SOUTH AFRICAN CIVIL AVIATION AUTHORITY

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

AIRCRAFT ACCIDENT REPORT AND EXECUTIVE SUMMARY

		Reference:		CA18/2/3/9945	
Aircraft Registration	**ZS-TCJ**	**Date of Accident**	21 January 2021	**Time of Accident**	1545Z
Type of Aircraft	Air Tractor AT-402B		**Type of Operation**	Aerial Work Operations (Part 137)	
Pilot-in-command Licence Type	Airline Transport Pilot Licence		**Age** 52	**Licence Valid**	Yes
Pilot-in-command Flying Experience	**Total Flying Hours**		18 290.7	**Hours on Type**	114.4

Last Point of Departure	Farm Sardinia in the Bultfontein District, Free State Province
Next Point of Intended Landing	Hoopstad Airfield, Free State Province
Damage to Aircraft (Substantial/Destroyed)	Destroyed

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

Farm Sardinia, Bultfontein, Free State Province; GPS co-ordinates: 28º 04' 56" S, 026º 05' 37" E at an elevation of 4 214ft

Meteorological Information	Wind speed: 02kt, Wind direction: variable, Visibility: 9999, Air temperature: 30°C						
Number of People On-board	1 + 0	**Number of People Injured**	0	**Number of People Killed**	1	**Other (On Ground)**	0

Synopsis

On Thursday, 21 January 2021, a pilot on-board an Air Tractor AT-402B aircraft with registration ZS-TCJ was engaged in a commercial crop-spraying operation at Farm Sardinia located between Hoopstad and Bultfontein in Bloemfontein, Free State Province. The operation was conducted under the provisions of Part 137 of the Civil Aviation Regulations (CAR) 2011 as amended. The crop-spraying operation was started the previous day (20 January 2021) and, in the morning of 21 January 2021, the aircraft was flown to New Tempe Aerodrome (FATP) for a scheduled mandatory period inspection (MPI). The arrangement was that after completion of the MPI, the aircraft would be flown back to Farm Sardinia for chemical and fuel upload; the ground crew tasked to help with the operation was stationed at the farm.

According to the ground crew personnel, the aircraft took off from FATP at 1100Z and landed at Farm Sardinia airstrip approximately 36 minutes (0.6 hours) later. Upon arrival, the ground crew prepared the aircraft for a crop-spraying operation where the first chemical solution load was uplifted. No fuel upliftment was required as the aircraft had enough fuel at that time (fuel uplift of 326 litres was added to 664 litres which was in the tanks prior to the flight to FATP). The aircraft commenced with the operation and completed three loads uneventfully, which were approximately 20 minutes apart between landing and loading. The last load was uplifted at approximately 1330Z in which the pilot was to complete the first sector. The aircraft was expected to land back at the farm at approximately 1400Z to load the next crop-spraying solution for the second sector; however, the expected landing time passed. The aircraft was observed still flying in a pattern used for crop-spraying over the farm. The last time the aircraft was heard flying was at approximately 1545Z over a maize field in the same farm.

According to one of the ground crew members, the aircraft was expected to land back at its home base in Hoopstad at approximately 1600Z. The aircraft did not arrive and the search for the missing aircraft was initiated through social media. The Aeronautical Rescue Coordination Centre (ARCC) was contacted at about 1800Z and an official search and rescue mission was initiated. The wreckage of the aircraft was located by the South Africa Police Service (SAPS) helicopter crew early the next morning.

The wreckage was found in an inverted position on a maize field on the farm the pilot was crop-spraying. The pilot had succumbed to his injuries and the aircraft was destroyed during the accident sequence. All relevant parties were informed about the accident.

Probable Cause/s and/or Contributory Factors			
The pilot performed a high nose turn which inadvertently placed the aircraft in an impending stall. The aircraft's nose dropped and the pilot's inputs further worsened the situation, causing the aircraft to roll and impact the ground in an inverted attitude and at a high angle of impact. **Contributory factor**: Incorrect technique used to recover the aircraft induced side slip during a turn which possibly led to a stall. Pilot's insufficient aircraft knowledge in relation to the accident aircraft's limitations.			
SRP date	8 March 2022	Publication date	18 March 2022

INTRODUCTION

Reference Number	**:** CA18/2/3**/**9945
Name of Owner/Operator	**:** Proman Lugbespruiting (PTY) LTD
Manufacturer	**:** Air Tractor Incorporated
Model	**:** AT-402B
Nationality	**:** South African
Registration marking:	**:** ZS-TCJ
Place	**:** Private Farm Sardinia, Bultfontein District, Free State Province
Date	**:** 21 January 2021
Time	**:** 1545Z

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 was notified to the Accident and Incident Investigations Division (AIID) on 22 January 2021 at about 0400Z. The investigator dispatched to Farm Sardinia near Bultfontein, Free State Province, on 22 January 2021 to conduct an on-site investigation. Notifications were sent to the State of Registry, State of Operator, and State of Manufacture and Design. The investigator co-ordinated with all authorities on site by initiating the accident investigation process according to CAR Part 12 and investigation procedures. The AIID is leading the investigation as the Republic of South Africa is the State of Occurrence.

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-402B 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
AIID	Accident and Incident Investigations Division
º	Degree
ºC	Degree Celsius
'	Minutes
"	Seconds
AG ratings	Agricultural Ratings
AGL	Above Ground Level
AMSL	Above Mean Sea Level
AMO	Aircraft Maintenance Organisation
ARCC	Aeronautic Rescue Coordination Centre
ATPL	Airline Transport Pilot Licence
CRS	Certificate of Release to Service
CVR	Cockpit Voice Recorder
CAR	Civil Aviation Regulations 2011
C of A	Certificate of Airworthiness
C of R	Certificate of Registration
CRS	Certificate of Release to Service
CVR	Cockpit Voice Recorder
FAKS	Kroonstad Airfield
FAPY	Parys Airfield
FATP	New Tempe Aerodrome
FDR	Flight Data Recorder
ft	Feet
GPS	Global Positioning System
hPa	Hectopascal
Kts	Knots
METAR	Meteorological Routine Aerodrome Report
MHz	Megahertz
Mph	Miles Per Hour
MPI	Mandatory Periodic Inspection
MSB	Mandatory Service Bulletin
No.	Number
PIC	Pilot-in-command
POH	Pilot Operating Handbook
QNH	Barometric pressure adjusted to sea level
SB	Service Bulletin
SI	Service Instruction
UTC	Co-ordinated Universal Time
VHF	Very High Frequency
Z	Zulu (Term for Co-ordinated Universal Time – Zero Hours Greenwich)

FACTUAL INFORMATION

1.1. History of Flight

1.1.1 On Thursday, 21 January 2021, a pilot on-board an Air Tractor AT-402B aircraft with registration ZS-TCJ was engaged in a commercial crop-spraying operation at Farm Sardinia, located between Hoopstad and Bultfontein in the Free State Province, when the accident occurred. The operation at Farm Sardinia was started on 20 January 2021, whereafter the aircraft returned to Hoopstad. The operation was uneventful. According to the ground crew, in the morning of 21 January 2021, the aircraft was uplifted with 326 litres of illuminating paraffin fuel to the 664 litres (three quarters full) already in the tank at its home base in Hoopstad Airfield, prior to the flight to New Tempe Airport (FATP) where a scheduled mandatory periodic inspection (MPI) was to be undertaken. The flight duration from Hoodstad to FATP was approximately 0.6 hours. Following the completion of the maintenance, a test flight was conducted and, thereafter, the aircraft was signed off and released to service. The pilot then conducted a pre-flight inspection in preparation for a flight to Farm Sardinia to continue with the crop-spraying operation which had started the previous day. The aircraft took off from FATP at approximately 1100Z and landed at Farm Sardinia private airstrip at approximately 1140Z. The flight lasted approximately 0.6 hours.

1.1.2 The ground crew was dispatched to assist the pilot with upliftment of fuel and crop-spraying chemical solution on site. The crop-spraying operation was conducted during visual meteorological conditions (VMC) by day and under the provisions of Part 137 of the Civil Aviation Regulations (CAR) 2011 as amended.

1.1.3 According to one of the ground crew members, upon arrival at the farm, the ground crew prepared the aircraft for the crop-spraying operation. An estimated 1000 kilograms of chemical mixture containing Sulphate, Kynoch water solution soluble fertiliser and super kelp was prepared for each spray run. One ground crew member stated that the aircraft did not require any fuel upliftment for the operation on the day as it had sufficient fuel on-board for the operation. The pilot was expected to spray two sectors of the farm on the day (21 January 2021).

1.1.4 The aircraft took off and the pilot commenced with the first crop-spraying operation run at approximately 1152Z. The aircraft made three landings between crop-spraying operation flights to load the crop-spraying solution. Each spray run lasted approximately 20 minutes. The second load was at 1218Z, and the third load at 1253Z. The last load was undertaken at approximately 1330Z in which the pilot was to complete the first sector. The aircraft was expected to land back at the farm at approximately 1400Z to uplift another load to commence with the second sector of crop-spraying. However, the expected landing time passed, and the pilot had not returned to the farm for the next upload. The aircraft was observed still flying in a pattern used for crop-spraying over the farm.

1.1.5 According to the ground crew member, the aircraft did not return for any upload of chemical; moreover, the aircraft was expected to land back at its home base in Hoopstad at approximately 1600Z. When the aircraft did not return, the ground crew contacted the operation offices to report the aircraft as missing; whereafter the search for the missing aircraft was initiated through social media. The Aeronautical Rescue Coordination Centre (ARCC) was contacted at about 1800Z and an official search and rescue was initiated. The wreckage of the aircraft was located by the South African Police Service (SAPS) helicopter crew on the farm, early the next morning.

1.1.6 The aircraft was found in an inverted position in a maize field (at the same farm where crop-spraying was being undertaken). The pilot had succumbed to his injuries; and the aircraft was destroyed during the accident sequence. The aircraft accident occurred on a farm during day light in visual meteorological conditions (VMC) at Global Positioning System (GPS) co-ordinates determined to be: 28º 04' 56" South, 026º 05' 37" East at an elevation of 4 214 feet (ft).

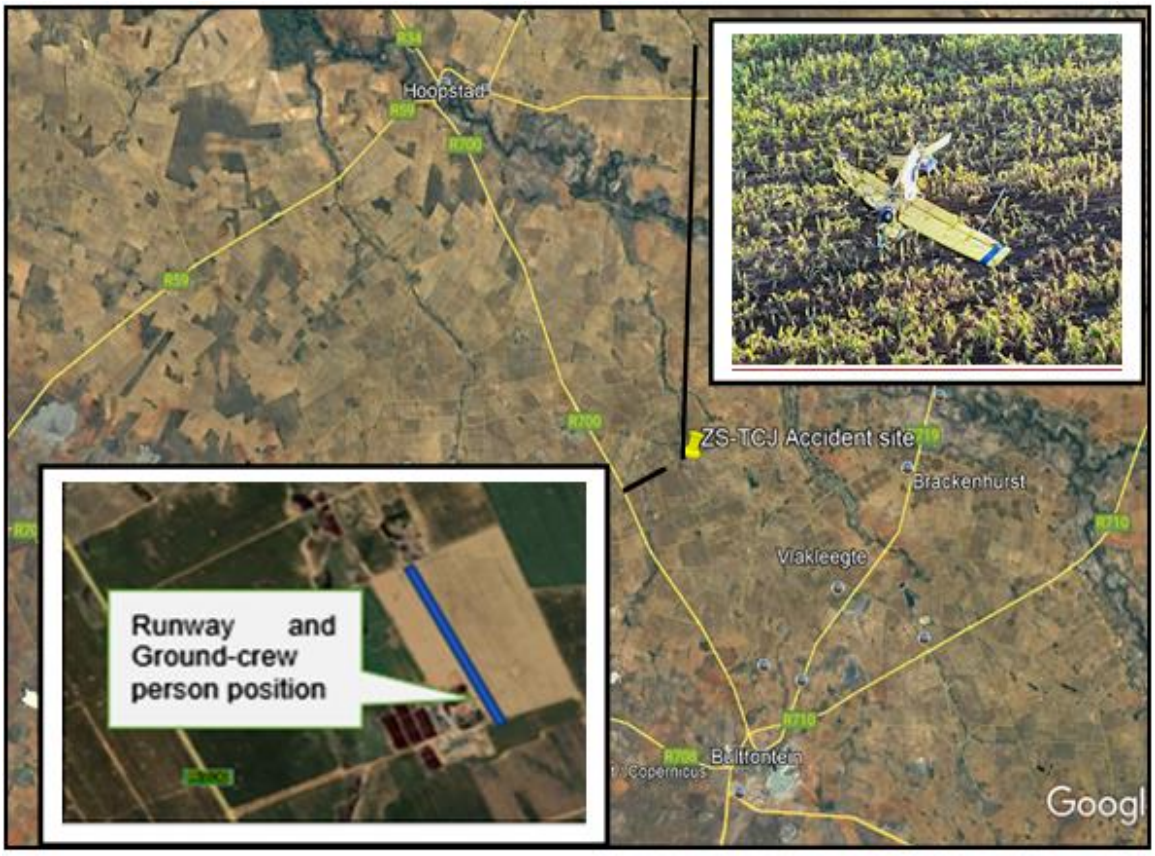

Figure 1: An aerial view of where the aircraft was discovered post-accident. (Source: Google Maps)

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 during the impact sequence.

Figure 2: The wreckage post-accident.

1.4. Other Damage

1.4.1 A small section of the maize crop was destroyed during the impact sequence; also, there was fuel spillage on the ground where crops are grown.

1.5. Personnel Information

Nationality	South African	Gender	Male	Age	52
Licence Number	*********	Licence Type	Airline Transport Pilot Licence		
Licence Valid	Yes	Type Endorsed	No		
Ratings	Instrument, Night				
Medical Issue Date	27 November 2020				
Medical Expiry Date	30 November 2021				
Restrictions	TML; VDL; SSL				
Previous Accidents	None				

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

TML – Restriction of the period of validity of the medical certificate
VDL – Correction for defective distant vision
SSL – Special restrictions as specified (this restriction is for applicants on protocol)

Flying Experience:

Total Hours	18 290.7
Total Past 24 Hours	5.3
Total Past 7 Days	30.7
Total Past 90 Days	114.4
Total on Type Past 90 Days	114.4
Total on Type	114.4

Note: The pilot's logbook was not fully recovered during the investigation. However, records of the pilot's crop-spraying operations history were provided by the operator as per submission by the pilot for reference at the time of employment. The pilot's family was also contacted to retrieve the pilot's actual logbooks, but all efforts were in vain. Only the same copies of the pilot's logbook records as the ones provided by the operator were presented.

1.5.1 The pilot had an Airline Transport Pilot Licence (ATPL) issued by the Regulator (SACAA) on 30 November 2020 with an expiry date of 30 November 2021. He conducted his licence revalidation skills test on 30 November 2020. The pilot was issued a Class 1 aviation medical certificate on 27 November 2020 with an expiry date of 30 November 2021.

1.5.2 A review of the pilot's logbook in relation to his previous experience in commercial agricultural crop-spraying operations revealed the following: The pilot began crop-spraying operation in December 1996. His initial training conversion was with a Piper PA 25-235 and he attained 11 hours between 10 and 13 December 1996. The aircraft type was endorsed on his licence. He then commenced with his crop-spraying training between 14 and 21 December 1996. There was neither a record of the Agricultural (AG) crop-spraying Rating Approval nor the Certification of Registration of Pest Control Operator Aerial Application and Advisory in his pilot's file during this period (or dated during this period). On 24 December 1996, the pilot began flying aircraft for crop-spraying operations as a qualified person. The pilot operated the aircraft for approximately seven months and attained a total of 451 crop-spraying hours on the aircraft type. On 9 September 1997, the pilot began training for an Airline Transport Pilot Licence (ATPL). He was initially issued the ATPL in 1998 and soon after, commenced his career as an ATPL pilot.

1.5.3 In December 2020, 23 years later, the pilot returned to conducting commercial crop-spraying operations. The pilot had to operate a new aircraft type, AT402B, at his new employment for crop-spraying operations, which is different from the one he was familiar with, the Piper PA 25-235. According to available information, the pilot did not have an Agricultural (AG) rating, and neither was the aircraft type endorsed on his licence when he was employed; only his crop-spraying experience was considered. The pilot initially attained his Certification of Registration of Pest Control Operator Aerial Application and Advisory on 10 December 2020 with an expiry date of 30 December 2023. On 14 December 2020, the pilot conducted a 1-hour aircraft type conversion, which was signed off by a rated instructor and was endorsed on his logbook.

1.5.4 Additional information was found in both the pilot's logbook copies and the aircraft flight folio which revealed that: the pilot was likely to have been flying the aircraft following his conversion and between training for crop-spraying operation without having an AG rating and supervision by a relevant AG-rated instructor. Between 15 and 16 December 2020, evidence in the logbook showed that he conducted his Agricultural (AG) dual training at Parys Aerodrome (FAPY) for approximately 5 hours. On 17 December 2020, the pilot flew from FAPY to Koppies where he continued with his AG dual training and accumulated 7.4 hours. Later the same day, the aircraft was flown to FATP for a mandatory periodic inspection (MPI) maintenance. On 18 December 2020, the pilot flew 0.5 hours, conducting an acceptance flight following the MPI. He later flew the aircraft to FAPY where he continued with AG training around the area for about 3 hours. The next day, 19 December 2020, the pilot flew from FAPY to Kroonstad Aerodrome (FAKS) for his AG rating test, and then from FAKS to Koppies for further AG training. The pilot concluded his AG training in about 18.2 hours. A submission for both aircraft types and the AG rating endorsement approval on the licence was made to the Regulator (SACAA) on 20 December 2020, which

was pending approval at the time of the accident. On 20 December 2020, the pilot flew from FAPY to his home base in Hoopstad.

1.5.5 An aircraft conversion and AG training on a single-seater aircraft type is normally conducted by supervision by a Grade I AG-rated instructor. The aircraft type rating is normally conducted using a two-way radio to communicate instructions. The pilot's submission consisted of application documents for an AG pilot rating (CA 61-175 & CA 61-01.0); this was submitted together with the pilot's logbook which had his AG rating endorsed on 19 December 2020. The pilot's logbook showed aircraft conversion and AG training records; also attached was the Certification of Registration of Pest Control Operator Aerial Application and Advisory. The application showed documented flight practises in aerial application with a total of 21.8 hours. According to the submission, the pilot was signed off on 19 December 2020 at FAKS by a Grade I instructor with an agricultural rating; however, there was no written proof of an AG test conducted on the day. Also, there was no mention of the person who supervised the pilot during his previous AG dual training exercises prior to the test, although it showed on the logbook that it was co-ordinated as dual training. Moreover, the logbook hours indicated that the AG rating test was conducted in 0.36 hours, whereas the instructor's logbook indicated 0.8 hours for AG rating test accumulated on the day (19 December 2019). The submission further showed a total of 597.5 actual hours as an agricultural pilot at the time.

1.5.6 On 20 December 2020, the pilot began with the crop-spraying operation (as a qualified pilot) on farms in the Hoopstad, Bultfontein, Makwassie and Witpan areas in the Free State province. Crop-spraying operation in these areas was delegated to the pilot of ZS-TCJ aircraft as the aircraft was stationed in Hoopstad. The pilot had accumulated a total of 114.4 hours on the aircraft type since the conversion.

The table below shows a breakdown of the pilot's crop-spraying flying hours and experience:

Year	Date (Day/Month)	Aircraft Type	Operation Type/ hours	
1996	10/12 to 13/12	PA25-235	Conversion	11 hrs
	14/12 to 21/12	PA25-235	Training	25 hrs
	24/12 to 31/12	PA25-235	Crop-Spraying	24 hrs
1997	02/01 to 28/02	PA25-235	Crop-Spraying	141 hrs
	03/03 to 30/04	PA25-235	Crop-Spraying	126 hrs
	05/05 to 06/07	PA25-235	Crop-Spraying	151 hrs
2020 2021	14/12/2020	AT-402B	Conversion	1 hr
	15/12 to 19/12	AT-402B	Training	18.2 hrs
	20/12/2020 to 21/01/2021	AT-402B	Crop-Spraying	95.2 hrs

According to Part 61.25.1 of the CAR's of 2011.

Requirements for Agricultural Pilot Rating

61.25.1 (1) An applicant for an Agricultural Pilot Rating must–

(a) hold a valid pilot licence issued in terms of Part 61 or Part 62 in the category aeroplane or helicopter, as applicable, and in the event of acting for remuneration, hold at least a valid CPL (Aeroplane or Helicopter) or a valid Part 96 authorisation, as applicable.

(b) hold the appropriate class or type rating;

(c) hold a current Pest Control Operator's Certificate issued in terms of the Fertilisers, Farm

Feeds, Agricultural Remedies and Stock Remedies Act, 1947 (Act No. 36 of 1947);
(d) have acquired the experience that include at least completion of not less than 300 hours of flight time, which must include not less than 30 hours in the case of aeroplanes and 10 hours in the case of helicopters, of flight experience in aerial application under supervision; and

(e) have undergone the skills test referred to in regulation 61.25.2. (2) At least 2 hours of the flight experience referred to in sub-regulation (1) must be dual instruction conducted by the holder of an appropriately rated Grade I or a Grade II flight instructor who shall be the holder of the appropriate category, class or type rating and the Agricultural Pilot Rating. The balance of the prescribed flight experience may be conducted under the supervision of the holder of a valid CPL or ATPL (Aeroplane or Helicopter, as the case may be) with an Agricultural Pilot Rating, designated by the Director in writing for the purpose.

Skill test for Agricultural Pilot Rating

61.25.2 *(1) An applicant for an Agricultural pilot rating must have demonstrated to an appropriately rated Grade 1 flight instructor with an Agricultural Pilot Rating, or to a person designated by the Director in writing for the purpose, the ability to perform as PIC of an aeroplane, helicopter or micro light aeroplane, as the case may be, the procedures and manoeuvres as prescribed in Document SA-CATS 61 with a degree of competency appropriated to the privileges granted to the holder of an Agricultural Pilot Rating.*

(2) The applicant must undergo the skills test referred to in sub-regulation (1) within 30 days immediately preceding the date of application.

(3) The skills test referred to in the sub-regulation (1) must be carried out in an aeroplane, helicopter, or micro light aeroplane, as the case maybe, that is equipped with dispensing apparatus and has been certified for agricultural aerial applications in terms of Part 21 or Part 24 as case may be.

Application for Agricultural Pilot Rating

61.25.3 (1) An application for an Agricultural Pilot Rating must be made to the Director in the appropriate prescribed form.

(2) An application must be accompanied by-

- *a) A certified true copy of the valid Pest Control Operator's Certificate issued in terms of the Fertilisers, Farm Feeds, Agricultural Remedies and Stock Remedies Act, 1947;*
- *b) A copy of the relevant page of the logbook of the applicant;*
- *c) The skills test report as prescribed in Document SA-CATS 61; and*
- *d) The appropriate fee as prescribed in Part 187*

(3) The Director must issue an Agricultural Pilot Rating in the prescribed format if the application complies with the prescribed requirements.

(4) An Agricultural Pilot Rating shall be valid for as long as the pilot license and pest control operator's certificate held by the holder of the rating , remain valid.

Privileges of Agricultural Pilot Rating

(CAR, 2011: Part 61.25.4(1) and CAR,1997: PART 61.35.4(1)) and

61.25.4 *(1) The holder of an Agricultural Pilot Rating may act as PIC of an agricultural aircraft, engaged in agricultural aerial applications, in respect of which he or she is the holder of the appropriate class rating or type rating by name.*

(2) The holder of an Agricultural Pilot Rating may not exercise the privilege in sub-regulation (1) unless such pilot has –

(a) within the 12 months immediately preceding the flight, conducted at least 5 hours of agricultural flight time; or
(b) successfully undergone skills test as contemplated in regulation 61.25.2 and which has been endorsed in the pilot's logbook.

1.6. Aircraft Information

The information below is an extract from AT-402B Airplane Flight Manual: FAA Approved Issued: 25 February 2008

1.6.1 The Air Tractor AT-402B is an all-metal cantilever low-wing monoplane designed specifically for agricultural purposes. It is a single-seater equipped with one Pratt & Whitney PT6A-15AG turbo prop engine. Its landing gear configuration consists of two fixed main landing gears in combination with a tail dragger wheel gear. The aircraft is fitted with a constant speed type three-bladed propeller regulated by a governor with reversible and feathering ability. The fuel system consists of wet wing tanks ranging between 120 and 290 US gallons each. A 400 US gallon single piece fibreglass hopper tank is equipped with an emergency dump gate controlled by a lever in the cockpit. A cockpit warning placard reading: "*A stall during skidding turns will cause the nose to pitch down sharply and result in a significant loss of altitude*" is displayed.

Airframe:

Manufacturer/Model	Air Tractor Inc AT-402B	
Serial Number	402B-1297	
Year of Manufacture	2014	
Date of Manufacture	2 January 2014	
Total Airframe Hours (at time of accident)	2 228.85	
Last MPI (hours & date)	2 225.0	21 January 2021
Hours Since Last MPI	3.5	
C of A (Issue date)	1 March 2020	
C of A (Expiry date)	31 March 2021	
C of R (Issue date) (Present Owner)	10 July 2020	
Type of Fuel Used in the Aircraft	Illuminating Paraffin	
Operating Categories	Part 137	
Previous Accidents	None	

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

Engine:

Manufacturer/Model	Pratt & Whitney PT6A-15AG
Serial Number	PCE-PD 067
Part Number	PT6A-15AG
Hours Since New	1 186.8
Hours Since Overhaul	Modular engine type

Propeller:

Manufacturer/Model	Hartzell / HC-B3TN-3D
Serial Number	BUA 32722
Part Number	T1028ZNS+4
Hours Since New	2 225.2
Hours Since Overhaul	TBO not reached

1.6.2 The aircraft was issued a Certificate of Airworthiness by the Regulator (SACAA) on 1 March 2020 with an expiry date of 31 March 2021. The aircraft was issued a Certificate of Registration by the Regulator on 10 July 2020. The aircraft maintenance organisation (AMO) that conducted the maintenance on the aircraft was approved by the Regulator. The AMO was in possession of an AMO-approved certificate issued by the Regulator on 5 October 2020 with an expiry date of 30 September 2021. On the morning of 21 January 2021, the aircraft was carrying 664 litres (three quarters) of Illuminating Paraffin fuel prior to the flight to FATP where it was scheduled for MPI maintenance checks; the aircraft was signed off for service after MPI. According to the engine manufacturer, the engine is designed to operate with Jet A1 fuel type; however, the fuel type used was approved as per Service Bulletin (SB) 12144 of TCDS number E4EA Revision: 30. The aircraft was issued a certificate relating to maintenance on 21 January 2021 at 2225.0 airframe hours with an expiry date of 21 January 2022 or at 2325.0 airframe hours, whichever comes first.

1.6.3 Aircraft maintenance records such as (logbooks, flight folio and MPIs) were reviewed. According to the records, all manufacturer's published SB, Service Instructions (SI), etc for both engine and airframe were complied with by the aircraft owner and the AMO. On 9 January 2021, the aircraft was involved in a bird strike incident whilst engaged in a crop-spraying operation; it sustained damages to the left-wing tip during the incident. The aircraft repairs were carried out and the aircraft was flown back to home base on 14 January 2021 to resume operation. The above-mentioned incident was not reported to the Accident and Incident Investigations Division (AIID) in accordance with Part 12, Subpart 2: Accident or incident notification procedures, Part 12.02.2 of CAR of 2011. According to the operator, the incident was discussed with the South African Civil Aviation Authority (SACAA) principal maintenance inspector (PMI) during their audit in January 2021. Copies of the flight folio and subsequent repairs were forwarded to the concerned inspector; there were no findings raised during this audit. This was in contravention to CAR Part 12, Subpart 2, 12.02.1 which requires that the "*PIC of an aircraft involved in an accident within the Republic, or if he or she is killed or incapacitated, a flight crew member, or if there are no surviving flight crew members or if they are incapacitated, the operator or owner, as the case may be, shall, as soon possible but at least within 24 hours since the time of the accident, notify the Director, an ATSU or the nearest police station, of such accident"*.

1.7. Meteorological Information

1.7.1 The weather information was obtained from the South African Weather Service (SAWS) for 21 January 2021 at 1530Z. The meteorological aerodrome report (METAR) information was obtained from the weather station at Bloemfontein Aerodrome (FABL) which is located approximately 100km from the accident site.

FABL 211530Z VRB02KT 9999 FEW040 30/14 Q1019 NOSIG=

Wind Direction	Variable	Wind Speed	02kt	Visibility	9999m
Temperature	30°C	Cloud Cover	Few	Cloud Base	4000ft
Dew Point	14°C	QNH	1019hPa		

1.8. Aids to Navigation

1.8.1 The aircraft was equipped with standard navigational equipment as approved by the Regulator for the aircraft type. There were no recorded defects with the navigational system prior to 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.

1.10. Aerodrome Information

1.10.1 The aircraft accident occurred on Farm Sardinia between Hoopstad and Bultfontein regions in the Free State province at GPS: S 28º 04' 56", E 026º 05' 37" at a field elevation of 1540ft. Other nearby aerodromes were 10km (5.4nm) further from the accident site.

1.11. Flight Recorders

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

1.12. Wreckage and Impact Information

1.12.1 The aircraft accident occurred during a crop-spraying operation. The pilot, who was expected to land back at his home base in Hoopstad at approximately 1600Z was reported missing as the aircraft never landed back at its home base. The aircraft was found in an inverted position facing west. All three landing gears were still intact following the accident. Figure 3 (left) which is an image from a phone device, shows the area where the aircraft was operating with the two sectors highlighted in orange. The aerial photographs (see Figure 3 right pictures) were taken by the SAPS helicopter crew after locating the wreckage.

Figure 3: The area where the aircraft was operating (left); the wreckage as it was found at the accident site (right).

1.12.2 The observation of the aircraft wreckage as it was found at the accident site:

- The aircraft impacted the ground with the top part of the left-wing leading-edge, the left top part of the nose section and the left fuselage part of the cockpit section. These damages are indicative of an aircraft that stalled while in a turn and impacted the ground in an inverted attitude.

- The aircraft was found in an inverted attitude with the left wing and the left nose section sustaining most of the impact damages. The section at which the left wing impacted the ground had a wing shape crater on the surface. The crater of the ground scars where the aircraft impacted the ground was limited to the part which first contacted the ground hard. This is indicative of an aircraft which was at a high angle of impact when it made contact with the ground with its left-wing tip and nose in an inverted attitude.

Figure 4: The damaged left wing due to impact.

- Damage on the left-wing indicated a downward folding of the leading-edge with more damage on the wing tip. Impact with the ground was from the top front part of the wing; the flap control surface on the left wing was at 10º position.

Figure 5: Damage on the right-side wing.

- The right-side wing was also found lying upside down (inverted position). The wing sustained damages to the attachment points and on the flight controls due to impact forces. Wrinkle damage was observed over the bottom and upper wing surface. The aileron control surface was bent due to impact. The wing was fairly intact with fuel tank containing sufficient fuel on-board. Damage was also observed on the wing tip, spray nozzle mounting bars which were bent, and the root attachment. The flaps were positioned between 5 and 8 degrees, which is the recommended position during turns.

- The left-side cockpit, towards the top of the nose section, was affected by impact forces. The top left-side of the nose section also showed damage caused by hard impact which created a crater. Downward twist deformation was also observed in the nose section.

- The cockpit compartment had collapsed during impact sequence, pushing the roof towards the cockpit floor (which was at the top side at the time as the aircraft was inverted).

1.12.3 Observation of the nose section and the engine:

- The nose section was destroyed with damages extending to the engine. The engine was destroyed; it had separated into two parts. The nose section had extensive damage, which caused the compressor section to separate.

- The propeller hub was destroyed due to impact with the ground. One of the three propeller blades had broken off. The propeller hub and the blade that broke off were found lodged into the soil. The damage on the propeller indicated that the engine was not turning with power at the time of impact. The propeller blades were found in a feathered position. This is indicative of an engine that experienced a sudden power interruption during the impact sequence.

Figure 5: The damaged propeller.

- All engine controls were still connected, and continuity was established. The throttle control was found in a full forward position. The propeller pitch control lever was found in a rear position and the propeller mechanism was found engaged in a flight mode position of the propeller settings.

Figure 6: The engine damage post-accident.

- Turbine blades were found protruding from the exhaust pipes. Also, there was damage observed on the compressor blades in the compressor section which had separated from the engine due to impact.

Figure 7: Damage on the engine turbine blades section.

- Damage on both the compressor and the turbine blades was consistent with damage caused while the engine was turning with no power during impact. Soil debris which was sucked in during the impact sequence was also observed.

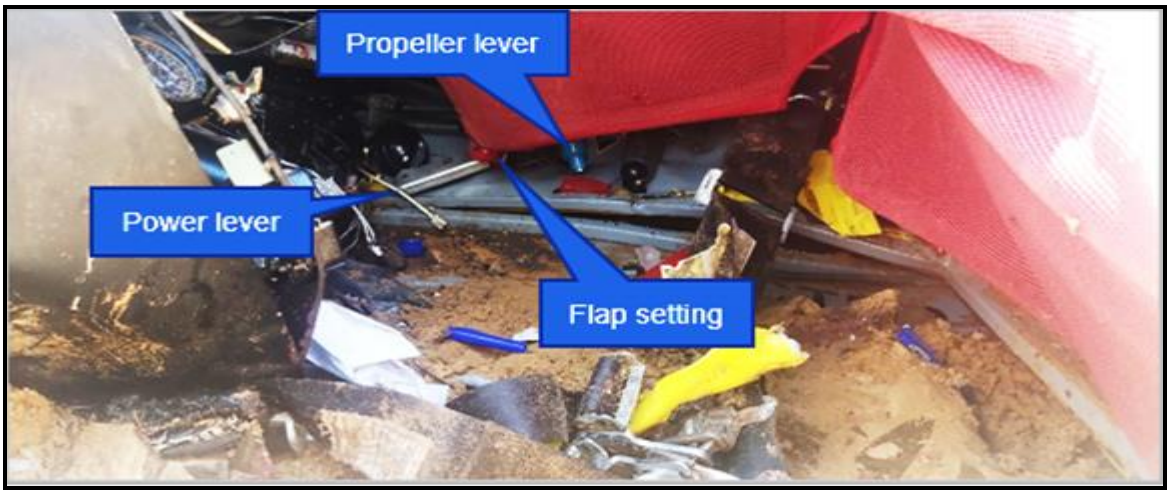

Figure 7: The aircraft's engine, propeller and flaps control.

1.12.4 The hopper tank emergency dumb gate (door) was found in a "closed" and "locked" position. This door is used in emergency situations/drills in case of an engine failure to help reduce the aircraft's weight by dumping the crop-spraying solution.

Figure 8: The hooper gate of the aircraft.

1.12.5 The aircraft wreckage pattern was associated with an aircraft that had stalled during a turn. The wreckage direction indicated that the aircraft was engaged in a right-turn; however, it stalled to the left and impacted the ground at a high angle with its left wing and a nose-low attitude.

1.13. Medical and Pathological Information

1.13.1 According to the pathological report, the pilot was fatally injured due to multiple injuries sustained during the accident sequence.

1.14. Fire

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

1.15. Survival Aspect

1.15.1 The accident was considered not survivable because of damages sustained by the cabin structure due to high impact forces. The cockpit area had collapsed from the bottom, causing the cockpit instruments to move upwards, limiting room/space for the occupant in the cockpit.

1.16. Tests and Research

1.16.1 Following the accident, the aircraft's engine manufacturer, through its satellite branch personnel based in South Africa, visited the accident scene to conduct investigation on the engine functionality. Although the engine sustained extensive damage, the following report was drawn with the conclusion based on the observation of the engine condition as found on site, as well as notes taken at the time. No further testing was conducted on any of the engine components.

External condition:

The engine had fractured and separated into two sections. The inlet case stuts had fractured, liberating the accessory gearbox (figure 9 & 10). The gas generator and the power section were still attached at 6'Oclock position and held by approximately 13 bolts.

Figure s9 and 10: Engine inlet stuts, liberating the accessory gearbox.

The exhaust case was bent, and the airframe exhaust stacks were crushed/deformed on the underside. Examination of the exhaust duct revealed TP blade fragments in the exhaust case (Figures 11 and 12). The blade fragments showed rubbing wear on the shrouded tip. Environmental debris was observed in the exhaust case's inner surface.

Figures (11 and 12): Damage of the exhaust case (left); PT blades fragment in the exhaust case (right)

1.16.2 The first stage compressor rotor aerofoils showed environmental debris. Foreign object damage was observed on the leading edges, rubbing wear and blade tip curl (Figure 13). The compressor rotor shaft was fractured, and the compressor rotor did not rotate.

Figure (13&14): Shows the damages on the compressor rotor blades

A review of the engine maintenance documents indicate that the engine was maintained in accordance with manufacturer's prescribed procedures. Engine inspection revealed that all damage sustained by the engine parts was attributed to the accident sequence.

1.16.3 The AGNAV system (Agricultural Navigation) equipment was also recovered and sent to the manufacturer's agent based in South Africa for extraction of information and analysis.

Report on findings on AgNav system for ZS-TCJ by the person who conducted the analysis:

The AGNAV *system unit was in bad shape, the front panel, LED screen and keypad were smashed and badly damaged. The carrier board with the hard drive was intact, however, it was covered with a sticky substance. The data could not be recovered as the carrier board was unserviceable due to the substance that caused an electrical short circuit in the system. I transferred the data (Hard Drive) to a serviceable system, and with the help of*

AGNAV INC in Canada, was able to recover the data from the last 3 jobs done. All the files were found corrupt due to impact and possible high voltage transfer to the system. All corrupt files were repaired one by one, which took a few days.

Findings according to the info on the data recovered:

1) *On the day, the system indicated that the aircraft moved away from the spraying site for a very long time. The system was running all the time but there was no data indicating number of movements, speed or height variation.*

2) *The pilot did return to the spray area, finish off the job that was left unfinished, then move onto the new and last field.*

3) *He sprayed about 37 ha of the last field on a boundary split pattern, during the spray runs, his speed was stable at approximately 244 km/h at a height of about 1273m above sea level.*
4) *Of concern is that although he was doing a split pattern and no need for high turns, he climbs to 1450-1480m(4757-4855 ft) in the turn and let the ground speed decay to about 118 km/h every turn.*

5) *After his last turn into the field, he was lined up for the spray run, his height and speed were the same as all the previous runs, but he did not open the spray valve, and started to veer off to the left but maintained speed and altitude. It was as if he was distracted by something.*

6) *He then continues in the same direction he started the climb, decay the groundspeed again to below stall speed, 114.9km/h at an altitude 1443 m (4734 ft) above sea level, started the decent but the speed only increased to max of 154.5km/h and 1366m (4481 ft), then there was an abrupt power loss, suspected that were the time of impact. From what I can figure he went into a spin, that turned inverted with no way to recover at all.*

7) *My personal opinion is that he practiced a dangerous way of high stall turns, that just look impressive and is of no gain in turning time, just add to stress on the aircraft and pilot.*

1.17. Organisational and Management Information

1.17.1 The operation was conducted under the provisions of Part 137 of the Civil Aviation Regulations (CAR) 2011 as amended.

1.17.2 The operator was in possession of an Air Service Licence issued by the Department of Transport on 15 May 2015. The operator was issued an Air Operating Certificate (AOC) on 12 February 2020 under the provisions of Part 135/137 of the CAR with an expiry date of 28 February 2021. The aircraft was duly authorised to operate under the AOC.

1.17.3 The operator's Operational Manual P135's Annexure I- Agricultural Operation Section 1 of General Provisions states:

1.2 Flight crew requirements

1.2.1 Proman shall ensure that all fights crew members utilised for commercial agricultural operation are in possession of the following:

a) A valid SACAA Commercial Pilots Licence with Agricultural Rating.
b) A valid Pest Control Operation's Certificate issued in terms of the Fertilisers, Farm Feeds, Agricultural Remedies and Stork Remedies Act, 1947 (Act No. 36 of 1947).
c) Commercial Pilots License working under the supervision of a pilot with an Agricultural Rating designated by the Commissioner for this purpose.

Section 4- Commercial Operations

4.2 Remote base operations
4.2.1 Proman shall when operating from a base other than the principal place of operation, for a period of 14 or more consecutive nights, appoint a base pilot who-
a) Holds a valid agricultural pilot rating.
b) Is responsible for the operations from that remote base; and
c) Is responsible for arranging work roster and maintaining records.

1.17.4 According to available information, after the pilot was signed off for AG operations, he progressively began at an average of 18.5 hours for the first two weeks. On the third week, he flew 25.5 hours. On the week of the accident, the pilot flew an average of 32.2 hours compared to the previous weeks. Although the operational hours were within the allowable maximum 35 weekly operating hours, the pilot exceeded the maximum 8 hours without authorisation on 17 January 2021.

Section 9: FLIGHT TIME AND DUTY PERIOD LIMITATIONS
*9.3 Maximum Flight time and Duty Limitations**: **Proman Lugbespuiting** shall not schedule a pilot for flight time for a period exceeding 8 consecutive hours during any given duty period unless authorised in this scheme and ensure that a pilot does not exceed the following maximum flight times:-*

- *10 hours during any duty of which a maximum of 8 hours may be consecutive;*
- *During the preceding 7 days for a pilot operation, 35 hours;*
- *During the preceding 30 days for a single pilot operation , 100 hours;*
- *300 hours during the preceding 90 days or*
- *1000 hours during the preceding 365 days*

1.17.5 **Employment**

According to the operator, the pilot's initial AG training which was conducted in 1996 (23 years prior to the accident flight) was sufficient for them not to expect him to do a dual AG training at the time of employment. However, they only expected the pilot to familiarise himself with the aircraft, the AGNAV system, and further attain his AG rating. The operator had considered his previous experience on a Piper PA25-235 on which he attained 36 hours of training and more than 30 hours of aerial application under supervision to comply with CAR 61.25.1. As such, the hours flown between the Air-Tractor 402 conversion and AG rating test did not have to be under supervision of an instructor or any person designated by the Director for the purpose. There was no evidence of the pilot's supervision during this time of training and neither had he attained his AG rating then, as there were no records available as proof (or confirmation).

1.17.6 **Training**

The operator only ensured that the aircraft was made available to the pilot; and the pilot had to ensure that he arranged his own training focused on aircraft rating, AGNAV system

familiarisation and AG rating tests. No other information relating to aircraft theorical familiarisation was made available by either the operator or the instructor who performed his aircraft conversion tests. Following the aircraft conversion test passed on 14 December 2020, the rating was endorsed on his logbook. The operator stated that he was informed by the pilot that he was given specific exercises by the instructor to familiarise himself with the aircraft's characteristics and manoeuvres when it had full and empty loads, as well as further exercises to perform landings and take-offs on dirt airstrips. However, there was no supervision afforded to the pilot during this time; this has been included in the pilot's logbook without the qualified instructor mentioned.

According to the operator, the aircraft was only assigned to the pilot for the purpose of training. The aircraft was only assigned to the pilot for use at the specific dates — 15, 16, 17 and 19 December 2020. Also, on 18 December 2020, the pilot was engaged in an AG training and attained 2 hours on the day. This was for the pilot to familiarise himself properly with the aircraft manoeuvring characteristics and the AGNAV system with loaded water for crop-spraying exercises and to further attain the AG rating. The operator stated that he was never involved and was never present during his training or supervision. The operator incurred all costs relating to fuel for operations on the specified days (above).

Although the operator stated that they were not involved at all with the pilot's training, they further stated that on 17 December 2020, the pilot was invited during a crop-spraying operation at Koppies to observe/familiarise himself with the procedures in respect of refuelling and keeping records. For this purpose, the operator does not understand why the pilot logged the hours as dual training. According to the logbook records of all three pilots employed by the operator, on 17 December 2021, the pilots operated different aircraft at different areas. The other two pilots were each operating at specific places, namely ZS-TNA (4.2 hours) at Parys; and ZS-XAX (4.7hours) at FAKS. According to ZS-TCJ's pilot logbook, the accident pilot was engaged in AG training at FAPY on the same date. No flight activities of ZS-TNA and ZS-XAX were recorded at Koppies on the date (17 December 2021) as per the operator's statement. Although the places mentioned above are within a radius of 90km, Koppies is situated halfway between FAKS and FAPY; aircraft's operational activities are specified as per the exact location. The information given above is in contradiction to the statement made by the operator regarding the activities which took place on the day (17 December 2021).

1.17.7 The AMO that certified the last maintenance inspection on the aircraft prior to the accident was in possession of an AMO approval certificate that was issued by the Regulator on 5 October 2020 with an expiry date of 30 September 2021.

1.17.8 The training organisation that tested the pilot for both his aircraft type conversion and AG rating could not produce evidence of the training assessment record for the pilot. According to the instructor, he never opened a file on any of the occasions when he was dealing with the pilot during type rating on 14 December 2020 and AG rating on 19 December 2020. According to the training procedures manual, three pages of two documents that cover a Syllabus for Differences & Familiarisation Training (SDFT) and the Practical Flight Training (PFT) were never used during any of the pilot's testing sessions at the ATO. The ATO was in possession of an ATO certificate: SACAA/1094/ATO-1 and an operational specification issued by the Regulator on 19 September 2019. The SDFT document covers the following: lesson/exercise which include briefing and practical. The PFT covers: lessons/exercise and time required for briefing, dual flight and solo flight. No other document was made available as evidence of the tests undertaken by the organisation except for the instructor's logbook hours. The hours indicated in the instructor's logbook did not correspond with the pilot's

hours for the tests conducted.

The timeframe for the assessment was insufficient to cover the requirements of the tests as per below.

According to SACAT 61.25.2 Skills Tests for Agricultural Pilot rating:

1. Conducting the Skills Test

The person conducting the skills test shall test an applicant for the issuing of an agricultural pilot rating on his or her ability to perform as pilot-in command of an aeroplane in the following procedures and manoeuvres with a degree of competency appropriate to the privileges granted to the holder of an agricultural pilot rating:

1. *Skill test shall be conducted in accordance with skills test appropriate from and shall include the following*
   - *a) Assessment of area to be sprayed*
   - *b) Load sheet*
   - *c) Weather report*
2. *In case of the short field take-off and landings*
   - *a) Short-field take-off and landings*
   - *b) Cross wind and down-wind take-offs and landings*
   - *c) Flight manoeuvres at minimum air speed*
   - *d) Accelerated stall*
   - *e) Maximum-rate and turns*
     - *i. Incipient recoveries entered into inside of and from outside of turns*
     - *ii. Precision landings, normal, down-wind and cross wind*
     - *iii. Exit from application area, turn around and re-entry to application area under various wind conditions*
     - *iv. Simulated application runs at appropriate heights*
     - *v. Entry to and exit from applications over obstructions*
       - *aa) Avoidance obstructions*
       - *bb) Emergency procedures*
     - *vi. Low-level forced landing technique*
     - *vii. Dump load*

1.17.9 According to the instructor, the pilot did his conversion to AT3T on 14 December 2020 (with him). The instructor further stated that he did not do any AG training with the pilot afterwards. The pilot did his crop-spraying training 23 years ago in a Piper Pawnee on which the AG rating was not required to do crop-spraying. After the conversion, the pilot did some training with one of the pilots employed by the operator. According to the pilot's records, he also did some training with an instructor at ATO 1204 (refer to 1.18.1 below) on 11 December 2020 and an endorsement was made in his logbook for AG rating (this information relates to 1.18.1) on PA 28-180 Cherokee registered ZS-FTP. The ATO was in possession of an ATO certificate: SACAA/1204/ATO-1, and the operational specification was issued by the Regulator on 23 February 2017 with an expiry date of 23 February 2022. On 19 December 2020, the pilot went back (to the ATO) for his AG rating test, where he completed his test; all documents were populated as per the regulations. The instructor also stated that he did not have a training file for the pilot.

According to Part 61, Subpart 25 of the CAR:

The skills test referred to in the sub-regulation (1) must be carried out in an aeroplane, that is equipped with dispensing apparatus and has been certified for agricultural aerial applications in terms of Part 21 or Part 24 as case may be.

1.18. Additional Information

1.18.1 Aircraft Agricultural Operations

This information is an extract from AT-402B Airplane Flight Manual: FAA Approved Issued: 25 February 2008

Agricultural Flying

Since agricultural flying is extremely varied, it is not practical to recommend operating procedure which in many cases would not fit a particular operation. However, the procedures outlined in this section are general and may be followed if they apply.

Swath (Spraying)

For a full load on hot day set propeller at 2100 RPM and at 1200ft/lbs torque or less, depending on how well the aircraft is performing. Spray runs may be made at 135 to 140 mph (117 to 122kts) (217 to 225km/h) (IAS) when the aircraft is heavy, which will provide good penetration as well as adequate speed for pull-ups and turns. As load diminishes, reduce RPM by 50 RPM increments so that as hopper nears empty, RPM is 2,000.

Reduce torque pressure as load diminishes to avoid excess speed over the crop, which reduces penetration. Spray speeds of 130 to 135 mph (113 to 117kts)(209 to 217km/h)(IAS) are normal as the hopper nears empty. The operator should select a speed which feels comfortable and best fits his particular operation. In gusty air always use 5 to 7mph (4 to 6kts)(8 to 11km/h)(IAS) more speed during turns when loaded.

Pull-Ups

Prior to pull-up apply additional power smoothly. Abrupt pull-ups should be avoided since excessive speed is lost which reduces turn performance. When making pull-up over wire avoid starting to bank too soon

Turns:

The previous training and experience will influence the operator flying the AT-402B. All conversional types of turns may be performed in the AT-402B. Flaps may be used as a turning aid providing small deflections are used (5 to 8 degrees). The usual method of using flaps is to make the pull-up and initial bank with flaps retracted. As the aircraft is being banked to turn back into the field, touch the flap switch briefly and let off a little back pressure on the stick, as the flaps cause a slight pitch up tendency. Continue the turn, and as you line up for your pass, retract the flaps.

Make coordinated turns. Use the slip indicator as a means of determining whether or not you are carrying bottom rudder. The AT-402B has excellent stall characteristics and if the aircraft is inadvertently placed in an impending stall situation, it is only necessary to relax

some back pressure on the stick to make recovery, and little altitude is lost, providing the turn is co-ordinated. A stall from a skidding turn will result in the nose dropping sharply with a significant loss of altitude.

In addition to being hazardous, a skidding turn can transfer fuel from one tank to another, which will result in flameout if one tank runs dry. Monitor the fuel level in each tank when the fuel level reach ½ tank and leave the selector switch on the low tank. Fuel transfer can occur when flying a racetrack pattern if the turns are not coordinated.

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.

Man

2.1.1 The pilot had an Airline Transport Pilot Licence issued by the Regulator on 30 November 2020 with an expiry date of 30 November 2021. He conducted his licence revalidation skills test on 30 November 2020. The pilot was issued a Class 1 aviation medical certificate on 27 November 2020 with an expiry date of 30 November 2021. The aircraft type and the AG ratings were not yet endorsed on his licence (only on his logbook); however, the pilot had made an endorsement application submission to the Regulator on 20 December 2020. Although the submission was made and that the logbook was endorsed, there was no evidence that the dual training with supervision took place as per CAR Part 61.25. It is highly possible that the pilot never had a chance to familiarise himself with the proper operation of the aircraft prior to his conversion test as the AGNAV system indicated that he conducted high stall turns which put the aircraft in an impeding stall situation.

2.1.2 It is likely that the pilot was conducting actual crop-spraying operations between his training. According to the analysis of the pilot's training times and pattern previously and currently, it has been observed that the pilot had never conducted training of over 4 hours in a day, except for this specific date in the accident aircraft type. However, the pilot recorded that he was conducting training on the day (17 December 2020) where he accumulated 7.4 hours in the Koppies area, which he attained during crop-spraying, based on the records.

2.1.3 The pilot provided incorrect information to both the operator and the Regulator to advance his employment agreement and the AG-rating approval. The employer failed to verify the information provided to ensure if the pilot's training was carried out according to the required AG rating requirements as per the regulatory procedures. The pilot was only provided with an aircraft; it was not clear if he was thoroughly familiar with its operational limitations. However, the employer denies

any involvement with the pilot's AG training as the employer does not possess an ATO certificate.

2.1.4 On 9 January 2021, the aircraft was involved in a bird strike incident while undertaking a crop-spraying operation; the incident was never reported to the local Regulator's Accident and Incident Investigations Division by either the operator or the maintenance organisation that conducted the repairs.

2.1.5 The pilot had also performed duties of a test pilot on the aircraft on three occasions, which include two MPI maintenance acceptance checks and wing repairs following a bird strike incident (which was never reported to the investigating authorities in accordance with Part 12 of the CAR 2011). The pilot had contravened CAR Part 61, Subpart 19 – post-maintenance test flight rating. General privileges of test pilot ratings state that 61.19.3 (2) *No person shall act as a test pilot of an aircraft requiring a test flight, as defined below, unless he or she is the holder of a valid pilot license with a test pilot rating.*

2.1.6 It is noted that the pilot, prior to his return to AG operation, had spent approximately 23 years as an airline transport pilot. The agricultural and airline transport operations are different; responsibilities and activities on the airline flight are less intense (more relaxed) than those required for crop-spraying operations. The pilot had spent 23 years of his life in a relaxed environment and, thereafter embarked on a more intense operation. The hours accumulated in a short period would have been very exhausting for the pilot's adjustment into the current undertakings. Although the pilot had flown 114.3 hours on the AT-402B over a period of just one month, the intensity of the operation might have caused fatigue on the pilot and degraded his performance. On 17 January 2021, the pilot exceeded 8 hours normal operational hours without authorisation; however, the operational hours were still within the weekly 35 hours maximum as per the Operator's Operations Manual Part 1: General: Section 9.

Machine

2.1.7 The aircraft was issued a Certificate of Airworthiness by the Regulator on 1 March 2020 with an expiry date of 31 March 2021. The aircraft was issued a Certificate of Registration by the Regulator on 10 July 2020. The AMO which conducted maintenance on the aircraft was approved by the Regulator. The AMO was in possession of an AMO approved certificate issued by the Regulator on 5 October 2020 with an expiry date of 30 September 2021. All aircraft systems were accounted for during investigation and all flight controls showed continuity. All damage on the controls was a result of the accident impact.

2.1.8 The aircraft wreckage was found inverted with impact damages sustained mostly on the left nose section area, left cockpit section and the left wing. The wreckage impact pattern and the damages observation are indicative of the aircraft that stalled and impacted the ground at a high angle of impact and on its left wing and left nose section first, in an inverted flight attitude. The crater resulting from the aircraft impact is indicative of a high angle of impact attitude. The wreckage pattern is indicative of the aircraft that stalled at a low height above ground and impacted the ground at a high angle of impact.

2.1.9 The direction at which the aircraft was facing is indicative of the aircraft that was turning at the time of the accident. This is also supported by the distance between the position of the field section where the aircraft was conducting crop-spraying

operation and the position where the aircraft crashed, which could be associated with the aircraft's possible turning point in relation with the ground during operation. According to the AGNAV system equipment data analysis, the aircraft was performing high turns which induced the speed decay below the stall speed of 114.9km/h at a low height. The aircraft was only able to increase speed to a maximum of 154.5 km/h, which was insufficient at an altitude of 1366m (4481.6ft) or 267ft AGL; this was likely inadequate to achieve a successful recovery. The pilot was fatally injured due to multiple injuries sustained during the accident sequence.

2.1.10 It is also likely that during a turn, the aircraft slipped as the nose was pitching up and then stalled due to the decayed speed. Fuel, as it was below half tanks, might have been transferred from one tank to another which would have caused an engine flame out. This is evident from the damage sustained by the propeller and the engine turbine and compressor blades which were consistent with an engine that was not producing power at the time of impact.

Organisational/ Employment and Training

2.1.11 The pilot's employment acceptance was based on his past experience, and the operator expected the pilot to attain the aircraft rating, familiarise himself with the agricultural navigation system (AGNAV) equipment and further achieve his AG rating. The operator only offered support to the pilot by availing the aircraft to him (pilot), as well as ensuring that the aircraft had fuel. The operator did not ensure if the pilot, who was under their employ, was operating the aircraft during his training under supervision of an instructor as per Part 61.25.1 (2) of the CAR 2011, which is a requirement for achieving an AG rating.

2.1.12 After the pilot had passed the test for aircraft type conversion on 14 December 2020, the operator placed the aircraft at his disposal; also, all the duties relating to the aircraft ZS-TCJ were passed on to the operating pilot as per the station's area responsibilities. This is in accordance with the operator's Operational Manual which could have led the pilot to perform crop-spraying during his AG rating training.

According to the operator, the aircraft was only made available to the pilot on the specific dates: 14,15,16,17 and 19 December 2020 during his conversion and training. The operator also denies conducting any AG training for the pilot on the days stated above. The statement above is not true as the pilot had the aircraft in his disposal since 14 December 2020 following conversion, until the date of the accident. Also, on 18 December 2020, the pilot was operating the aircraft for his AG training.

2.1.13 The operator further stated that on 17 December 2020, the pilot was invited to join the operation where two other pilots were performing crop-spraying at Koppies to familiarise himself with procedures as well as observe refuelling and record keeping. According to available records, neither of the other two pilots were operating in Koppies, specifically on that day, except for the accident pilot who was engaged in his AG training for approximately 7.4 hours. The information stated above contradicts the statement made by the operator on the day (17 December 2020) regarding the pilot's on-site invitation.

2.1.14 There was sufficient fuel on-board the aircraft tanks at the time of the accident. The aircraft was uplifted with approximately 326 litres of fuel on the morning of the accident day prior to the flight to FATP. Some of the fuel spilled from the left wing following the accident sequence, whilst fuel on the right wing was noted during on-

site investigation during aircraft recovery. Good weather conditions prevailed on the day of the accident. Fuel and weather conditions did not contribute to the cause of the accident.

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 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 had an Airline Transport Pilot Licence (ATPL). His licence was renewed by the Regulator on 30 November 2020 with an expiry date of 30 November 2021. According to his logbook, he had flown a total of 18 290.7 hours, of which 114.4 hours were on the aircraft type.

3.2.2 The pilot was issued a Class 1 aviation medical certificate on 27 November 2020 with an expiry date of 30 November 2021.

3.2.3 The aircraft type was not endorsed on his licence; however, the pilot had conducted an aircraft conversion for the aircraft type on 14 December 2020 and had submitted all the relevant paperwork to the Regulator on 20 December 2020 in order to have the aircraft type rating endorsed on his licence.

3.2.4 The pilot did not have the AG rating endorsed on his licence at the time of the accident. However, the pilot had made a submission to the Regulator for both AG rating and aircraft rating endorsement on 20 December 2020 following AG rating test on 19 December 2020. The AG rating was endorsed on his logbook.

3.2.5 The pilot's AG training was conducted inappropriately without dual supervision by a Grade 1 instructor rated for the purpose or a person with a written letter designated by the Director for such purpose. However, his licence was endorsed by a qualified instructor following the

tests as per CAR Part 61.25. The pilot's logbook was initially endorsed unduly by an instructor (DFE) without special rating on the aircraft category.

3.2.6 Both pilot's tests were conducted without the ATO keeping records/file for the pilot; instead, only the logbook endorsement following both tests (which did not have corresponding data relating to time of each test from the instructor and the pilot's logbooks) was made available during investigation.

3.2.7 The pilot acted unduly and without proper ratings as a test pilot after the aircraft's MPI maintenance.

3.2.8 Both the aircraft owner and the aircraft maintenance organisation failed to report the aircraft's bird strike incident to the local Accident and Incident Investigations Division which occurred on 9 January 2021. The incident was only reported to the PMI who did not further report the incident or verify the reporting if the correct procedure was administered by the operator.

3.2.9 Fine weather conditions prevailed at the time of the accident; the weather did not play a role in this accident.

3.2.10 There was sufficient fuel remaining on the right-side wing other than the spillage on the left-side wing due to impact damage.

3.2.11 The aircraft had a Certificate of Airworthiness issued by the Regulator on 1 March 2020 with an expiry date of 31 March 2021. The aircraft was issued a Certificate of Registration by the Regulator on 10 July 2020. The AMO that conducted the maintenance on the aircraft was approved by the Regulator.

3.2.12 The pilot performed a high nose turn which inadvertently placed the aircraft in an impending stall situation. The aircraft's nose dropped and the pilot's inputs further worsened the situation, causing the aircraft to roll and impact the ground in an inverted attitude and at a high angle of impact. The pilot used the wrong technique in an attempt to correct the situation and further caused the aircraft to roll and impact the ground in an inverted attitude.

3.2.13 The pilot was fatally injured during the accident sequence.

3.2.14 Shortcomings of operator and pilot with regards to regulations.

3.3. Probable Cause/s

3.3.1 The pilot performed a high nose turn which inadvertently placed the aircraft in an impending stall situation. The aircraft's nose dropped and the pilot's inputs further worsened the situation, causing the aircraft to roll and impact the ground in an inverted attitude and at a high angle of impact.

3.4. Contributory Factors

3.4.1 Incorrect technique used to recover the aircraft's induced side slip during a turn which possibly led to a stall.

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 to the Director of Civil Aviation to conduct an audit on the endorsement and issuing of licences and ratings of AG pilots.

4.2.2 Operators need to ensure that they conduct verification of qualifications prior to employment.

5. APPENDICES

5.1 None.

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