AIRCRAFT ACCIDENT REPORT AND EXECUTIVE SUMMARY

		Reference:		CA18/2/3/10080	
Aircraft Registration	**ZS-IGG**	**Date of Accident**	26 November 2021	**Time of Accident**	1150Z
Type of Aircraft	Cessna 421B Golden Eagle		**Type of Operation**	Private (Part 91)	
Pilot-in-command Licence Type	Commercial Pilot Licence		**Age**	37	**Licence Valid**	Yes
Pilot-in-command Flying Experience	**Total Flying Hours**		394.8	**Hours on Type**	20
Last Point of Departure	Hoedspruit Eastgate Aerodrome (FAHS) in Limpopo Province				
Next Point of Intended Landing	Rand Aerodrome (FAGM), Gauteng Province				
Damage to Aircraft	Substantial				

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

On an open field, north of FAMB at Global Positioning System (GPS) co-ordinates determined to be S25° 41 08´.40" E029° 26 25´.90" at an elevation of approximately 4 886ft

Meteorological Information	Wind direction: 070°; Wind speed: 2 knots; Temperature: 0°C; Dew point: -4ºC						
Number of People On-board	1 + 2	**Number of People Injured**	1	**Number of People Killed**	0	**Other (On Ground)**	0

Synopsis

On Friday, 26 November 2021, a pilot accompanied by two passengers on-board a Cessna 421B Golden Eagle aircraft with registration ZS-IGG took off on a private flight from Hoedspruit Eastgate Aerodrome (FAHS) in Limpopo province to Rand Aerodrome (FAGM) in Germiston, Gauteng province. Before departing FAHS, the pilot conducted a pre-flight inspection, and all was normal with no defects recorded in the flight folio. The aircraft had about 482 litres (l) or 127 US gallons of Avgas 100LL fuel in the tanks. According to the FAHS control tower, the aircraft took off from Runway 09 at 1100Z and climbed to flight level (FL) 140 or 14 000 feet (ft) above mean sea level (AMSL). After approximately 45 minutes in cruise and whilst overhead Witbank (FAWI) in Mpumalanga province, the pilot broadcasted on Johannesburg (JHB) area control frequency 126.7-Megahertz (MHz) that his aircraft's engines were running rough. The pilot requested to descend to a lower altitude. During this time, it was drizzling, and the outside air temperature (OAT) was 0°C. The pilot reported that he noted nothing abnormal on the gauges. The area control then cleared the pilot to descend to a lower altitude and directed him to Middleburg Aerodrome (FAMB), which was in proximity to his position. During final approach for Runway 14, both engines stopped simultaneously, and neither of the propellers was feathered. The aircraft could not reach the runway and the pilot opted to execute a forced landing on an open field, approximately 0.81 nautical miles (nm) north of FAMB. The aircraft was substantially damaged during the forced landing. The pilot suffered minor injuries, whilst the two passengers were not injured. The investigation determined that the cause of the accident was due to the pilot's task saturation owing to the high workload after the engines ran rough during instrument meteorological conditions (IMC). This made him vulnerable to errors; thus, misinterpreting the cause of malfunction on the engines and carrying out the opposite of what is required in accordance with (IAW) the Aircraft Flight Manual (AFM) (refer to paragraph 1.6.4.).

Probable Cause

Double-engine failure during approach for an emergency landing following the rough-running engines which were most likely induced by ice obstructing the engine air filters.

Contributing Factor

The pilot seemed to have been subjected to task saturation as he operated as a single crew.

SRP Date	16 August 2022	Publication Date	24 August 2022

ABBREVIATION	DESCRIPTION
AD	Airworthiness Directive
AFM	Aircraft Flight Manual
ATO	Aviation Training Organisation
AGL	Above Ground Level
AIID	Accident and Incident Investigations Division
AMM	Aircraft Maintenance Manual
AMO	Aircraft Maintenance Organisation
AMSL	Above Mean Sea Level
ARCC	Aeronautical Rescue and Coordination Centre
ATPL	Airline Transport Pilot Licence
FABB	Brakpan Aerodrome
CAR	Civil Aviation Regulations
CPL	Commercial Pilot Licence
CRS	Certificate of Release to Service
CVR	Cockpit Voice Recorder
ELT	Emergency Locator Transmitter
EMS	Emergency Medical Services
FAA	Federal Aviation Administration
FAGM	Rand Aerodrome
FAHS	Hoedspruit Eastgate Aerodrome
FALA	Lanseria International Airport
FAMB	Middleburg Aerodrome
FDR	Flight Data Recorder
FL	Flight Level
Ft	Feet
FIKI	Flying into Known Icing Conditions
GPS	Global Positioning System
Hp	Horsepower
IAW	In Accordance With
IFR	Instruments Flight Rules
IIC	Investigator-in-charge
L	Litres
JHB	Johannesburg
MHz	Megahertz
MAP	Manifold Air Pressure
NM	Nautical Miles
NTSB	National Transportation Safety Board
POH	Pilot's Operating Handbook
RPM	Revolutions per Minute
SACAA	South African Civil Aviation Authority
SAPS	South African Police Service
SB	Service Bulletin
USA	United States of America
Vmca	Minimum Control Airspeed Airborne
UK-CAA	United Kingdom Civil Aviation Authority

Reference Number	**:** CA18/2/3/10080
Name of Owner/Operator	**:** Duratone (Pty) Ltd
Manufacturer	**:** Cessna Aircraft Cooperation
Model	**:** Cessna 421B Golden Eagle
Nationality	**:** South African
Registration Marks	**:** ZS-IGG
Place	**:** On an open field, north of Middleburg Aerodrome (FAMB)
Date	**:** 26 November 2021
Time	**:** 1150Z

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.

Any person who has information concerning this accident should contact the Accident and Investigations Division (AIID) on AIIDinbox@caa.co.za

Investigation Process:

On Friday, 26 November 2021, the Accident and Incident Investigations Division (AIID) was notified of an accident involving a Cessna 421B Golden Eagle aircraft with registration ZS-IGG which occurred on an open field, north of Middleburg Aerodrome (FAMB). The AIID has appointed an investigator-in-charge (IIC) and a co-investigator. Notifications were sent to the State of Registry, State of Operator and the State of Manufacture and Design. No accredited representatives were appointed. The AIID will lead the investigation and issue the final report. The information contained in this final report is derived from the initial information gathered by the investigating team during the on-site investigation.

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

Notes:

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

- *Accident – this investigated accident*
- *Aircraft – the Cessna 421B Golden Eagle 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 obtained from different sources and may be adjusted from the original for the sole purpose of improving clarity of the report. Modifications to images used in this report are limited to cropping, magnification, file compression; or enhancement of colour, brightness, contrast; or the addition of text boxes, arrows or lines.

Disclaimer:

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

1. FACTUAL INFORMATION

1.1. History of Flight

1.1.1 On Wednesday, 24 November 2021, a pilot accompanied by two passengers (family members) on-board a Cessna 412B Golden Eagle twin-engine aircraft with registration ZS-IGG took off on a private flight from Rand Aerodrome (FAGM) in Germiston, Gauteng province, to Eastgate Hoedspruit Aerodrome (FAHS) in Limpopo Province. Their intention was to return to Rand Aerodrome (FAGM) on 26 November 2021 (which was two days later). Visual meteorological conditions (VMC) by day prevailed at the time of the flight; and the flight plan was filed with Johannesburg (JHB) briefing office. The flight folio page serial number 30 indicated that 310 litres of Avgas 100LL fuel was uplifted; the main (tip) tanks and auxiliary tanks were filled to capacity, and the fuel in the aircraft totalled 662 litres (174 US gallons). Before departure at FAGM, the pilot reported that he conducted a pre-flight inspection, and all was normal with no defects recorded in the flight folio. The flight to FAHS was uneventful and lasted about 1.2 hours.

1.1.2 On Friday, 26 November 2021, the pilot and the same two passengers drove to FAHS where the pilot conducted a pre-flight inspection on the aircraft with no abnormalities noticed. The aircraft had about 482 litres (l) or 127 US gallons of fuel remaining in the tanks. Visual meteorological conditions (VMC) by day prevailed at the time of the flight, and the aircraft was operated under instrument flight rules (IFR). The flight plan was filed with the JHB briefing office. Visibility at departure aerodrome (FAHS) was good with the broken cloud base at 4 000 feet (ft) above ground level (AGL). The engines start-up was uneventful, and the pilot waited until all the engines indications were within the green arch with normal fuel flow on both engines. According to the FAHS control tower, the ZS-IGG aircraft took off from Runway 09 at 1100Z. The pilot reported that the aircraft climbed to flight level (FL) 140 or 14 000ft AMSL with the engines set at 31 inches of manifold air pressure (MAP) and 1800 revolutions per minute (RPM). After approximately 45 minutes in cruise and whilst overhead Witbank (FAWI) in Mpumalanga province, the pilot broadcasted on JHB area control frequency 126.7-Megahertz (MHz) and advised them that the engines were running rough.

1.1.3 During this time, it was drizzling, and the outside air temperature (OAT) was 0°C. The pilot noted nothing abnormal on the aircraft instruments or gauges, however, the aircraft could not maintain altitude. The pilot enquired with JHB area controller if there were any high grounds around Witbank (FAWI). The pilot reported the weather condition as overcast with the cloud base at 4 000ft and tops at 10 000ft AGL. The controller cleared the pilot to descend to a lower altitude and directed him to Middleburg Aerodrome (FAMB), which was in proximity to his position. The pilot caught sight of FAMB after descending through the clouds. He reported that whilst descending, he selected the auxiliary fuel pumps to HIGH mode, thinking that the rough-running engines were initiated by fuel starvation. But there

was no change to the rough-running engines. During final approach for Runway 14, both engines stopped simultaneously, and the aircraft was unable to reach the destined runway. The pilot executed a forced landing on an open field, approximately 0.81 nautical miles (nm) north of FAMB. The aircraft sustained substantial damages during the forced landing. The pilot suffered minor injuries, whilst the two passengers were unharmed.

1.1.4 The South African Police Service (SAPS) and the Emergency Medical Services (EMS) were notified of the accident, and they swiftly responded to the accident site. The paramedics administered first aid to the pilot and, together with the passengers, were all transported to Midmed Hospital for medical check-ups. All three occupants were released the same day. The flight was conducted under the provisions of Part 91 of the Civil Aviation Regulations (CAR) 2011 as amended.

1.1.5 The accident occurred on an open field, north of FAMB at Global Positioning System (GPS) co-ordinates determined to be S25° 41 08´.40" E029° 26 25´.90" at an elevation of approximately 4 886ft.

Figure 1: The accident site, north of FAMB on Runway 14. (Source: Google Earth Map)

1.2. Injuries to Persons

Injuries	Pilot	Crew	Pass.	Total On-board	Other
Fatal	-	-	-	-	
Serious	-	-	-	-	
Minor	1	-	-	1	
None	0	-	2	2	
Total	**1**	**-**	**2**	**3**	

1.3 Damage to Aircraft

1.3.1 The aircraft sustained substantial damages during the accident sequence.

Figure 2: A view of the aircraft at the accident site.

1.4 Other Damage

1.4.1 None.

1.5 Personnel Information

Nationality	British	Gender	Male	Age	37
Licence Type	Commercial Pilot Licence (CPL)				
Licence Valid	Yes	Type Endorsed	Yes		
Ratings	Instruments Rating				
Medical Issue Date	17 November 2021				
Medical Expiry Date	30 November 2022				
Restrictions	None				
Previous Accidents	None				

Flying Experience:

Total Hours	394.8
Total Past 24 Hours	0
Total Past 7 Days	1.2
Total Past 90 Days	20
Total on Type Past 90 Days	20
Total on Type	20

The pilot was a British citizen. He had a valid United Kingdom Civil Aviation Authority (UK-CAA) issued Commercial Pilot Licence (CPL) and a Class 1 aviation medical certificate, issued on 18 November 2021 with an expiry date of 30 November 2022 with no restrictions. The available information showed that a frozen Airline Transport Pilot Licence (ATPL) was issued to the pilot by the UK-CAA because he had passed all theoretical examinations but did not meet the 1500 hours / flight experience required. On 19 January 2019, the pilot sent an email to the South African Civil Aviation Authority (SACAA) seeking assistance in converting his UK-CAA CPL to SACAA licence. The SACAA form number CA61.01.13b, dated 21 January 2019, showed that there was consensus between the SACAA and the pilot that his CPL issued by UK-CAA be converted to the SACAA CPL. The SACAA form number CA61-11.4, dated 25 July 2019, indicated that the pilot was then revalidated to a CPL at Lanseria International Airport (FALA). The SACAA statement of examination results, dated 6 August 2019, indicated that the pilot had passed the air law, meteorology, flight performance and planning procedures on 18 July 2019. Another statement of examination results, dated 6 August 2019, indicated that the pilot completed the instruments rating on 24 July 2019. The pilot's skills test was completed on 30 November 2020 with an expiry date of 30 November 2021.

Pilot's type conversion/difference training:

On 11 March 2019, the pilot completed his type conversion on a Cessna 421C-model under the auspices of an approved training organisation (ATO). The topics covered included the following:

- The student is required to fill out a type technical, which is referenced in the Pilot's Operating Handbook (POH) of the aircraft; the intended training is to be conducted prior to the flight.
- A briefing before the flight in which the above type technical is discussed and corrected, if there are any issues.
- Pre-flight walk-around conducted with the student pilot and all exterior points discussed.
- Cockpit familiarisation conducted using a checklist or standard operating procedures (SOP), whichever is applicable.
- Initial air experience which is conducted in the aircraft where all systems are practically demonstrated and practised.
- Practise of unusual flight conditions, such as slow flight and stall entry and recovery/spin avoidance.
- Emergency procedures – managing engine fires/failures/abnormalities – generally a few scenarios are practised in the most threatening situations such as after take-off and during go-arounds, including restart procedures. This, then, leads to a minimum control airspeed airborne (Vmca) demonstration and recovery.
- Emergency descent procedure.
- Ice protection and inadvertent icing encounters.

The conversion concludes with at least three circuits and a heavy load to demonstrate performance and centre of gravity shifts. Finally, a debrief and any student questions are discussed.

According to available information (form CA61-13.06), the pilot had flown a total of 2.3 hours dual (one flight) to complete his conversion onto the aircraft type. The ATO, under which the type conversion was conducted, was consulted by the investigation team to seek clarity regarding a Cessna 421B type conversion. The ATO indicated that they had only assisted the pilot with the Cessna 421C model with a conventional fuel system.

1.6 **Aircraft Information**

1.6.1 Aircraft description

Source: Pilot's Operating Handbook (POH):

The Cessna 421B Golden Eagle aircraft is a 7 seat, all-metal, low wing pressurised cabin aircraft manufactured by Cessna Aircraft Cooperation in the United States of America (USA). The aircraft is designed for single pilot operation. The cabin is accessed from a door on the left-hand side behind of the wing. The aircraft was certified by the Federal Aviation Administration (FAA) to operate into known icing conditions (FIKI) and it is equipped with the surface de-ice (deice boots), heated propellers, heated windshield, heated static source, and the alternate air system. The aircraft is powered by two Teledyne Continental GTSIO-520-H turbocharged, six-cylinder reciprocating, horizontally opposed, fuel injected engines rated at 375-horsepower (hp) at 2,235 revolution per minute (RPM) and 39,0 inches manifold pressure. The engines were each fitted with a McCauley three bladed, full feathering, constant speed propeller. The propeller control lever controls the propeller governor. Oil pressure from the propeller governor drives the blades toward fine pitch (increasing RPM) while a spring and counterweights drive the blades toward coarse pitch (decreasing RPM) when the oil pressure is reduced. In the event of an engine failure, the propeller can be feathered (full coarse pitch to reduce drag) by moving the propeller control lever to the feathered position. The aircraft had a tricycle retractable landing gear which was electrically controlled and hydraulically actuated. It comprises of four split flaps (two per wing). Each flap is attached to the wing rear spar lower surface and is actuated by two push-pull rods attached to bell cranks in the wing. The flaps can be set to 0°, 15°, 30° and 45° detent positions or to an intermediate position between any of the detents.

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

1.6.2 Cessna 421B fuel system description:

Fuel was contained in six individual wing tanks. The main tanks (tip) are located on each wing tip and the auxiliary tanks are in the main wing structure outboard of each engine. The useable fuel 193 litres (51 US gallons) in each main tank and 138 litres (36.5 US gallons) in each auxiliary tank. The 26.6 US gallons capacity wing locker tanks were not filled; thus, the total useable capacity of fuel was 662 litres (174 US gallons). The fuel selector handles of each side (left or right) are situated between the seats on the floor, and they provide selection of: OFF, AUXILLIARY, MAIN and CROSSFEED. The auxiliary fuel pumps system on the C421B model was modified in accordance with (IAW) the Service Bulletin (SB) MEB88-3. The switches are labelled AUX PUMP, L (left engine) and R (right engine) and switch positions are LOW, OFF and HIGH. The LOW position operates the auxiliary pumps at low speed and are used, when required, to supplement fuel pressure for all normal operations. The HIGH position is reserved for emergency operation and operates the pumps at high speed. The HIGH position supplies sufficient fuel flow to sustain partial engine power in the event of an engine-driven fuel pump failure. Cessna owner's manual recommends that the aircraft be operated via the main (tip) tanks fuel supply during take-off, landing, and all normal operations. A caution is highlighted in the owner's manual alerting operators that should the auxiliary fuel pump switches be placed in the HIGH position with the engine-driven fuel pump (s) operating normally, total loss of engine power may occur. The aircraft POH identified Avgas LL100 as the primary fuel. The engine cockpit instrumentation included fuel pressure gauges, the fuel flow indicators, and the manifold pressure gauges. The cockpit annunciator panel provided visual indications for the fuel related system.

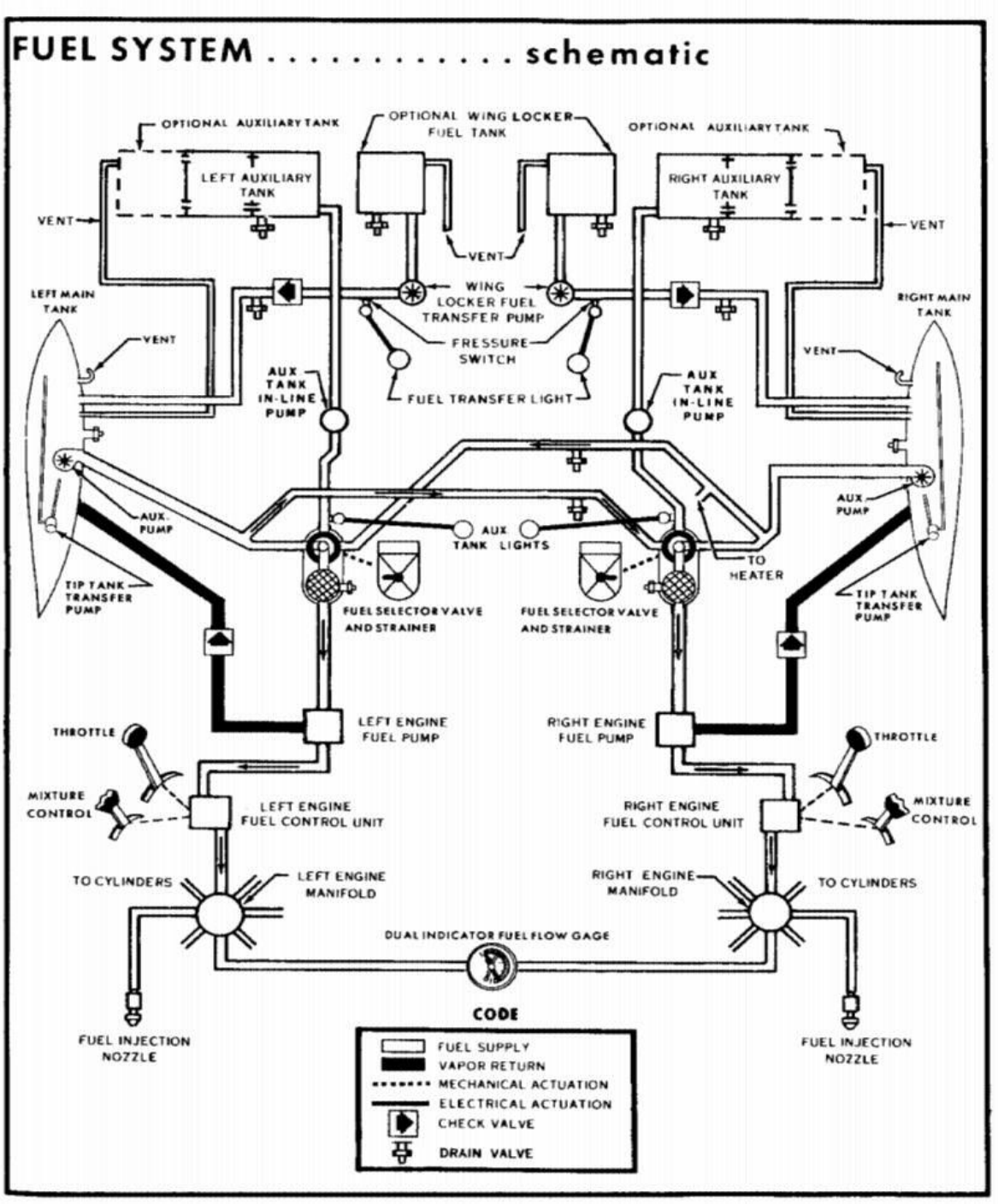


Diagram 1: Cessna 421B fuel sytem schematic.

1.6.3 Sudden Engine Roughness In-flight Procedure: Source – Aircraft Flight Manual

a) Power – REDUCE IMMEDIATELY (Both engines)

1) Manifold Pressure. -32.5 inches. Hg MAXIMUM

2) RPM – 1950 MAXIMUM (1800 recommended)

b) Engine – Determine affected engine

c) Problem – ANALYSE

d) Engine – SECURE (If roughness cannot be cleared)

e) Operating Engine – ADJUST

f) Trim Tabs – ADJUST (5° bank towards good engine)

g) As soon as practical – LAND

1.6.4 Air Inlet (Induction) or Filter and Cold (external) Alternate Air Inlet Icing: (Source – AFM)

1. Alternate Air Controls – PULL OUT

2. Propellers – INCREASE (Avoid continuos operation in the yellow arch)

3. Mixture – LEAN as required

4. "Pressurised Air" Control – PULL TO DUMP (LH and/ or RH as appropriate)

a) Above 10000ft. with both air sources dumped

1) If supplemenray oxygen is not available – EMERGENCY DESCENT to 10000ft

2) If supplementay oxygen is available:

(a) Oxygen Knob – PULL on

(b) Assure each passenger is using oxygen

(c) Descent as soon as practical to 10 000ft

Airframe:

Type	Cessna 421B	
Serial number	421B-0221	
Manufacturer	Cessna Aircraft Company	
Year of manufacture	1972	
Total airframe hours at the time of accident	7117.1	
Last Mandatory Periodic Inspection (Hours & Date)	7092.10	17 February 2021
Hours Since Last Mandatory Periodic Inspection	25	
Certificate of Airworthiness (Issue Date)	20 December 2017	
Certificate of airworthiness (Expiry Date)	31 March 2022	
C of R (Issue Date) (Present owner)	12 December 2016	
Maximum take-off weight	3379.3 kg	
Type of fuel recommended	Avgas 100LL	
Fuel used	Avgas 100LL	
Operating categories	Part 91	

*NOTE: The aircraft was previously owned and operated by Three Diamonds Air Charters in Brakpan Aerodrome (FABB), Benoni, Gauteng province. In 2021, the aircraft was sold to the new owner and the aircraft's documentation such as the logbooks, the last maintenance work pack, the Service Bulletins (SBs) and Airworthiness Directives (ADs) proof of compliance files were handed over to the new owner. The new owner continued to fly the aircraft with the previous owner's name or brand on it until the day of the accident flight. The aircraft was deregistered, and re-registered (with SACAA) under the new owner's name, Duratone (Pty) Ltd, and a new Certificate of Registration was issued on 5 January 2022.

The aircraft's flight folio page serial number 29 showed that a 200-hour mandatory periodic inspection (MPI) was carried out on 17 February 2021 at 7092.10 total airframe hours. The aircraft was maintained by a Regulator-approved aircraft maintenance organisation (AMO). The AMO-approval certificate was issued by the Regulator on 6 March 2021 with an expiry date of 28 February 2022. The Certificate of Release to Service (CRS) was issued by the AMO on 17 February 2021 with an expiry date of 16 February 2022 or at 7192.10 airframe hours, whichever comes first. Examination of the aircraft's technical records indicated that the aircraft was properly certificated and maintained in accordance with (IAW) the SACAA regulations and approved procedures. All applicable ADs and mandatory SBs on the aircraft were complied with. Scrutiny of the aircraft's flight folio revealed that there were no technical defects pending on the aircraft prior to the accident flight.

Aircraft Mass and Balance:

The investigation team was unable to determine a detailed mass and balance of the aircraft at the time of the accident. The aircraft departed FAGM for FAHS with 662 litres (529.6kg) of Avgas 100LL fuel in the tanks. The flight to FAHS took about 1.2 hours, and approximately 180 litres of fuel was used. The aircraft departed FAHS with 482 litres of fuel (385.6kg) and had flown about 0.7 hours until the accident, and approximately 113.5 litres (90.8kg) of fuel was used. The fuel calculations were based on a consumption rate of approximately 47.0 US gallons per hour, which was obtained from the POH. The weight of the three occupants added together was 250kg However, the weight of the luggage and miscellaneous items in the cabin could not be determined because they were removed from the aircraft.

Engine 1 (Left):

Type	Continental GTSIO-520-H
Serial Number	817510R
Hours Since New	7089.4
Hours Since Overhaul	1558.4

Propeller 1:

Type	McCauley 3AF34C92-P
Serial Number	799834
Blade Serial Numbers	i. K117366YS ii. K117383YS iii. K117403YS
Hours Since New	7089.4
Hours Since Overhaul	101.4

Engine 2 (Right):

Type	Continental GTSIO-520-H
Serial Number	2190494-72D
Hours Since New	7152.8
Hours Since Overhaul	339.4

Propeller 2:

Type	McCauley 3AF34C92-P
Serial Number	7810566
	i. K97841YS ii. K101202YS iii. K101203YS
Hours Since New	7089.4
Hours Since Overhaul	101.4

1.7 Meteorological Information

1.7.1 An official weather report was obtained from the South African Weather Service (SAWS) for Mpumalanga on 26 November 2021.

i. The significant weather charts showed scattered stratocumulus and cumulus clouds forecasted over FAWI, ranging between 7 000ft and 8 000ft above ground level (AGL) and the top expected at 12 000ft AGL at 1200Z. A review of the weather report indicated icing weather conditions overhead FAWI at about 14 000ft.

Wind direction	070°	Wind speed	02kts	Visibility	N/a
Temperature	0°C	Cloud cover	N/a	Cloud base	N/a
Dew point	-4°C	QNH	N/a		

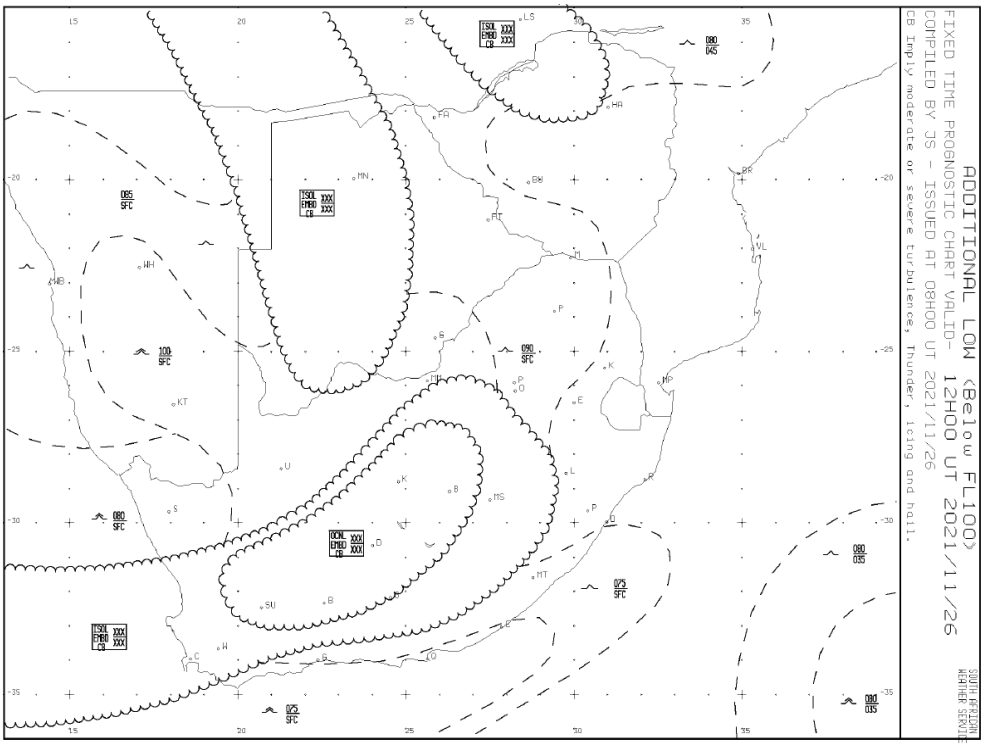


Figure 4: A satellite image showing icing conditions at the time of flight.

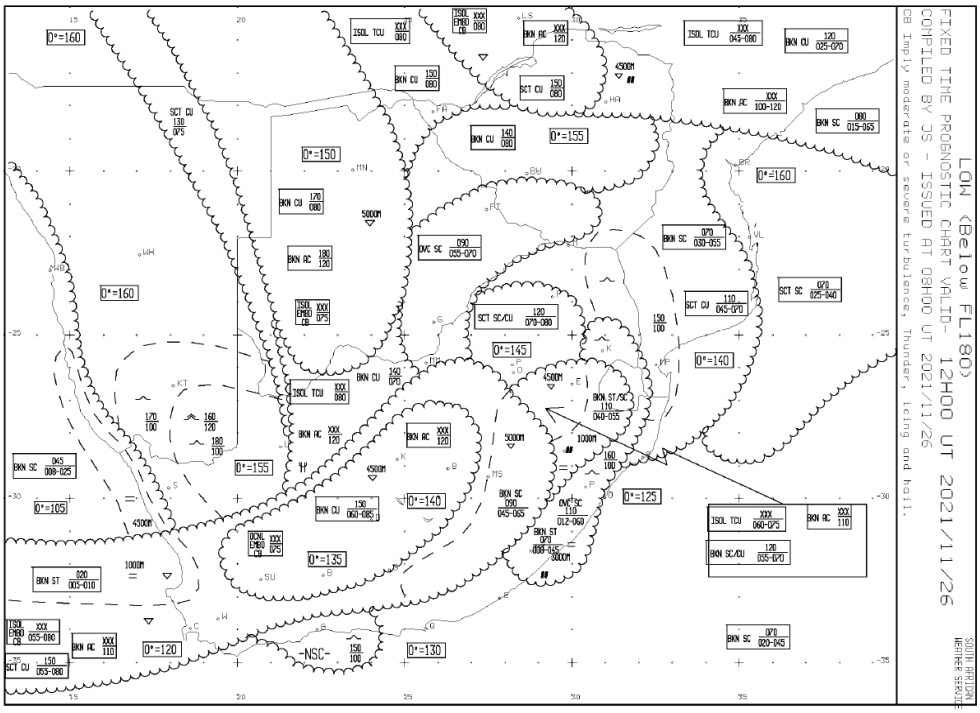


Figure 5: A satellite image showing the icing conditions at the time of flight.

1.8 Aids to Navigation

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

I. Magnetic compass

II. Garmin GTX 330

III. Garmin GNS 430

IV. Bendix King KT-76A

V. Rockwell Collins WXR-220

VI. Bendix King KX155

VII. Bendix King KN-62A

1.8.2 Aeronautical charts covering the route from FAHS to FAGM were recovered from the aircraft. The charts were unmarked and there was no physical evidence of a prepared navigation log.

1.9 Communication

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

1.9.2 The pilot broadcasted on JHB area control very high frequency (VHF) 126.7MHz before descending to FAMB. The aircraft was fitted with an Emergency Locater Transmitter (ELT). After impact, the ELT transmitted signals to Johannesburg Information, further alerting the relevant authorities.

1.10 Aerodrome Information

1.10.1 The accident occurred on an open field, north of FAMB, approximately 0.81nm at GPS co-ordinates determined to be S25° 41 08´.40" E029° 26 25´.90" and at an elevation of approximately 4 886ft.

Aerodrome Location	Middleburg Aerodrome (FAMB)	
Aerodrome Co-ordinates	S25° 41 08´.40" E029° 26 25´.90"	
Aerodrome Elevation	4 886ft	
Runway Designations and Dimensions	14/32	1800m × 25m
Runway Designations and Dimensions	02/20	1345 × 25m

Runway Used	None
Runway Surface	Gravel and Asphalt
Aerodrome Status	Licensed
Approach Facilities	Runway Lighting

1.11 Flight Recorders

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

1.12 Wreckage and Impact Information

1.12.1 Examination of the accident site indicated that the aircraft landed hard on an open field. The main landing gear doors separated from their respective struts and all three landing gears broke off (at the struts) during landing. The aircraft skidded on its belly and stopped approximately 65 metres from the first point of impact. The pitot probe/tube mounted underneath the nose section broke off. The bottom fuselage skin and the antennas were damaged. The nose gear strut/wheel assembly was found approximately 12m from the first point of impact, followed by the left main gear strut/wheel assembly that was found on the left, approximately 16m; and the right main gear strut/wheel assembly, which was further away, approximately 22m from the first point of impact. All three landing gears strut oleos and the tyres had pressure. The fuselage nose-section collapsed in compression and separated on the right-side nose-cargo compartment area. The right-side main (tip) tank suffered overload failure at its attachment area, however, the fuel pipe feeding the engine was still intact. The wing structure, including the auxiliary fuel tanks and the locker tanks, was intact. All seats were found still attached to the floor boards and were undamaged. All the seat belts were accounted for and operated normally when tested. Both the left and the right fuel selector valve handles on the cockpit floor panel were found selected to the OFF position. It was the investigators' thought that the pilot selected them to the OFF position before he vacated the aircraft.

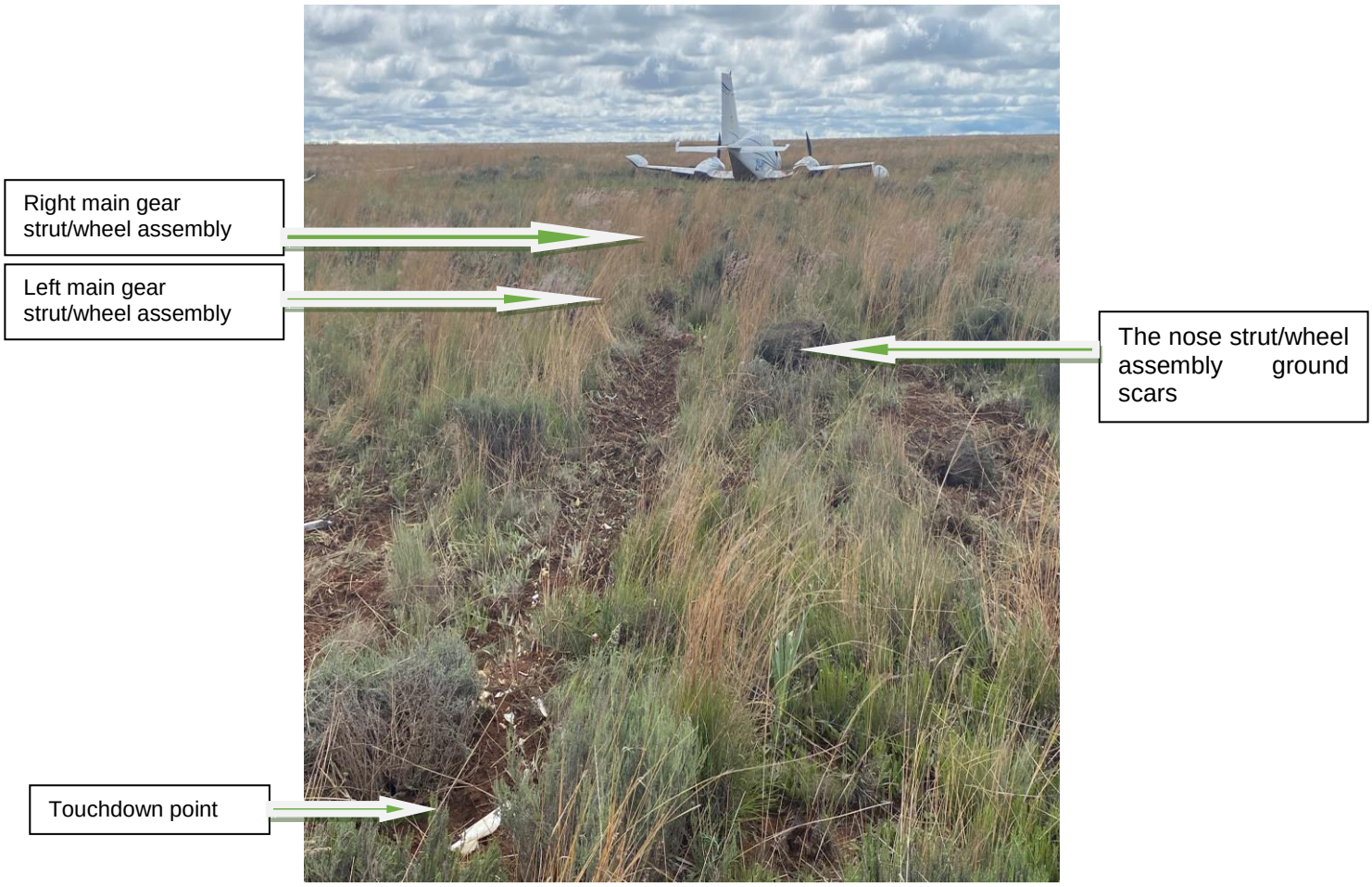


Figure 6: First point of impact and the final position of the aircraft.

Figure 7: View of the broken main landing gear struts with the wheel assemblies still attached.

1.12.2 Examination of the engines control instruments showed both throttle levers in a closed position. The mixture control levers were both in idle cut-off position. All instruments, radios

and switches were intact. The aircraft's landing gear selector handle was in an extended position and both the flap selector and the flap position indicator were found at 45° flaps, extended. None of the circuit breakers were pulled. *The alternate air levers (T-handles on the left pilot's side below the control column) which select the induction air intake in case the primary air intake (air filters) becomes obstructed were found in the closed position despite the AFM that requires that in the event the engines' air filters become obstructed or blocked, they should be opened to allow the unfiltered air into the engines. The auxiliary fuel pumps switches on the left pilot's side-panel were selected to HIGH mode.*

Figure 8: A view of the aircraft's console showing the landing gear selector handle in an extended position and the flap position indicator at 45°.

Figure 9: The left and right ALTERNATE AIR levers in a closed (OFF) position.

Figure 10: A view of the auxiliary fuel pumps in a HIGH mode setting. There is a placard (yellow window above) installed on the left pilot's side panel stating AUX PUMP HIGH FOR ENGINE DRIVEN PUMP FAILURE (VERY LOW OR NO FUEL PRESSURE).

1.12.3 The engines were found still attached to their respective mountings and the propellers secured to their engine flanges. Examination of the aircraft's propellers/blades showed that the engines were not operational during landing. Neither of the propellers was feathered (turned to a very high pitch with the blades almost parallel to the airstream).

Figures 11 and 12: Pictures showing neither of the propellers feathered.

1.12.4 A detailed examination of the aircraft's primary flight controls from the control column and rudder pedal control assemblies, to the respective flying control surfaces did not reveal any evidence of a pre-accident flying control system failure. It was, however, not possible to eliminate the possibility of a pre-accident control restriction due to the impact-related disruption of the aircraft's structure.

1.13 Medical and Pathological Information

1.13.1 None.

1.14 Fire

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

1.15 Survival Aspects

1.15.1 The accident was considered survivable as the occupants were properly restrained with the aircraft-equipped safety harnesses during the flight, as well as the low impact force associated with the accident. Work-order 13131, dated 5 March 2021, showed that a Kannad 406 AF ELT part number S1821502-02, serial number 40131-0019 was installed on the tail section and on the left-side of the aircraft in accordance with (IAW) the Maintenance Manual (MM) 25-63-05, Revision 4, dated 20 January 2019. The ELT activated and was detected by the Aeronautical Rescue and Coordination Centre (ARCC) in JHB. The ELT was switched off by the investigators during their on-site investigation.

Figure 13: The ELT installed on the aircraft's tail-section.

1.16 Tests and Research

1.16.1 The investigation focused on the aircraft's control systems, the fuel system, engines and propellers. Testing of the aircraft fuel system confirmed that the fuel tank selectors in the cockpit floor and their respective fuel selector valves were operating normally, and no evidence of restrictions was reported. Both main (tip) fuel tanks contained sufficient fuel. Fuel samples taken from both tip tanks were clear, bright and of the correct colour (blue) with no visible signs of contamination. Tests carried out on the tip tanks quantity sensors, the fuel quantity and fuel flow gauges confirmed that they operated normally and were correctly calibrated. There was no evidence of a mechanical failure in either engine, and tests confirmed that both engines' ignition systems and propeller governors were operational. The aircraft's flight folio entries indicated no pre-accident defects with the fuel system.

1.16.2 The weather forecast by the SAWS on the day indicated icing or freezing weather conditions overhead FAWI. The pilot stated that the engines were running normal until the aircraft entered FAWI airspace, which was concentrated with ice that seemed to have obstructed the air filters on the in-board of each nacelle and starved them of air. The aircraft was certified to operate into known icing conditions, and selecting the alternate air and allowing the unfiltered air into the engines for proper combustion was all that was needed IAW the AFM. In contrast, the pilot assumed that the engines' malfunction was caused by fuel starvation and had selected the auxiliary fuel pumps switches to HIGH mode. This did not resolve the anomaly because the engines were already starved of air. Stapled hard copies of the emergency procedures were found on top of the aircraft's instrument panel post-accident.

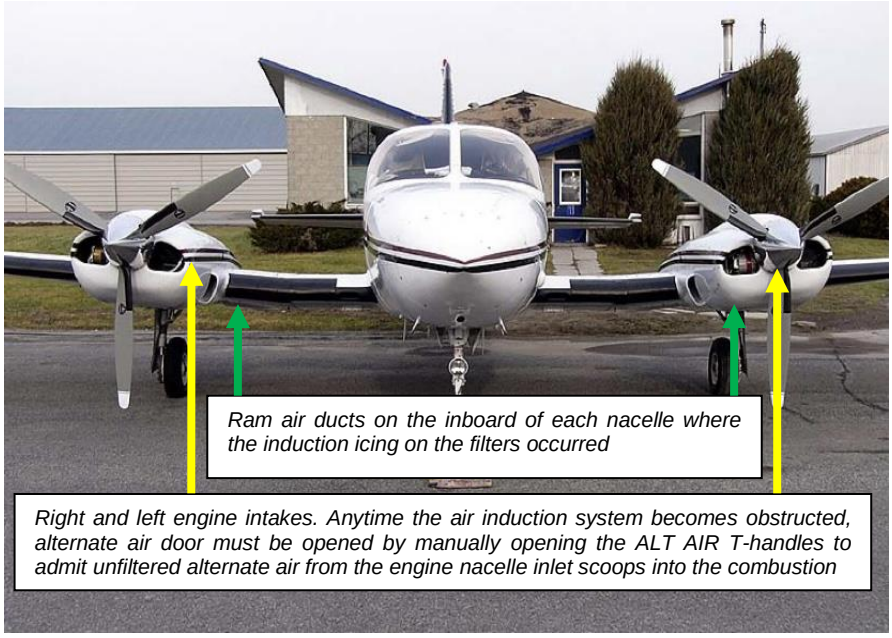


Figure 14: The file picture of the Cessna (not ZS-IGG). (Source: https://www.jetphotos.com) The picture shows the ram air ducts on the inboard of each nacelle and the alternate air entry point through the nacelles into the combustion.

1.16.3 The aircraft alternate air source was tested post-accident and was found to be operational. The pilot had logged 20 hours on the aircraft model and there was nothing suggesting that he misunderstood the fuel-usage philosophy on the aircraft. The investigators had intended to run the engines post-accident, but because some parts of the aircraft/engine were removed at the accident site before the aircraft was recovered to a safe place, this was not possible. Engine compression was attained in all cylinders.

1.17 Organisational and Management Information

1.17.1 The flight was conducted IAW the provisions of Part 91 of the South African Civil Aviation Regulations 2011 as amended.

1.17.2 A 200-hour MPI was carried out on 17 February 2021 at 7092.10 total airframe hours. The Certificate of Release to Service (CRS) was issued by the AMO on 17 February 2021 with an expiry date of 16 February 2022 or at 7192.10 airframe hours, whichever comes first.

1.17.3 The aircraft was maintained by the SACAA-approved AMO. The AMO approval certificate was issued by the Regulator on 6 March 2021 with an expiry of 28 February 2022.

1.18 Additional Information

1.18.1 Induction System Icing – (Source: FAA advisory circular No: 20-113)

Induction system icing may be characterized as impact ice, throttle ice, and fuel vaporization ice. *Anyone, or a combination of the three kinds of induction icing, can cause a serious loss of power by restricting the flow of the fuel/air mixture to the engine and by interference with the proper fuel/air ratio*. Because induction icing accidents can be prevented by the pilot in virtually all cases, improved pilot awareness, attention, and adherence to recommended procedures should reduce accidents of this type.

1.18.2 Impact Ice – (Source: FAA advisory circular No: 20-113)

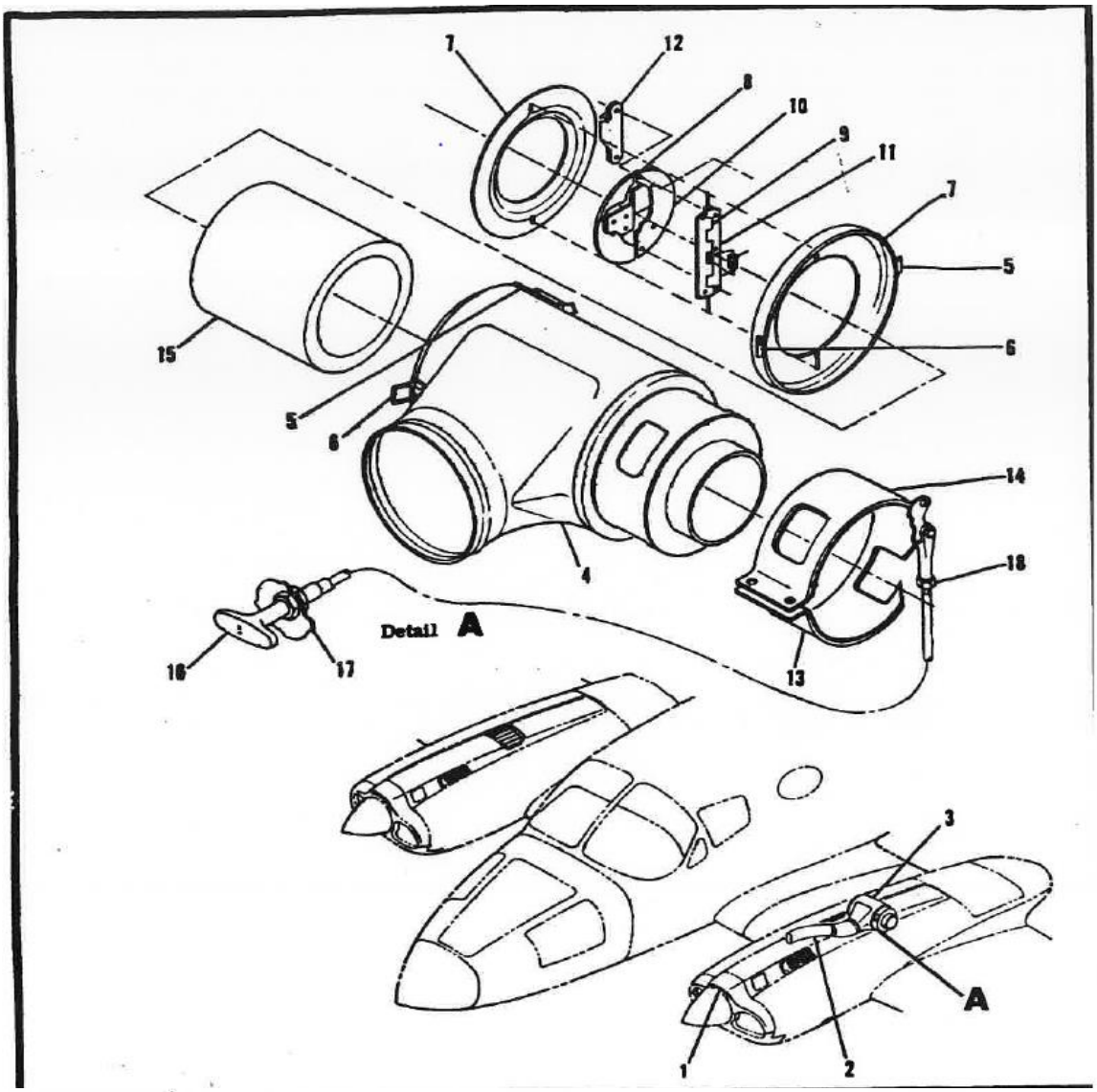
Impact ice is formed by moisture-laden air at temperatures below freezing, striking, and freezing on elements of the induction system which are at temperatures of 32° F, or below. Under these conditions, ice may build up on such components as the air scoops, heat or alternate air valves, intake screens, am protrusions in the carburetor. Pilots should be particularly alert for such icing when flying in snow, sleet, rain, or clouds, especially when they see ice forming on the windshield or leading edge of the wings. The ambient temperature at which impact ice can be expected to build most rapidly is about 25° F. When the supercooled moisture in the air is still in a semiliquid state. This type of icing affects an engine with fuel injection, as well as carbureted engines. It is usually preferable to use carburetor heat or alternate air as an ice prevention means, rather than as a de-icer,

because fast forming ice which is not immediately recognized by the pilot may significantly lower the amount of heat available from the carburetor heating system.

Additionally, to prevent power loss from impact ice, it may be necessary to turn to carburetor heat or alternate air before the selector valve is frozen fast by the accumulation of ice around it. When icing conditions are present, it is wise to guard against a serious build up before de-icing capability is lost. The use of partial heat for ice prevention without some instrumentation to gauge its effect may be worse than none at all under the circumstances. Impact icing is likely under extremely cold conditions, because the relative humidity is usually low in cold air and because such moisture as is present usually consists of ice crystals which pass through the air system harmlessly. The use of partial heat when the temperature is below 32° F may, for example, raise the mixture temperature up to the danger range, whereas full carburetor heat would bring it well above any danger of icing.

1.18.3 Cessna 421B Air Induction System – (Source: Engine Service Manual)

Induction air enters the system through a ram air duct located on the inboard duct of each nacelle and is directed through a filter mounted to the turbocharger compressor air inlet. A magnetically controlled alternate air door incorperated in the airfilter permits compresor suction to open the door and admits alternate air if the air induction system becomes obstructed. A manually controlled alternate air door within the nacelle permits the pilot to open it to admit alternate (heated engine compartment air) if the air induction system should become obstructed. An exhaust driven turbocharger is automatically controlled by controllers to maintain a manifold pressure at 39.5 inches Hg, from sea level to acritical altitude (16.000ft) regardless of temperature. The turbocharger is completely automatic requiring no pilot action to critical altitudes.



1. Air Inlet Scoop
2. Duct
3. Canister
4. Container
5. Latch
6. Latch
7. End Cap
8. Door
9. Hinge-Half
10. Door
11. Hinge-Half
12. Hinge-Half
13. Valve
14. Seal
15. Dry Air Filter
16. Alternate Air Control
17. Bracket- Control Pedestal
18. Nut

Diagram 2: Turbocharger induction air components. (Source: Engine Service Manual)

1.18.4 Task Saturation – (Source: US National Business Aviation Association (NBAA)

Task saturation is having too much to do without enough time, tools or resources to do it. That can lead to an inability to focus on what really matters. As task saturation increases, a pilot, cabin crewmember, flight line employee or maintenance technician might start shutting down, unable to continue performing. Another symptom is constantly shuffling and reorganizing while accomplishing nothing. A third symptom is a marked increase in errors.

1.19 Useful or Effective Investigation Techniques

1.19.1 None.

2. ANALYSIS

2.1 General

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

2.2 Analysis

2.2.1 Pilot:

Examination of the pilot's file held at the SACAA indicated that the pilot was appropriately qualified and certified to conduct the flight on the day of the accident. The pilot was fit and well rested; also, he had a valid Class 1 aviation medical certificate issued on 18 November 2021 with an expiry date of 30 November 2022 with no restrictions.

2.2.2 Aircraft:

Examination of the aircraft's logbooks and flight folio indicated that the aircraft was properly maintained IAW the existing regulations. The last 200-hour MPI on the aircraft was carried out on 17 February 2021 at 7092.10 total airframe hours. The Certificate of Release to Service (CRS) was issued by the AMO on 17 February 2021 with an expiry date of 16 February 2022 or at 7192.10 airframe hours, whichever comes first. The aircraft was maintained by the SACAA-approved AMO. The AMO-approval certificate was issued by the Regulator on 6 March 2021 with an expiry date of 28 February 2022.

2.2.3 The forecasted weather conditions and conclusion:

The SAWS broadcasted icing or freezing weather conditions overhead FAWI at about 14000ft. The pilot reported nothing abnormal with the aircraft prior to entering FAWI airspace but had experienced rough-running on both engines, which was considered uncommon because each engine was fuel-fed from a separate tip tank. The FAA advisory circular 20-113 warns pilots of system icing known as impact ice, which can build up on aircraft components, such as the air filters when moisture-laden air is below freezing points. Based on the outside air temperature in the area in which the flight was being operated and lack of apparent cause of engines' malfunction, it is likely that the primary air induction system became obstructed with ice (particles) during the flight.

The pilot appeared to have overlooked the AFM and reverted to memory action items; thus did not consider opening the alternate air source to allow proper combustion. Instead, he selected the auxiliary fuel pumps to HIGH mode, assuming that the anomaly was caused

by fuel starvation. This did not resolve the anomaly because the engines were already starved of air. The pilot, after noticing that the power could not be restored, seemed to have changed his focus from troubleshooting the engines' fault to ensuring that the aircraft was safe for descent.

The pilot broadcasted his intention to the JHB area controller who cleared him to descend to a lower altitude and to find FAMB, which was in proximity to his position. During final approach for Runway 14, both engines stopped. The pilot stated that the aircraft could not reach the runway and he executed a forced landing on an open field, approximately 0.81nm north of FAMB. The investigation determined that the cause of the accident was due to the pilot's task saturation owing to the high workload following the rough-running engines in IMC, which made him vulnerable to errors.

2.2.4 Pilot's workload:

The aircraft was operated by a single pilot in IMC in an area that he was unfamiliar with, and that alone carried a high workload that is already greater than it would have been if two pilots were on-board. In a flight with two crew pilots, the pilot at the controls usually handles the flying duties, and the other pilot operates the radio, confirms instrument readings, calls out minimum altitudes, and performs other tasks. Dividing tasks in this manner enables the crew to evenly share the workload, thus, making informed decisions.

3 CONCLUSION

3.1. General

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

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

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

3.2. Findings

3.2.1 The flight was conducted IAW the provisions of Part 91 of the South African Civil Aviation Regulations 2011 as amended.

3.2.2 The aircraft had about 482 litres of fuel remaining; therefore, fuel was sufficient for a planned flight to FAGM.

3.2.3 The aircraft was issued a Certificate of Airworthiness on 20 December 2017 with an expiry date of 31 March 2022.

3.2.4 The aircraft was issued a Certificate of Registration on 12 December 2016.

3.2.5 A review of the weather report indicated in-flight icing hazards overhead FAWI.

3.2.6 The pilot was a British citizen with a valid UK-CAA issued CPL and a Class 1 medical certificate issued on 13 April 2018 with an expiry date of 30 April 2019. The pilot's latest medical certificate was issued by the SACAA on 18 November 2021 with an expiry date of 30 November 2022 with no restrictions.

3.2.7 The SACAA form number CA61.01.13b, dated 21 January 2019, indicated that there was consensus between the SACAA and the pilot that his CPL issued by the UK-CAA be converted to the SACAA CPL.

3.2.8 The SACAA form number CA61-11.4, dated 25 July 2019, indicated that the pilot was then revalidated to a CPL at FALA.

3.2.9 The SACAA statement of examination results, dated 6 August 2019, indicated that the pilot had passed the air law, meteorology, flight performance and planning procedures on 18 July 2019. Another statement of examination results, dated 6 August 2019, indicated that the pilot completed the instruments rating on 24 July 2019. The pilot had an endorsement of single and multi-engine aircraft on his licence, including a Cessna 421C model aircraft.

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

3.2.11 The last 200-hour MPI on the aircraft was completed on 17 February 2021 at 7092.10 airframe hours. The aircraft was maintained by an approved AMO that was certified by the Regulator. The AMO approval certificate was issued by the Regulator on 6 March 2021 with an expiry date of 28 February 2022.

3.2.12 The investigation found that neither of the propellers was feathered.

3.3 Probable Cause

3.3.1 Double-engine failure during approach for an emergency landing at FAMB following rough-running engines which were most likely induced by ice obstructing the engine air filters.

3.4 Contributing Factor/s:

3.4.1 The pilot seemed to have been subjected to task saturation as he operated as a single crew.

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 None.

This report is issued by:

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