**Age**	66	**Licence Valid**	Yes
Pilot-in-command Flying Experience		**Total Flying Hours**			415.0	**Hours on Type**	Unknown
Last Point of Departure	Swellendam Aerodrome (FASX), Western Cape Province						
Next Point of Intended Landing	Worcester Aerodrome (FAWC), Western Cape Province						
Damage to Aircraft	Destroyed						

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

Ridgemont Farm near Robertson (GPS position: 33º50’21.64” South 019º46’21.99” East)

Meteorological Information	Surface wind: 020°/13kt; temperature: 31°C; dew point: 10°C; visibility: CAVOK						
Number of People On-board	1+0	**Number of People Injured**	0	**Number of People Killed**	1	**Other (On Ground)**	0

Synopsis

On Tuesday morning, 29 August 2023, the pilot and owner of the Tri Cubby with registration ZU-EIB took off on a private flight from Worcester Aerodrome (FAWC) to Swellendam Aerodrome (FASX), both in the Western Cape province. After arrival at FASX, an approved person (AP) replaced the two rudder cables with new ones. During the return flight from FASX to FAWC, the aircraft crashed on a farm near Robertson in the Western Cape province. The pilot was fatally injured in the accident.

The investigation revealed that the aircraft was flown in turbulent mountain wave conditions, and the aircraft experienced an interruptive flight condition. As the aircraft’s centre of gravity (CG) is positioned ahead of the forward CG limit, the interruptive flight condition caused a stall/spin; also, there was the possibility of luggage moving forward and restricting movement of the front cockpit’s control column (the luggage was placed on the front seat), which resulted in an unrecoverable situation. The aircraft nose-dived and impacted the ground.

Probable Cause/s and/or Contributory Factors

During flight, the aircraft encountered mountain wave turbulence which caused an abrupt flight manoeuvre. As a result, the luggage in the front cockpit seat shifted and rested on the front control column, pushing it forward. This prevented the pilot from pulling back the controls and, thus, the aircraft’s nose pitched down. The aircraft nose-dived and impacted the ground.

- Adverse weather conditions during flight.
- The pilot did not ensure that the luggage on the front seat was properly secured before the flight as he did not consider the possibility of the back rest tilting forward.

SRP date	10 September 2024	Publication date	18 October 2024

Occurrence Details

Reference Number	**:** CA18/2/3/10361
Occurrence Category	**:** Accident (Category 1)
Type of Operation	**:** Private (Part 94)
Name of Operator	**:** Private Flight
Aircraft Registration	**:** ZU-EIB
Aircraft Make and Model	**:** Micro Wings Cubby, Tri Cubby
Nationality	**:** South African
Place	**:** Ridgemont Farm, Robertson District, Western Cape Province
Date and Time	**:** 29 August 2023 at 1055Z
Injuries	**:** The pilot was fatally injured
Damage	**:** Destroyed

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.

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.

Investigation Process

The Accident and Incident Investigations Division (AIID) of the South African Civil Aviation Authority (SACAA) was notified of a fatal accident on 29 August 2023 at 1103Z. The occurrence was classified as an accident according to the CAR 2011 Part 12 and the International Civil Aviation Organisation (ICAO) STD Annex 13 definitions. Investigators had dispatched to the accident site.

Notes:

1. *Whenever the following words are mentioned in this report, they shall mean the following:*
   Accident — this investigation accident
   Aircraft — the Tri Cubby 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 have been adjusted from the original for the sole purpose of improving clarity of the report. Modifications to images used in this report were limited to cropping, magnification, file compression; or enhancement of colour, brightness, contrast; or addition of text boxes, arrows, or lines.*

Disclaimer

Table of Contents

Abbreviation	Description
º	Degrees
ºC	Degrees Celsius
AIID	Accident and Incident Investigations Division
AMO	Aircraft Maintenance Organisation
AoA	Angle of Attack
AP	Approved Person
ATF	Authority to Fly
BEW	Basic Empty Weight
CAR	Civil Aviation Regulations
CAVOK	Ceiling and Visibility OK (for VFR flight)
CG	Centre of Gravity
C of R	Certificate of Registration
CPL	Commercial Pilot Licence
CRS	Certificate of Release to Service
EMS	Emergency Medical Services
FASX	Swellendam Aerodrome
FAWC	Worcester Aerodrome
ft	Feet
GPS	Global Positioning System
hPa	Hectopascal
kg	Kilogram(s)
kt	Knot(s)
lbs	Pound(s)
m	Metre(s)
MAC	Mean Aerodynamic Chord
METAR	Meteorological Aerodrome Report
nm	Nautical miles
PIC	Pilot-in-command
QNH	Barometric Pressure Adjusted to Sea Level
SACAA	South African Civil Aviation Authority
SAWS	South African Weather Service
TBO	Time Between Overhaul
UTC	Co-ordinated Universal Time (GMT)
VMC	Visual Meteorological Conditions
Z	Zulu (Term of Universal Co-ordinated Time – Zero Hours Greenwich)

FACTUAL INFORMATION

1.1 History of Flight

1.1.1 On Tuesday morning, 29 August 2023, a pilot on-board the Tri Cubby aircraft with registration ZU-EIB took off on a private flight from Worcester Aerodrome (FAWC) to Swellendam Aerodrome (FASX), both located in the Western Cape province. The flight was conducted under visual meteorological conditions (VMC) by day and under the provisions of Part 94 of the Civil Aviation Regulations (CAR) 2011 as amended.

1.1.2 The pilot was the owner of the aircraft. The flight from FAWC to FASX was approximately 60 nautical miles (nm) and was uneventful. Upon arrival at FASX, the pilot parked the aircraft at the approved person's (AP's) hangar for him to conduct maintenance; the AP had to replace the two rudder cables with 3mm stainless steel cables. According to the AP, the pilot had an overnight suitcase which he had placed on the front seat (tandem seating arrangement, with the pilot flying from the aft seat) of the aircraft. The pilot brought the suitcase should he need to stay overnight as he was not certain how long the maintenance would take or in case of adverse weather conditions. The AP also stated that he had a sports bag and a flight bag placed on top of the suitcase. The suitcase was secured to the seat with the aircraft's lap strap. The aircraft was fitted with dual flight controls.

1.1.3 At approximately 1020Z after the maintenance, the pilot took off from FASX to FAWC. At 1055Z whilst flying overhead Robertson area, a farm worker at Ridgemont Farm noticed a light aircraft that was approaching from the direction of the mountain; he saw it spinning shortly before it descended in a nose-down attitude and impacted the ground; it burst into flames upon impact on the ground. The eyewitness rushed to the scene, which was approximately 650 metres (m) from where he was initially positioned. Other farm workers who saw the smoke also drove to the scene with a water tanker. Due to the intensity of the fire, the farm workers were unable to get too close to the wreckage, but they managed to contain the fire by spraying water on it. The accident occurred approximately 38 nautical miles (nm) after take-off from FASX whilst en route to FAWC. The aircraft was found in a steep vertical nose-down and tail-high attitude. The aircraft was destroyed by the post-impact fire that erupted following the explosion. The pilot was fatally injured in the accident.

1.1.4 The accident occurred during daylight whilst the aircraft was flying from FASX to FAWC at Global Positioning System (GPS) co-ordinate determined to be 33º50'21.64" South 019º46'21.99" East, at an elevation of 580 feet (ft).

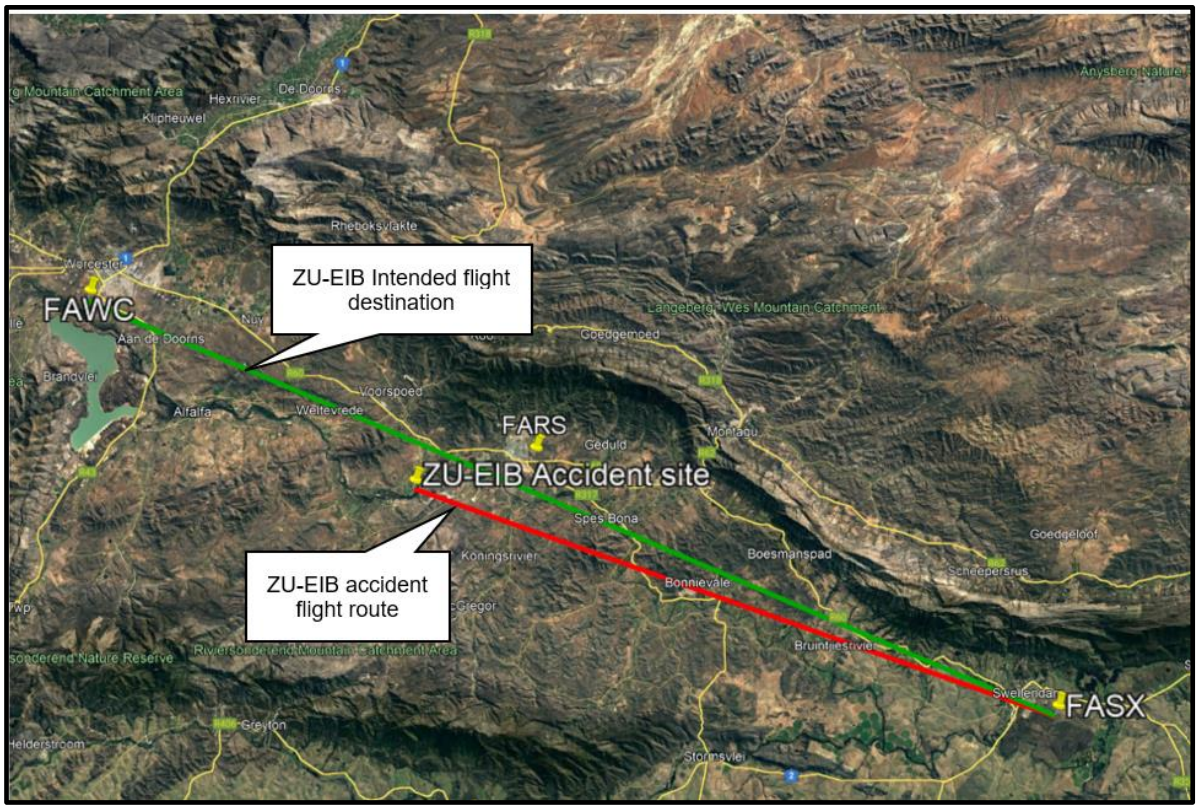

Figure 1: The route flown by the aircraft, and the accident site. (Source: Google Earth)

1.2 Injuries to Persons

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

Note: Other, means people on the ground.

1.3 Damage to Aircraft

1.3.1 The aircraft was destroyed by the fuel-fed post-impact fire that erupted during the accident.

Figure 2: The aircraft after the accident.

1.4 Other Damage

1.4.1 Minor damage was caused to the vegetation around the accident site.

1.5 Personnel Information

1.5.1 The pilot was initially issued a Private Pilot Licence (PPL) on 24 May 2010 by the Regulator (SACAA). His Commercial Pilot Licence (CPL) was issued on 1 May 2023 with an expiry date of 30 April 2024. The aircraft type was endorsed on his licence. The pilot was issued a Class 1 aviation medical certificate on 16 March 2023 with an expiry date of 30 September 2023. The pilot was the owner of the aircraft. He was also a former aircraft maintenance engineer (AME) from the South African Airways Technical (SAAT).

1.5.2 The pilot purchased the aircraft from the previous owner in Bloemfontein, Free State province. According to the person who travelled with the pilot to Bloemfontein, they collected the aircraft from the previous owner on 18 May 2023 at New Tempe Aerodrome (FATP), Free State province. The aircraft was flown back by the pilot from New Tempe (FATP) via Victoria West and Williston to Diemerskraal Aerodrome in Wellington, Western Cape province. During landing at Victoria West, the aircraft was hard landed in which the nose landing gear strut was slightly bent. The pilot attempted to fix the strut; however, he was not able to restore it to perfect condition. The pilot was involved in some of the maintenance that was conducted on the aircraft. The pilot also flew the aircraft between Diemerskraal and Malmesbury several times as a sole occupant before he attained his rating. The aircraft's Authority to Fly (ATF) was not valid and he did not have the aircraft type rating.

Pilot-in-Command (PIC)

Nationality	South African	Gender	Male	Age	66
Licence Type	Commercial Pilot Licence (CPL)				
Licence Valid	Yes	Type Endorsed	Yes		
Ratings	Night				
Medical Expiry Date	30 September 2023 (Class 1)				
Restrictions	Must wear corrective lenses during flight Hypertension protocol				
Previous Accidents	None				

Note: Previous accidents refer to past accidents the pilot was involved in, when relevant to this accident.

Flying Experience:

Total Hours	415.0
Total Past 90 Days	1.0
Total on Type Past 90 Days	1.0
Total on Type	Unknown

Note: The pilot's flying logbook was in the aircraft during the flight and was damaged by the post-impact fire, hence it was unreadable.

1.5.3 On 20 May 2023, the pilot completed his conversion to the aircraft type. After the conversion flight, the pilot took the aircraft for its annual inspection. This was the first tandem seat aircraft type that was endorsed on his licence. The pilot flew the aircraft from the aft seat. The total flying hours entered in the table above were obtained from the pilot's application form to the Regulator when he applied for his CPL in May 2023. (Note: *His flying hours at the time of the accident could not be determined with certainty as the pilot's logbook was in the aircraft and was damaged by the post-impact fire.)*

1.5.4 On Sunday, 27 August 2023, the pilot conducted a flight with a friend who advised him that the rudder cables were sluggish and needed to be changed. On 29 August 2024, the pilot flew to Swellendam Airfield to meet the aircraft manufacturer for the said rudder cable change maintenance. On-board the aircraft, the pilot had a luggage consisting of a suitcase and

sports bag which he had placed on the front seat. The luggage was prepared in case maintenance took longer to complete, or the weather conditions became unconducive, and thus, propel him to stay overnight.

1.6 Aircraft Information

1.6.1 The Tri Cubby (Source: Aircraft type's Pilot Operating Handbook [POH])

The aircraft type is a tandem configuration cockpit arrangement. It has a steel tube construction that is covered with fabric with a high wing configuration. It has a fixed tricycle landing gear and is equipped with a Volkswagen 2.1L engine fitted with a Powerfin two-bladed propeller. When the aircraft's empty weight and balance are calculated properly the centre of gravity (CG) is positioned in front of the wing leading edge. The wing leading edge is the datum from which all arm measurements are taken.

Figure 3: The file picture of the ZU-EIB aircraft. (Source: Manufacturer)

Airframe:

Manufacturer/Model	Micro Wings Cubby, Tri Cubby	
Serial Number	AK 0510 K	
Year of Manufacture	2006	
Total Airframe Hours (at the time of the accident)	Unknown	
Last Inspection (Hours & Date)	270.2	23 May 2023
Hours Since Last Inspection	Unknown	
CRS Issue Date	23 May 2023	
ATF (Issue Date & Expiry Date)	8 September 2017	31 August 2024
C of R (Issue Date) (Present Owner)	23 June 2023	

MTOW	450kg (992 lbs)
Type of Fuel Used	Mogas
Operating Category	NTCA-Part 94
Previous Accidents	None

Note: Previous accidents refer to past accidents the aircraft was involved in, when relevant to this accident.

Engine:

Manufacturer/Model	Volkswagen 2.1L
Serial Number	905
Hours Since New	Unknown
Hours Since Overhaul	Unknown

Propeller:

Manufacturer/Model	Powerfin E 70 FP
Serial Number	90RW8
Hours Since New	Unknown
Hours Since Overhaul	Unknown

1.6.2 A review of the aircraft maintenance manual was conducted. There was an affidavit in the aircraft logbook which stated that the aircraft's initial maintenance records were lost, and a new logbook was opened on 9 September 2016. The aircraft had an Authority to Fly that was issued by the Regulator on 21 August 2023 with an expiry date of 31 August 2024. An annual inspection maintenance was conducted and certified, and the aircraft was issued a Certificate of Release to Service (CRS) on 23 May 2023 at 270.20 airframe hours with an expiry date of 23 May 2024 or at 370.20 airframe hours, whichever comes first.

1.6.3 On 27 August 2023, the pilot flew the aircraft with a friend who advised him about the sluggish rudder cables which required replacement. The pilot arranged to meet with the approved person (AP) who is also the aircraft manufacturer for the replacement of the rudder cables. On 29 August 2023, the rudder cables were replaced. This was confirmed by the AP. The AP had requested the flight folio from the pilot to sign off the work completed on the aircraft, but he was informed that the flight folio was still at the maintenance facility. It was, therefore, not possible for the investigator to obtain the actual number of flight hours post the last annual inspection as the Hobbs meter was also destroyed in the post-impact fire.

1.6.4 It was observed on the front seat that the backrest could fold forward to allow access to the rear seat. The safety harnesses (lap strap) were attached correctly to the aircraft airframe.

1.6.5 Aircraft Mass and Balance

On 13 December 2021, the aircraft's mass and balance was assessed, revealing anomalies in the centre of gravity (CG) calculations. The weight and balance sheet indicated positive

arm measurements behind the wing's leading edge and negative ones in front. For CG calculations, the main wheel arms were negative, and the nose wheel arms were positive. Moments used in the calculations were incorrectly listed as positive instead of negative. The calculated CG was at 18.11% of the Mean Aerodynamic Chord (MAC), outside the specified range of 18% to 33% MAC. This discrepancy was evident when comparing calculated values (219.6 mm and 402.6 mm for 18% and 33% MAC) with the provided values (267 mm and 457 mm).

CoG calculations	Reading	Tare	Weight	Arm	Moment
Right wheel	116,5 kg	0,0	116,5 kg	-53,0 mm	(6 175)
Left wheel	114,0 kg	0,0	114,0 kg	-51,0 mm	(5 814)
Nose or tail wheel	75,0 kg	0,0	75,0 kg	1060,0 mm	79 500
Totals: BEW (Basic Empty Weight)			305,5kg		67 512

CoG location from Wing leading edge. Mm	220,99	mm
CoG location from Wing leading edge.% of Cord	18,11	% OK

An error was also found in the Flight Manual example, which listed the aircraft's arm as -75 mm, implying a CG 75 mm ahead of the datum. The moment should have been -1905, but a positive moment of 1905 was used. Before the accident, the pilot did not have the complete Flight Manual, which only provided an incomplete datum information. The full Flight Manual received after the accident showed the datum at the wing's leading edge, with discrepancies between the nose wheel and tailwheel configurations affecting mass and balance calculations. The Flight Manual specified a CG range of 18% to 33% MAC. There was a minor discrepancy in the specific gravity (SG) of Mogas used for calculations, resulting in a 1.5 kg difference.

Weight	Arm (see the CUBBY picture)	Arm Moment divided by 10
Aircraft = 254	- 75	1905
Fuel = 45	565	2542,5
Pilot = 80	945	7560
Passenger = 70	245	1715
Baggage = 8	1435	1148
TOTAL = 459	N/A	**14870,5**

$$\text{C of G (\% MAC)} = \frac{\text{Arm Moment divided by 10}}{\text{Total Weight (kg)}} = \frac{\mathbf{14870,5}}{\mathbf{459}} = 32,4\%$$

For the flight on 27 August 2023, the pilot had incomplete flight information. Corrections for negative arm moments calculations showed the aircraft was 3kg over the recommended 450kg limit, but the CG was at the forward limit of 18% MAC, which was still within acceptable limits despite the excess weight. The pilot was unaware that the actual weight was 504.5 kg, which is 54.5 kg over limit. This excess weight and forward CG position could have affected handling. A photo from the flight indicated neutral elevator trim, but the elevator and trim tab might have been rigged to create a nose-up force. These issues, along with normal flight manoeuvres may have impacted the aircraft's performance and handling.

Figure 4: Trim tap at nose-up position settings. (Source: Technical Expert)

On 27 August 2023, the pilot was not aware that the aircraft was 305kg and that the total weight was 504.5kg, which was 54.5kg over the weight indicated for the aircraft. Some Cubby information indicates the aircraft's weight was increased to 500kg with a decrease in the G-loading. The CG was also ahead of the 18% to 33% CG range. *The Figure 4 photo was taken during the flight on 27 August 2023, and it indicates that the elevator trim setting was approximately neutral.*

It is possible that the elevator and elevator trim tab were rigged in a way that a nose-up force was created with the elevator trim in a neutral position. The flight on 27 August 2023 was an easy flight with no unusual attitudes other than climb, straight and level flight, turns and descend. The control inputs were observed as usual for such a type of aircraft during flight.

1.7 Meteorological Information

1.7.1 The weather information below was obtained from the Meteorological Aerodrome Report (METAR) that was issued by the South African Weather Service (SAWS) for Cape Town International Aerodrome (FACT) on 29 August 2023 at 1200Z. FACT is 60nm south-west of the accident site, which makes it the closest official weather station.

FACT 291200Z 02013KT CAVOK 31/10 Q1016 NOSIG=

Wind Direction	020°	Wind Speed	13kt	Visibility	9999m
Temperature	31°C	Cloud Cover	None	Cloud Base	None
Dew Point	10°C	QNH	1016hPa		

The METAR for FACT indicates north-easterly wind direction with a moderate surface wind speed of 13 knots (kts). The big difference between current temperate and dew point temperature indicates dry conditions, which coincide with clear conditions presented in the satellite imagery (see Figure 5).

1.7.2 Satellite Image

The Day Natural Colours satellite imagery of the MeteoSat Second Generation (MSG) taken at 1200Z on 29 August 2023 indicates no significant clouds (show clear skies) over the area of the accident.

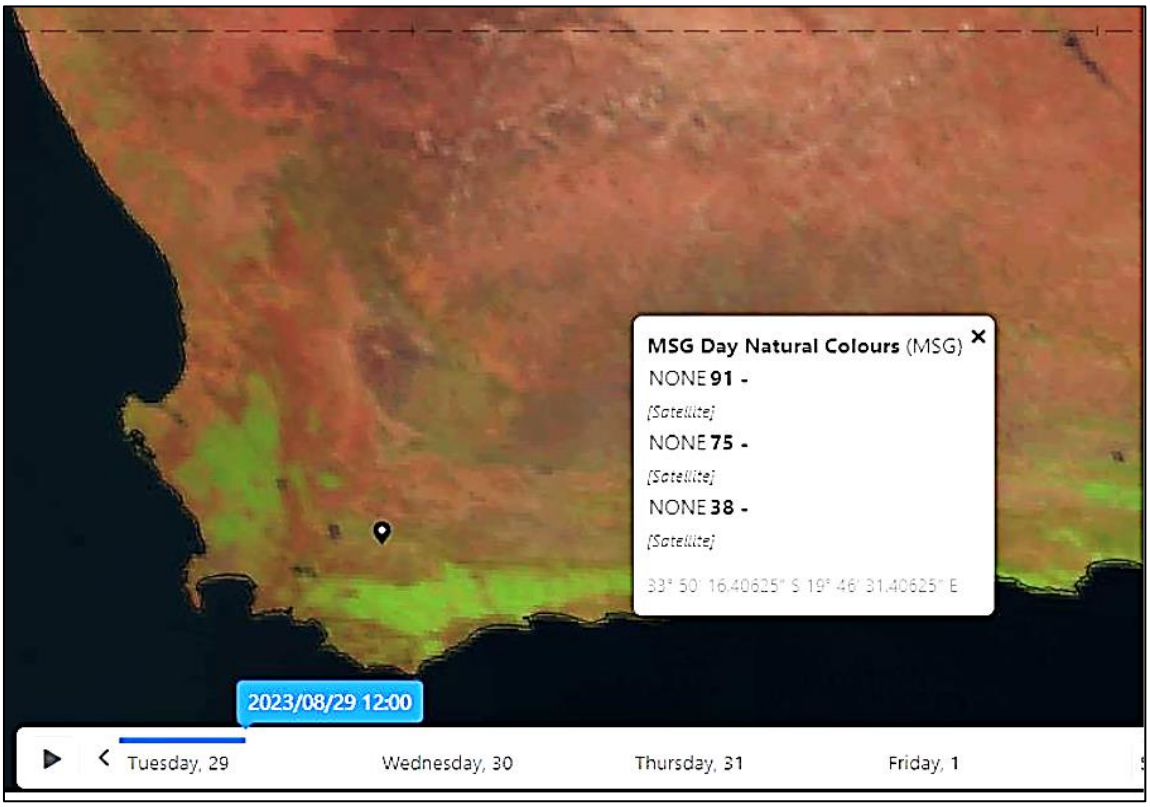

Figure 5: Day Natural Colours satellite imagery at 1200Z on 29 August 2023.

1.7.3 Upper-Air Ascent

The 1200Z Cape Town (FACT-68816) upper air ascent (see Figure 6) valid for 29 August 2023 shows dry conditions which indicate the absence of significant clouds at low levels. This coincides with the clear conditions on the satellite imagery and the METAR above. The profile also shows an increase of 15kts in wind speed between 1000 hPa and 950 hPa, with wind direction backing with height.

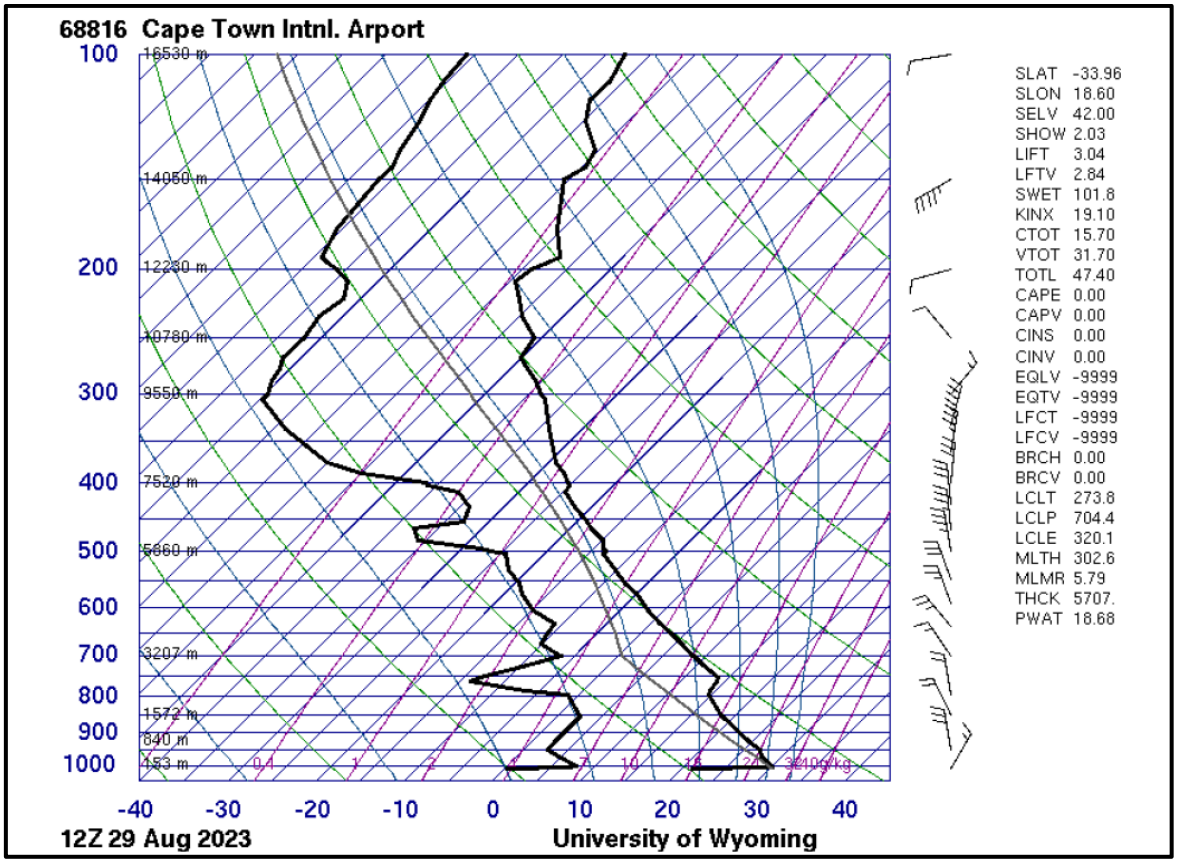

Figure 6: Upper air ascent for FACT on 29 August 2023.

This is an indication of severe low-level turbulence. The presence of low-level inversion in the ascent supports the presence of severe turbulence. In addition, the 15kts north-easterly winds at 153m indicate that there could have been mountain wave turbulence in the north-westerly to south-easterly orientation in the vicinity of the accident site.

1.7.4 Severe Turbulence in Roberston

A pilot on-board a Cessna 172 aircraft with a student pilot who was on a navigational exercise flight from Robertson Airfield (FARS) to Coledon, situated approximately 50nm from the accident site, stated that Robertson is surrounded by mountains which peak to about 5000ft. During the summer months, the prominent winds come from the south-easterly and blow constantly with mild turbulence. During winter months, the winds blow from the north-west with severe turbulence. When these winds blow down the Breede River Valley, severe turbulence is created. The Rooiberg Mountain is 3500ft high and Robertson is situated on its leeward side. He stated that he had experienced extreme turbulence on the precise place (location) where the aircraft accident occurred. He further stated that he would not be surprised if the accident could be attributed to the severe turbulence because during their flight, they experienced severe turbulence and decided to abandon the exercise and fly back to their home base, which is FARS.

1.8 Aids to Navigation

1.8.1 The aircraft was equipped with standard navigational equipment as approved by the Regulator. There were no records indicating that the navigational equipment was unserviceable before the flight.

1.9 Communication

1.9.1 The aircraft was equipped with a standard communication system as approved by the Regulator. There were no recorded defects with the communication system before the flight.

1.10 Aerodrome Information

1.10.1 The accident did not occur at or near the aerodrome.

1.11 Flight Recorders

1.11.1 The aircraft was neither equipped with a flight data recorder (FDR) or a cockpit voice recorder (CVR), nor was it required by regulation to be fitted to the aircraft type.

1.12 Wreckage and Impact Information

1.12.1 The aircraft impacted the ground in a high-speed nose-down attitude in a south-easterly direction, which was the opposite direction to which the aircraft was flying. There were no skid marks or any other damage apart from the aircraft being consumed by the post-impact fuel-fed fire. The aircraft wreckage remained in a nose-down attitude (tail in the air). The attitude at which the aircraft remained is indicative of a nose-dive impact. Emergency Medical Services (EMS) personnel had cut several structural beams to retrieve the deceased. During the on-site investigation by the AIID team, the EMS personnel availed themselves to point out the areas and parts that they had cut.

Figure 7: The aircraft as it came to rest.

1.12.2 No evidence could be found that the structural integrity of the aircraft was compromised, and all the flight controls were accounted for. The elevator trim was found in the full nose-up position (see Figure 9). The two rudder cables that were replaced before the accident flight were found intact and securely connected (see Figure 10). The right rudder cable was, however, cut by the EMS personnel and this was pointed out to the investigators.

Figure 8: Evidence of luggage found in the front cockpit seat. (The left picture shows the luggage as it was found on the aircraft and the right picture shows the remaining parts of the luggage bag).

1.12.3 Evidence of luggage and books was found in the front seat, leaning against the front control stick (column), although the fire had consumed most of it.

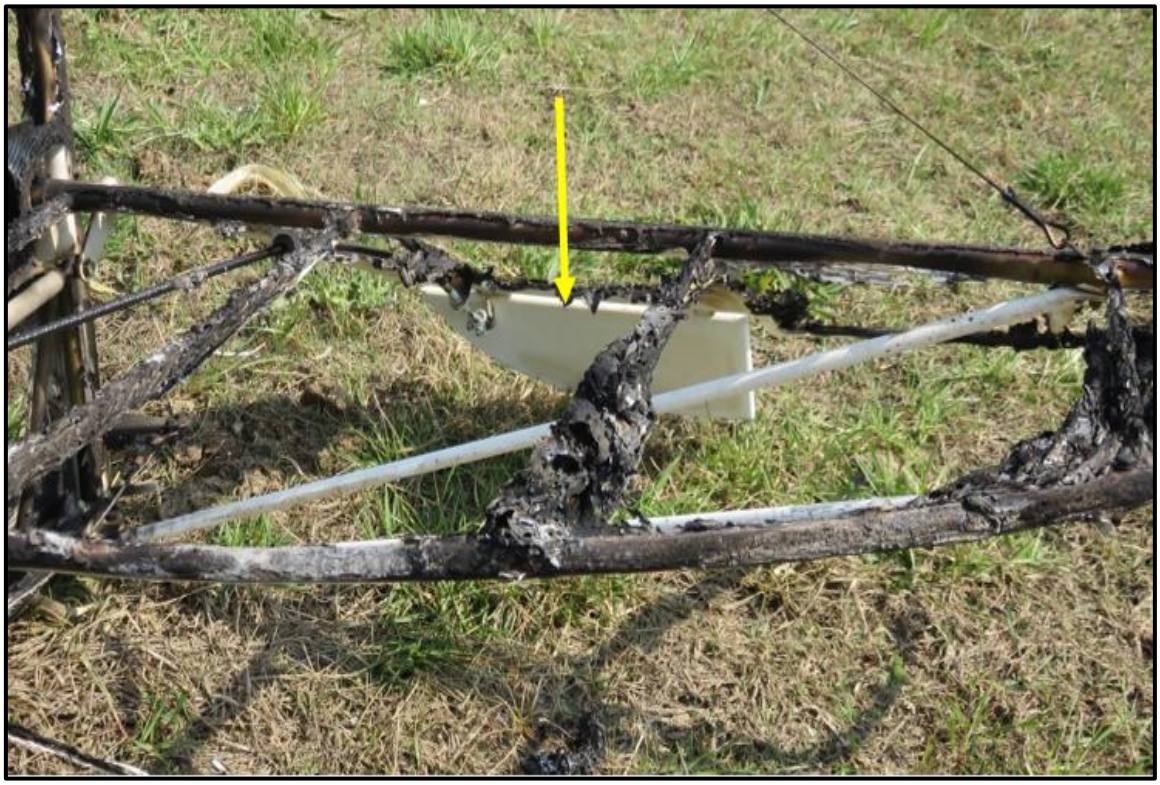

Figure 9: The elevator trim tab in the full nose-up position.

Figure 10: The two rudder cables were secured on both sides of the rudder attachments.

Figure 11: The left wing.

Figure 12: The right wing.

1.13 Medical and Pathological Information

1.13.1 According to the post-mortem report, the pilot sustained fatal injuries due to polytrauma during the accident sequence. "*Polytrauma is a medical term referring to a person who has*

been subjected to multiple traumatic injuries such as serious head injuries in addition to serious burns" (Source: National Institute of Health).

1.14 Fire

1.14.1 The aircraft was consumed by the post-impact fuel-fed fire.

1.14.2 The farm staff from where the accident occurred had used a water tanker to attempt to extinguish the fire. They only had water at their disposal, which had little effect on the fuel-fed fire.

1.14.3 The fire service from the nearest town (Robertson), which was approximately 14 kilometres (km) from the farm, also responded to the accident scene; however, the fire was already contained at the time of their arrival.

1.15 Survival Aspects

1.15.1 The accident was not considered survivable due to the destruction of the cockpit and the post-impact fuel-fed fire.

1.16 Tests and Research

1.16.1 Tests of the aircraft components or systems were not conducted as the aircraft was destroyed by the post-impact fire.

1.17 Organisational and Management Information

1.17.1 This was a private flight conducted under the provisions of Part 94 of the CAR 2011. The pilot was the aircraft owner.

1.17.2 The aircraft's last annual inspection was conducted and certified on 23 May 2023 by an approved person.

1.18 Additional Information

1.18.1 Australian Transport Safety Board - Mountain Waves
Source: https://www.atsb.gov.au/publications/2005/mountain_wave_turbulence

Mountain Waves and Associated Turbulence

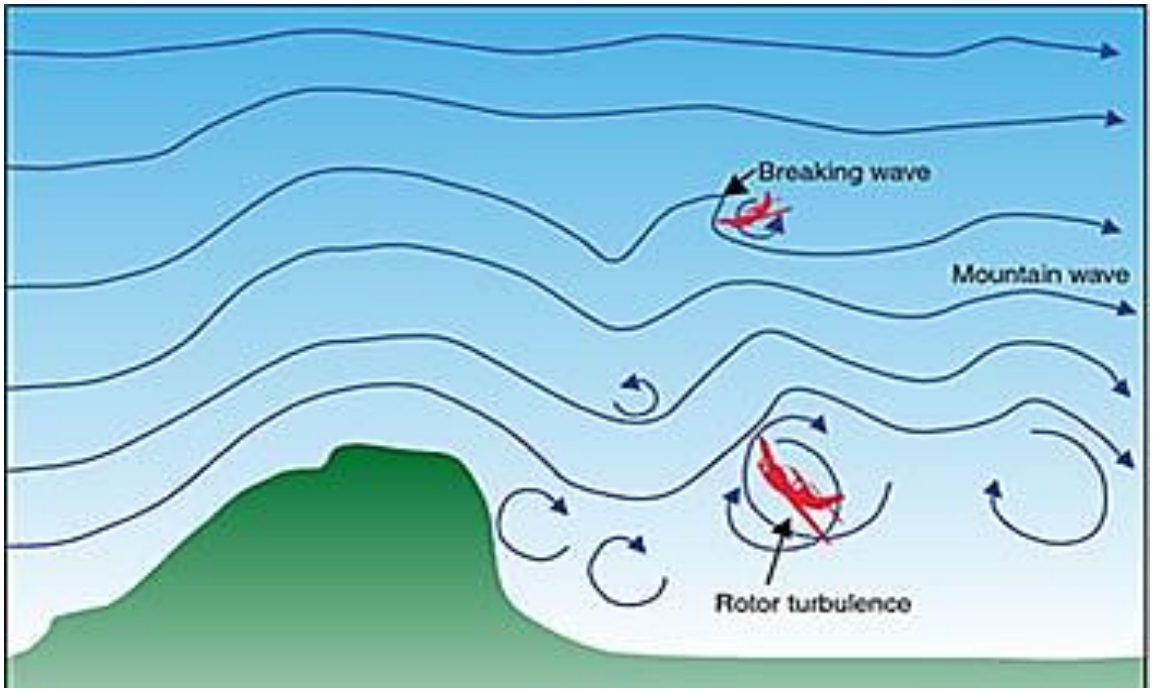

Figure 13: A depiction of mountain waves and turbulence.

In Australia, mountain waves are commonly experienced over and to the lee of mountain ranges in the south-east of the continent. They often appear in the strong westerly wind flows on the east coast in late winter and early spring. Mountain waves are a different phenomenon from the mechanical turbulence found in the leeward side of the mountain ranges and can exist as smooth undulating airflow or may contain clear air turbulence in the form of breaking waves and 'rotors'. Mountain waves are defined as 'severe' when the associated downdrafts exceed 600 ft/min and/or severe turbulence is observed or forecast.

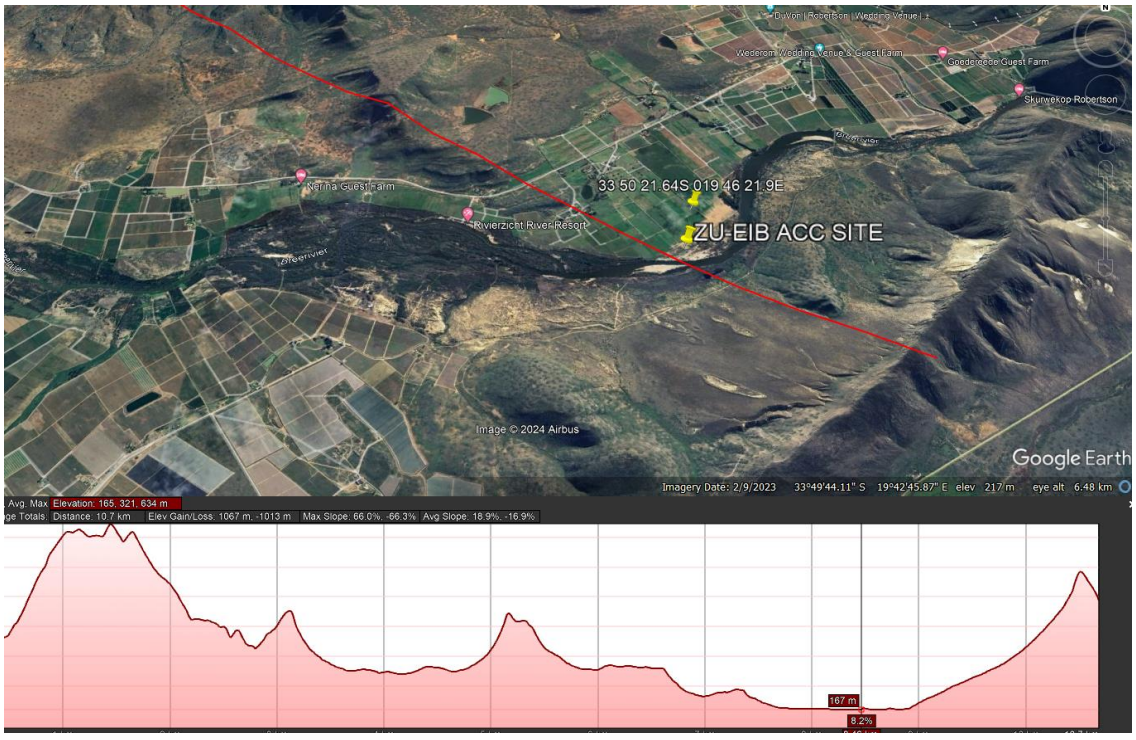

Figure 14: View of the terrain. (Source: Google Map).

'Breaking waves' and 'rotors' associated with mountain waves are among the hazardous phenomena that pilots can experience. Understanding the dynamics of the wind is important in improving aviation safety.

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 organisation or individual.

2.2. Analysis

The pilot

2.2.1 The pilot had a Commercial Pilot Licence (CPL) that was initially issued on 24 May 2010 by the Regulator. His licence renewal was issued on 1 May 2023. The pilot had the aircraft type endorsed on his licence.

2.2.2 The pilot was issued a Class 1 aviation medical certificate on 16 March 2023 with an expiry date of 30 September 2023.

2.2.3 The pilot had conducted his conversion to the aircraft type on 20 May 2023, whereafter the aircraft type was endorsed on his licence. This was the first tandem seat aircraft type that was endorsed on his licence. The pilot flew the aircraft from the aft seat. The conversion flight was a single flight with a duration of 1 hour. The pilot had a total of approximately 415.0 hours.

The aircraft

2.2.4 The aircraft design was such that the centre of gravity (CG) was in front of the datum of the aircraft, which was taken from the wing's leading edge. The arms values of the nose and main landing gears were represented with the wrong values, which could have been misleading to the pilot during mass and balance calculations. The pilot of ZU-EIB was unaware of these errors because he had not received the actual flight folio and empty mass and balance sheet by the time of the accident flight.

2.2.5 The investigation could not determine with certainty how many hours were flown on the aircraft after the last maintenance inspection as the pilot did not have the flight folio with him;

it was still with the AMO that conducted the last maintenance inspection. It was also noted that the pilot flew with a friend on the weekend before the accident flight who advised him to replace the rudder cables as they appeared sluggish during the flight.

2.2.6 Calculations indicate that during the accident flight, the aircraft's centre of gravity (CG) was positioned forward of the limits specified in the flight manual. This forward CG would have necessitated increased elevator input to maintain the nose-up attitude during the flight. This requirement aligns with the observation that the elevator trim tab was found in the nose-up position during the wreckage inspection (see Figure 9). Given that the aircraft was a smaller model with low-wing loading, and considering the turbulent conditions reported in the weather report, it is plausible that the aircraft was already operating at a high angle of attack (AoA). The turbulence could have exacerbated this situation, which led to a stall. The stall likely precipitated a spin, consistent with the eyewitness' account of the aircraft spinning before entering a vertical dive towards the ground, ultimately impacting the terrain.

Environment

2.2.7 The weather conditions indicated good visibility with no clouds below 5000ft in the area of the accident site. The wind was moderate from the north-easterly direction. The possibility of moderate to severe mountain wave turbulence, which could have been hazardous to aviation operations, was present in the area. Keeping in mind the weather report was for FACT, the wind conditions in the mountains were much more severe. This was attested by the Cessna pilot who took off from FARS and was engaged in navigational training with a student pilot when they experienced severe turbulence in the vicinity and decided to abandon training and flew back to home base.

2.2.8 It is likely that during the flight whilst in the area of Robertson, the pilot flew at a height that was within the mountain wave turbulence envelope (range) and it experienced an in-flight upset. This could have caused the aircraft to reach the stall angle of attack (AoA) and enter a spin manoeuvre and the subsequent nose-dive. There is also a possibility that the luggage that was on the front seat fell forward onto the front cockpit's control column, pushing it forward. Although the luggage was secured to the front seat, the seat's backrest design could not restrain the luggage to hold it in place. The pilot was unable to recover the aircraft before it could impact the ground whilst faced with the turbulent conditions and the stall/spin condition that the aircraft entered, as well as the possibility of the luggage shifting during the flight.

2.2.9 The luggage included a suitcase packed with clothes, which the pilot intended to use in case he stayed overnight as he anticipated the possibility of the aircraft maintenance taking too long or the unpredictable weather conditions. According to the eyewitness (AP) in Swellendam, they had advised the pilot during his preparation for departure about the luggage and the prevailing weather conditions. The aircraft had sufficient space behind the

rear seat where the luggage could have been stored, however, there were several aircraft maintenance-related books stored in that space.

2.2.10 On the day of the flight, the weather conditions in the morning were conducive for a safe flight. During the return flight in the afternoon, the pilot flew at a height within the mountain peak as he was aware of the prevailing weather conditions. This was also confirmed by the eyewitness who saw the aircraft as it approached his position.

2.2.11 The pilot sustained fatal injuries due to polytrauma condition during the accident sequence.

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 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 occurring, or would have mitigated the severity of the consequences of the accident. The identification of contributing factors does not imply the assignment of fault or the determination of administrative, civil, or criminal liability.

3.2. Findings

<u>The pilot</u>

3.2.1. The pilot had a Commercial Pilot Licence (CPL) that was initially issued on 24 May 2010 by the Regulator. His renewed CPL was issued on 1 May 2023. The pilot had the aircraft type endorsed on his licence.

3.2.2. The pilot was issued a Class 1 aviation medical certificate on 16 March 2023 with an expiry date of 30 September 2023.

3.2.3. The pilot conducted his conversion to the aircraft type on 20 May 2023, whereafter the aircraft type was endorsed on his licence. This was the first tandem seat aircraft type that was endorsed on his licence. The pilot flew the aircraft from the aft seat. The conversion flight was

a single flight with a duration of 1 hour.

The aircraft

3.2.4. The aircraft's last annual inspection was conducted on 23 May 2023 at 270.2 airframe hours by an AP.

3.2.5. Due to a lack of recorded information, the total airframe hours of the aircraft could not be determined at the time of the accident.

3.2.6. The aircraft was re-issued an Authority to Fly (ATF) on 21 August 2023 with an expiry date of 31 August 2024.

3.2.7. The aircraft's Certificate of Registration (C of R) was issued to the present owner on 23 June 2023.

3.2.8. The aircraft was issued a Certificate of Release to Service (CRS) on 23 May 2023 with an expiry date of 22 May 2024 or at 370.2 airframe hours, whichever comes first.

3.2.9. The aircraft's design was such that the empty weight centre of gravity (CG) was located in front of the datum of the aircraft which was taken as the wing's leading edge. The nose and main landing gear arm moments reflected the incorrect values. The pilot flew the aircraft from the rear cockpit seat to compensate for the CG.

3.2.10. The aircraft's elevator trim tab displayed a nose-up setting during impact.

3.2.11. It could not be determined with certainty how many hours were flown on the aircraft after the last maintenance inspection as the pilot did not have the flight folio during this flight. The flight folio was not in the aircraft as it was still with the AMO that conducted the last maintenance.

Environment

3.2.12. Weather conditions indicated good visibility with no clouds below 5000ft around the accident site. The wind was moderate from the north-easterly direction in Cape Town. The possibility of moderate to severe mountain wave turbulence, which could be hazardous to aviators, was present in the area of the accident scene. It was also evident that there was severe mountain wave turbulence at a height above 5000ft in the vicinity of the accident site.

3.2.13 According to the flight instructor who was flying with a student pilot on-board a Cessna 172 at about the same time this accident occurred stated that they had to return to FARS due to severe turbulence in the area.

3.3. Probable Cause/s

3.3.1. The aircraft encountered mountain wave turbulence during the flight which caused an abrupt flight manoeuvre. As a result, the luggage in the front cockpit seat shifted and rested on the front control column, further pushing it forward. This prevented the pilot from pulling back the controls, which caused the aircraft's nose to pitch down and enter a nose-dive until it impacted the ground.

3.4. Contributory Factor/s

3.4.1. Adverse weather conditions during flight.

3.4.2. The pilot did not ensure that the luggage on the front seat was properly secured before the flight as he did not consider the possibility of the back rest tilting forward.

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 Recommendation/s

4.2.1. It is recommended that the Director of Civil Aviation (DCA), through the Airworthiness Division (AD), to send a notification within 30 days to all Cubby aircraft owners about potential inaccuracies in empty weight mass and balance from their last weighing. The success of this action will be measured by achieving at least a 95% confirmation rate of receipt and understanding among the owners.

4.2.2. It is recommended that the Director of Civil Aviation conducts a comprehensive review within 60 days of the Cubby aircraft's mass and balance procedures in the Pilot's Operating Handbook and the design of the aircraft seats. The review should focus on implementing a firmer seat design with an improved safety harness. The success of this review will be measured by the completion of the review and the documentation of any implemented safety improvements.

5. APPENDICES

5.1. None.

This report is issued by:
Accident and Incident Investigations Division
South African Civil Aviation Authority
Republic of South Africa