AIRCRAFT ACCIDENT REPORT AND EXECUTIVE SUMMARY

				Reference:		**CA18/2/3/10337**	
Aircraft Registration	**ZS-TFH**	**Date of Accident**	21 June 2023			**Time of Accident**	1436Z
Type of Aircraft	Air Tractor AT- 802A			**Type of Operation**		Aerial Works - Firefighting (Part 137)	
Pilot-in-command Licence Type	Commercial Pilot Licence (CPL)			**Age**	49	**Licence Valid**	Yes
Pilot-in-command Flying Experience		**Total Flying Hours**			3 146.80	**Hours on Type**	273.2
Last Point of Departure	Nelspruit Airport (FANS), Mpumalanga Province						
Next Point of Intended Landing	Elandshoogte Airfield near Ngodwana, Mpumalanga Province						
Damage to Aircraft	Destroyed						

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

Nooitgedacht Plantation (SAPPI) in Ngodwana at GPS co-ordinates 25°39′33.03″ S 030°32′10.01″ E at an elevation of 6322 feet (ft)

Meteorological Information	Wind direction: 080°; wind speed: 2 kts; visibility: 5km; cloud cover: scattered; cloud base: 1 300ft; temperature: 19°C; dew point: 11°C; QNH: 1019						
Number of People On-board	1+0	**Number of People Injured**	0	**Number of People Killed**	1	**Other (On Ground)**	0

Synopsis

On Wednesday, 21 June 2023 at 1409Z, a pilot on-board an Air Tractor AT-802A with registration ZS-TFH took off on a firefighting mission from Nelspruit Airport (FANS) in Mpumalanga province to Nooitgedacht Plantation in Ngodwana in the same province. The flight was conducted under visual flight rules (VFR) in visual meteorological conditions (VMC) and under the provisions of Part 137 of the Civil Aviation Regulations (CAR) 2011 as amended.

The ZS-TFH pilot took off from FANS with 3000 litres (l) of water; he released the first load on the left side of the fire and, thereafter, flew to Elandshoogte Airfield Runway 27 to refill the hopper with more water. The aircraft took off again and routed to the scene of the fire. After the pilot released the second load of water on the right side of the fire and whilst maintaining track to fly out, the aircraft impacted the rising terrain and crashed. A video footage was recorded by the spotter aircraft in the vicinity; it showed the aircraft drop its second water load and, thereafter, impacted the rising terrain. The aircraft burst into flames and catapulted forward for approximately 250 metres (m) before it came to rest in an inverted orientation and facing north. The pilot was fatally injured. The aircraft was destroyed by a post-impact fire.

Probable Cause/s and/or Contributory Factors

The pilot misjudged the climb height required to clear the terrain. This resulted in the left main gear and the hopper impacting the rising terrain.

SRP Date	11 June 2024	Publication Date	14 June 2024

Occurrence Details

Reference Number	**:** CA18/2/3/10337
Occurrence Category	**:** Category 1
Type of Operation	**:** Agricultural Operations (Part 137)
Name of Operator	**:** Kishugu Aviation (PTY) LTD
Aircraft Registration	**:** ZS-TFH
Aircraft Make and Model	**:** Air Tractor AT- 802A
Nationality	**:** South African
Registration	**:** ZS-TFH
Place	**:** Nooitgedacht Plantation, Ngodwana, Mpumalanga Province
Date and Time	**:** 21 June 2023 at 1436Z
Injuries	**:** Fatal
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 the occurrence on 21 June 2023 at 1436Z. The occurrence was classified as an Accident according to the CAR 2011 Part 12 and ICAO STD Annex 13 definitions. Notification/s were sent to the State of Registry/Operator/Design/Manufacturer in accordance with CAR 2011 Part 12 and ICAO Annex 13 Chapter 4. The State of Design and Manufacturer had appointed a non-travelling accredited representative and advisor. Investigator/s were dispatched to the Accident site for this Accident.

Notes:

1. *Whenever the following words are mentioned in this report, they shall mean the following:*
   Accident — this investigated accident
   Aircraft — the Air Tractor AT-802A 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

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Abbreviation	Description
°	Degrees
°C	Degrees Celsius
AIID	Accident and Incident Investigations Division
AMO	Aircraft Maintenance Organisation
AOC	Air Operating Certificate
ASL	Air Service Licence
C of A	Certificate of Airworthiness
C of R	Certificate of Registration
CPL	Commercial Pilot Licence
CRS	Certificate of Release to Service
CT	Compressor Turbine
CVR	Cockpit Voice Recorder
FANS	Nelspruit Aerodrome
FDR	Flight Data Recorder
FOD	Foreign object damage
ft	Feet
GPS	Global Positioning System
hPa	Hectopascal
Km	Kilometres
kt	Knots
L.E	Leading edge
m	Metres
METAR	Meteorological Aerodrome Report
MHz	Megahertz
OPS SPEC	Operation Specifications
QNH	Barometric pressure adjusted to sea level
SACAA	South African Civil Aviation Authority
SAPPI	South African Pulp and Paper Industries
SAWS	South African Weather Service
SOP	Standard Operating Procedure
UTC	Co-ordinated Universal Time
VMC	Visual Meteorological Conditions
Z	Zulu (Term for Universal Co-ordinated Time - Zero Hours Greenwich)

1. FACTUAL INFORMATION

1.1. History of Flight

1.1.1. On Wednesday afternoon, 21 June 2023 at 1409Z, a pilot on-board the Air Tractor AT-802A (Bomber) with registration ZS-TFH took off on a firefighting mission with a water load of 3000 litres from Nelspruit Fire dispatch office at Nelspruit Airport (FANS), Mpumalanga province, to Nooitgedacht Plantation in the same province. The flight was conducted in visual flight rules (VFR) and under visual meteorological conditions (VMC) by day. The provisions of Part 137 of the Civil Aviation Regulations (CAR) 2011 as amended were followed for this flight.

1.1.2. According to the operator, ZS-TFH was dispatched with a spotter Cessna 206 aircraft (ZS-PFS), an AT-802, a Thrush, a Huey (ZS-HLA) and a Black Hawk which were also missioned to extinguish the runaway fire that was reported at Nooitgedacht Plantation, a property of the South African Pulp and Paper Industries (SAPPI). The ZS-TFH took off and routed west towards Nooitgedacht Plantation. After reaching the fire scene, ZS-TFH released the first load of water on the left side of the aircraft's approach (left side of the fire) and, thereafter, flew to Elandshoogte Airfield Runway (RWY) 27 to refill the hopper with the second load of water. The pilot took off again from Elandshoogte RWY 27 at 1431Z to drop the second load on the right side of the fire. The pilot released the second load of water and, after initiating a climb, the aircraft impacted the rising terrain and crashed.

1.1.3. The pilot of the Huey ZS-HLA who was dispatched along with ZS-TFH stated that as he was positioning to drop a load of water on the fire after ZS-TFH had completed its drop, he noted ZS-TFH on final approach in a southerly direction. Moments before impact, he realised that the aircraft seemed to be flying lower that the recommended height. Thereafter, he observed the aircraft as it impacted an upslope near the base of the fire; it caught alight and began to disintegrate as it tumbled up the terrain. It came to rest approximately 200 metres (m) near the fire line. He also stated that during the run-in, the aircraft was flying in a southerly direction.

1.1.4. The pilot of the spotter aircraft ZS-PFS stated that he was positioned above the fire approximately 600ft above ground level (AGL). He observed ZS-TFH on short final approach. The ZS-TFH started the water drop on the fire line but impacted the terrain shortly after. He further stated that everything seemed normal at the time when ZS-TFH started the water drop.

1.1.5. The video footage from the spotter aircraft shows ZS-TFH *"dropping the second load of water at 1436Z* (see Figure 1), *about three (3) seconds later, the aircraft is observed impacting the rising ground hard and bursting into flames whilst catapulting forward. It came to rest in an inverted position on the rising terrain* (see Figure 3). After seeing the ZS-TFH on fire, the

other aircraft which were part of the firefighting mission released their water loads on ZS-TFH to extinguish the fire.

1.1.6. An eyewitness who is an employee of SAPPI was travelling in a vehicle at the time. He stated that he observed the aircraft impacting the terrain beyond his parked vehicle. He stated that he ran up the hill to render help to the pilot, but the aircraft was engulfed in flames when he reached the accident site.

1.1.7. The pilot was fatally injured, and the aircraft was destroyed by the post-impact fire.

1.1.8. The accident occurred during daylight at Nooitgedacht Plantation (SAPPI) in Ngodwana at Global Positioning System (GPS) co-ordinates determined to be 25°39′33.03″ South 030°32′10.01″ East, at an elevation of 6322 feet (ft).

Figure 1: ZS-TFH as it released its second load of water. (Source: Operator)

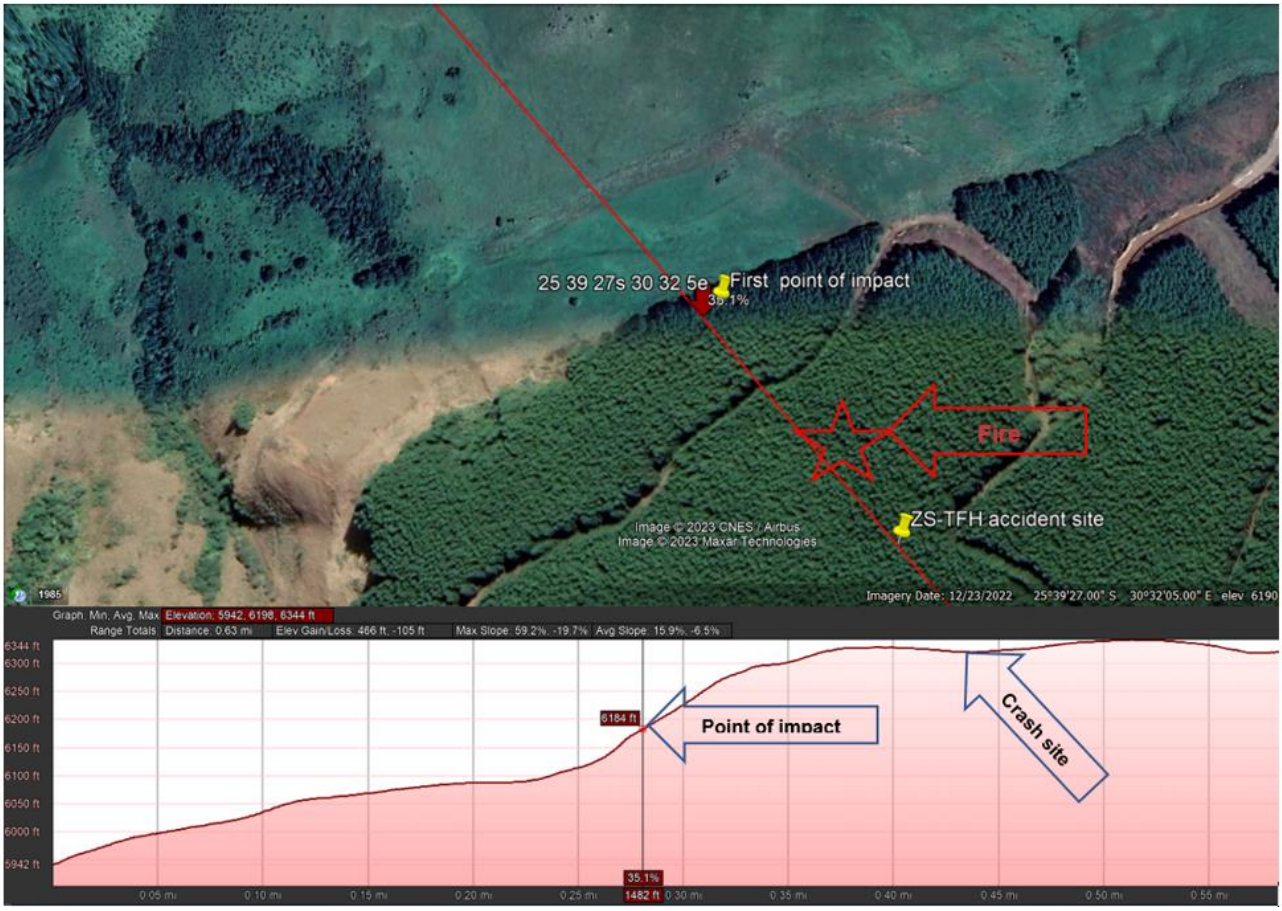

Figure 2: An aerial view (top) and elevation profile (bottom) of the crash site. (Source: Google Earth)

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 post-impact fire.

Figure 3: The wreckage post-accident.

1.4. Other Damage

1.4.1. None.

1.5. Personnel Information

Nationality	South African	Gender	Male	Age	49
Licence Type	Commercial Pilot Licence (CPL)				
Licence Valid	Yes	Type Endorsed	Yes		
Ratings	Instrument and Night ratings				
Medical Expiry Date	31 July 2023				
Restrictions	None				
Previous Accidents	None				

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

Flying Experience:

Total Hours	3 146.80
Total Past 24 Hours	2.5
Total Past 7 Days	4.7
Total Past 90 Days	15.9
Total on Type Past 90 Days	15.9
Total on Type	273.2

1.5.1. The pilot was initially issued a Commercial Pilot Licence (CPL) on 26 February 2009 under Part 61 of the South African Civil Aviation Regulations (CAR) 2011. The licence was revalidated on 5 June 2023, after which a licence was reissued with an expiry date of 30 June 2024. The operator had employed the pilot on 1 May 2019.

1.5.2. The pilot completed his aerial firefighting training on 9 July 2019.

1.5.3. The pilot completed his company's fire season competency and operational check on 19 December 2022, and he was found competent. He also completed his pilot competency check on 30 December 2022 after which a certificate was issued with an expiry date of 30 June 2023.

1.5.4. The pilot was issued a Class 1 medical certificate on 26 July 2022 with an expiry date of 31 July 2023.

1.5.5. The hours in the table above are as per the pilot's logbook which was last updated on 20 June 2023.

1.5.6. The pilot's last day-off was on 13 June 2023. He was rostered to be on duty from 14 to 21 June 2023, but only flew on 17, 19, 20 and 21 June 2023 for a total of 4.7 hours.

1.5.7. The pilot completed his last company's firefighting operational check on 17 June 2023, and he was found competent. He was then issued a certificate with an expiry date of 30 June 2024.

1.5.8. The pilot completed the company's pilot competency check on 6 May 2023, and he was found competent. He was issued a certificate with an expiry date of 30 November 2023.

1.5.9. Pilot Scheduling

Operator's Scheduling Policy (Standard Operating Procedure [SOP])

Scheduling:

Except for the variances published below, crew members shall be scheduled in accordance with the provisions of SA-CATS Parts 96, 127 and 135 respectively.

However, because of the nature of fire-fighting operations Flight crew members may be required to be available for duty for lengthy periods of time before being afforded duty free days.

Flight Crew Members shall:

5.7.1 Accumulate 2 off days per week, for any consecutive period of duty at the base of operations. Such consecutive period shall not exceed 6 weeks unless agreed to by the flight crew member concerned and in no case shall exceed 7 weeks.

5.7.2 Be afforded 1 day travelling time at the beginning and end of each consecutive period of duty which will not form part of the days off period as calculated in 5.7.1

5.7.3 Be planned to have 144 duty free days in each 52-week period which

includes any annual and ad hoc leave and additional days off on low fire danger (FDI) rating periods as determined.

5.7.4 Not be required to work more than 240 duty days in any 52-week period.

Cumulative duty and flying hours

5.7.5 Maximum cumulative duty hours: The average weekly total of duty hours may not exceed seventy hours over seven days, or sixty hours averaged over any two consecutive weeks.

5.7.6 The maximum cumulative duty hours in any 52-week period may not be more than 1680 hours.

5.7.7 All types of duty, flight duty, ground duty, split duty, stand-by and positioning is counted in full for this purpose. Any period of seven or more consecutive days within which the flight crew member is employed on duty other than flight duty, flight watch or home reserve, standby or positioning is not included in calculating the above average weekly total of duty hours.

5.7.8 High Intensity Operations

Minimum Rest Periods during high intensity fire-fighting operations

Consecutive Days of operation	*1*	*2*	*3*	*4*	*5*	*6*	*7*
Hours flown in the period	*7*		*20*	*25*	*29*	*32*	*35*
Min Rest period (hours)	*10*	*1 0*	*24*	*10*	*1 0*	*10*	*48*

5.8 Health and Fatigue Assessments

Flight Crew members are required by law to undergo and pass regular medical assessments. A pilot may only fly if he/she is in possession of a valid flying medical, appropriate to the type of licence possessed.

SA CARS Parts 96, 127 and 135 require the following compliance:

1.5.10 None of the specified limits were exceeded, the pilot was rostered on duty from 14 June 2023, and only started flying on 17 June 2023, three days after the beginning of the duty period.

1.6. Aircraft Information

1.6.1. Air Tractor AT-802A (Source: https://at802f.com/aircraft-overview/aircraft-equipment/)

The Air Tractor AT-802A has a Pratt & Whitney PT6A-67AG 1350 turboprop engine. The aircraft are fitted with a 5-blade constant speed reversing Hartzell propeller. It has an 820-gallon fiberglass hopper, heat-cured derakane resin and 18-gallon foam tank. The aircraft is fitted with computer-controlled rotary- actuated fire gate doors to provide a constant flow rate for drops. It has 11.0-12 low-pressure tyres with dual 4-piston brakes and electrically operated high-lift flaps. The aircraft has 308-gallon fuel tanks, LED position and strobe lights, 600-watt retractable landing lights and LED nose mounted lights. It is fitted with an attitude gyro, turn windows.

Airframe:

Manufacturer/Model	Air Tractor AT-802A	
Serial Number	802A-0214	
Year of Manufacture	1990	
Total Airframe Hours (At Time of Accident)	1930	
Last Inspection (Hours & Date)	1924.7	31 May 2023
Hours Since Last Inspection	5.3	
CRS Issue Date	31 May 2023	
C of A (Issue Date & Expiry Date)	10 February 2015	29 February 2024
C of R (Issue Date) (Present Owner)	3 February 2015	
Type of Fuel Used	Jet A1	
Operating Category	Agricultural Operations (Part 137)	
Previous Accidents	None	

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

Engine:

Manufacturer/Model	Pratt & Whitney PT6A-67F
Serial Number	PCE-RZ 0019
Part Number	PT6A-67F
Hours Since New	1265.9
Hours Since Overhaul	TBO not yet reached

Propeller:

Manufacturer/Model	Hartzell HC-B5MA-3D
Serial Number	HBA 1685
Part number	HC-B5MA-3D
Hours Since New	1265.3
Hours Since Overhaul	190.4

1.6.2. According to available information, the aircraft was first registered to the present owner on 3 February 2015. The Certificate of Release to Service (CRS) was reissued on 31 May 2023 with an expiry date of 30 May 2024 or at 2024.7 hours, whichever occurs first.

1.6.3. Overhaul intervals are 3000 hours and 1500 hours hot section inspection for the engine, and 3000 hours or 72 months for the propeller blades.

1.7. Meteorological Information

1.7.1. The weather information below was obtained from the weather report that was issued by the South African Weather Service (SAWS), recorded at Kruger Mpumalanga Aerodrome (FAKN) on 21 June 2023 at 1400Z. FAKN is located 53 kilometres (km) from the accident site.

Wind Direction	45°	Wind Speed	7kts	Visibility	5km
Temperature	17°C	Cloud Cover	Scattered	Cloud Base	2 500ft
Dew Point	11°C	QNH	1027 hPa		

1.7.2 The following weather conditions were reported by the pilot of the Huey (UH-1H) (ZS-HLA), dispatched with ZS-TFH.

Wind Direction	310°	Wind Speed	10-15kts	Visibility	10km
Temperature	25°C	Cloud Cover	None	Cloud Base	Clear
Dew Point	Unknown	QNH	Unknown		

1.8. Aids to Navigation

1.8.1. The aircraft was equipped with standard navigational equipment as approved by the Regulator (SACAA). There were no records indicating that the navigational equipment was unserviceable prior to 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 prior to the flight. The aircraft was in communication with the dispatching officer on frequency 123.55-Megahertz (MHz).

1.10. Aerodrome Information

1.10.1 The accident occurred 17km south-east of Elandshoogte Airfield.

Aerodrome Name	Elandshoogte Airfield
Aerodrome Location	Nelspruit, Mpumalanga Province
Aerodrome Status	Unlicensed
Aerodrome GPS coordinates	25°30'21.76" South 030°29'43.19" East
Aerodrome Elevation	6273 ft
Runway Headings	09/27
Dimensions of Runway Used	1159 X 12
Heading of Runway Used	N/A
Surface of Runway Used	Asphalt
Approach Facilities	None
Radio Frequency	124.8 MHz

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 on this aircraft.

1.12. Wreckage and Impact Information

1.12.1. The aircraft impacted the rising terrain and dispersed in a radius of 350m. The aircraft impacted the terrain with the left-side main landing gear and the hopper and then burst into flames. It catapulted forward for approximately 250m before it came to rest in an inverted position facing north.

Figure 5: A blue paint mark on the rock that the aircraft's hopper impacted.

1.12.2 Both main landing gears and the hopper separated from the fuselage and dispersed in the direction in which the aircraft catapulted. The tail wheel remained attached to the main wreckage. The wings were damaged by impact forces but remained attached to the fuselage. The flaps and ailerons separated from the wings.

Figure 6: The direction of flight, the area that was on fire (pre-existing) and position of the eyewitness. (Source: Operator)

1.12.3 The aircraft was flying perpendicular to the wind direction (see Figure 7 below).

Figure 7: Wind direction at the time ZS-TFH released water on the fire line. (Source: Operator)

Figure 8: The front view of the main wreckage with damaged wings.

Figure 9: Left view of the main wreckage.

1.12.4 The right-side flap was found approximately 10m from the main wreckage; it was severed before the aircraft came to rest.

Figure 10 and 11: Shows bottom and top view of the right-side flap.

1.12.5 The left and right ailerons broke off from the wing trailing edge during the accident sequence.

Figure 12: The right-side aileron with the trim tab missing. **Figure 13:** Shows the left-side aileron with the trim tab still attached.

1.12.6 The jackscrew was found in an open position, an indication that the flaps were extended (down).

Figure 14: The open flap jackscrew.

1.12.7 Parts of the aircraft separated and scattered in different directions, including the propeller blades. Only three of the five blades were recovered.

Figures 15, 16 and 17: Three of the five propeller blades were recovered at the accident site.

1.13. Medical and Pathological Information

1.13.1 Post-mortem examination revealed that the pilot succumbed from a blunt force to his chest and head injuries consistent with high energy impact. There was no soot in the upper airways which suggested that the pilot had already deceased when he sustained the burn injuries.

1.14. Fire

1.14.1. A post-impact fire destroyed the aircraft.

1.15. Survival Aspects

1.15.1. The accident was not considered survivable because of the impact forces that destroyed the aircraft's cabin, as well as the post-impact fire.

1.16. Tests and Research

1.16.1. On 3 May 2023 (prior to the accident) a borescope inspection was conducted on the Pratt & Whitney PT6AF engine serial number PCE-RZ0019 to evaluate the engine component condition in the compressor and hot section. According to the borescope report, the following was found:

Compressor Section:

The overall condition of the viewed compressor section components is considered fair, with moderate coating deterioration on the inlet case and light levels of erosion and FOD and to the L.E.'s of the 1st stage compressor rotor & stator and 2nd stg. Recommend monitoring the inlet housing coating deterioration/loss for adverse progression or perform an insitu coating restoration repair.

Hot Section:

The overall condition of the viewed hot section components is considered fair with moderate levels of wear and deterioration observed. Note: Recommend performing a shroud segment hand grind repair to remove the material build-up in order to save/extend CT blade life.

1.16.2. On 11 July 2023 a post-accident engine borescope was conducted on the Pratt & Whitney PT6AF serial number PCE-RZ0019 to evaluate the engine component condition in the compressor and hot section. The inspection was conducted in the presence of the investigating team. The following was found.

Compressor section:

The first stage compressor rotor blades, first stage compressor stator and the second stage compressor blades. Compressor inlet housing was found in fair condition with moderate coating deterioration and associated areas of coating loss and dirt build-up observed. First stage compressor rotor blades found in fair condition with light to moderate levels of FOD & erosion and with previous blends observed. First stage stator and second stage compressor blades found in fair condition with light levels of erosion and FOD/nicks observed. Heavy levels of dirt and debris contamination observed throughout the compressor section.

Hot Section:

Access through the fuel nozzle ports was used to inspect the compressor turbine blades, shroud segments, compressor turbine vane ring, small exit duct, fuel nozzles and combustion chamber liner. Combustion chamber liner condition was in fair condition with multiple spots of thermal erosion with coating loss on cooling ring and with carbon build-up observed. The compressor turbine blades were found in fair condition, with dust build up and light thermal erosion observed. Compressor turbine (CT) shroud segments found in fair condition with light

levels of thermal erosion observed. Compressor turbine vane ring was found in fair condition with light coating deterioration, dust build-up and one outer wall crack onto vane L.E. observed. S.E. duct was found in a good condition with light thermal coating deterioration observed. Fuel nozzles inspected and found in good condition with light carbon build-up around the sheaths. The second stage power turbine blade condition with light thermal coating deterioration and light surface corrosion observed evidence of dirt and debris contamination observed throughout the hot section area.

1.16.3 Borescope summary: Engine s/n PCE-RZ0019

Compressor section:

The overall condition of the viewed compressor section components is considered fair, with moderate coating deterioration on the inlet case and light levels of erosion to the L.E.'s of the 1st stage compressor rotor & stator and 2nd stg. rotor observed. Foreign debris observed throughout the compressor section.

Hot Section:

The overall condition of the viewed hot section components is considered fair with normal levels of wear and deterioration observed. Foreign debris observed throughout the hot section. No evidence of component failure was observed to the viewed sections. See Appendices 1 for the full engine borescope report.

1.17. Organisational and Management Information

1.17.1. The flight was conducted in accordance with the provisions of Part 137 (Agricultural Operations) of the CAR 2011 as amended.

1.17.2. The aircraft maintenance organisation (AMO) which conducted the last maintenance inspection on the aircraft had an approved AMO certificate that was issued by the Regulator on 1 January 2023 with an expiry date of 31 January 2024.

1.17.3. The operator was last audited by the Regulator on 10 November 2022, after which an Air Operating Certificate (AOC) was issued on 14 November 2022 with an expiry date of 30 November 2023. The ZS-TFH aircraft was endorsed on the operator's operations specifications (OPS SPEC).

1.17.4. The operator was issued an Air Service Licence (ASL) on 8 July 2019.

1.18. Additional Information

1.18.1 None.

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

2.2.1 The pilot's last day-off was on 13 June 2023. He was rostered to be on duty from 14 to 21 June 2023 but only flew on 17, 19, 20 and 21 June 2023. According to the roster, SOP and regulations, the pilot was rostered within limits. The pilot had conducted similar operations many times in the past. The pilot was familiar with the operational environment and how to extinguish a runaway fire. He was qualified and had the correct rating for this flight.

2.2.2 The ZS-TFH was dispatched with four other aircraft to a firefighting mission to extinguish the runaway fire that was reported at Nooitgedacht Plantation. After reaching the scene, ZS-TFH released the first load of water on the left side of the aircraft's approach (left side fire) and, thereafter, flew to Elandshoogte Airfield Runway 27 to refill the hopper with the second load of water. The pilot took off again from Elandshoogte Runway 27 to drop the second load on the right side of the fire.

2.2.3 The aircraft dropped the water load, impacted the rising terrain with the left main gear and the hopper, and burst into flames. Just before impact, the tail of the aircraft projected down, which indicated that the pilot tried to pull up, but the left main landing gear and the hopper struck the ground. There was insufficient time and distance for the aircraft to gain enough altitude to clear the terrain. The aircraft impacted the rising ground and caught fire; thereafter it catapulted forward for approximately 250m. It came to rest in an inverted position. After witnessing ZS-TFH on fire, the other aircraft on the firefighting mission released water loads on ZS-TFH to extinguish the post-impact fire.

2.2.4 The aircraft was maintained in accordance with the approved maintenance procedure and schedule. The on-site wreckage examinations did not identify any aircraft defects or anomalies that might have contributed to or caused the accident. A post-accident engine borescope found no evidence of component failure in the reviewed sections. All five propeller blades separated and scattered in different directions during the accident sequence, and only three of the five blades were recovered.

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

3.2.1 The pilot was issued a Commercial Pilot Licence (CPL) on 26 February 2009 in accordance with Part 61 of the South African CAR 2011. The licence was revalidated on 5 June 2023, after which a licence was reissued with an expiry date of 30 June 2024.

3.2.2 The pilot was issued a Class 1 medical certificate on 7 December 2021 with an expiry date of 31 July 2023.

3.2.3 The pilot completed his aerial firefighting training on 9 July 2019. His last competency check was conducted on 17 June 2023 with an expiry date of 20 June 2024. The pilot completed a company fire season competency and operational check on 19 December 2022.

3.2.4 The last update on the pilot logbook was on 20 June 2023.

3.2.5 The AMO which conducted the last maintenance inspection prior to the flight had an AMO certificate that was issued by the Regulator on 1 September 2022 with an expiry date of 31 September 2023.

3.2.6 The last annual inspection on the aircraft was conducted on 31 May 2023 at 1924.7 airframe hours. The aircraft was issued a Certificate of Release to Service (CRS) on 31 May 2023 with an expiry date of 30 May 2024 or at 2024.7 hours, whichever occurs first.

3.2.7 The operator was last audited by the Regulator on 10 November 2022, after which an AOC was issued on 14 November 2022 with an expiry date of 30 November 2023. The ZS-TFH aircraft was endorsed on the operator's Ops Spec.

3.2.8 Clear weather conditions prevailed at the time of the flight.

3.2.9 The aircraft was flying perpendicular to the wind direction. This meant that the wind was pushing the water towards the fire.

3.2.10 The pilot did not achieve a positive rate of climb after the second water drop. The pilot attempted to pull up, but he was late; the left main gear and the hopper impacted the rising terrain.

3.2.11 The aircraft impacted the rising terrain with the left-side main landing gear and hopper before it burst into flames and catapulted forward for approximately 250m; it came to rest in an inverted position facing north.

3.2.12 The weather did not have a bearing to this accident.

3.3. Probable Cause/s

3.3.1 The pilot misjudged the climb height required to clear the terrain. This resulted in the left main gear and the hopper impacting the rising ground.

3.4 Contributory Factor/s

3.4.1 None.

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. None.

5. APPENDICES

5.1. Appendix 1: Post-accident borescope report:

This report is issued by:

Accident and Incident Investigations Division
South African Civil Aviation Authority
Republic of South Africa

Post-accident borescope report:

Turbine Engine Management Services (Pty) Ltd

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ENGINE BORESCOPE CONDITION REPORT

Date: 11/07/2023 **Customer: FFA Aviation**

Engine Model: PT6A-67F **Engine s/n: PCE-RZ0019**

Aircraft Serial Number: ZS-TFH **Job Number: T2583**

A borescope inspection was performed to evaluate engine component condition in the follow areas flowing aircraft crash: Compressor section and Hot section.

Engine s/n. PCE-RZ0019.

Compressor Section: Access through the inlet housing was used to inspect the inlet housing, 1st stage compressor rotor blades, 1st stage compressor stator and the 2nd stage compressor blades. Compressor inlet housing was found in fair condition with moderate coating deterioration and associated areas of coating loss and dirt build-up observed. 1st stage compressor rotor blades found in fair condition with light to moderate levels of FOD & erosion and with previous blends observed. 1st stage stator and 2nd stage compressor blades found in fair condition with light levels of erosion and FOD./nicks observed. Heavy levels of dirt and debris contamination observed throughout the compressor section.

Compressor inlet housing condition with areas moderate coating deterioration and associated coating loss. Evidence of foreign debris observed (Grass, sand/dirt etc..).

1st stage compressor blade condition with light levels of erosion and oil wetness observed. Foreign debris observed.

1st stage compressor blade condition with light levels of erosion and oil wetness observed. Foreign debris observed.

1st stage stator with light L.E. erosion and dirt build-up observed. 2nd stage comp. blade condition with light L.E. erosion observed. Foreign debris observed in 2nd stg. compressor area.

Hot Section: Access through the fuel nozzle ports was used to inspect the compressor turbine blades, shroud segments, compressor turbine vane ring, small exit duct, fuel nozzles and C.C. liner. C.C. liner condition in fair condition with multiple spots of thermal erosion with coating loss on cooling ring and with carbon build-up observed. The compressor turbine blades were found in fair condition, with dust build up and light thermal erosion observed. C.T. shroud segments found in fair condition with light levels of thermal erosion observed. Compressor turbine vane ring was found in fair condition with light coating deterioration, dust build-up and one outer wall crack onto vane L.E. observed. S.E. Duct was found in a good condition with light thermal coating deterioration observed. Fuel nozzles inspected and found in good condition with light carbon build-up around the sheaths. 2nd stg. P.T. blade condition with light thermal coating deterioration and light surface corrosion observed. Evidence of dirt and debris contamination observed throughout the hot section area.

Combustion chamber with light thermal erosion and foreign debris observed.

C.T. blade and segment condition with light erosion and dust build-up observed. Foreign debris observed in CT. area.

C.T. vane condition with light thermal coating deterioration, dirt build-up and light cracking

SED. condition with light thermal deterioration, coating loss and dirt build-up. Foreign matter observed.

2nd stg. P.T. blade condition with light thermal coating deterioration and light surface corrosion. Foreign debris observed forward of 2nd stg. PT. blades.

Borescope summary:

Engine s/n PCE-RZ0019.

Compressor section: The overall condition of the viewed compressor section components is considered fair, with moderate coating deterioration on the inlet case and light levels of erosion to the L.E.'s of the 1st stage compressor rotor & stator and 2nd stg. rotor observed. **Foreign debris observed throughout the compressor section.**

Hot Section: The overall condition of the viewed hot section components is considered fair with normal levels of wear and deterioration observed. **Foreign debris observed throughout the hot section.**

No evidence of component failure was observed to the viewed sections.

Note:. Due to the nature of borescope inspections and the limited access to internal components, the findings in this report are limited to the viewed areas only. Turbine Engine Maintenance Repair & Overhaul (Pty) Ltd , are in no way liable for any damages or claims made against, with respect to the work performed and the contents of this report.

Note: This report does not constitute a CRMA or a Certificate of release.