AIRCRAFT ACCIDENT REPORT AND EXECUTIVE SUMMARY

Reference:	CA18/2/3/10130

Helicopter Registration	ZS-RVP	**Date of Accident**	2 March 2022	**Time of Accident**	0740Z
Type of Helicopter	Agusta-Bell 206A	**Type of Operation**	Private (Part 91)		
Pilot-in-command Licence Type	Private Pilot Licence (PPL)	**Age**	54	**Licence Valid**	Yes
Pilot-in-command Flying Experience	**Total Flying Hours**	475.9	**Hours on Type**	0	
Last Point of Departure	Virginia Aerodrome (FAVG), Kwazulu-Natal Province				
Next Point of Intended Landing	Virginia Aerodrome (FAVG), Kwazulu-Natal Province				
Damage to Helicopter	Substantial				

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

On the grass, 3 metres (m) west of Runway 05 at FAVG at Global Positioning System (GPS) co-ordinates determined to be 29° 46’14” South 031°03’30” East, at an elevation of 20 feet

Meteorological Information	Wind: 060°at 14kt, temperature: 30°C, Dew point: 21°C, Visibility: 9999m, QNH: 1011hPa

Number of People On-board	1+2	**Number of People Injured**	1	**Number of People Killed**	0	**Other (On Ground)**	0

Synopsis

On Wednesday morning, 2 March 2022 at 0740Z, a pilot and two passengers on-board an Agusta-Bell 206A helicopter with registration ZS-RVP took off on a private flight from Virginia Aerodrome (FAVG) in KwaZulu-Natal province with the intention to return to the same aerodrome. The flight was conducted in visual flight rules (VFR) by day and under the provisions of Part 91 of the Civil Aviation Regulations (CAR) 2011 as amended.

The pilot stated that during transition after lift-off in ground effect, the engine spooled down and, as a result, he decided to execute a forced landing on the grass next to the runway. The helicopter impacted the ground hard and rolled to its left-side. The helicopter was substantially damaged during the accident. The pilot and one passenger were not injured, whilst the other passenger sustained minor injuries and was taken to hospital; the passenger was discharged later the same day. After the accident, the engine was subjected to a test-cell bench test, and the engine met all the parameters during the test run in accordance with (IAW) the manufacturer’s specification. The cause of the uncommanded shutdown was attributed to fuel starvation due to fuel shutoff valve that was in the closed/off position during start and lift-off phases.

Probable Cause

During transition, the engine experienced an uncommanded shutdown due to fuel starvation because of the fuel shutoff valve that was in the closed/off position during engine start. This led the pilot to execute an unsuccessful forced landing.

Contributory Factor/s

1. Unavailability of the checklist.
2. Initiating an early flare (incorrect manoeuvre executed during loss of engine power).
3. Inadequate experience.

SRP Date	11 April 2023	Publication Date	14 April 2023

Occurrence Details

Reference Number	**:** CA18/2/3/10130
Occurrence Category	**:** Category 1
Type of Operation	**:** Private (Part 91)
Name of Operator	**:** Blue Bird Aviation
Helicopter Registration	**:** ZS-RVP
Helicopter Make and Model	**:** Agusta Bell 206A
Nationality	**:** South African
Place	**:** Grass area adjacent Runway 05 at Virginia Aerodrome
Date and Time	**:** 2 March 2022 at 0740Z
Injuries	**:** One of the passengers sustained minor injuries
Damage	**:** Substantial

Purpose of the Investigation

In terms of Regulation 12.03.1 of the Civil Aviation Regulations (CAR) 2011, this report was compiled in the interest of the promotion of aviation safety and the reduction of the risk of aviation accidents or incidents and not to apportion blame or liability.

All times given in this report are Co-ordinated Universal Time (UTC) and will be denoted by (Z). South African Standard Time is UTC plus 2 hours.

Investigation Process

The Accident and Incident Investigations Division (AIID) of the South African Civil Aviation Authority (SACAA) was notified of the occurrence which occurred on 2 March 2022 at 0740Z. The occurrence was classified as an accident according to the CAR 2011 Part 12 and ICAO STD Annex 13 definitions. Notifications were sent to the State of Registry, Operator, Design and Manufacturer in accordance with the CAR 2011 Part 12 and ICAO Annex 13 Chapter 4. The State of Manufacturer has appointed an accredited representative. The investigators had dispatched to the accident site for this accident.

Notes:

1. *Whenever the following words are mentioned in this report, they shall mean the following:*
   Accident — this investigated accident
   Helicopter — the Agusta-Bell 206A 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

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

Table of Contents

Abbreviation	Description
°	Degrees
°C	Degrees Celsius
AGL	Above Ground Level
AIID	Accident and Incident Investigations Division
AME	Aircraft Maintenance Engineer
AMO	Aircraft Maintenance Organisation
AMSL	Above Mean Sea Level
ARCC	Aeronautical and Rescue Coordination Centre
ARFF	Airport Rescue and Fire Fighting
ASMCC	South African Mission Control Centre
ATC	Air Traffic Control
ATNS	Air Traffic and Navigation Services
ATZ	Air Traffic Zone
C of A	Certificate of Airworthiness
CCTV	Closed-Circuit Television
C of R	Certificate of Registration
COSPAS-SARSAT	Cosmicheskaya Sistyema Poiska Avariynich Sudov (Search and Rescue Satellite-aided Tracking)
CRMA	Certificate Relating to Service
CRS	Certificate of Release to Service
CVR	Cockpit Voice Recorder
DFE	Designated Flight Examiner
ELT	Emergency Locator Transmitter
ERPM	Engine Revolution Per Minute
FAVG	Virginia Data Recorder
FAOR	O.R. Tambo International Airport
FDR	Flight Data Recorder
FSTD	Flight Simulator Training Device
ft	Feet
GPS	Global Positioning System
hPa	Hectopascal
ICAO	International Civil Aviation Organisation
IPS	Inches Per Second
kt	Knots
m	Metres
MEOSAR	Medium Altitude Earth Orbit Search and Rescue
METAR	Meteorological Aerodrome Report
MM	Maintenance Manual
MPI	Mandatory Periodic Inspection
NR	Main Rotor Speed
PAC	Power Assurance Check
PIC	Pilot-in-command
PN	Part Number
PPL	Private Pilot Licence
PTT	Push-to-Talk
QNH	Barometric Pressure Adjusted to Sea Level
RPM	Revolutions Per Minute
RRPM	Rotor Revolution Per Minute
SACAA	South African Civil Aviation Authority
SAMCC	South African Mission Control Centre
SAWS	South African Weather Service

SN	Serial Number
Z	Zulu (Term for Universal Co-ordinated Time - Zero Hours Greenwich)

1. FACTUAL INFORMATION

1.1. History of Flight

1.1.1. On Wednesday morning, 2 March 2022 at approximately 0740Z, a pilot and two passengers on-board an Agusta-Bell 206A helicopter with registration ZS-RVP took off on a private flight from Virginia Aerodrome (FAVG) in KwaZulu-Natal province with the intention to land back at the same aerodrome. The pilot intended to route along the north coast. The flight was conducted under visual flight rules (VFR) by day and under the provisions of Part 91 of the Civil Aviation Regulations (CAR) 2011 as amended. Clear weather conditions prevailed at the time of the flight.

1.1.2. The pilot stated that on arrival at FAVG, he met with the two passengers at approximately 0640Z. The flight was planned to take approximately 30 minutes along the north coast before returning to FAVG. One passenger was seated on the left front seat and the other was seated in the rear cabin on the right-side seat behind the pilot.

1.1.3. The helicopter was fitted with dual flight controls (collective, cyclic and anti-torque pedals). The pilot stated that he familiarised himself with the cockpit, switched "ON" the battery and completed all initial checks. An external power supply was used for engine start-up phase. During the first engine start, the pilot had a challenge with his transmission to the tower using the cyclic push-to-talk (PTT) switch; he could receive audio from the tower but was unable to transmit. He then shut down the helicopter and approached another pilot in the nearby hangar who had just landed. The pilot (from the hangar) showed him another PTT switch on the cyclic that he could use to transmit to the tower, which operated as expected. Thereafter, the ZS-RVP pilot started the engine and prepared for lift-off. The pilot stated that during lift-off whilst in the in-ground effect (IGE) hover, the engine revolutions per minute (RPM) were at 100% and torque was indicating 80%, the pressures and temperature indications were in the green. Whilst transitioning into forward flight, the main rotor RPM started to decay; he then checked the throttle, and it was in the open position. The RPM continued to decay. The pilot lowered the collective control stick; however, this also had no effect on the engine RPM. The helicopter yawed to the left and the pilot responded with a right pedal movement, but the helicopter impacted the ground hard on its skid gears and rolled over to the left. Once the helicopter came to rest, the pilot released his safety harness and assisted the passengers out of their harnesses and the helicopter. Thereafter, he returned to the helicopter and closed the fuel shutoff valve. One of the people who responded to the scene disconnected the battery.

1.1.4. According to the first eyewitness, he was driving north up the taxiway when a black Bell helicopter with registration ZS-RVP was on the helicopter pad outside Hangar 5 with the engines running. He pulled over to the left outside Hangar 3 with the helicopter in front of him and waited for it to take-off. The helicopter lifted to a low hover and slowly taxied across the grass towards the runway and began to gain altitude. He then proceeded on the taxiway and, as he was driving up to Hangar 7, he observed from his peripheral view the helicopter's tail boom swing up into the air, followed by parts detaching and falling to the ground. He did not see clearly what had happened, but the aircraft had done a 180° rotation and plummeted to the ground. He then rushed to the scene to find the passengers and the pilot exiting the aircraft.

1.1.5. The second eyewitness (the pilot who assisted with identifying the PTT switch on the cyclic) was standing outside the hangar watching the accident helicopter take-off. He stated that the take-off was normal, but during transition, he observed the nose pitching up and the engine noise changing as if the helicopter was going back to idle, the pilot did not recover until the helicopter crashed. During impact, the main rotor blades severed the tail boom. The airport fire and rescue personnel responded to the accident site.

1.1.6. The third eyewitness, the air traffic control (ATC) on duty, stated that ZS-RVP was given lift-off clearance from Runway 05. The wind was north-easterly at 19 knots (kts). Visibility was greater than 10 kilometres (km) with broken clouds at 2000 feet (ft). There was no other aircraft in the aerodrome traffic zone (ATZ) at the time. The helicopter lifted off normally with no unusual manoeuvres. Once overhead the runway in the initial climb (estimated to be about 50-100 feet from ATC's perspective), the helicopter suddenly lost altitude and crashed on the grass on the west-side of the runway. The crash alarm was activated immediately. There was no distress call from ZS-RVP.

1.1.7. According to the Aeronautical and Rescue Coordination Centre (ARCC) located at O.R. Tambo International Aerodrome (FAOR), confirmation of an Emergency Locator Transmitter (ELT) distress signal frequency 406.0248-Megahertz (MHz) was received by Medium Altitude Earth Orbit Search and Rescue (MEOSAR) at 0903Z but was unlocated. At 0907Z, a *Cosmicheskaya Sistyema Poiska Avariynich Sudov* (COSPAS) SARSAT (Search and Rescue Satellite-Aided Tracking) satellite received a distress signal with ID: HEX ID CB264C7462ABED1, and at 0910Z, the South African Mission Control Centre (SAMCC) operations manager called the owner of the aircraft who informed him that he had sold the helicopter; he then provided the details of the new owner. The SAMCC operations manager called the new owner but could not reach him. At 0920Z, the new owner returned the call and was told about the distress signal that was received; he confirmed that ZS-RVP had crashed at FAVG.

1.1.8. According to the closed-circuit television (CCTV) video footage captured by one of the cameras mounted in the hangar facing towards the south, the helicopter is seen *"lifting off in a northerly direction. During transition, the helicopter yaws violently to the left with a slight nose up pitch, followed by a sudden loss of height. Thereafter, the main rotor blades lose momentum (increased coning angle as they were turning very slowly), the helicopter then impacts the ground hard with its skids and the main rotor blades sever the tail boom. The helicopter then rolls over to the left. Moments later, the airport fire and rescue personnel arrive at the scene, followed by an emergency vehicle".*

1.1.9. The passenger who was seated on the front left seat took a video using her cellular telephone, which was shared with the investigation team. The footage '*displays the instrument panel and the left half of the outside of the helicopter. During lift-off, the fuel shut-off valve toggle switch is in the off position, the torque indicator needle is at 50%, the dual engine revolutions per minute/rotor revolutions per minute (ERPM/RRPM) gauge indicator is in the green arch. Thereafter, two caution amber lights illuminate on the caution panel, followed by the Master Warning lights when the torque rolls back to zero percent*. *The ERPM displayed 65% whilst the RRPM indicated 70% when the master warning lights illuminate. The engine sound is clearly audible. The engine could be heard spooling down shortly after the helicopter gets airborne. Thirteen seconds into the flight, the ERPM/RRPM needle rolls back, followed by a violent yaw to the left, which is corrected by a right pedal input. The low rotor aural warning sounds*; and the footage ends.

Figure 1: A video still showing arrows indicating positions of the fuel valve in the off position, torque indicator and dual gauge. (Source: Video footage from the passenger)

Figure 2: A video still showing master warning and caution as well as an additional caution message on the caution panel. (Source: Video footage from the passenger)

1.1.10 A closed-circuit television camera (CCTV) that was mounted in the hangar at an aircraft maintenance organisation (AMO) facility facing the runway captured the helicopter during hover, taxi and take-off phases. This footage shows “the *helicopter lifting off and continuing with transition at a heading of 050 at low height (level to the trees located next to the runway). The nose of the helicopter then yaws violently to the left, about 45°, and then back to the heading of 050. Thereafter the helicopter descends vertically with the nose pitched up. The rotor blades flap up before the helicopter impacts the ground hard with the tail rotor guard, followed by skid gears. During impact, the main rotor blades sever the tail boom and the helicopter rolls to its left before it comes to a stop”.*

Figure 3: Coning angle of the main rotor blades. (Source: CCTV camera still image)

1.1.11 The accident occurred on the grass, 3 metres (m) west of Runway 05 at FAVG in Durban, KwaZulu-Natal province at Global Positioning System (GPS) co-ordinates determined to be 29° 46'14" South 031°03'30" East at elevation of 20 feet (ft).

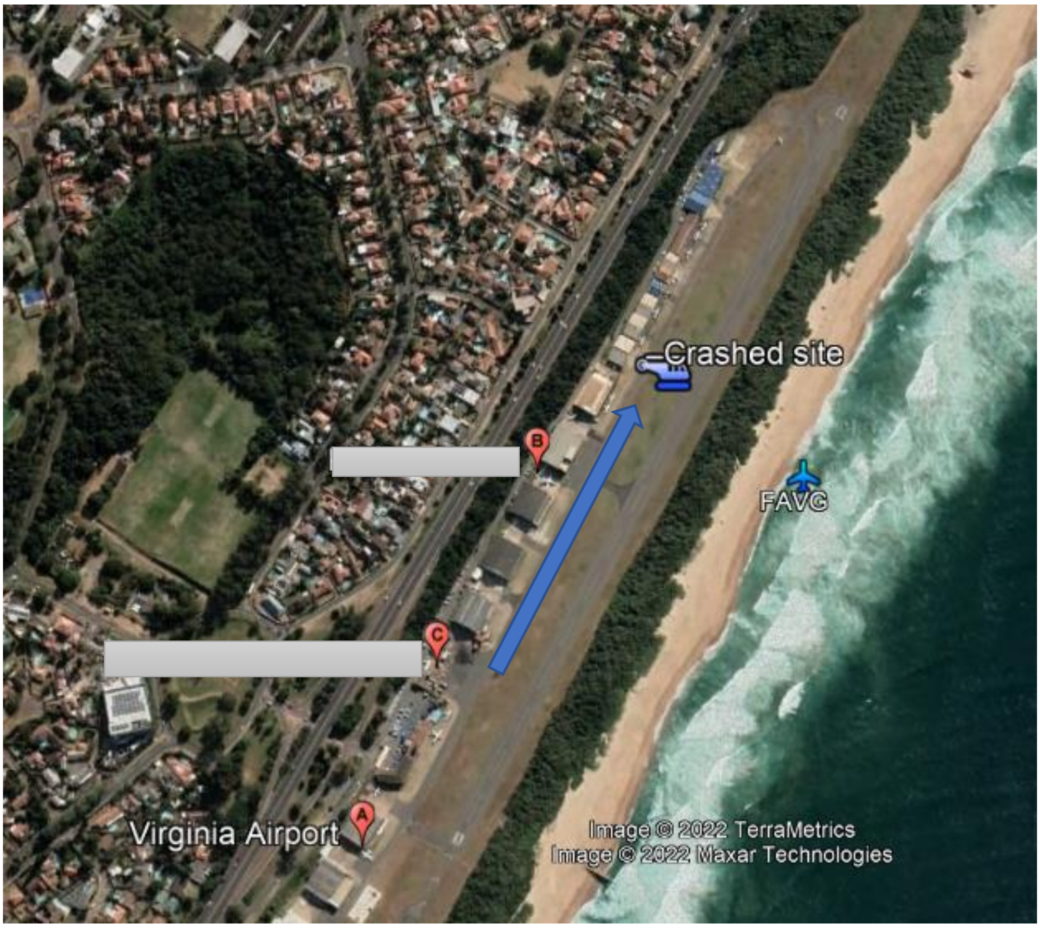

Figure 4: Overlay of the accident site and the direction of the helicopter. (Source: Google Earth)

1.2. Injuries to Persons

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

Note: Other means people on the ground.

1.2.1. The passenger seated on the rear cabin sustained minor injuries and was taken to hospital for a medical check-up. The passenger was discharged later the same day.

1.3. Damage to Helicopter

1.3.1. The helicopter was substantially damaged.

Figure 5: The helicopter as it came to rest. (Source: Johan Hattingh)

1.4. Other Damage

1.4.1. None.

1.5. Personnel Information

Nationality	South African	Gender	Male	Age	54
Licence Type	Private Pilot Licence (PPL) Helicopter				
Licence Valid	Yes	Type Endorsed	Yes		
Ratings	None				
Medical Class & Expiry Date	28 February 2023				
Restrictions	None				
Previous Accidents	None				

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

Flying Experience:

Total Hours	475.9
Total Past 24 Hours	0
Total Past 7 Days	3.3
Total Past 90 Days	112.9
Total on Type Past 90 Days	0
Total on Type	0

1.5.1. The pilot was issued a Private Pilot Licence (PPL) helicopter on 12 November 2021 with an expiry date of 30 November 2023. The pilot was issued a Class 2 medical certificate on 23 February 2022 with an expiry date of 28 February 2023 with no medical restrictions.

1.5.2. According to the pilot's logbook summary of hours, the pilot had different types of aircraft endorsed on his licence including but not limited to Bell 206 (BH06) where he had accumulated a total of 112 flying hours on Bell 206 (BH06), of which 12.8 hours were dual flying and 81.2 were as pilot-in-command (PIC); and Bell 206L (BH206L) where he had accumulated 148 hours, of which 4.7 hours were dual hours and 138.4 were as PIC. The pilot also had a class rating of B06 (which includes Bell-Agusta 206 Jet Ranger/Long Ranger/Sea Ranger). There were no records found that indicated either familiarisation or difference in training was conducted by the pilot before the accident flight.

1.5.3. Difference in training CAR/CATS Part 61.09.8

(1) Differences training consists of theoretical knowledge instruction, a theoretical knowledge examination and flight training as prescribed in Document SA-CATS 61 and is required when converting to—

(a) an aircraft within a class rating which has an additional system or additional systems, as prescribed in Document SA-CATS 61;

(b) an aircraft of a different aircraft manufacturer within a class rating; and

(c) a variant of a type as specified in the list of aircraft types published by the Director on the Authority website.

(2) Differences flight training for aircraft within a class and for all helicopters may be carried out in an aircraft or in an FSTD approved for the purpose.

(3) Differences flight training for aeroplanes of a type shall be carried out in an FSTD approved for the purpose, except when such FSTD is not available, in such case, the differences flight training shall be carried out in an aircraft.

(4) Differences training shall be conducted by an approved ATO or a foreign training organisation as specified in this Subpart.

1.5.4 Familiarisation training 61.09.9

(1) Familiarisation training is required when converting to—

(a) an aircraft within a class rating which does not require differences training; or

(b) a variant of a type as specified in the list of aircraft types published by the Director on the Authority website.

(2) Familiarisation training consists of—

(a) theoretical knowledge instruction as prescribed in Document SA-CATS 61;

(b) flight training, only if deemed necessary by the instructor, taking into consideration—

(i) the experience level of the applicant; and

(ii) handling characteristics, performance characteristics and weight of the particular aircraft.

(3) Familiarisation flight training, if deemed necessary, may be carried out in an aircraft or in an FSTD approved for the purpose. Such flight training shall be conducted by an ATO or a foreign training organisation.

(4) Familiarisation training does not have to be conducted by an ATO if no flight training is involved.

1.6. Helicopter Information (Source: Pilot's Operating Handbook [POH])

1.6.1. *The Agusta Bell 206A model is a single pilot, five place, single turbine engine, light helicopter with two-blade semi-rigid main rotor, and a tail rotor that provides directional control. The airframe consists of semi-monocoque fuselage with a metal and fiberglass covering; an aluminum alloy monocoque tail boom that supports the vertical fin, fixed horizontal stabiliser, tail rotor and tail rotor drivetrain; and aerodynamically shaped coupling and fairings to protect all roof mounted components. The primary load-carrying structures are two built-in cabin bulkheads, a vertical control tunnel from the floor to the cabin roof, and a pair of longitudinal beams in the cabin roof. Landing gear is tubular skid type made of aluminium alloy. Optional pop-out or fixed floats are available.*

Audio Warning System: Bell 206A POH

Engine Out Warning System

When this system (if functional) is activated an intermittent audio signal is produced and the ENG OUT light is illuminated (N1 less than 55%).

Rotor Low RPM Warning System

When this system is activated the ROTOR LOW RPM light is illuminated and a steady audio signal is produced. The low RPM warning system is activated when the collective pitch is off the down stop and rotor RPM is less than 90%.

Airframe:

Manufacturer/Model	Agusta-Bell/AB206A	
Serial Number	8217	
Year of Manufacture	1970	
Total Airframe Hours (At Time of Accident)	2 347.7	
Last Inspection (Date & Hours)	6 December 2021	2 338.1
Airframe Hours Since Last Inspection	9.6	
CRS Issue Date	6 December 2021	
C of A (Issue Date & Expiry Date)	16 September 2013	30 September 2022
C of R (Issue Date) (Present Owner)	15 December 2021	
Operating Category	Part 91	
Type of Fuel Used	Jet A1	
Previous Accidents	None	

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

Engine:

Manufacturer/Model	Rolls Royce 250-C20B
Serial Number	CAE-802472
Part Number	6887190
Hours Since New	2 176.1
Hours Since Overhaul	Modular Assembly

1.6.2 According to the airframe logbook, the last maintenance inspection that was carried out on the helicopter prior to the accident flight was certified on 6 December 2021 at 2 338.1 airframe hours. Following the maintenance inspection, the aircraft maintenance organisation (AMO) issued a Certificate of Release to Service (CRS) at 2 338.1 airframe hours on 6 December 2021, with an expiry date of 5 August 2022 or at 2 438.1 airframe hours, whichever comes first. The helicopter was registered to the present owner on 15 December 2021.

1.6.3 The following maintenance and replacement of parts were carried out and recorded in the logbook as part of the inspection:

- Aft and forward pylon mounts rod-end were changed (replaced) with new ones.
- Main rotor hub and tail rotor hub overhaul were carried out (CRMA number J3960-1).
- Mast inspection was carried out (CRMA number J3960-1).
- Main rotor gearbox inspection was carried out (CRMA number J3960-1).
- Tail rotor balancing was carried out and inches per seconds (IPS) were 0.1.
- Hydraulic pump and reservoir were fitted and topped up with hydraulic fluid.
- New collective lever was fitted.
- Main rotor track and balancing was carried out.
- Pitot, transponder and compass swing checks were carried out.

1.6.4 According to the engine logbook, the 100-hour MPI on 6 December 2021 was carried out in accordance with the South African Civil Aviation Technical Standards (SA-CATS) and Rolls Royce Electronic Manual Schedule Revision 24, dated 1 June 2020.

1.6.5 The following maintenance and replacement of parts were carried out and recorded in the logbook:

- Engine-driven fuel pump (Part number (PN): 23003114, Serial number (SN): PE7774 was removed and replaced with (Part number: 23003114, Serial number: 8852).
- Starter generator output shaft seal was replaced, and the new O-ring was fitted on starter generator output shaft.
- Engine mounting nuts were retorqued and new split pin was fitted.
- Throttle fuel control rigging was carried out and idling was adjusted.
- Ground runs were carried out; all jobs are contained under job number J3960-1 and helicopter was declared safe for flight.

1.6.6 According to the flight folio Serial Number 52105, the owner of the helicopter who is a licensed helicopter pilot conducted a conversion into the helicopter type on 22 December 2021 with a designated flight examiner (DFE). On 21 January 2022, another private flight was conducted with the DFE. According to the DFE, on 23 February 2022 during autorotation, the rotor revolutions per minute (RPM) were not achieved between the threshold markings (90% to 107%). A defect was reported to the AMO, whereupon the pitch change links were adjusted. Power recovery wash was carried out by the aircraft maintenance engineer (AME). Thereafter, the DFE and the owner conducted a post-maintenance flight. During the flight, a power assurance check (PAC) was carried out as well as autorotation and plotting of the graph. According to the graph, the autorotation revolutions were at 106%, which were 6%

higher than normal. This was recorded in the flight folio and the helicopter was duly signed off by the AME.

According to the flight folio Serial Number 52106 dated 23 February 2022, there was a defect entered for "*autorotation revolutions need to be adjusted*". The owner stated that during autorotation, the target main rotor speed (NR) obtained was 92% and the manual states that it should be 100%. The AMO adjusted the length of both pitch links by shortening them three full turns. According to the maintenance manual BHT-206A/B-series-MM-3 figures 18 and 19, '*one full turn of the course threaded clevis of the change pitch link rod will change autorotation RPM about 3%NR'*. The manual further states that '*if RPM is low, decrease the length of the pitch change assemblies equally. If RPM is high, lengthen the assemblies'.* The adjustment of the pitch change links was carried out in accordance with the manual.

1.6.7 Aircraft Checklist Part 91.03.3

(1) The owner or operator of an aircraft shall establish and make available to the flight crew and other personnel in his or her employ needing the information, a checklist system for the aircraft, to be used by such flight crew and other personnel for all phases of the operation under normal, abnormal and emergency conditions.

(2) The PIC shall ensure the checklists used on board the aircraft are complied with and utilised having due regard to human factors principles.

(3) The checklists required in terms of subregulation (1) shall be designed having due regard to human factors principles as prescribed in Document SA-CATS 91.

1.6.8 Checklist Design to Incorporate Human Factor Principles (Source: SA-CATS 91.03.3[2])

(1) The checklist shall be designed with simplicity, consistency with the desired human/system interface functions and compatibility with the expected operational concepts in mind and shall reflect at least the following additional considerations –
- *(a) the number of flight crew members to action the checklist;*
- *(b) the physical size of the checklist;*
- *(c) the ease of use and readability;*
- *(d) the logical flow of checklist items;*
- *(e) the workload imposed by the checklist; and*
- *(f) the effect of completing each item on achieving the goal of the item.*

Main Rotor Gearbox:

Part Number	206-040-002-005
Serial Number	188
Hours Since New	7104.7
Hours Since Overhaul	1506.8

Main Rotor Blades:

Number of blades	1	2
Part Number	206-010-200-33	206-010-200-33
Serial Number/s	M3-1822	M3-1826
Hours Since New	4 378.0	4 378.0
Hours Since Overhaul	TBO not reached	TBO not reached

Tail Rotor Gearbox:

Part Number	206-040-400-013
Serial Number	715
Hours Since New	4280.7
Hours Since Overhaul	3668.7

Tail Rotor Blades:

Number of blades	1	2
Part Number	206200-301	206200-301
Serial Number/s	C332	C338
Hours Since New	1 680.3	1 680.3
Hours Since Overhaul	TBO not reached	TBO not reached

1.6.9 Fuel Shutoff Valve

(Source: AB206 A/B series Maintenance Manual [MM] Chapter 28-20-01)

A motor operated shut-off valve incorporating a thermal relief feature is installed in the main fuel supply line and is located in fuel compartment above the fuel filler cap. Valve is electrically controlled by an ON-OFF switch located on instrument panel and is protected by a circuit breaker located in the overhead console panel. In [the] event of electrical failure valve will remain in position selected before failure.

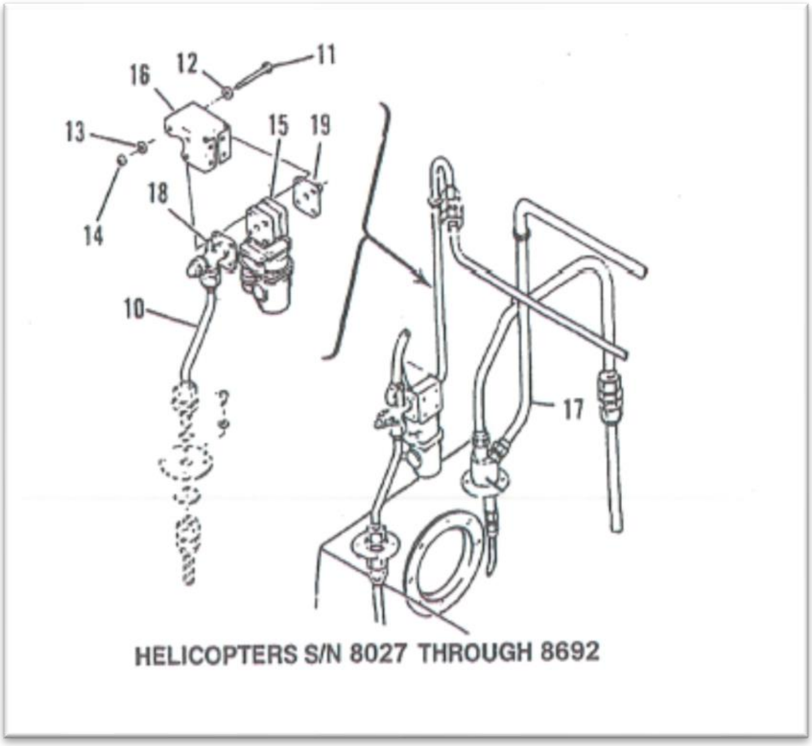

Diagram 1: Schematic diagram of fuel shutoff valve assembly. (Source: AB206 A/B series MM)

1.6.10 Fuel System Description (Source: AB206 A/B Series MM)

The 206A/B series helicopter fuel system incorporates a single bladder type fuel cell located below and aft of passenger seat. Installed within the fuel cell are two electrically operated boost pumps. Lower and upper tank indicating units and sumo drain valve. Some helicopters are also equipped with a low fuel level switch mounted on the drain valve. Booster pumps are interconnected and supply fuel through a single hose assembly to the fuel shut-off valve, and from there to the engine mounted fuel filter and pump assembly. Several helicopters incorporate an airframe-mounted fuel filter between the shut-off valve and the engine fuel pump. The airframe fuel filter is installed on the aft face of the right-hand side of the forward firewall. The fuel filter has a manual drain valve, by-pass capability and an impending bypass switch. The switch is connected to the caution/warning and advisory panel in the pump drain port. The fuel cell is filled from the right side. A ground jack is also installed on the right-hand side of the helicopter near the filler port.

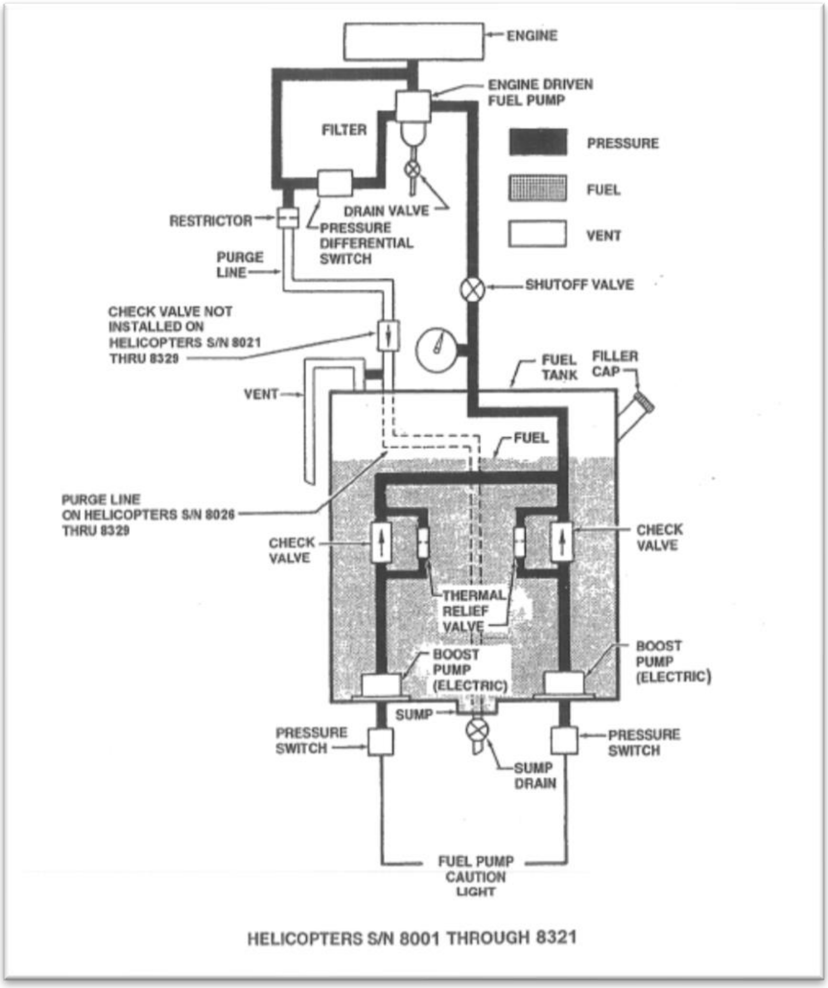

Diagram 2: Fuel system schematic. (Source: AB206 A/B series Maintenance Manual)

1.7. Meteorological Information

1.7.1. The weather information below was obtained from the Meteorological Aerodrome Report (METAR) that was issued by the South African Weather Service (SAWS) on 2 March 2022 at 0940Z, recorded at FAVG.

METAR FAVG 020900Z AUTO 06014KT //// // ////// 30/21 Q1011=

Wind Direction	060°	Wind Speed	14kts	Visibility	9999m
Temperature	30°C	Cloud Cover	Unknown	Cloud Base	Unknown
Dew Point	21°C	QNH	1011hPa		

1.7.2. The pilot was given the prevailing wind at the time by the ATC which was 060° at 19 knots and broken clouds at 2000ft.

1.8. Aids to Navigation

1.8.1. The helicopter was equipped with standard navigational equipment as approved by the Regulator (SACAA). There were no records indicating that the navigational equipment was unserviceable prior to the accident.

1.9. Communication

1.9.1. The helicopter was equipped with a standard communication system as approved by the Regulator. There was a defect with one of the PTT switches prior to take-off.

1.10. Aerodrome Information

1.10.1. The accident occurred at FAVG Aerodrome.

Aerodrome Location	Durban, KwaZulu-Natal Province
Aerodrome Status	Licensed
Aerodrome Co-ordinates	29°46'14.0" South, 031°03'31.0" East
Aerodrome Altitude	20 ft
Runway Headings	05/23
Runway Dimensions	925mx22m
Heading of Runway Used	05
Runway Surface	Asphalt
Approach Facilities	None
Radio Frequency	120.6 MHz

1.11. Flight Recorders

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

1.12. Wreckage and Impact Information

1.12.1. During transition, the engine experienced uncommanded shutdown and the helicopter lost height and crashed on the ground (grass), 3m west of Runway 05. The helicopter touched down hard with the skid gears first in a near level orientation. After impact, the helicopter rolled over to the left with the nose section pointing to a heading of 260°. Both skid gears broke off and the front cross tube separated. The main rotor blades severed the tail boom in three parts and the tail boom separated from its attachment points. The tail cone, tail gearbox and tail rotor blades were still attached and were found near the fuselage. The main rotor blades were still attached to the main rotor hub.

Figure 6: Main wreckage post-accident. (Source: Ronald Collyer)

1.12.2. Tail Boom Assembly:

When the main rotor blades severed the tail boom, the tail drive shaft separated and broke into pieces which scattered in different directions. The damage on the fractured skin indicated that the main rotor blades made contact with the tail boom before it separated from the fuselage. The piece that was furthest was found approximately 20m east of the runway edge. The horizontal stabiliser and pieces of the control tail rotor tubes were found in the middle of the runway, east of the main wreckage.

The front of the tail boom and front piece of the tail rotor drive shaft were found west of the main wreckage. The furthest part that was found east of the runway was a piece of the tail drive shaft. The tail rotor blades were still attached to the tail rotor hub and their condition was good. The control tube was severed into pieces, which were found in different locations. The continuity of the drive was confirmed between the tail gearbox and the output shaft.

Figure 7: Horizontal stabiliser and control tube. (Source: Ronald Collyer)

Figures 8 and 9: Tail rotor shaft assemblies. (Source: Ronald Collyer)

Figure 10: Tail cone with tail rotor blade attached. (Source: Ronald Collyer)

1.12.3 Main Rotor Drive System:

The main rotor blades were still attached to the hub. One of the blades had a puncture which penetrated the core on the outboard section. The condition of the other blade was good. The pitch change links were both fractured in the middle as a result of impact. The main transmission attachment mount (left) was damaged, which caused the bottom of the transmission to collapse and penetrate the roof. The control tubes were still connected between the swashplate (non-rotating) and the servo actuators. All three servo actuators were not damaged. The output shaft failed on the side of the gearbox as a result of impact.

1.12.4 Flight Controls:

The helicopter was fitted with dual controls. The condition of the dual controls was good. The throttle was moving without difficulty. Continuity could not be achieved due to constricted control tubes as a result of impact forces. The tail rotor control tube was broken into pieces as a result of impact.

1.12.5 Powerplant:

The powerplant was still attached to its mountings and no visible oil or fuel leaks were observed on the platform. The compressor was rotated by hand and the engine turned freely. Pipes and hoses were checked, and no damage was observed.

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 cabin structure remained intact and all occupants had made use of the safety restraints in the helicopter.

1.16. Tests and Research

1.16.1 Post-accident, engine inspection on site revealed that the engine external condition was good. After the drive shaft was removed, the engine was turned by hand at the side of the compressor blades, and it turned freely. There was no sound of turbine rubbing which would indicate severe internal damage to turbine assembly. There were no fragments observed in the exhaust system and turbine outlet.

1.16.2 The following components were examined on site prior to engine removal — the fuel pump assembly, the governor and the chip detectors (lower and top).

<u>The fuel pump assembly PN: 500239 5D; SN: 8852</u>

The external condition of the fuel pump assembly was in good condition. The fuel pump was removed by the AME from the engine to check for operational capability in the presence of the AIID investigators. The following conditions were observed:

- The fuel pump filter was removed and checked for sediment, and it was found to be clean.
- The splines and shaft were checked, and the overall condition was good with no missing splines or visible wear, the shaft did not shear off.
- The shaft was rotated freely without any difficulties.

Following the checks, the fuel pump was re-fitted to the same engine by the AME.

Figure 11: The shaft and the splines of the fuel pump.

Figure 12: The condition of the fuel pump strainer after being removed from the pump assembly at the testing facility.

1.16.3 The governor continuity was checked by moving the switch (increase-decrease) on the collective forward; the needle moved, showing increments on the dial scale and the opposite was the same when movement was reversed.

1.16.4 The engine oil was drained from the accessory gearbox and the oil was found to be clean with no sediment. The engine electrical and mechanical chip detectors were removed and checked; no filings/chips were visible at the tips.

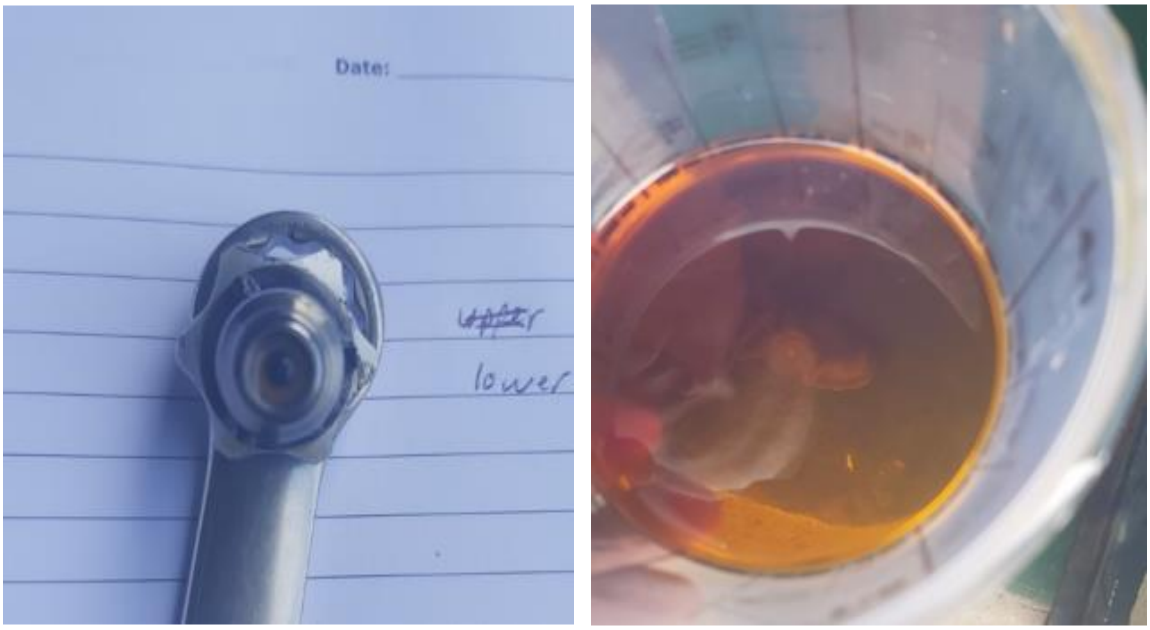

Figure 13&14: The chip detector (left) and drained oil from the accessory gearbox (right) at the testing facility.

1.16.5 The engine was removed from the airframe and placed into a suitable shipping container for further examination at an approved facility.

1.16.6 Engine Bench Testing Summary Report (Source: Accredited Representative [engine manufacturer])

The engine was removed from the shipping container and installed in a turnover stand under the supervision of the CAA IIC. The magnetic chip detectors were inspected with no chips or ferrous debris noted. The engine mounted fuel filter was inspected with no contaminates noted in the filter element, with residual fuel observed in the filter bowl. The chip detectors, fuel nozzle, and fuel filter element were reinstalled for testing. A pneumatic leak check was performed on the fuel control system with no leaks detected. (It was noted that an obsolete Pc air tube, attached from the compressor to the Pc air filter, was an obsolete configuration. This condition was not deemed causal to a power loss and the serviceable tube would not have caused operational issues.)

A cursory external exam of the engine revealed no damage. The N2 system turned freely and was continuous from the 4th stage turbine wheel to the Power Take-off Gear. The N1 system turned freely with some noise emanating from the fuel pump, suggesting the pump gears were dry. The engine was installed on the test stand. The engine started normally on *the first attempt and stabilized at ground idle (~65%) within 20 seconds. As the engine was accelerated to 100% N2 speed condition, some speed oscillations were observed. The cause of the oscillations was not conclusively determined, but the test stand operator stated that this condition had been observed in the past and was previously attributed to the dynamometer sensitivity. The oscillations did not repeat after several more accelerations. Several power calibration points were recorded and the engine reached a maximum observed output power of 363 shp (corrected). Due to software issues, standard day predicted data was unavailable.*

Summary: The engine started, idled, and accelerated as designed during the testing with no flame outs or uncommanded power fluctuations noted. No anomalies were observed during the exam or testing which would have caused the reported sudden power loss during the event.

Figure 15: Accident engine fitted on a test bench.

Figure 16: Screenshot of the engine parameters during bench testing.

Figure 17: Needle position during ground idle.

1.17. Organisational and Management Information

1.17.1. This was a private flight conducted under the provisions of Part 91 of the CAR 2011 as amended.

1.17.2. The AMO that conducted the last mandatory periodic inspection (MPI) was issued an AMO certificate on 31 January 2021 with an expiry date of 28 February 2022.

1.18. Additional Information

1.18.1. Fuel shutoff valve switch, maintenance manual.

Figures 18 and 19: The position of fuel shutoff valve differences between Bell 206 and Agusta-Bell 206A helicopters.

1.18.2. Engine Pre-start Check (Source: Flight Manual AB206A)

NOTE

Helicopters may be equipped alternatively with switches marked ENGINE, ANTI-ICING or DE-ICING and HYDRAULIC SYSTEM or CONTROL BOOST.

Flight controls : Release friction; check freedom of movement and adjust to (cyclic) neutral (collective) flat pitch position and pedals.

Throttle : Check freedom of full travel and flight idle stop operation.
Check co-pilot throttle if installed.
Return to closed position.

LDG LTS switch : OFF.
ENGINE DE-ICING or
ENGINE ANTI-ICING switch : OFF.
CONTROL BOOST or
HYDRAULIC SYSTEM switch : ON.
FUEL VALVE switch : ON, guard closed.
Altimeter : Set to field elevation.
Instruments/Gauges : Static position at zero.
Overhead switches : OFF.

GEN switches : OFF.

Circuit breakers : In (as required).

BAT switch : On for battery start;

On for GPU start;

OFF for battery cart start.

Observe TRANSOIL PRESS, ENG OUT, and ROTOR LOW RPM caution/warning light segments illuminated and applicable audio signal(s) operative.

WRN HORN MUTE button

(if installed) : Press to mute.

NOTE

Engine out audio may be deactivated.

CAUTION LT TEST button : Press to test illumination of each segment utilized.

Turbine outlet temperature

(TOT LT TEST) button : Press, check TOT light illuminates.

ROTOR LOW RPM system : Check as follows; (if WRN HORN MUTE button is installed, the following does not apply).

Collective pitch : Increase; check ROTOR LOW RPM light and audio ON.

Collective pitch : Full down; check ROTOR LOW RPM light On and audio Off.

Flight controls : Neutral/flat pitch position, apply friction (if needed).

FUEL BOOST AFT and

FWD circuits breakers : In; check fuel pressure within limits and FUEL PUMP caution light off.

ANTI COLL LT switch : On (if required).

1.18.3. Complete Loss of Thrust**:**

Reduce throttle to flight idle, immediately enter autorotation and maintain a minimum airspeed of 58 MPH (50 knots) IAS during the descent.

NOTE

Airflow around the vertical fin may permit controlled flight at low power levels and sufficient airspeed when a suitable la ding site is not available; however, the touchdown shall be accomplished with the throttle in the full closed position.

1.18.4. Engine Failure and Autorotation**:**

Collective pitch : Adjust as required to maintain rotor RPM, 90% to 70%

NOTE

Rotor RPM maintained at the high end of the operating range will provide maximum rotor energy to accomplish the landing; but will cause an increase rate of descent.

WARNING

Reduce forward speed to desired autorotative airspeed for existing conditions. Airspeed for minimum descent is 60 MPH (52 knots) IAS. Airspeed for maximum glide distance is 80 MPH (69 KNOTS) IAS

At low altitude, close throttle and flare as required to lose excessive speed

Apply collective pitch as flare effect decreases to further reduce forward speed and cushion landing

It is recommended that level touchdown be made prior to passing through 70% rotor RPM. Upon ground contact, collective pitch shall be reduced smoothly while maintaining cyclic in neutral position or centered position.

WARNING

Excessive ground run with collective up, or any tendency to float for long distance prior to ground contact shall be avoided.

Maximum airspeed for steady autorotation is 115 MPH (100 knots) IAS. Autorotation above this speed results in high rates of descent and low rotor speed. A blue radial is installed on the airspeed on the airspeed indicator as a reminder of this condition.

1.18.5 Human Factors Applications in Aviation Operations (Source: ICAO Document 9683)

Control of human error

To contain and control human error, one must first understand its nature. There are basic concepts associated with the nature of human error: the origins of errors can be fundamentally different; and the consequences of similar errors can also be significantly different. While some errors are due to carelessness, negligence or poor judgement, others may be induced by poorly designed equipment or may result from a normal reaction of a person to a particular situation. The latter kind of error is likely to be repeated and its occurrence can be anticipated.

Input characteristics. Humans have been provided with a sensory system for collecting information from the world around them, enabling them to respond to external events and to carry out the required task. But all senses are subject to degradation for one reason or another, and the sources of knowledge here are physiology, psychology and biology.

Information processing. These human capabilities have severe limitations. Poor instrument and warning system design has frequently resulted from a failure to take into account the capabilities and limitations of the human information processing system. Short- and long-term memory are involved, as well as motivation and stress. Psychology is the source of background knowledge here.

1.18.6 Aircraft checklist Part 91.03.3

(1) The owner or operator of an aircraft shall establish and make available to the flight crew and other personnel in his or her employ needing the information, a checklist system for the aircraft, to be used by such flight crew and other personnel for all phases of the operation under normal, abnormal and emergency conditions.

(2) The PIC shall ensure the checklists used on board the aircraft are complied with and utilised having due regard to human factors principles.

(3) The checklists required in terms of subregulation (1) shall be designed having due regard to human factors principles as prescribed in Document SA-CATS 91.

1.18.7 Checklist Design to Incorporate Human Factors Principles *(Source: SA-CATS 91.03.3[2])*

(2) The checklist shall be designed with simplicity, consistency with the desired human/system interface functions and compatibility with the expected operational concepts in mind and shall reflect at least the following additional considerations –

(g) the number of flight crew members to action the checklist;
(h) the physical size of the checklist;
(i) the ease of use and readability;
(j) the logical flow of checklist items;
(k) the workload imposed by the checklist; and
(l) the effect of completing each item on achieving the goal of the item.

1.19. Useful or Effective Investigation Techniques

1.19.1. None.

2. ANALYSIS

2.1. General

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

2.2. Analysis

2.2.1. Man

The pilot was issued a Private Pilot Licence (PPL) on 12 November 2021 with an expiry date of 30 November 2023. The pilot was issued a Class 2 medical certificate on 23 February 2022 with an expiry date of 28 February 2023 with no medical restrictions. At the time of the accident, the pilot was flying the aircraft type for the first time. The idea of carrying out the pre-start for the second time might have caused the pilot to omit some of the procedures especially if the fuel shutoff valve was located on the other side (compared to other aircraft in the series that the pilot was accustomed to). Also, he did not have a Quick Reference Handbook which is required by regulation to minimise human factor elements. This might have led to the pilot being distracted. The evidence collected on the pilot's logbook revealed that there were no records indicating that familiarisation or difference in type training was carried at the ATO or prior to the flight. This was not in line with the CAR Part 61.09.8 and 61.09.9. The investigation established that the pilot's experience with the helicopter type was inadequate, and thus, played a role in this accident.

2.2.2. Machine

According to the airframe logbook, the last maintenance inspection that was carried out on the helicopter prior to the accident flight was certified on 6 December 2021 at 2 338.1 airframe hours. Following the maintenance inspection, the AMO issued the CRS at 2 338.1 airframe hours on 6 December 2021 with an expiry date of 5 August 2022 or at 2 438.1 airframe hours, whichever comes first. The helicopter was registered to the present owner on 15 December 2021. Examination and testing of engine and airframe components revealed no anomalies. The test-cell bench test of the engine did not reveal any malfunction, and the engine operated normally.

2.2.3. Investigation

It is likely that during the first start when the pilot shut down after encountering a defect with the PTT switch, the battery was switched off prior to switching off the shutoff valve. This resulted in the shutoff valve remaining in the open position as stipulated in the maintenance manual. It is evident that when the helicopter engine was started for the second time, the shutoff valve was in the off position, according to the video. As a result, the engine continued to run for a few seconds using residual fuel (upstream of the fuel system) until there was none remaining, which caused the engine to starve during the lift-off phase. This was evidenced by a decrease (spooling down noise) in engine RPM. There was no Quick Reference Handbook that was found in the cockpit as required by the Regulation (Part 91.03.3[2]). The Airframe Flight Manual for the helicopter was in the baggage compartment at the time of the accident. It is likely that the pre-start checks were completed without referencing any material and this led to a human factor element playing a role. Although the pilot had prior experience flying the Bell 206 helicopter, it is worth noting that he was flying the Agusta-Bell 206A for the first time, which had a different instrument panel compared to the Bell 206. The position/location and design of the shutoff valve switch is different between the two aircraft types. No familiarisation or difference in training was conducted with the ATO or qualified flight instructor. There were no records found on the pilot's logbook that this type of training was conducted. This was not in line with the CAR Part 61.09.8.

Considering the height that the helicopter was at when the uncommanded engine shutdown occurred, it could have been landed safely if the pilot had recognised the engine failure on time and reacted immediately in accordance with the POH procedures. However, as indicated on the dual gauge indicator when the engine and rotor RPM started to decay, there was no corrective action conducted. The POH states that during the engine failure and autorotation at low altitude, *close throttle and flare as required to lose excessive speed*. The flare was likely initiated early which led to excessive decrease in the rotor RPM as observed on the CCTV video footage because there was no power being produced by the engine. Instead of a level touchdown, a hover landing was executed.

3. CONCLUSION

3.1. General

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

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

- **Findings —** are statements of all significant conditions, events, or circumstances in this accident. The findings are significant steps in this accident sequence, but they are not always causal or indicate deficiencies.
- **Causes —** are actions, omissions, events, conditions, or a combination thereof, which led to this accident.

- **Contributing factors —** are actions, omissions, events, conditions, or a combination thereof, which, if eliminated, avoided or absent, would have reduced the probability of the accident occurring, or would have mitigated the severity of the consequences of the accident. The identification of contributing factors does not imply the assignment of fault or the determination of administrative, civil, or criminal liability.

3.2. Findings

3.2.1. The pilot was issued a Private Pilot Licence (PPL) on 12 November 2021 with an expiry date of 30 November 2023.

3.2.2. The pilot was issued a Class 2 medical certificate on 23 February 2022 with an expiry date of 28 February 2023 with no medical restrictions.

3.2.3. The pilot was flying the helicopter type for the first time, and there were no records found which indicated familiarisation or difference in training was conducted; this was not in line with the CAR Part 61.09.9 and 61.09.8, respectively.

3.2.4. The last MPI prior to the accident flight was conducted by the AMO with a CRS that was issued at 2 338.1 airframe hours on 6 December 2021 with an expiry date 5 August 2022 or at 2 438.1 airframe hours, whichever comes first. The last work carried out prior to the accident was the adjustment of pitch change links (shorten the length) to correct the rotor RPM during autorotation and this did not have a bearing to this accident.

3.2.5. The helicopter was issued an initial Certificate of Airworthiness (C of A) on 16 September 2013 with an expiry date of 30 September 2022.

3.2.6. There was no Quick Reference Handbook found in the helicopter at the time of the accident as required by the CAR Part 91.03.3.

3.2.7. The AMO that conducted the last MPI was issued an AMO certificate on 31 January 2021 with expiry date of 28 February 2022.

3.2.8. The helicopter was registered to the current owner on 15 December 2021.

3.2.9. The passenger seated on the front left seat took a video of the flight using her mobile phone. The footage showed fuel shutoff valve toggle switch in the off position, the torque indicator needle at 50%, the dual (ERPM/RRPM) gauge indicator in the green arch. There was an amber light in the central alerting auxiliary panel. The engine sound was clearly audible, and the engine was confirmed spooling down, followed by a reduction of ERPM and RRPM.

3.2.10. The examination and testing of engine components (governor and fuel pump) on site revealed no anomalies.

3.2.11. The engine was removed from the airframe and was transported to an approved engine maintenance facility for further examination and testing. The engine was subjected to examination and bench testing in the presence of the engine accredited representative and investigators, and the engine started normally without any difficulties.

3.2.12. The weather was not a factor to this accident.

3.2.13. The helicopter was started with the fuel shutoff valve in the off position, which resulted in the engine operating with residual fuel (upstream of the fuel system) before the engine spooled down due to fuel starvation.

3.3. Probable Cause/s

3.3.1. During transition, the engine experienced uncommanded shutdown due to fuel starvation because the fuel shutoff valve was in the off position during engine start, causing the pilot to execute an unsuccessful forced landing.

3.4. Contributory Factor/s

3.4.1. Unavailability of the checklist.
3.4.2 Initiating an early flare (incorrect manoeuvre executed during loss of engine power).
3.4.3 Lack of familiarisation on helicopter type.

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 Message

4.2.1. Pilots operating the same helicopter type but different series for the first time are urged to familiarise themselves with its operation as stated in the CAR Part 61.09.9**.**

5. APPENDICES

5.1. None.

This report is issued by:

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