SOUTH AFRICAN CIVIL AVIATION AUTHORITY

HELICOPTER ACCIDENT REPORT AND EXECUTIVE SUMMARY

			Reference:	CA18/2/3/10288		
Aircraft Registration	ZS-HKC	**Date of Accident**	19 April 2023	**Time of Accident**	1145Z	
Type of Aircraft	Guimbal Cabri G2		**Type of Operation**	Training (Part 141)		
Pilot-in-command Licence Type	Commercial Pilot Licence	**Age**	25	**Licence Valid**	Yes	
Pilot-in-command Flying Experience	**Total Flying Hours**	432.9	**Hours on Type**	209.9		
Last Point of Departure	Mossel Bay Aerodrome (FAMO), Western Cape Province					
Next Point of Intended Landing	Mossel Bay Aerodrome (FAMO), Western Cape Province					
Damage to Helicopter	Substantial					
Location of the accident site with reference to easily defined geographical points (GPS readings if possible)						
Open field (farmland) approximately 1.6nm west of FAMO (GPS co-ordinates: 34°09'21.10" South 022°01'36.80" East)						
Meteorological Information	Surface wind; 260°/3kt, temperature; 21°C, dew point; 16°C, CAVOK					
Number of People On-board	2 + 0	**Number of People Injured**	1	**Number of People Killed**	0	**Other (On Ground)** 0

Synopsis

On Wednesday afternoon, 19 April 2023, a flight instructor and a student pilot on-board a Guimbal Cabri G2 helicopter with registration ZS-HKC took off from Mossel Bay Aerodrome (FAMO) in the Western Cape province with the intention to perform autorotation training (Exercise 14). The flight was conducted under visual meteorological conditions (VMC) by day and under the provisions of Part 141 of the Civil Aviation Regulations (CAR) 2011 as amended.

The third autorotation was to be conducted at 800 feet (ft) above ground level (AGL) with the student pilot as the pilot flying (PF). At 300ft AGL, the instructor called out “opening throttle” and (the flight instructor) opened the throttle, but there was no response from the engine. The instructor noted that the low oil pressure warning light (red) had illuminated, and he took control of the helicopter. At this stage, he noticed a slight decay in the main rotor revolutions per minute (RPM). He then lowered the collective pitch control lever to the fully down position and initiated a flare at a height of approximately 40ft AGL.

The speed at touchdown was approximately 15 knots (kts). The helicopter touched down hard on its skid gear, approximately 1.6 nautical miles (nm) west of FAMO on an even ground, bounced and rotated approximately 90° to the right before it came to rest in an upright position. The flight instructor suffered a mild head injury with an abrasion to his right temple of 10 centimetres (cm), which was superficial. The student pilot was not injured. The helicopter sustained substantial damage.

Probable Cause

The flight instructor initiated the flare at 40ft AGL and the helicopter touched down hard on its skid gear as there was not enough inertia in the main rotor blades to cushion the landing. The helicopter bounced back into the air and rotated approximately 90° to the right after the tail boom was severed by the main rotor blades.

SRP date	10 September 2024	Publication date	10 September 2024

Occurrence Details

Reference Number	**:** CA18/2/3/10288
Occurrence Category	**:** Accident (Category 1)
Type of Operation	**:** Training (Part 141)
Name of Operator	**:** Starlite Aviation Training Academy
Aircraft Registration	**:** ZS-HKC
Aircraft Make and Model	**:** Hélicoptèrer Guimbal, Cabri G2
Nationality	**:** South African
Place	**:** Open farmland 1.6nm west of FAMO, Western Cape Province
Date and Time	**:** 19 April 2023 at 1145Z
Injuries	**:** The pilot-in-command sustained minor injuries to his head
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 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) was notified of an accident on 19 April 2023. The occurrence was classified as an accident according to the CAR 2011 Part 12 and the International Civil Aviation organisation (ICAO) STD Annex 13 definitions. A notification was sent to the State of Design and Manufacturer in accordance with the CAR 2011 Part 12 and the ICAO Annex 13 Chapter 4. The State appointed a non-travelling accredited representative as well as an expert. An investigator was dispatched to the accident site.

Notes:

1. *Whenever the following words are mentioned in this report, they shall mean the following:*
   Accident — this investigated accident
   Aircraft — the Cabri G2 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 to improve the clarity of the report. Modifications to images used in this report were limited to cropping, magnification, file compression; enhancement of colour, brightness, contrast; or addition of text boxes, arrows, or lines.*

Disclaimer

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Table of Content

Abbreviation	Description
°	Degrees
°C	Degrees Celsius
AIID	Accident and Incident Investigations Division
AMO	Aircraft Maintenance Organisation
ATO	Approved Training Organisation
CAR	Civil Aviation Regulations
C of A	Certificate of Airworthiness
C of R	Certificate of Registration
CPL	Commercial Pilot’s Licence
CRS	Certificate of Release to Service
CVR	Cockpit Voice Recorder
FAMO	Mossel Bay Aerodrome
FDR	Flight Data Recorder
Ft	Feet
GPS	Global Positioning System
hPa	Hectopascal
Kt	Knots
M	Metres
METAR	Meteorological Aerodrome Report
MHz	Megahertz
MPI	Mandatory Periodic Inspection
Nm	Nautical Miles
NOSIG	No Significant Change
PF	Pilot Flying
QNH	Barometric Pressure Adjusted to Sea Level
RPM	Revolutions per Minute
SACAA	South African Civil Aviation Authority
SAWS	South African Weather Service
SPL	Student Pilot Licence
TBO	Time Between Overhaul
UTC	Universal Co-ordinated Time
VHF	Very High Frequency
VMC	Visual Meteorological Conditions
Z	Zulu (Term for Universal Co-ordinated Time - Zero Hours Greenwich)

1. FACTUAL INFORMATION

1.1 History of Flight

1.1.1 On Wednesday morning, 19 April 2023, a flight instructor and a student pilot on-board a Cabri G2 helicopter with registration ZS-HKC were conducting a training flight from Mossel Bay Aerodrome (FAMO) in the Western Cape province. The intention of the flight was to perform autorotation training. The flight was conducted under visual meteorological conditions (VMC) by day and under the provisions of Part 141 of the Civil Aviation Regulations (CAR) 2011 as amended.

1.1.2 At 1130Z, the flight instructor and the student pilot took off and flew to the general flying area (GFA) located to the west of FAMO to perform autorotation (Exercise 14). The first two autorotation training exercises were conducted from 700 feet (ft) above ground level (AGL). After each of the two autorotation exercises, the duo landed and discussed the exercise that they had just completed.

1.1.3 Thereafter, they took off for their third autorotation, this time, to climb to 800ft AGL. The student pilot was the pilot flying (PF). The flight instructor stated that he had his right hand on the throttle, which is located on the collective pitch control lever, which was procedural. At approximately 300ft AGL, the flight instructor called out to the PF "opening throttle" but there was no response from the engine. The flight instructor noticed that the engine's low oil pressure warning light (red light) had illuminated on the instrument panel and the oil pressure indicated 0.2 bar in the red arc, which was low.

1.1.4 The flight instructor then took control from the student pilot. He noted a slight decay in the main rotor RPM and, thus, lowered the collective pitch control lever to fully down position and initiated a flare at a height of approximately 40ft AGL. The instructor stated that he kept the flare for as long as possible and levelled off the helicopter before ground contact to prevent a possible tail strike. The speed at touchdown was approximately 15 knots. The helicopter touched down hard on its skid gear on an uneven terrain, bounced and rotated approximately 90° to the right before it came to rest in an upright position (on its skid gear). It was during this phase that the main rotor blades severed the tail boom. The flight instructor suffered a mild head injury with an abrasion to his right temple of 10 centimetres (cm), which was superficial. The student pilot was not injured. The helicopter was substantially damaged.

1.1.5 The accident occurred during daylight at an open field approximately 1.6 nautical miles (nm) west of FAMO at Global Positioning System (GPS) co-ordinates determined to be 34°09'21.10" South 022°01'36.80" East, at an elevation of 531 feet.

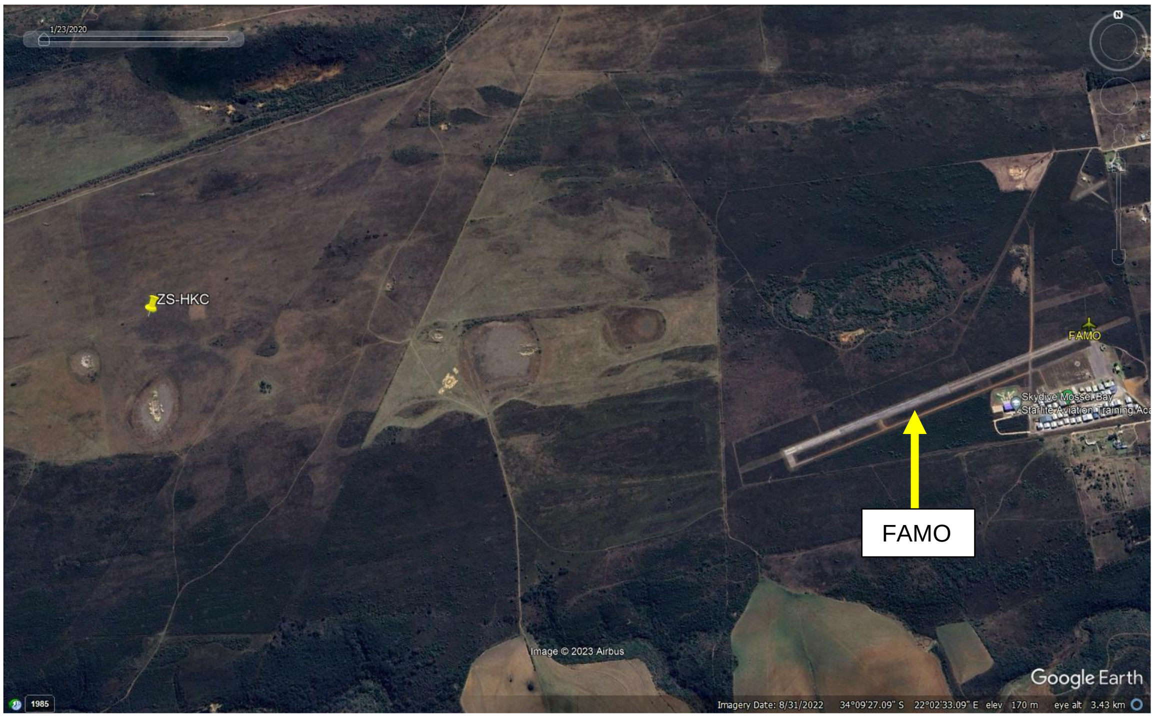


Figure 1: The accident site (yellow pin ZS-HKC) in relation to FAMO. (Source: Google Earth)

1.2 Injuries to Persons

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

Note: Other, means people on the ground.

1.3 Damage to Aircraft

1.3.1 The helicopter's main rotor blades severed the tail boom.

Figure 2: The helicopter as it came to rest.

1.4 Other Damage

1.4.1 No other damage was caused.

1.5 Personnel Information

1.5.1 Pilot-in-command (PIC)

Nationality	South African	Gender	Male	Age	25
Licence Type	Commercial Pilot Licence (CPL)				
Licence Valid	Yes	Type Endorsed	Yes		
Ratings	Instructor Rating Grade III and Night				
Medical Expiry Date	29 February 2024 (Class 1)				
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	432.9
Total Past 90 Days	84.1
Total on Type Past 90 Days	84.1
Total on Type	209.9

The flight instructor started flying on 23 January 2020 and obtained his Private Pilot Licence (PPL) helicopter on 26 August 2020.

According to the endorsement section of the pilot's logbook, he was signed out on 30 December 2020 after he complied with Part 61.09.8 of the CAR differences training onto the Cabri G2 type helicopter.

He performed his skill test for his Commercial Pilot Licence on 19 January 2022 and completed his Flight Instructor Rating (Grade III) successfully on 9 March 2022. According to the endorsement section of his logbook, he completed his flight instructor familiarisation on the Robinson R22 and R44 type helicopters on 31 March 2022.

The pilot joined the approved training organisation (ATO) as a flight instructor on 3 October 2022. On the same day, he started with his ab initio training on the Cabri G2 helicopter, flying with an authorised flight instructor designated by the ATO. According to his training file, he flew basic autorotation on 15 December 2022 and advanced autorotation on 3 March 2023; both these flights were with a flight instructor. He never flew any autorotation to the ground (landing the helicopter from an autorotation) during his ab initio training. Training student pilots to perform this manoeuvre was not a regulatory requirement.

The table below reflects the flight instructor's hours per helicopter type.

Total Hours on R22	32.3
Total Hours on R44	30.5
Total Hours on Cabri G2	130.8
Total Instruction Hours	193.6

1.5.2 Student Pilot (SPL)

Nationality	South African	Gender	Male	Age	28
Licence Type	Student Pilot Licence (SPL)				
Licence Valid	Yes	Type Endorsed	Yes		
Ratings	None				
Medical Expiry Date	30 November 2027 (Class 2)				
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	31.9
Total Past 90 Days	31.5
Total on Type Past 90 Days	31.5
Total on Type	31.9

The student pilot had a Student Pilot Licence (SPL). The Cabri G2 is the only helicopter type the student pilot had flown during his training. He had accumulated a total of 31.9 flying hours.

1.6 Aircraft Information

1.6.1 Helicopter Description

(Source: www.guimbal.com)

The Guimbal Cabri G2 is a two-seat light helicopter designed for flight training, general aviation and personal use. The helicopter comprises full composite structure and is fitted with a single 4-stroke reciprocating engine. The helicopter is equipped with a three-blade rigged main rotor head system and a shrouded fenestron tail rotor system. It is also fitted with a crash-resistance fuel cell and energy-absorbing crash-resistant seats.

Airframe:

Manufacturer and Model	Hélicoptèrer Guimbal, Cabri G2	
Serial Number	1094	
Year of Manufacture	2015	
Total Airframe Hours (at time of the accident)	1 638.9	
Last Inspection (Hours & Date)	1 581.0	9 February 2023
Airframe Hours Since Last Inspection	57.9	
C of A (Issue Date & Expiry Date)	23 March 2020	31 March 2024
C of R (Issue Date) (Present Owner)	8 November 2021	
MTOW	700kg (1 544lbs)	
Type of Fuel Used	Avgas 100LL	
Operating Category	Training (Part 141)	
Previous Accidents	None	

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

Engine:

Manufacturer/Model	Lycoming / O-360-J2A
Serial Number	L-42539-36E
Hours Since New	1 638.9
Hours Since Overhaul	TBO not yet reached

1.6.2 Weight and Balance

An official weight and balance for the accident flight was obtained from the ATO facility (see Appendix A) and indicated the take-off weight of 676.7 kilograms (kg), which was within limits. Both the lateral and longitudinal centre of gravity (CG) positions were within limits. According to the flight manual, the maximum take-off weight for this helicopter is 700kg.

1.7 Meteorological Information

1.7.1 An official weather report was obtained from the South African Weather Service (SAWS).

The meteorological aerodrome report (METAR) that was issued on 19 April 2023 at 1200Z for George Aerodrome (FAGG) weather station, which is the closest to the accident site (approximately 20nm away), recorded the following weather conditions:

FAGG 191200Z 19003KT 100V220 CAVOK 24/16 Q1010=

Wind direction	: 190° (south-westerly)
Wind speed	: 03 KT (5.56 km/h)
Visibility	: 10 km or more
Clouds	: No significant cloud
Weather	: No weather of significance to aviation
Temperature	: 24°C
Dew point temperature	: 16°C
Pressure reduced to mean sea level	: 1010hPa

The METAR for FAGG (above) indicates a light south-westerly surface wind. The difference between the current temperature and dew point temperature indicates a relatively dry condition at low levels of the atmosphere, which supports the data in the satellite imagery (Figure 3).

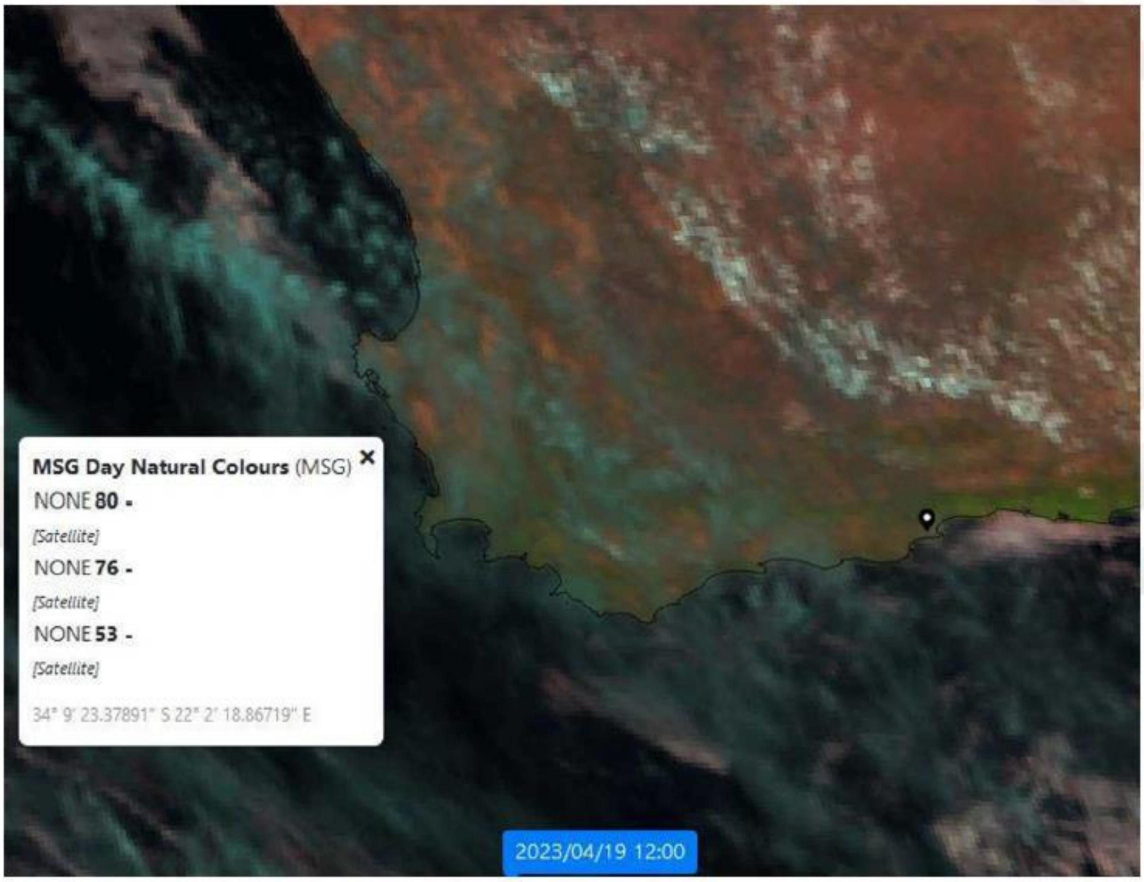


Figure 3: The MeteoSat Second Generation (MSG) Day Natural Colours satellite imagery taken on 19 April 2023 at 1200Z. (Source: SAWS [copyright MSG])

1.7.2 The weather information entered in the table below was obtained from the pilot questionnaire (form CA 12-03) from both pilots.

Wind Direction	260°	Wind Speed	3kt	Visibility	9999m
Temperature	21°C	Cloud Cover	Scattered	Cloud Base	2 900ft
Dew Point	Unknown	QNH	1010hPa		

1.7.3 The METAR issued on 19 April 2023 at 1130Z for FAGG was as follows:

FAGG 191130Z 21004KT 160V250 CAVOK 24/16 Q1010=

Wind Direction	210°	Wind Speed	4kt	Visibility	9999m
Temperature	24°C	Cloud Cover	Nil	Cloud Base	Nil
Dew Point	16°C	QNH	1010hPa		

1.7.4 There is an independent weather station at FAMO. The weather information is used by all pilots at the ATO who receive the data on their cellular phones via a mobile application (App) iWeathar Lite. The information in diagrams 1 and 2 was obtained from this weather station via the application on the day.

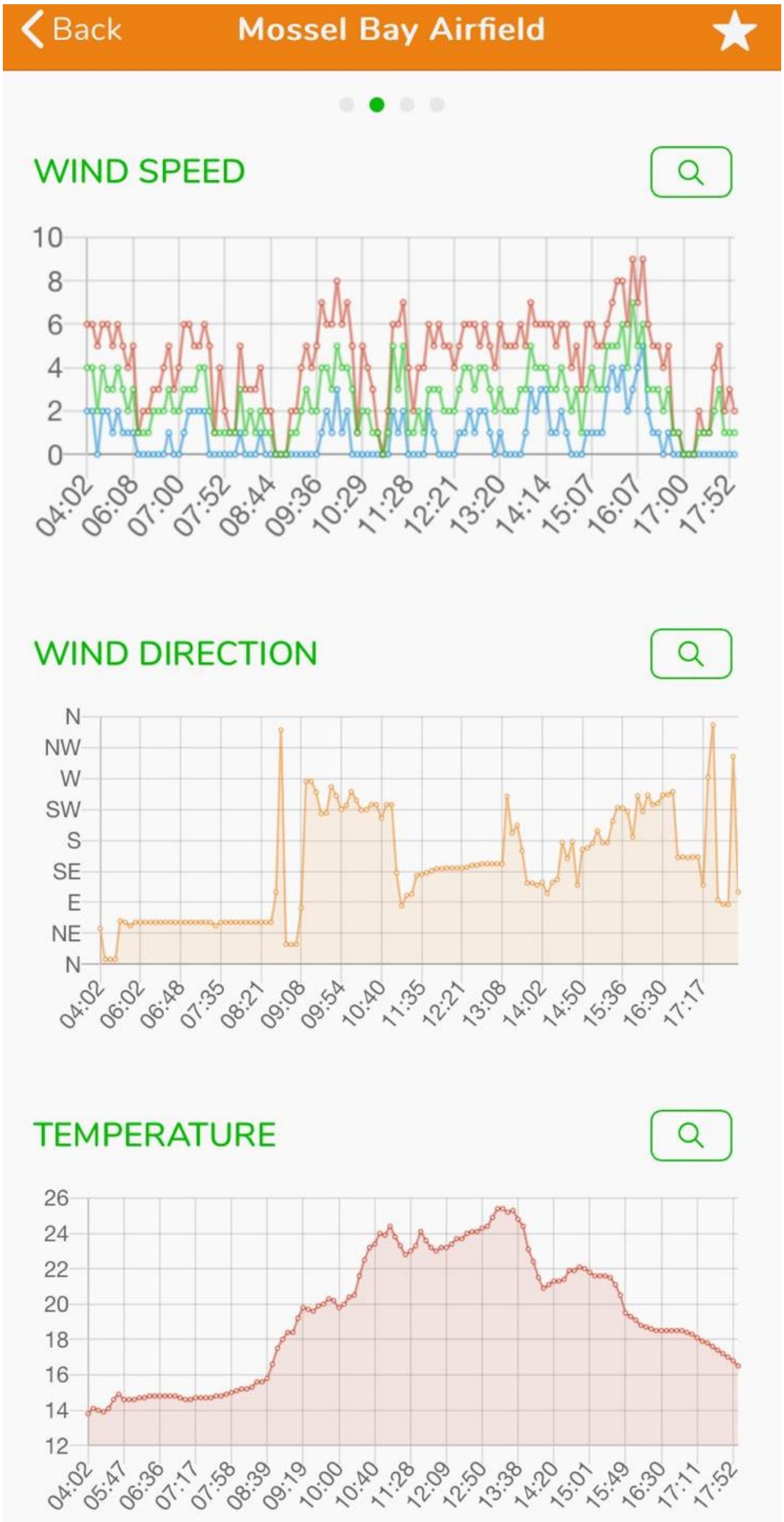


Diagram 1:

Diagram 2:

1.7.5 The weather conditions at the time of the accident as per diagrams 1 and 2 indicate the following conditions:

Wind Direction	215°	Wind Speed	3kt	Visibility	9999m
Temperature	23°C	Humidity	75%	Cloud Base	2 300ft
Dew Point	16°C	QNH	1011hPa		

1.7.6 The carburettor icing-probability chart (Figure 4) indicates moderate icing during cruise flight and serious icing during descent power. It should be noted that carburettor icing is not restricted to cold weather. It can occur in warm days if the humidity is high enough, especially at low power settings.

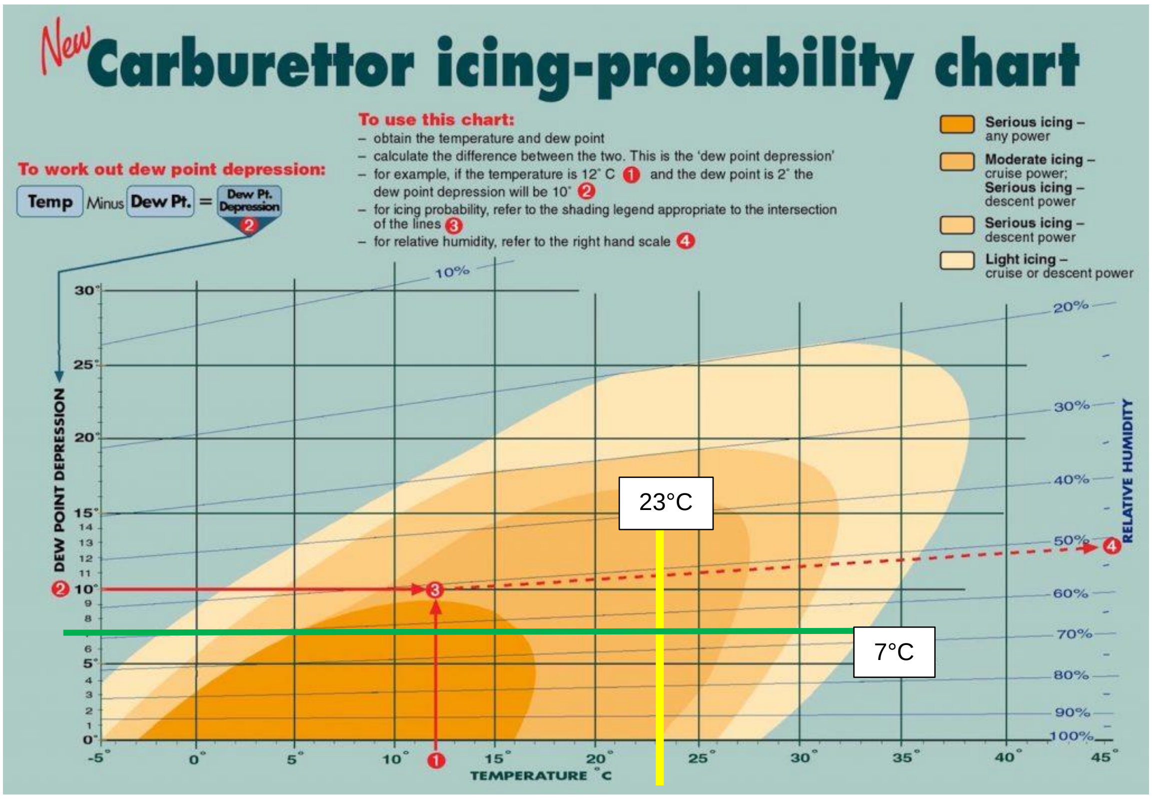


Figure 4: The icing probability is where the yellow and green lines cross.

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 before the flight.

1.9 Communication

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

1.9.2 The helicopter was operated outside of the controlled airspace and the crew was transmitting their intentions on the frequency below the terminal control area (TMA).

1.10 Aerodrome Information

1.10.1 The accident did not occur at an aerodrome.

1.11 Flight Recorders

1.11.1 The aircraft was neither equipped with a flight data recorder (FDR) or a cockpit voice recorder (CVR), nor was it required in accordance with the regulations.

1.12 Wreckage and Impact Information

1.12.1 The helicopter touched down hard on its skid gear on an open terrain in a north-westerly direction (320°) approximately 1.6 nautical miles (nm) west of FAMO, whereafter it bounced and rotated to the right about 90° before it came to rest in an upright position on its skid gear facing north-east (050°). Following the hard landing, the main rotor blades flapped down and severed the tail boom as the helicopter rotated to the right, evidenced by the debris which was located to the west (left side of where the main wreckage came to rest). *The main rotor blades on this helicopter type rotate clockwise when viewed from above; this further supports the wreckage distribution*. The magnetic chip detector on the tail rotor gearbox was removed on site and inspected, it was found to be free of any metal particles (see Figure 9).

Figure 5: Fragments of the fenestron shroud in the foreground.

Figure 6: The front view of the helicopter with the blue blade severed near the hub assembly.

Figure 7: View of the aft position of the helicopter with the tail boom severed.

Figure 8: Substantially damaged fenestron and tail rotor drive shaft assembly.

Figure 9: The magnetic chip detector on the tail rotor gearbox was clean.

Figure 10: The entire tail rotor drive shaft assembly.

1.13 Medical and Pathological Information

1.13.1 Not applicable.

1.14 Fire

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

1.15 Survival Aspects

1.15.1 This accident was survivable. Both occupants were secured to their respective seats by the four-point safety harnesses. There was no deformation of the skid gear or the cockpit area.

1.16 Tests and Research

1.16.1 The helicopter was loaded on the back of a truck and was transported to an aircraft maintenance organisation (AMO) at FAMO. Following an inspection of the helicopter, it was noted that the engine was not damaged, there was no evidence of oil leaks or damage to any component, and the fuel system's integrity was not compromised. It was possible to rotate the engine (using the main rotor head), and no unusual sounds were heard that could have implied a possible mechanical failure which might have existed and that could have prevented normal engine operation, and there was compression on each of the cylinders.

There was sufficient oil when the dipstick was checked. The throttle and mixture control linkages were inspected, and they operated normally and were attached correctly. It was decided to conduct an engine ground run with the engine in the airframe and the main rotor blades removed.

(i) There were approximately 60 litres of fuel remaining in the fuel tank at the time of the accident.

(ii) The gascolator was removed before the engine ground run and it was found that the fuel filter inside the unit was clean and the fuel that remained in the bowl was free of contamination and was of the correct grade.

(iii) The engine air intake assembly as well as the air filter were removed and inspected; the air filter was found to be clean.

(iv) The engine oil dipstick was removed on-site, and it was found that the engine contained an adequate amount of oil.

(a) (b)

Figure 11: A picture of the fuel filter (a) and the gascolator, (b) with some fuel inside, which was clean.

The battery was connected, and the electrical system was functional. The main rotor blades were removed, and a rated pilot on the helicopter type was made available to perform the engine ground runs. The engine started without difficulty and was allowed to warm up whilst running at ground idle. The engine revolutions per minute (RPM) were increased by advancing the throttle, and no engine abnormalities were noted. Several engine ground runs were performed.

Unlike conventional carburettor heating systems found on most reciprocating aircraft engines that are fitted with a carburettor, this helicopter is equipped with a two-mode carburettor heating system: (1) normal automatic mode or (2) manual mode. There is a switch on the instrument panel where the pilot can select either auto mode (recommended selection) or the pilot could opt for manual mode by selecting the switch to either HOT or COLD.

Figure 12: Instrument panel with the carb heat switch in the yellow window.

The auto mode was selected when the helicopter was flown. This function does not require pilot's intervention, and the system detects the possibility of carburettor icing when the temperature in the carburettor drops to 7°C and below, it will allow hot air to enter the carburettor by opening a valve that bleeds hot air from the exhaust. Once the carburettor temperature reaches 15°C and above, the valve will close. Figure 13 illustrates the location of the temperature (Tcarb) probe in the carburettor that activates the valve. The valve is located within the air induction box that also contains the air filter.

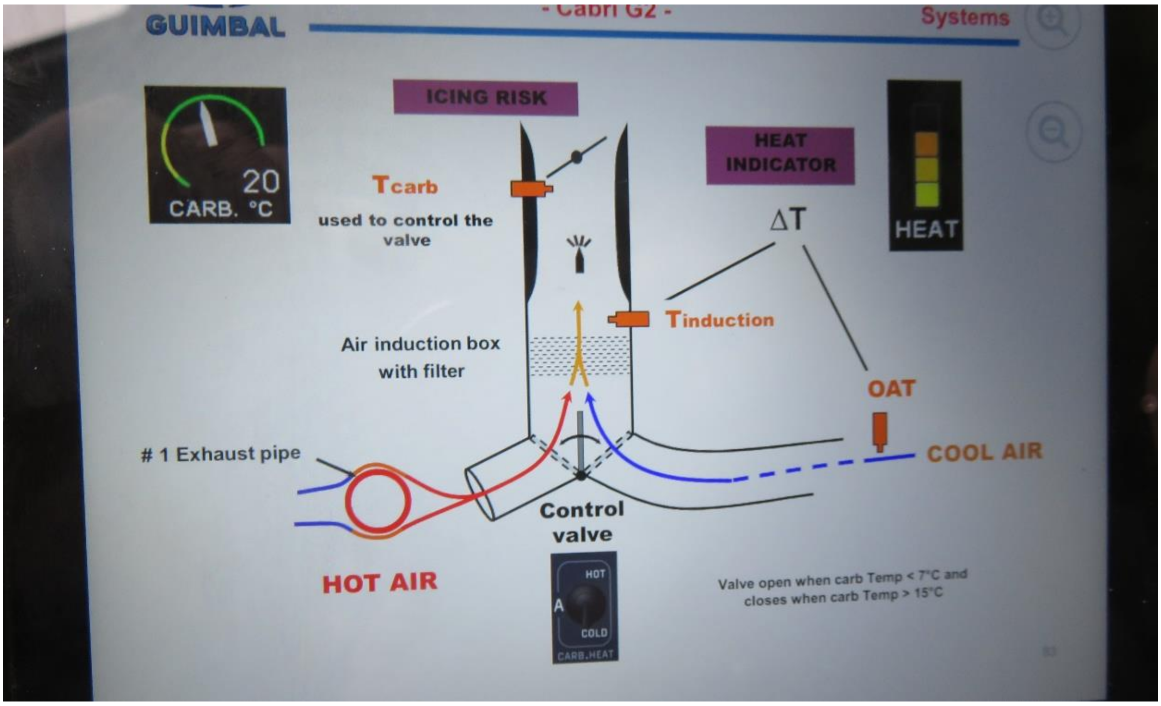


Figure 13: Illustration of the carburettor heating system.

The air induction box was removed, and the air filter was inspected and found to be in a good condition as it was replaced during the last maintenance inspection. *Figures 14 and 15 provide the reader with insight into the AUTO carb heat hot air valve. This valve, when activated, must open or close within 7 seconds*. The functionality of the valve was tested, and the valve opened and closed within the 7-seconds activation time. It should be noted that these photographs were taken with the photographer lying under the helicopter looking up.

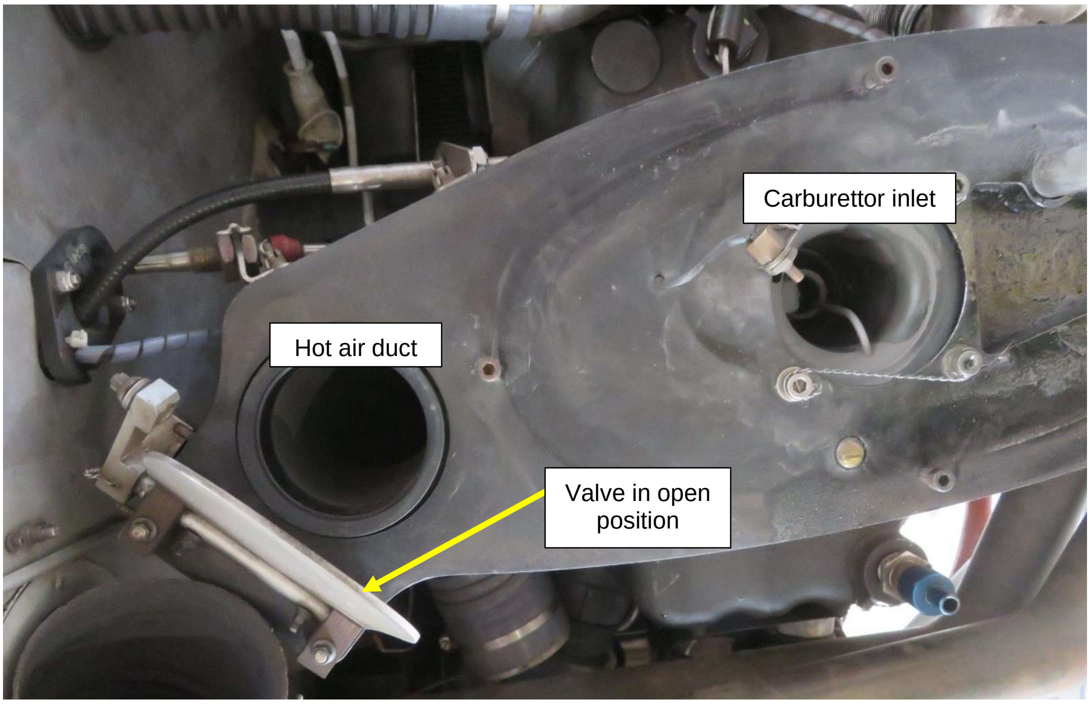


Figure 14: With the air induction box removed, the valve is in the open position.

Figure 15: The valve in the close position.

1.17 Organisational and Management Information

1.17.1 This was a training flight conducted under the provisions of Part 141 of the CAR 2011.

1.17.2 An approved training organisation (ATO) was issued an ATO Certificate by the Regulator on 9 September 2019 with an expiry date of 30 June 2024.

1.17.3 The last maintenance inspection that was conducted on the helicopter prior to the accident flight was certified on 9 February 2023 at 1 581.0 airframe hours. The AMO was issued an approval certificate by the Regulator (SACAA) on 23 December 2022 with an expiry date of 31 October 2023. A further 57.9 hours were flown with the helicopter since the inspection.

1.18 Additional Information

1.18.1 Autorotation
(Source: Helicopter Flying Handbook, FAA-H-8083-21A, Chapter 11)

In a helicopter, an autorotative descent is a power-off manoeuvre in which the engine is disengaged from the main rotor system and the rotor blades are driven solely by the upward flow of air through the rotor. In other words, the engine is no longer supplying power to the main rotor.

The most common reason for an autorotation is failure of the engine or drive line, but autorotation may also be performed in the event of a complete tail rotor failure, since there is virtually no torque produced in an autorotation. In both areas, maintenance has often been a *contributing factor to the failure. Engine failures are also caused by fuel contamination or exhaustion as well resulting in a forced autorotation. If the engine fails, the freewheeling unit automatically disengages the engine from the main rotor allowing the main rotor to rotate freely. Essentially, the freewheeling unit disengages anytime the engine revolutions per minute (rpm) is less than the rotor rpm.*

At the instant of engine failure, the main rotor blades are producing lift and thrust from their angle of attack (AOA) and velocity. By lowering the collective pitch, which must be done immediately in case of an engine failure, lift and drag are reduced, and the helicopter begins an immediate descent, thus producing an upward flow of air through the rotor system. This upward flow of air through the rotor provides sufficient thrust to maintain rotor rpm throughout the descent. Since the tail rotor is driven by the main rotor transmission during autorotation, heading control is maintained with the antitorque pedals as in normal flight.

When landing from an autorotation, the only energy available to arrest the descent rate and ensure a soft landing is the kinetic energy stored in the rotor blades. Tip weights can greatly increase this stored energy. A greater amount of rotor energy is required to stop a helicopter with a high rate of descent than is required to stop a helicopter that is descending more slowly. Therefore, autorotative descents at very low or very high airspeeds are more critical than those performed at the minimum rate of descent airspeed.

Technique

Position 1: Refer to Illustration 1. From level flight at the appropriate airspeed (cruise or the manufacturer's recommended airspeed), 500–700 feet above ground level (AGL), and heading into the wind, smoothly but firmly lower the collective pitch control to the full down position, maintaining rotor rpm in the green arc with collective. If the collective is in the full down position, the rotor rpm is then being controlled by the mechanical pitch stops. During maintenance, the rotor stops must be set to allow minimum autorotational rpm with a light loading. This means that some collective pitch adjustments can be made if the air density or helicopter loading changes. After entering an autorotation, the collective pitch must be adjusted to maintain the desired rotor rpm. Coordinate the collective movement with proper antitorque pedal for trim, and apply cyclic control to maintain proper airspeed. Once the collective is fully lowered, decrease the throttle to ensure a clean split/separation of the needles. This means that the rotor rpm is higher than the engine rpm and a clear indication that the freewheeling unit has allowed the engine to disconnect. After splitting the needles, readjust the throttle to keep engine rpm above normal idling speed, but not high enough to cause rejoining of the needles. The manufacturer often recommends the proper rpm for that particular helicopter.

At position 2, adjust attitude with cyclic control to obtain the manufacturer's recommended autorotation or best gliding speed. Adjust collective pitch control, as necessary, to maintain rotor rpm in the green arc. Aft cyclic movements cause an increase in rotor rpm, which is *then controlled by a small increase in collective pitch control. Avoid a large collective pitch increase, which results in a rapid decay of rotor rpm, and leads to "chasing the rpm." Avoid looking straight down in front of the aircraft. Continually crosscheck attitude, trim, rotor rpm, and airspeed.*

At the altitude recommended by the manufacturer (position 3), begin the flare with aft cyclic control to reduce forward airspeed and decrease the rate of descent. Maintain heading with the antitorque pedals. During the flare maintain rotor rpm in the green range. Care must be taken in the execution of the flare so that the cyclic control is neither moved rearward so abruptly that it causes the helicopter to climb nor moved so slowly that it does not arrest the descent, which may allow the helicopter to settle so rapidly that the tail rotor strikes the ground. In most helicopters, the proper flare attitude is noticeable by an apparent groundspeed of a slow run. When forward motion decreases to the desired groundspeed, which is usually the lowest possible speed (position 4), move the cyclic control forward to place the helicopter in the proper attitude for landing.

In many light helicopters, the student pilot can sit in the pilot seat while the instructor pulls down on the helicopter's tail until the tail rotor guard or "stinger" touches the surface. This action gives the student an idea of airframe attitude to avoid, because a pilot should never allow ground contact unless the helicopter is more nose low than that attitude. Limiting the flare to that pitch attitude may result in slightly faster touchdown speeds, but will eliminate the possibility of tail rotor impact on level surfaces.

The landing gear height at this time should be approximately 3 -15 feet AGL, depending on the altitude recommended by the manufacturer. As the apparent ground speed and altitude decrease, the helicopter must be returned to a more level attitude for touchdown by applying forward cyclic. Some helicopters can be landed on the heels in a slightly nose-high attitude to help decrease the forward groundspeed whereas others must land skids or landing gear level to equally spread the landing loads to all of the landing gear. Extreme caution should be used to avoid an excessive nose-high and tail-low attitude below 10 feet. The helicopter must be close to the landing attitude to keep the tail rotor from contacting the surface.

At this point, if a full touchdown landing is to be made, allow the helicopter to descend vertically (position 5). Increase collective pitch, as necessary, to arrest the descent and cushion the landing. This collective application uses some of the potential energy in the rotor system to help slow the descent rate of the helicopter. Additional antitorque pedal is required to maintain heading as the collective pitch is raised due to the reduction in rotor rpm and the resulting reduced effect of the tail rotor. Touch down in a level flight attitude.

One common error is holding the helicopter off the surface versus cushioning the helicopter on to the surface during an autorotation. Holding the helicopter in the air by using all of the rotor rpm potential energy usually causes the helicopter to have a hard landing, which results *in the blades flexing down and contacting the tail boom. The rotor rpm should be used to cushion the helicopter on to the surface for a controlled, smooth landing instead of allowing the helicopter to drop the last few inches.*

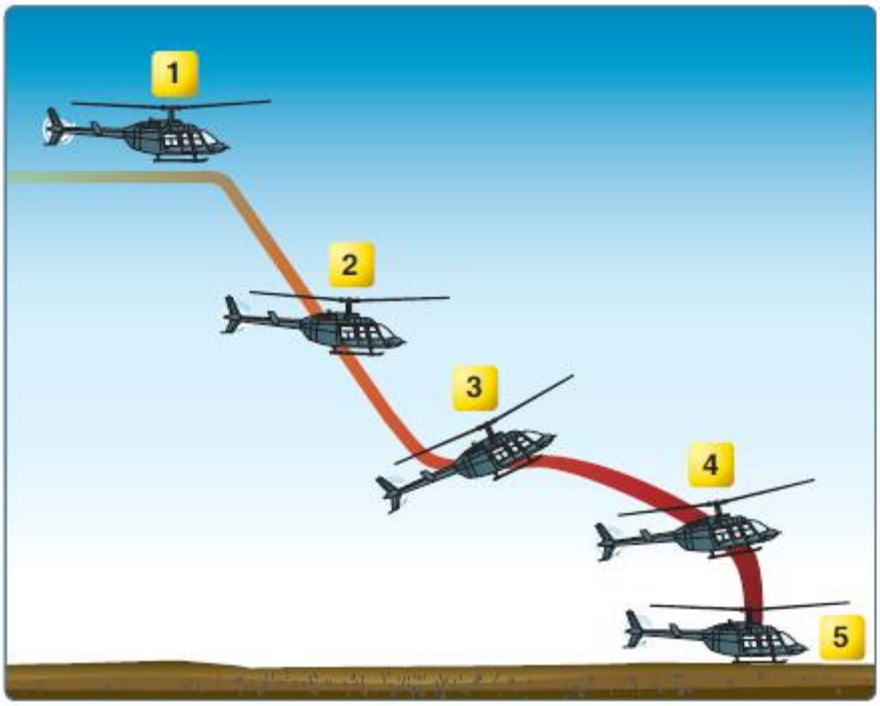


Illustration 1: Straight-in autorotation.

Autorotation practice as prescribed in the Helicopter Flight Manual, Section 4, Normal Procedures, is attached to this report as Appendix C.

1.18.2 How Engine Design Influences Carburettor Ice
(Source: Sky Ranch Engineering Manual, Chapter 3 Engine Performance, Pg. 149 to 152)

Engine design and fuel characteristics influence the formation of carburettor ice. Flight instructors instruct on what weather conditions are the most conducive for carburettor icing. A carburettor has many functions; while accomplishing those functions, it has some side effects, one of which is a drastic change in temperature of the mixture when it evaporates liquid gasoline into gaseous gasoline. The carburettor evaporates fuel, which lowers the temperature of the mixture in the intake system. There is also a drop in temperature in the carburettor caused by the lowered pressure across the venturi. A drop in temperature causes two things to happen: (A) the dew point is lower and (B) the air becomes more dense. As the temperature drops, the air holds less moisture; if the temperature drops below the dew point, some of the moisture in the air condenses into water droplets. The higher the air temperature or the more humid the air, the more potential water there is. While running engines on a test bed on a humid day, you can see water condensing on the carburettor body to the point that the entire carburettor body will be wet and dripping. The outside surface of the carburettor is *so cold it condenses water out of the air. The temperature drop caused by fuel evaporation depends upon the volatility of the fuel and the fuel/air ratio. The more volatile the fuel, the more the temperature drop will be. A more volatile fuel causes carburettor ice to form at higher ambient temperatures. Switching from aviation gasoline to a more volatile automotive gasoline may increase the temperature drop due to volatilization. If the combination of reducers takes the carburettor's body temperature below freezing in the presence of air-laden moisture, ice will be created. The rate of ice creation increases with increases in fuel/air mixture. This is because increasing the fuel/air ratio increases the evaporation rate of the fuel.*

The complete evaporation of liquid gasoline at the stoichiometric ratio creates a theoretical temperature drop of 40°F (4.5°C). Theoretically, with pure gasoline, carburettor icing can form at an ambient temperature of 72°F (22°C). The temperature drop caused by the adiabatic expansion of gases at the venturi combines with the heat loss attributable to the evaporation of the fuel and further raises the ambient temperature at which carburettor ice forms. Combining both the temperature drop caused by vaporization and the venturi effect will give a drop of 60°F (15°C) to 70°F (21°C).

Ice formations begin in the vicinity of the butterfly and may build up to such an extent that a drop in power output results because the ice chokes the venturi section, thereby reducing airflow. This loss of power causes a drop of manifold pressure in aircraft equipped with constant-speed propellers and induces a drop in rpm in aircraft with fixed-pitch propellers. If not detected (or countered with carburettor heat), carburettor ice will cause complete engine stoppage. After engine stoppage the evaporation stops, and residual heat will in time melt the ice.

The temperature of the carburettor must be lowered to the freezing level for carburettor ice to form. Airframe design affects carburettor temperature. If the carburettor is mounted such that engine-cooling air flows up past the carburettor before the air passes by the hot engine, the carburettor will be cooler, and ice will form at higher ambient temperatures than with the more common down-draught cooling. Down-draught engine cooling also means that the engine cooling air has been heated by the engine before it passes the carburettor. Up-draught cooling is common with pusher engine installations.

Avoid extended power-off descents in carburettor icing conditions even when using full carburettor heat. During power-off descents, the exhaust pipe cools and there is not sufficient heat available to preheat the incoming air supply to the carburettor to prevent ice formation. Continental data from service bulletin M50-7 …"indicates that in two minutes after the throttle is closed, with carburettor heat 'ON', the carburettor air temperature can drop as much as 72°F (22°C)". During the application of carburettor heat, there is a noticeable loss of power. This is because hot air is less dense than cold air. The cylinders fill with less air on a pound-for-pound basis. In technical terms, the application of carburettor heat decreases the engine's *volumetric efficiency. Carburettors meter fuel based on airflow but not air density. The application of carburettor heat does not change the volume of air but reduces the mass of the air, so the carburettor meters the same amount of fuel. This accounts for mixture richening that occurs with the application of carburettor heat. The net effect is the loss of approximately 13% power at sea level in standard conditions.*

The manifold pressure gauge can be used to detect carburettor ice on constant-speed propeller engines. When setting up for cruise configuration, be precise. Select a cruise altitude and trim for that altitude. If you set your manifold pressure at 22 inches, set it right at 22. Then, if later on, you notice the manifold pressure slightly less than 22 inches, you can apply carburettor heat. Pull the carburettor heat full out and then full in. When you push the heat back in you should regain the lost manifold pressure. The ice will have choked the carburettor causing a slight loss in manifold pressure. After the carburettor heat has cleared the ice, you will have regained the lost manifold pressure.

1.18.3 Helicopter Flight Manual

During an autorotation, the rate of descent (ROD) is high. Main rotor RPM control is critical at these points to ensure adequate rotor energy is available to cushion the landing. The flight manual under Power Failures, Section 3, Emergency Procedure, page 3-2 has a warning at the bottom of the page, which states the following:

Warning
Safe landing may not be possible if the power failure occurs within the “unsafe” zone of the Height / Velocity (H/V) diagram. Operation inside this zone should be avoided.

During an autorotation, the helicopter is mostly flown inside the unsafe H/V area, especially as it is descending closer to the ground.

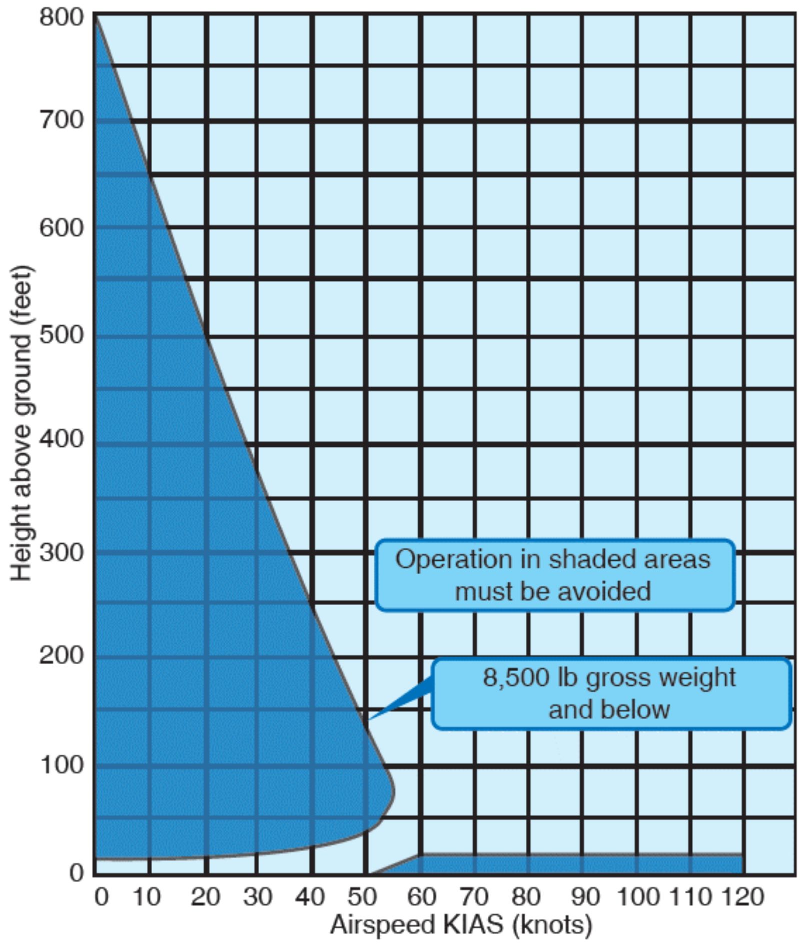


Figure 16: Height/velocity chart.

1.18.4 Private Pilot Licence (Helicopter) Skills Test Standards
(Source: SA Technical Standards, Appendix 1.4, Helicopter Category Flight Standards)

Section 1.4.12 Unit S8: Executive Advance Manoeuvres and Procedures

1.4.12 Unit Description: Skills and knowledge to control the helicopter by the application of advanced manoeuvres and procedures.

Elements		**Evidence**
S S8.2	Perform Autorotative	Autorotative flight is entered and maintained at a nominated speed and heading in a balanced flight. • Alter heading through 360 degrees using 45° of bank in balanced flight at a nominated speed. • Transition helicopter from autorotative flight to a climb at nominated heading and speed. • Perform autorotative landing.

		• Terminate helicopter to the hover from autorotative flight, using power. • Perform autorotative flight at best range and minimum descent rate speeds.

1.4.13 Unit S8: Assessment Guide

1.4.13.1 During assessment, the pilot should be observed to perform the following checks and actions as evidence of ability to meet the licensing standards.

1.4.13.2 The checks and actions detailed in this guide are advisory. Checks and actions in approved checklists, placards, Flight Manual and Operations Manuals have procedures and guidelines that must be followed.

Elements		**Evidence**
S8.2	Perform Autorotative	• Controlled corrective action is applied to establish autorotative flight. • Altitude is adjusted to achieve nominated airspeed (± 5 kts). • Heading is maintained (± 5°). • Helicopter is balanced. • Rotor RPM is maintained within rotor limitations. • Perform steep turn during autorotative flight. Airspace cleared procedure is performed. • Controlled corrective action is used to increase angle of bank to 45° (± 10°). • Altitude is adjusted to achieve nominated airspeed (± 5 kts). • Helicopter is balanced. • Rotor RPM is maintained within engine limitations. • Nominated roll-out heading or geographical feature is achieved (± 15° then ± 5°). • Transition to a climb Minimum descent altitude is anticipated and not descended below (± 100 feet). • Engine RPM is increased to match rotor RPM. (‘rejoin the needles’). Collective pitch (power) is increased to set climb power. • Yaw is prevented using anti-torque pedals (± 5°).

		• Altitude is adjusted to achieve nominated climb speed (± 5 kts). • Helicopter is balanced. • Rotor RPM is maintained within limitations. • Cyclic control is trimmed if applicable. • Perform autorotative landing. Helicopter is maintained at the hover altitude without lateral or rearwards movement. • Collective pitch is used to control touchdown rate. • Helicopter is landed ± 25 metres of nominated touchdown point. • After touchdown collective pitch (power) is lowered at a rate that maintains ground contact and adjusted to ensure deceleration of the helicopter without adverse longitudinal pitching. • Terminate to the hover with power Engine RPM is increased to match rotor RPM at an altitude which will ensure the ability to safely increase power to hover the helicopter. • Altitude is adjusted to achieve a controlled decreasing closure rate and reducing rate of descent to the termination point. • Skids are parallel to direction of travel. • Collective pitch (power) is increased to stabilise hover and co-ordinated use of cyclic pitch to achieve the hover altitude. • Yaw is controlled using anti-torque pedals. • Perform autorotative flight at best range and endurance speeds. Controlled corrective action is applied to establish autorotative flight at best range or endurance speed. • Altitude is adjusted to achieve nominated airspeed (± 5 kts). • *Heading is maintained* (± 5°). • *Helicopter is balanced*. • Rotor RPM is maintained within rotor limitations. • Elements of Airmanship: Lookout is maintained using a systematic scan technique at a rate determined by, traffic density visibility and terrain. • *Helicopter is landed into wind*.

		• *Situation awareness is maintained*. • A plan is formulated that ensures the safe completion of autorotative manoeuvres. • Priorities are set to ensure the safe completion of autorotative manoeuvres.

1.18.5 Cabri G2 Flight Manual

Emergency Procedure

Attached to this report as Appendix B is the emergency procedure in the event that the pilot encounters an engine power failure. This procedure cautions the pilot on the effect of carburettor icing and clogged air filter.

System Description

Attached to this report as Appendix C is the carburettor heat information as contained in the Flight Manual.

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 concerning this accident. This shall not be read as apportioning blame or liability to any organisation or individual.

2.2 Analysis

2.2.1 The pilots

This was a training flight with a flight instructor and a student pilot on-board. They were conducting Exercise 14 (Basic Autorotations) and completed two autorotation successfully. According to the flight instructor's training file, he flew basic as well as advanced autorotation with a flight instructor during his ab initio instructor training under the ATO. The difference between basic and advanced autorotation is not defined in his training file. It was discussed with the chief flight instructor (CFI) who is also a designated flight examiner (DFE). The DFE mentioned that they do not train their personnel to fly autorotation to the ground as the risk associated with it is too high. However, they practise autorotation using power recovery technique and terminate the practise before the actual touch down. In this accident, the flight instructor who took control of the helicopter when the engine did not respond, had to fly the helicopter which was already in autorotational flight to the ground, something he was not trained to do and something he had not exercised or conducted before, and which was not a regulatory training requirement as per the SA Technical Standards, Appendix 1.4, Helicopter Category Flight Standards.

The flight instructor stated that he initiated the flare at 40ft AGL and had encountered a decay in the main rotor RPM, which caused the helicopter to touch down hard to an extent that it bounced back into the air and rotated approximately 90° to the right. During the bounce, the main rotor blades severed the tail boom, but the helicopter remained in an upright position. The flare, initiated at 40ft AGL and with the airspeed below 40 to 50 knots placed the helicopter within an "unsafe" operating zone of the H/V chart (see Figure 16) and an uneventful autorotational landing was highly improbable. The flight instructor, not being attuned to autorotation to the ground, most probably initiated the flare at a high height above the ground, followed by a situation he wanted to avoid which was the decay in main rotor inertia.

During an autorotation, the rate of descent (ROD) is high. Main rotor RPM control is critical to ensure adequate rotor energy is available to cushion the landing. The flight manual in section 3, page 3-2 warns pilots to avoid the shaded area for a safe landing as it might not be possible when operating within the "unsafe" zone of the H/V diagram. During an autorotation, the helicopter is mostly flown inside the unsafe H/V area, especially as it is descending to the ground.

2.2.2 Helicopter

The helicopter was maintained in accordance with the existing regulations and approved maintenance schedule, and no reported defects were noted that could have contributed or have caused the engine to stop in-flight. Following an assessment of the helicopter, it was possible to run the engine in the airframe post-recovery. The engine started without difficulty and normal operation was noted. The air induction box was removed, and the air filter was found to be clean. The automatic carburettor icing unit was activated, and the valve opened from the fully closed to the fully open position within 7 seconds as per the manufacturer's guidance material. The throttle linkage was intact and functional and was manipulated during the engine ground runs that were performed.

Carburettor icing was considered as the most plausible possibility that could have caused engine stoppage. In this case, the conditions were conducive to carburettor icing according to the icing chart on page 13 of this report, which indicated the probability of serious icing was likely as they were low on power and in descent trajectory. The helicopter was fitted with an automatic carburettor heating system, which was selected to auto. The operation of the device was found to function within the prescribed limits when it was tested post-recovery. However, the possibility of ice forming in the carburettor venturi before the automatic carburettor heating system detected and activated could not be confirmed.

2.2.3 Environment

The humidity at the time of the flight was approximately 75%, this information was obtained from the graph on page 12 of the report. The conditions for serious carburettor icing were highly favourable at the time of the flight as indicated in the carburettor icing probability chart.

The terrain where the training flight was conducted was flat and covered with grass. There was no intention of the crew to land in the area but following the engine stoppage, they were obliged to. The flat terrain most probably contributed to the helicopter remaining in an upright position on its skid gear, which reduced the risk of serious injuries.

3. CONCLUSION

3.1 General

From the available evidence, the following findings and contributing factors were made concerning 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

The pilots

3.2.1 The flight instructor had a Commercial Pilot Licence (CPL) that was issued on 27 January 2022. The licence was reissued on 13 January 2023 with an expiry date of 30 January 2024. The flight instructor had flown a total of 432.9 hours of which 209.9 hours were on the helicopter type.

3.2.2 The flight instructor was issued a valid Class 1 aviation medical certificate on 1 February 2023 with an expiry date of 29 February 2024.

3.2.3 The student pilot had a Student Pilot Licence (SPL). The Cabri G2 is the only helicopter type the student pilot had flown during his training. He had accumulated a total of 31.9 flying hours.

3.2.4 The student pilot was issued a valid Class 2 aviation medical certificate on 25 November 2022 with an expiry date of 30 November 2027.

The helicopter

3.2.5 The helicopter was issued a Certificate of Airworthiness (C of A) on 23 March 2020 with an expiry date of 31 March 2024.

3.2.6 The helicopter was issued a Certificate of Registration (C of R) on 8 November 2021.

3.2.7 The last maintenance inspection that was conducted on the helicopter before the accident flight was certified on 9 February 2023 at 1 581.0 airframe hours. The helicopter had accumulated a further 57.9 airframe hours since the said inspection.

3.2.8 The Certificate of Release to Service (CRS) was issued on 9 February 2023 with an expiry date of 8 February 2024 or at 1 681.0 hours of flight time, whichever occurs first.

3.2.9 The helicopter was operated within the prescribed weight and balance limitations during this flight.

3.2.10 Approximately 60 litres of fuel was in the fuel tank at the time of the accident, as well as sufficient engine oil. The gascolator was removed and the filter was inspected and was found clean. No evidence of fuel contamination was found.

3.2.11 The air induction box was removed, and the air filter was found to be clean. The automatic carburettor icing unit was activated, and the valve opened from the fully closed to the fully open position within 7 seconds.

3.2.12 Multiple engine ground runs were performed with the engine in the airframe. The engine started without difficulty and responded to throttle inputs.

Environment

3.2.13 Fine weather conditions prevailed at the time of the flight, which was consistent with the official weather report received from the SAWS.

3.2.14 Additional weather information was obtained from the ATO pilot group, accessed via a cell phone application (APP). This weather data was obtained from an independent weather station that belongs to the Mossel Bay Aero Club.

3.2.15 The terrain where the helicopter touched down was an open farmland that was fairly flat and covered with grass. The flight manual indicates that it is ideal that autorotation be conducted over an area that is hard and smooth to reduce the risk of damage to the helicopter and injury to the occupants.

Training

3.2.16 The flight instructor was not trained by the ATO to fly autorotation to the ground.

3.2.17 In the SA-CATS guidance material (SA Technical Standards, Appendix 1.4, Helicopter Category Flight Standards) there in no requirement to teach student pilots to fly an autorotation to the ground (landing from an autorotation), these requirements were in line with the ATO curriculum.

3.3 Probable Cause

3.3.1 The flight instructor initiated the flare at 40ft AGL and the helicopter touched down hard on the skid gear as there was not enough inertia in the main rotor blades to cushion the landing. The helicopter bounced back into the air and rotated approximately 90° to the right after the tail boom was severed by the main rotor blades.

3.4 Contributory Factors

3.4.1 The engine stoppage was considered a significant contributory factor to this accident. As to why the engine stopped in operation could not be determined with certainty, however, carburettor icing could not be excluded as it was within the serious icing range (power-off descent).

3.4.2 Another significant contributory factor was that the flight instructor was not trained to fly autorotation to the ground. Regulatory requirements (SA Technical Standards, Appendix 1.4, Helicopter Category Flight Standards) do not require that student pilots perform a "touchdown" autorotation either or was not approved by the ATO as the risk associated with such manoeuvre is high.

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

4.2.1 A safety recommendation was issued shortly after the on-site investigation was concluded and was accepted and implemented by the ATO.

4.3 Safety Message

4.3.1 It is essential that the flying crew take the necessary precautionary actions to ensure that they are adequately protected during flight. It is, therefore, recommended that pilots should fly with helmets, especially during helicopter and crop-spraying operations. Fire-resistant clothing, preferably a flying overall (Nomax) should always be worn. This affordable safety gear could increase a pilot's crash survivability rate in case of an accident.

5. APPENDICES

5.1 Appendix A (Weight and Balance as provided by ATO)
5.2 Appendix B (Cabri G2 Flight Manual, Section 3, Emergency Procedures)
5.3 Appendix C (Cabri G2 Flight Manual, Section 4, Normal Procedures, Autorotation practice)
5.4 Appendix D (Cabri G2 Flight Manual, Section 7, System Description)

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

Appendix A

Issue	:	1	CABRI G2 MASS AND BALANCE & CHECKLIST	STARLITE AVIATION GROUP
Amendment	:	001		
Effective Date	:	19 October 2022		
Doc Ref No	:	TS/H/FAMO/MB03		

No flight may be authorised without a Mass and Balance as per Civil Aviation Regulations

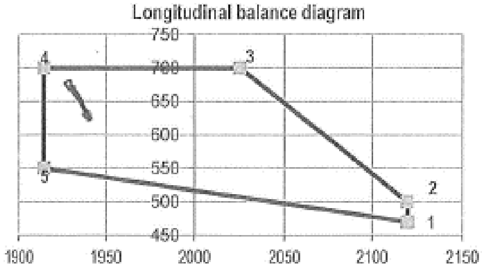
AIRCRAFT TYPE	REGISTRATION	DATE	Autho Ref No:
Cabri G2	ZS-HKC	19.04.23	

Pilot in Command/Instructor	Student/Passenger	Training	H & F	Charter
R. Schillach.	B. Verger.	✓		

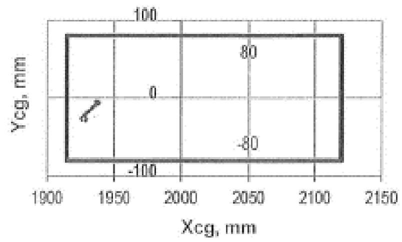
Base of operation	Virginia	Mossel Bay ✓	Other
Routing:	FAMO		

	Weight (kg)	LONGITUDINAL Arm(mm)	LONGITUDINAL Moment	LATERAL Arm(mm)	LATERAL Moment
BASIC EMPTY MASS	447.7	2207	988073.9	0.0	0.0
Remove right door		1250		+600	
Remove left door		1250		-600	
Right seat	92	1300	106600	+320	26240
Left seat	100	1300	130000	-280	-28000
Main luggage compartment	5	1854	9270	323	~~[illegible]~~ 1615
Front luggage compartment		325		0	
ZERO FUEL MASS	634.7	1944	1233943.9	-0.2	-145
Main Tank Fuel	42	1833	76986	-313	-13146
TAKE OFF MASS	676.7	1937	1310929.9	-19.6	-13291
Main Tank Fuel		1833		-313	
LANDING MASS					

Longitudinal balance diagram



Lateral balance diagram



Main Fuel max useable	
Maximum Gross Weight	700kg
Minimum Gross Weight	
Max per seat incl. baggage	
Max baggage	40kg
Minimum pilot solo weight	
Liters to kg	0.7

Notes:

60 x 0.7 = 42.

PIC Signature: [signature]

Hélicoptères Guimbal
CABRI G2

SECTION 3
EMERGENCY PROCEDURES

Power failures

General

Engine failure can be detected by :

- Yaw acceleration, nose to the right,
- Engine noise level decreases,
- Tachometer needles desynchronization on the EPM (engine decreases)
- OIL P warning on the EPM and OIL P red light coming ON.
- Plasma beeper,
- Rotor speed decreasing and "low NR" horn.

Caution : A slow decay in engine power, caused by carburetor icing or air filter clogging, is compensated by the governor and can be overlooked by the pilot.
The MLI indication will not change while in PWR mode, but will rapidly shift to FLO mode, then increase to 100%.

Primary transmission failure can be detected by :

- High yaw rate, nose to the right,
- Engine noise level increases,
- Tachometer needles desynchronization on the EPM (engine increases). Eventual engine overspeed only if the governor is OFF
- Rotor speed decreasing and "low NR" horn.

In case of a primary transmission failure, apply following power failure actions. Roll off the twist grip as soon as possible.

Warning :

Safe landing may not be possible if the power failure occurs within the "unsafe" zone of the H/V diagram (refer to section 5).

Operation inside this zone should be avoided.

3-2 EASA Approved Original issue

Aural warnings

Loud horn warning :

A continuous tone warns the pilot when rotor speed approaches low speed limit.

An intermittent tone warns the pilot when rotor speed approaches high speed limit.

A short tone warns the pilot when the LOW FUEL light goes on.

Note : The continuous horn can be temporarily muted by setting the NR switch to MUTE. It reengages itself when the condition disappears.

Beeper warning :

A high-frequency continuous beep warns the pilot in three situations :

- when oil pressure is lost with Plasma ignition ON – in conjunction with OIL P red warning light,
- to warn that engine ignition is HOT at startup,
- to prevent from leaving the Plasma ignition ON when leaving the helicopter (MASTER OFF as well as ON).

EPM parameters out of limitations

Note: All EPM parameters are displayed in corresponding color (inverted), and blink during 10 seconds when exceeding limit.

Parameter	Exceeds	Corrective actions
Carb T	Yellow arc	1. Check how much bricks are lightened, 2. Move carb heater switch to HOT as necessary, 3. Check bricks appears and temp gets out of yellow and **CONTINUE FLIGHT** → If stays, avoid prolonged flight at low power setting. → In case of carb. icing (*), **LAND AS SOON AS POSSIBLE** Carry-on a cautious landing. (*) Refer to page 3-2 for detection means

Appendix C

Power failure in hover in ground effect practice

1. Roll-off throttle frankly until on its stop,
2. Counteract yaw motion by applying left pedal,
3. Increase collective as ground approaches, to smooth landing,
4. Push collective down once landed.

Note 1 : If the helicopter is light, it may bounce after a first touchdown.

Note 2 : The Cabri G2 has no natural tendency to depart in roll or pitch after failure. No systematic corrective cyclic action is needed.
A slight forward motion at impact is recommended for better control.

Note 3 : For a forgiving practice, respect a maximum of 5 feet height.

Note 4 : Avoid practice at maximum gross weight.

Autorotation practice

1. Lower collective full down,
2. Counteract yaw motion by applying left pedal,
3. Roll-off throttle through its spring ramp to its stop,
4. Maintain IAS between **30 and 50 kt IAS (50 kt IAS recommended)** by controlling longitudinal cyclic,
5. Slightly increase collective if required to keep rotor speed in the green arc,
6. At about 60 feet AGL, apply aft cyclic to raise the helicopter nose smoothly and continuously.
7. As ground closes-on, apply forward cyclic to level the helicopter while raising the collective to stop sink rate.
    - With a **50 kt IAS** approach, landing requires a longer distance but is easier to manage. Little action is required on the collective control since the flare will stop the sink rate.
    - A **30 kt IAS** approach needs smaller cleared area for landing but is more difficult to manage.
8. Use pedals to minimize ground drift,
9. Once stopped, lower the collective.

Note : When autorotation is stabilized with collective full down, the rotor speed should stay in the authorized range, whatever the weight and the altitude in flight envelope.

Caution : If airspeed drops below 30 kt IAS, push frankly the cyclic forward to recover airspeed.

Training

Caution : The Cabri G2 has a very capable rotor, giving her comparatively permissive autorotation characteristics. This allows efficient training and practice, from different situations and using different piloting techniques.
Following procedures are given as guidelines and should be followed for best safety.

However, pilot and instructor should keep in mind that power failure training is a very demanding practice, requiring a high level of awareness, good health and personal condition, and aircraft in perfect airworthy state.

Power failure practice must be limited to the strict needs of instruction and maintaining good proficiency. Never practice autorotation as a show.

Pilot must stay familiar with Height-velocity diagram page 5-3 together with procedures described in Section 3 to follow them in case of an actual failure.

Autorotation must only be practiced over an area that would minimize hazards associated with an actual engine failure.
Smooth and hard surface should be preferred to practice running landings.
In order to familiarize with Cabri G2 landing attitude, practice powered running landings before autorotation training.

Caution : Before attempting running landings, check thoroughly carbide wear shoes. An unexpected drift during a running landing is a clue to a carbide shoe failure. Always check in case of doubt.

Rapid throttle chops should not be used to practice autorotation.

During autorotation training, try to keep the helicopter skids level at touchdown, to avoid unpleasant pitch-down and bouncing.

If the ground is not smooth and if the rotor speed is too low when the helicopter touches the ground, a pitch oscillation can happen, leading to an uncomfortable landing. In that case, the pilot has to keep the cyclic control in the neutral position in order to prevent induced oscillations.

Aborting autorotation practice

If power recovery is decided during autorotation :

1. Roll-in throttle until governor engages,
2. Gradually raise collective pitch to stop autorotation and descent,
3. Control yaw during power recovery with pedals.

Note : Do not worry for very fast engine acceleration. There is no risk of overtorque at re-synchronization. Be prepared to yawing to the left when power recovers.

Carburetor heat

The Cabri is equipped with a two-mode carburetor heat :

- Normal automatic mode (switch on AUTO) : the EPM monitors carburetor temperature and controls the heating valve to keep it outside the yellow zone,
- Manual / test mode (switch on HOT or COLD) : The pilot manually controls the valve, overriding the EPM.

Indicator

A four-brick indicator informs the pilot of the amount of carburetor heating actually measured at carburetor inlet.

Full carburetor heat is divided in four steps, each represented by one brick.

Note 1 : During ground run or at low power setting, with a warm engine, T. induction may be biased by carburetor body heat radiation. For this reason, a brick can appear whereas the heating valve is closed.

Note 2 : - In automatic mode, the EPM gradually opens the valve as needed to maintain Tcarb out of the yellow zone. The amount of heating is given by the indicator.
- In manual mode, the pilot can either completely open (HOT) or completely close (COLD) the valve. When on HOT, all four bricks might not be lighted, depending on environmental conditions.

Note 3 : Conditions conducive to carburetor icing are :
High humidity, low temperature,
Operating near water,
Moderate to low power setting.

Note 4 : In manual operation, switching from one position to the other should be done smoothly, with a small pause on Auto.