AIRCRAFT ACCIDENT REPORT AND EXECUTIVE SUMMARY

			Reference:	CA18/2/3/9118	
Aircraft registration	ZU-EFH	**Date of accident**	1 January 2013	**Time of accident**	±0505Z
Type of aircraft	Aeroprakt A-22 (Aeroplane)		**Type of operation**	Private flight	
Pilot-in-command licence type	Private pilot	**Age**	41	**Licence valid**	Yes
Pilot-in-command flying experience	Total flying hours	909,8		Hours on type	396,9
Last point of departure	Phalaborwa aerodrome (FAPH), Limpopo province.				
Next point of intended landing	Phalaborwa aerodrome (FAPH), Limpopo province.				
Location of the accident site with reference to easily defined geographical points (GPS readings if possible)					
Open field next to the Phalaborwa aerodrome fence (GPS position: 23°56.695' South 031°09.344' East)					
Meteorological information	Surface wind: 260°/2kts, Temperature: 24°C, Cloud base: 2 000 ft, CAVOK				
Number of people on board	1 + 1	**No. of people injured**	0	**No. of people killed**	2

Synopsis

The pilot, accompanied by a passenger, also the holder of a valid private pilot license took-off from runway 19 at Phalaborwa aerodrome (FAPH) at approximately 0505Z with the intention to conduct a private flight of the area. According to an eyewitness who was walking towards the South of the aerodrome he saw the aircraft after it became airborne flying in a southerly direction. The aircraft was at a height of approximately 200-300 feet above ground level (AGL) when the engine suddenly stopped. He then observed the aircraft making a right-hand turn, as if it was turning back towards the runway/aerodrome. Following the turn it was observed to descend in a steep nose down attitude. The aircraft disappeared from his view behind some trees and burst into flames on impact. He ran towards the accident site to find the aircraft ablaze. The intensity of the fire was of such a nature that he was unable to do anything to extinguish it. The local rescue and fire-fighting services was informed of the accident and rushed to the scene and extinguished the fire. The aircraft was destroyed during the accident sequence and both occupants were fatally injured.

Probable Cause

Unsuccessful landing following an engine stoppage after take-off.

Contributory factor:
The decision by the pilot to turn back towards the runway/aerodrome after the engine stopped should be regarded as a significant contributory factor to this accident.

ASP date		Release date	

AIRCRAFT ACCIDENT REPORT

Name of Owner	**:** J.W. Horn
Name of Operator	**:** Private flight
Manufacturer	**:** Aeroprakt
Model	**:** A-22
Nationality	**:** South African
Registration Marks	**:** ZU-EFH
Place	**:** Phalaborwa (Limpopo province)
Date	**:** 1 January 2013
Time	**:** ± 0505Z

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.

Purpose of the Investigation:

*In terms of Regulation 12.03.1 of the Civil Aviation Regulations (1997) 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 establish legal liability**.*

Disclaimer:

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

1. FACTUAL INFORMATION

1.1 History of flight

1.1.1 At approximately 0505Z on the morning of 1 January 2013, the pilot, accompanied by a passenger, also the holder of a valid private pilot licence took off from runway 19 at Phalaborwa aerodrome (FAPH) with the intention to conduct a private flight of the area. According to an eyewitness who was walking in the veld to the south of the aerodrome he first heard the aircraft as it took off and it flew in his direction (towards the South). As the aircraft was basically a beam overhead him, at a height of approximately 200-300 feet above ground level (AGL) the engine stopped. He then observed the aircraft executing a right turn as if it was turning back towards the runway/aerodrome. He was unable to follow its flight path all the way as his view was obscured by some trees. A few seconds later he heard a sound associated with the aircraft impacting the ground. He ran in that direction and as he approached the scene he found the aircraft engulfed in flames where it had crashed in an open grass covered area, adjacent to the aerodrome perimeter fence. The investigating team were able to determine from the eyewitness's account that the aircraft was in a steep nose down attitude in the region of between 30° to 45° after it turned and descended. The pilot and passenger were fatally injured in the accident and the aircraft was destroyed by the post impact fire.

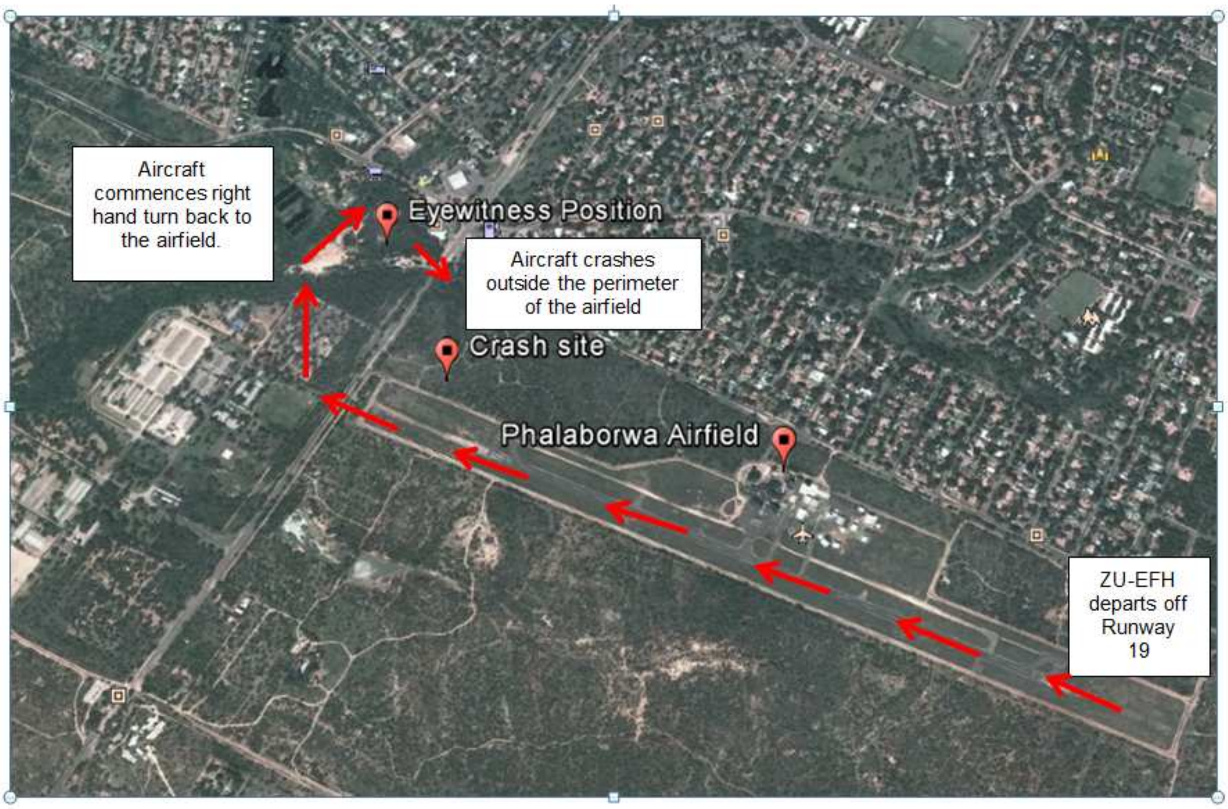


Figure 1. Illustration of the flight path of the aircraft after take-off from runway 19 (based on estimation).

1.1.2 The accident occurred during daylight conditions at a geographical position that was determined to be 23° 56.695' South 031°09.344' East at an elevation of 1 382 feet above mean sea level (AMSL). The Google earth image (figure 2) on the next page indicates the GPS position of the accident site in relation to the threshold of runway 01. The distance from the accident site to the threshold of runway 01 was 350 metres (m).

Figure 2. The GPS position indicates the location of the accident site to the West of the aerodrome fence.

1.2 Injuries to persons

Injuries	Pilot	Crew	Pass.	Other
Fatal	1	-	1	-
Serious	-	-	-	-
Minor	-	-	-	-
None	-	-	-	-

1.2.1 The passenger was also a holder of a private pilot's licence and was also rated on the aircraft type**.**

1.3 Damage to aircraft

1.3.1 The aircraft was destroyed by the post impact fire.

Figure 3. A photo of the burnt out wreckage adjacent to the aerodrome perimeter fence.

1.4 Other damage

1.4.1 Minor damage was caused to vegetation in the area of the accident site.

1.5 Personnel information

1.5.1 Pilot-in-command (PIC)

Nationality	South African	Gender	Male	Age	41
Licence number	0270515174	Licence type	Private pilot		
Licence valid	Yes	Type endorsed	Yes		
Ratings	Night rating, Single engine piston test rating				
Medical expiry date	30 November 2013				
Restrictions	Hypertension protocol Cholesterol protocol Must wear corrective lenses				
Previous accidents	None				

Flying experience:

Total hours	909,8
Total past 90-days	unknown
Total on type past 90-days	unknown
Total on type	396,9

1.5.2 According to the CAA pilot file the pilot started with flying training towards his micro-light pilot license in December 2001 and completed his training on 24 April 2002. The CAA issued him with a micro-light pilot licence on 29 April 2002. The pilot had the Aeroprakt A-22 type aircraft endorsed on his license according to available records after he had completed his conversion onto type on 15 July 2006. His type conversion included 16,3 hours of dual flight training and 0,2 of solo flying.

1.5.3 On 3 December 2007 he applied for a student pilot licence towards obtaining his private pilot license. He completed his private pilot training on 29 February 2008 and was issued with a private pilot license on 19 March 2008. According to the CAA pilot file he concluded his conversion onto the Piper PA-32-300 series aircraft on 5 August 2008. On 4 February 2009 he successfully completed his skills test towards obtaining his night rating, which comprised of 20,1 hours of flying. His last type conversion on record was conducted on 19 July 2012 onto the Tecnam Echo type aircraft under the auspices of an accredited aviation training organisation (ATO) No. CAA/0141.

1.5.4 The investigating team engaged with the late pilot's wife but it was not possible to obtain his pilot logbook after the accident. It would appear that he kept it in electronic format, which could not be located. The hours entered into the column above was obtained from the CAA pilot file with the last logbook summary on record dated 17 July 2012. Additional flying hours were however obtained from the flight folio of another aircraft ZS-NCE (Piper PA-32-300) to which the pilot was a partner and also flew. According to the aircraft flight folio that was made available to the investigating team the last time he had flown the aircraft ZS-NCE was on 8 December 2012.

1.5.5 According to available records the pilot's last aviation medical examination prior to the accident flight was conducted on 22 November 2012. The pilot was accordingly issued with a class II medical for a period of one year when referring to form CAA CA67-02(a) – Aviation Medical Report.

1.5.6 The pilot opted to keep both his National Pilot license, which was issued by the Recreational Aviation Administration of South Africa (RAASA) current as well as his private pilot license, which was issued by the South African Civil Aviation Authority (SACAA). The last *examination and practical skills test report for a recreation pilot* (form CA62-05) on record was signed on 19 July 2012 by both the pilot and the flight examiner. This skills test was flown on the Tecnam Echo type aircraft and the duration of the flight was 1 hour and 30 minutes. The test was conducted under the auspices of an accredited ATO No. CAA/0141. Subheading 10 of the skills test report deals with forced landings. There are nine evaluation points under this subheading and they comprised of the following.

10. Forced landings	**Score**
1. Airspeed and conservation of height	4 out of 5
2. Selection of field land landing path	5 out of 5
3. Accuracy of turns and airspeed	4 out of 5
4. Cockpit procedure	4 out of 5
5. Plan of descent	4 out of 5
6. Final line overshooting, undershooting	4 out of 5
7. Judgement of approach	5 out of 5
8. Procedure on final approach	4 out of 5
9. Radio procedure	5 out of 5

The pilot was found proficient during the skills test and his National Pilot licence was accordingly renewed. His last practical skills test towards his private pilot license was conducted on 22 March 2012 on a Piper PA-28-180 the duration of the flight was one hour.

1.6 Aircraft information

1.6.1 The Aeroprakt A-22 Foxbat is a Ukrainian design and built two seat, high-wing, tricycle gear ultra-light aircraft manufactured by Aeroprakt. The first prototype made its maiden flight on 21 October 1996, and a German-certified version entered production in 1999.

The A-22's structure is almost completely all-metal with only the engine cowling, wing fillets and wheel spats being made of composites. The wings and control surfaces are fabric covered. The aircraft has excellent visibility, due to the large amount of glazing, including convex doors that allow the occupants to look straight down. The A-22 uses a 3-axis control system, giving the pilot full control over the aircraft. The A-22 uses flaperons in place of ailerons and flaps and giving a stall speed of between 28 to 32 knots (52 - 59 km/h) with the flaperons fully down.

The kit comes with either the 80 hp (60 kW) Rotax 912UL optionally the 100 hp (75 kW) Rotax 912ULS. The 85 hp (63 kW) Jabiru 2200 engine can also be fitted.

Originally the A-22 came fitted with a 40 liter inboard fuel tank behind the seats although later models have wing tanks holding 37,5 liters per side. The propeller is a 3-blade composite ground adjustable KievProp. Dual controls are standard, using a single central "Y" yoke or optionally twin yoke control system

1.6.2 This specific aircraft (ZU-EFH) was fitted with the standard dual controls with a twin yolk control system

Figure 4. A view of an Aeroprakt A-22 type aircraft.

Airframe:

Type	Aeroprakt A-22
Serial number	149
Manufacturer	Aeroprakt
Year of manufacture	2006
Total airframe hours (at time of accident)	*No documented data available

Last annual inspection (hours & date)	400,1	18 July 2012
Hours since last annual inspection	Unknown	
Authority to Fly (issue date)	19 July 2012	
Authority to Fly (expiry date)	17 July 2013	
C of R (issue date) (present owner)	18 June 2006	
Operating categories	Private	

NOTE: The airframe hours at the time of the accident could not be determined with accuracy as no documented evidence (i.e., flight folio) could be obtained to substantiate such hours. The airframe, engine and propeller hours where obtained from the last Annual Inspection notification form for amateur built non certified production built and kit built aircraft (form reference; RA 24.1 CARS 24) on record with the Recreational Aviation Administration of South Africa (RAASA) dated 18 July 2012.

Engine:

Type	Rotax 912ULS
Serial number	6778615
Hours since new	34,1
Hours since overhaul	T.B.O. not yet reached

1.6.3 The aircraft was purchased as new in June 2006 and at the time was equipped with a Rotax 912ULS engine, serial No. 5646551. The engine was removed by an Approved Person (AP) at 366,0 airframe hours in June 2011 after the aircraft owner reported a rough running engine and requested that the problem be rectified. During the troubleshooting of the engine, the AP discovered that the magnetic plug on the gearbox had excessive ferrous material attached to it. The amount was deemed to be in excess of what could be associated with normal wear and tear. The AP suspected that either the camshaft or valve lifters were worn beyond limits. He then opened the rocker cover on the No.1 cylinder and found that the intake valve would not open due to excessive cam lobe wear.

1.6.4 The engine was then forwarded to a Rotax engine expert in Gauteng for disassembly and an estimated repair cost. The person responded that the engine was damaged beyond economical repair. A new engine, also a Rotax 912ULS, serial No. 6778615 was purchased by the owner and was installed in the aircraft on 13 July 2011 in the aircraft owner’s hangar in Phalaborwa. Following the installation of the new engine the aircraft was re-weighed and was subjected to a post maintenance acceptance flight by a commercial pilot who was the holder of a class II test pilot rating. No anomalies were noted with the engine operation during the flight.

1.6.5 The only items that were transferred from the old engine installation to the new engine were the oil and fuel hoses, which were deemed to be in good condition at the time. There was also a small change to the routing of the water hoses on top of the engine to comply with the Aeroprakt A-22 engine installation requirement. The new engine also came with new ignition components, carburettors and fuel pump. In March 2012 the owner flew the aircraft to the AP facility in White River where a 25-hour inspection was performed on the engine, which included an oil change, replacing the oil filter and the removal and inspection of the magnetic plug, which were found to be satisfactorily.

Propeller:

Type	Keiv 263
Serial number	263/293
Hours since new	400,1
Hours since overhaul	T.B.O. not yet reached

1.6.6 Weight and balance:

Item	**Weight (kg)**
Aircraft empty weight	285,5
Pilot	136
Passenger	101
Zero fuel weight	**522,5**
Fuel (40L)	28
Take-off weight	**550,5**

1.6.7 The maximum take-off weight (MTOW) for this aircraft (Aeroprakt A-22, Serial No. 149) was 450 kg. This information was obtained from the pilot operating handbook (POH) dated 14 April 2006 that was approved by the regulating authority and of which a copy was placed on the CAA aircraft file.

During the investigation process it was noted that there was conflicting data available on the maximum take-off weight for this aircraft type (Aeroprakt A-22).

This data originated from the aircraft manufacturer, the agent in South Africa as well as an Approved Person (AP). The CAA Certification division was requested to provide clarity in this regard and it was determined that the Type Certificate Data Sheet (TCDS) on record also reflected a maximum take-off weight of 450 kg. No evidence could be obtained to indicate that any revisions/supplements to the POH were received nor approved by the regulating authority to reflect a revised maximum take-off weight for this aircraft type.

1.6.8 The aircraft empty weight that was used for the weight and balance calculation was obtained from an official aircraft weighing data sheet. The document was signed on 13 July 2011 by the AP that performed the task after the fitment of the new engine.

1.6.9 The weights used in the calculation for the pilot and passenger (also a pilot) were obtained from their respective aviation medical records. The PIC's last aviation medical examination was conducted on 22 November 2012 and his weight was documented to be 136 kg. The post mortem report reflect a weight of 91 kg, however this weight was not considered for calculation purposes due to post impact fire exposure. According to his aviation medical report dated 21 February 2012 the passenger/pilot weight was documented to be 101 kg. The post mortem report for the passenger did not contain any weight related information (the subheading was left blank). A doctor's letter dated 17 July 2013 was made available to the investigating team, on the letter the doctor state that he estimated the weight of the passenger, who was a patient of him to be ± 85 kg. Being an estimated weight the investigating team was unable to consider this weight to be accurate and therefore did not use it in the weight and balance calculation.

1.6.10 Due to the absence of documented evidence (aircraft flight folio) it was not possible to determine the fuel quantity onboard the aircraft for the flight with accuracy. Two empty 20 litre containers (Jerry cans) were found in the back of the pilot's vehicle that was parked at the aerodrome. It was believed that these containers were emptied into the aircraft prior to the flight, but following an interview with the late pilot's wife it was ascertained that these two containers were used to store fuel for a generator at their home and was never used to refuel the aircraft. It was noted that there was a trailer type fuel bowser parked in the hangar where the aircraft was standing along with several other aircraft. The meter reading on the pump display was 132 litres, which was well above that of the total capacity of the aircraft and was therefore not of any value to the investigating team. There were also two, 200 litre drums with a hand crank pump and filtering device secured to one of the drums. The possibility that the pilot might have pumped fuel from the drum into the aircraft was possible. (See view of drum with hand crank pump and trailer in figure 5 on the next page).

For the purpose of the weight and balance calculation a value of 20 litres per tank (left and right wing tanks) was considered as a reasonable value considering the intensity of the post impact fire that erupted following impact. It should be noted that the value used is an estimated value the actual value could have been slightly more or less. Due to the absence of the flight folio, which was destroyed in the post impact fire it was not possible to obtain any historical data on the fuel uplifts into the aircraft over a period of time, therefore no average fuel quantity (per flight) could be determined that would have assisted in the weight and balance calculation.

(a) (b)

Figure 5. A view of a 200 litre drum with a hand crank device (a) as well as a trailer type bowser in the hangar (b).

1.6.11 Taking the above calculations into consideration it would be reasonable to estimate that the aircraft was 72.5Kg overweight with no fuel on board and 100.5kg over weight with 40 litres of fuel on board.

1.7 Meteorological information

1.7.1 An official weather report was obtained from the South African Weather Services (SAWS) for the day, time and place of the accident. The following meteorological conditions were observed from the FAPH 010500Z AUTO METAR (Meteorological Aerodrome Report).

Wind direction	260°	Wind speed	2 kts	Visibility	+ 10 km
Temperature	24℃	Cloud cover	Broken	Cloud base	2 000 ft
Dew point	19℃				

1.7.2 Satellite Image

The satellite image indicates broken (BKN) low-level cloud in the Phalaborwa area with a cloud base above 2 000 feet. The image dated 1 January 2013 at 0515Z.

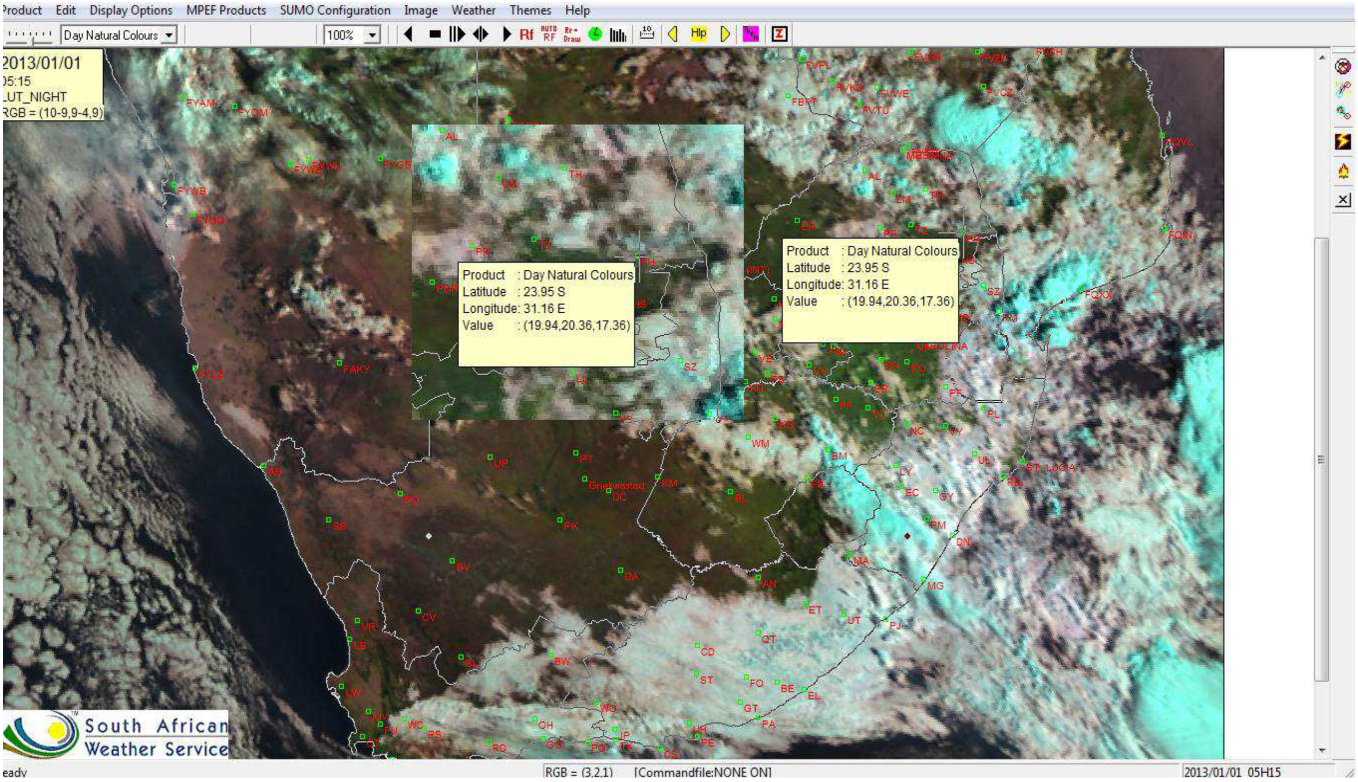


Figure 6. Satellite image of the country taken on 1 January 2013 at 0515Z.

1.7.3 Taking the temperature and dew point into consideration the dew point depression was calculated to be 5℃ at the approximate time of the accident. When consulting the carburettor icing-probability chart (see figure 7 on the next page) it reflects a moderate probability for carburettor icing in the cruise configuration, the accident aircraft was on take-off phase of flight when the engine failed, therefore at full power.

1.8 Aids to navigation

1.8.1 The aircraft was equipped with standard navigational equipment as approved by the regulator for the aircraft type. There were no recorded defects that the navigation equipment was unserviceable prior to or during the flight.

1.9 Communication

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

1.9.2 Phalaborwa is an unmanned licensed aerodrome. Aircraft are required to broadcast their intentions on the VHF frequency 124.80 MHz.

1.9.3 A hand-held VHF radio was located on the accident site, the unit was found to be undamaged and still on. The frequency selected on the display was 124.80 MHz.

1.10 Aerodrome information

Aerodrome location	Phalaborwa aerodrome	
Aerodrome co-ordinates	South 23°56.099 East 031°0 9.183	
Aerodrome elevation	1 432 feet	
Runway designations	01/19	
Runway dimensions	1 369 x 18 m	
Runway used	19	
Runway surface	Asphalt	
Approach facilities	PAPI 3°, VOR, NDB, Runway light s	
Aerodrome status	Licensed	

1.11 Flight recorders

1.11.1 The aircraft was not equipped with a flight data recorder (FDR) or a cockpit voice recorder (CVR), nor was either required to be fitted to this type of aircraft according to the regulations.

1.12 Wreckage and impact information

1.12.1 The wreckage came to rest in an open grass field just outside the aerodrome perimeter fence (western side). The first ground impact was with an embankment, which were approximately 70-80 centimetres (cm) in height on a heading of 045°M. The aircraft impacted with the embankment in a nose down attitude of approximately 30° to 45°, which caused one of the p ropeller blades to break off at the hub assembly on impact, the propeller hub assembly with the other two blades still attached was located on the accident site, attached to it was a section of the propeller reduction gearbox.

Figure 7. A view of the main wreckage as it came to rest.

1.12.2 The first impact point was about 15 meters from where the main wreckage came to rest. The wreckage was found to have rotated through approximately 120°. The fabric/composite covered fuselage and wings where consumed within a short period of time by the post impact fire that erupted. It was not possible to ascertain flight control continuity due to the fire damage.

1.12.3 The propeller with hub assembly was located approximately 5 meters from the first impact point. Two of the three propeller blades were still attached to the propeller hub. The evidence presented by the propeller was indicative of non rotation, indicating it was most probably stationary on impact, which correlated with the observation that was made by the eyewitnesses, which indicated that the engine stopped shortly after take-off. The damage to the engine was consistent with the impact sequence and was located lying in an inverted position next to the main wreckage. The engine was subjected to the post impact fire and all the electrical wiring, fuel and oil lines were destroyed as a result.

(a)

(b)

Figure 8. A view of the engine as it came to rest (a) and the propeller with two of the three blades still attached (b).

1.12.4 The face plate of the vertical speed indicator (VSI) with the needle mechanism intact was located on the accident site. The needle indicated a rate of descent of ±700 feet per minute, as can be seen in figure 10(a) below. This was the only flight instrument that was not completely destroyed. A hand held VHF radio was located on site. The radio was still in a working order and displayed the Phalaborwa aerodrome frequency 124.80 MHz.

(a)

(b)

Figure 9. A photo of the VSI faceplate (a) as well as the VHF had held radio that was located on site (b).

1.13 Medical and pathological information

1.13.1 An post mortem was conducted on both the occupants. The cause of death was determined to be *"Multiple blunt force injuries due to an aviation accident"*

1.14 Fire

1.14.1 The wreckage was consumed by the post impact fire that erupted. According to an eyewitness the aircraft exploded on impact and was engulfed in flames. The fire services from the local authority responded to the scene and extinguished the fire.

1.15 Survival aspects

1.15.1 The accident was not considered to be survivable due to the high impact forces associated with the accident as well as the post impact fire that erupted and consumed the wreckage.

1.16 Tests and research

1.16.1 The engine, a Rotax 912ULS, Serial No. 6778615 was recovered from the accident site as well as the propeller, which had a section of the propeller gearbox attached to it. The engine was transported to an aircraft maintenance organisation in Gauteng where a teardown inspection was performed. The engine sustained substantial fire damage. The purpose of the teardown inspection was to assess the mechanical integrity of the engine. The examination of the engine did not reveal evidence of any pre-existing failures or conditions that would have prevented normal engine operation. A summary of the engine teardown report can be found attached to this report as Annexure A.

1.17 Organizational and management information

1.17.1 This was a private flight. The owner of the aircraft was also the pilot.

1.17.2 The last annual inspection that was carried out on the aircraft prior to the accident was certified by Approved Person (AP) No. 59, who was accordingly accredited by the Aero Club of South Africa. The annual inspection was certified on 18 July 2012 at 400,1 airframe hours.

1.18 Additional Information

1.18.1 Aeroprakt A-22 Flight Manual, Section 3, Emergency procedures pg. 15

Engine failure

1. *"In case of engine failure during the take-off roll switch OFF the engine ignition system and discontinue the take-off.*

2. *If the aircraft is at altitude up to 50 meters (164 feet) switch the engine OFF and land straight, avoiding head-on collision with any obstacles.*

3 *If the engine failed during climb, set the aircraft into a steady descent at a speed of 56 mph and if the altitude is sufficient turn the airplane towards the airfield, switch the ignition off, and make a landing.*

4. *If case of engine failure during level flight set the aircraft into steady descent at a speed of 60 mph, switch the ignition off, estimate wind direction and strength, choose a place for landing and land (preferably into the wind). Under favourable flight conditions try to restart the engine in flight. If the altitude is not sufficient, land.*

5. *If there is no place for landing and conditions do not allow restarting the engine in-flight, use the recovery system (installed as an option – ballistic parachute).*

1.18.2 To restart the engine in flight

- *"Set the throttle to idle engine speed position;*
- *Set the ignition switches into the ON position;*

- *Turn the key to the start the engine".*

1.18.3 Landing with the engine stopped

"This aircraft has no peculiar handling features during the landing with the engine stopped and the flaperons up or down. Recommended speed at descent is 60 mph, enter into the flare at 5 meters, flare out at 0.5 m, landing speed 35 mph. Maximum gliding ratio for the aircraft is approximately 10.

1.18.4 Engine failure after take-off (single engine)

Attached to this report as Annexure B is an article from the FAA Aircraft Flying Handbook on the height required to '*land back*' following an engine failure after take-off at 300 feet AGL. Taking several factors into consideration they came to the conclusion that 1 316 feet would be required. It should be noted that several factors plays a roll and the result might vary from aircraft type to type as well as the influence of environmental factors.

1.19 Useful or effective investigation techniques

1.19.1 None.

2. ANALYSIS

2.1 Pilot (Man)

The pilot was the holder of a national pilot license as well as a private pilot license at the time of the accident. His last aviation medical examination prior to the accident flight was conducted on 22 November 2012, he was found to meet the medical requirements and was issued with class II medical certificate that was valid for a period of one year.

The pilot's total flying experience on the Aeroprakt A-22 type aircraft from the time he completed his type conversion until the accident flight on 1 January 2013 could not be determined with certainty as it was not possible to obtain documented evidence (pilot logbook or an electronic version thereof) to substantiate the information. Available information, on record, indicate he had accumulated a total of 396,9 hours on type until 17 July 2012, which was the last electronic logbook printout on record. The pilot who was also the owner of the aircraft since June 2006 was therefore very familiar with the aircraft and its flying characteristics. The pilot opted to execute a right-hand turn, what appeared to be an attempt to turn back towards the runway/aerodrome. The height above ground level when the engine stopped was at no means adequate to ensure a successful forced landing, evidence to that is that the aircraft was still in a steep nose down attitude when it collided with the ground.

The decision by the pilot at the time to turn back was most probably based on his knowledge, skills and experience. All training related theory as well as practical training provides clear guidelines on what the actions should be followed in such an event. The ideal would be to immediately establish the best glide attitude and land the aircraft straight ahead. There are however, several factors that will determine this decision as one would want to avoid built-up areas, being that residential, industrial or mining areas. If it is not possible to land straight ahead it is not recommended to deviate more than 30° to either the left or the right-hand side of the nose, which allow for a landing arc of 60° on t he nose. The option of turning back to the runway/aerodrome should not be considered at all, unless there is ample altitude available to make such a turn and land the aircraft successfully. The success rate in executing a safe forced landing by turning back to the runway/ aerodrome following an engine failure/stoppage after take-off is extremely remote and not advisable at all. The following information (quote below in italic format) was contained in Chapter 3 of the aircraft flight manual, Emergency Procedure, *'Engine failure'.*

"If the engine failed during climb, set the aircraft into a steady descent at a speed of 56 mph and if the altitude is sufficient turn the airplane towards the airfield, switch the ignition off, and make a landing".

This information was found to be in contrary to what is regarded as international best practise with reference to training pilots how to deal with an engine failure after take-off (single engine aircraft).

Taking the stall speed for this aircraft type into consideration which was between 28 to 32 knots (52 to 59 km/h) with flaperons down a forced landing straight ahead might have resulted in some damage to the aircraft and possibly property, if any. It is believed that by deviating from recommended/trained procedures a survivable accident became a non-survivable accident.

It could not be determined if the pilot at any stage prior to this flight may have practised this manoeuvre where he would turn back to the runway/aerodrome following a simulated engine failure after take-off. According to his last practical skills test report on record, dated 19 July 2012 he was evaluated on forced landings (subheading 10 on the test report) and was found to be proficient at the time.
The weight and balance calculation indicated that the aircraft was approximately 100 kg (22%) overweight on take-off. Flying the aircraft overweight is not the only concern but along with that goes the centre of gravity (CG). The CG position plays and important role in the stability, controllability and performance of the aircraft.

Weight and balance limits are placed on aircraft for two principal reasons:

(i) Because of the weight of the aircraft on the aircraft primary structure and its performance characteristics; and

(ii) Because of the effect the location of this weight has on the flight characteristics, particularly in stall and spin recovery and stability.

The take-off/climb and landing performance of an aircraft are determined on the basis of its maximum allowable take-off and landing weights. A heavier gross weight will result in a longer take-off run and shallower climb, a faster touchdown speed and a longer landing roll.

2.2 Aircraft (Machine)

On 13 July 2011 the aircraft was fitted with a new engine. The actual hours on the engine could not be determined with accuracy due to the absence of documentation (aircraft flight folio) but it was believed that it had not accumulated more than 100 hours since new. The annual inspection information dated 18 July 2012 reflect the engine hours at the time to be 34,1. This inspection was carried out one year after the new engine was fitted.

Due to the post impact fire that consumed the aircraft it was not possible to make any observations within the cockpit area. The position of the throttle and choke could therefore not be correlated to what was found during the engine teardown inspection, nor was it possible to make any observations with reference to the procedures the pilot should have followed once the engine had stopped. It was evident from the engine teardown inspection that the throttle was in the closed position and the choke partially open. The position of the choke lever should have been in the fully closed or retarded position, as it was not required for start, nor taxi on the day as the temperature on start-up was approximately 24℃. The possibility that the choke lever was disrupted during the impact sequence could not be ruled out. It is expected that should the choke have been applied during start and or take-off one would have expected not to see the brownish deposit on the spark plugs and within the exhaust system, which is indicative of normal engine operation but rather a black deposit, which can be associated with a rich air/fuel mixture due to access fuel being allowed to enter the carburettor at a reduced air flow.

The probability that the pilot attempted to restart the engine once it had stopped after take-off was considered, there was however, very little to no time available to attempt an engine restart. At that stage of the flight the pilot had most probably diverted all his attention towards flying the aircraft.

Following an assessment of the ground impact markings as well as the damage to the aircraft (especially the engine impact damage) it was evident that the aircraft was in a steep nose down attitude when it impacted with an embankment. The teardown inspection of the engine did not reveal any pre or post impact mechanical failure that would have prevented the engine from normal operation.

When considering the intensity of the post impact fire there should have been a substantial amount of fuel onboard the aircraft, it was however, not possible to determine the actual quantity as no documented evidence (i.e., aircraft flight folio) could be obtained to reflect the fuel status of the aircraft prior to take-off.

The position of the respective fuel valves which were located within either of the roof pillars (left and right wing tanks) could not be determined. The position of these fuel valves were regarded as essential in order to ensure that fuel was supplied to the engine via gravity feed the valves where required to be in the open position.

2.3 Environment

According to an official weather report for the day, time and place, the wind was reported to be from the West (260°M) at 2 knots, wh ich accounted for a slight tail wind component once the pilot executed the right-hand turn following the engine stoppage. The wind being very light at the time was not considered to have had any bearing on this accident. Conditions were regarded as favourable for flying with the temperature being 24℃.

2.4 Conclusion

The vertical speed indicator that was recovered on site reflected a rate of descent of 700 feet per minute (11,7 feet or 3,56 meters per second). Considering this value as being a true indication of the rate of descent at the time of impact, had the aircraft been at a height of 200 feet above ground level when the engine stopped it most probably would have impacted with the ground 18 seconds after the turn was executed and 26 seconds if it was at 300 feet above ground level. Even if we work on an average time span of 22 seconds (250 feet) the pilot had very little time available to recover from the attitude the aircraft was at prior to ground impact.

The cause for the engine stoppage could not be determined with certainty. The engine was installed in the aircraft on 13 July 2011 as a new engine, it was believed that the aircraft had not flown more than 100 hours following the engine installation.

The source of fuel uplift could not be determined with accuracy nor the quantity of fuel that was in the aircraft prior to take-off. A 200 litre drum that contained some fuel was found in the hangar as well as a trailer type fuel bowser. Both the containers had filtering devices fitted to them.

The decision to attempt to turn back towards the runway/aerodrome was considered to be an impulsive/hasty decision. Ground impact markings indicated that the aircraft was still in a steep nose down attitude when it collided with an embankment. Performing this type of manoeuvre at a height of 200 to 300 feet above ground level would not be in anyway adequate for a successful recovery in fact it should not be attempted, nor recommended at all.

3. CONCLUSION

3.1 Findings

3.1.1 The pilot was the holder of a valid private pilot licence and had the aircraft type endorsed in his license.

3.1.2 The pilot was also the holder of a valid aviation medical certificate that was issued by a CAA accredited medical examiner.

3.1.5 The aircraft was in possession of a valid Authority to Fly certificate at the time.

3.1.6 The last annual maintenance inspection that was carried out on the aircraft prior to the accident flight was certified on 18 July 2012 at 400,1 airframe hours.

3.1.7 No traceability of the actual airframe hours at the time of the accident could be found due to the absence of the flight folio. The last documented hours were recorded when the last annual inspection was certified.

3.1.8 Phalaborwa aerodrome was an unmanned facility and therefore no air traffic control recordings were available.

3.1.9 It was not possible to determine the actual fuel quantity that was onboard the aircraft prior to the accident flight. Working on an estimated fuel quantity of 20 litres a side it was determined that the aircraft's maximum take-off weight was exceeded by approximately 100 kg on take-off.

3.1.10 According to an official weather report that was obtained the prevailing wind at the time was from the South (260°M) at 2 knots. The pi lot had elected to use runway 19 for take-off.

3.1.11 An eyewitness that was walking towards the South of the aerodrome indicated that the engine stopped shortly after take-off from runway 19 where after he observed it to execute a right turn.

3.1.12 The aircraft was then observed to descend in a steep nose down attitude of between 30° to 45°, it impacted with an embankment while in this attitude, cart wheeled and caught alight.

3.1.13 The choke was found to be partially applied with both carburettor units displaying a similar choke position, which correlated with the choke splitter position.

3.1.14 Both carburettor throttle quadrants indicate that the throttle being in the near close position. This was confirmed by the position of the splitter unit located, which was still attached to both carburettors via their respective cabling.

3.1.15 The engine teardown inspection did not reveal any pre or post impact mechanical failure that would have prevented normal engine operation.

3.1.16 The vertical speed indicator that was recovered on site indicate a rate of descent in order of 700 feet per minute (11,7 feet or 3,56 meter per second).

3.1.17 The prevailing weather conditions at the time was not considered to have had any bearing on the accident.

3.2 Probable cause:

3.2.1 Unsuccessful landing following an engine stoppage after take-off

3.3 Contributory factor/s:

3.3.1 The decision that was taken to execute a right turn back towards the runway/aerodrome, as stated in the pilot operating handbook, following the engine stoppage should be regarded as a significant contributory factor to this accident. This was regarded as an impossible turn taking into consideration the height above ground level when the engine stopped.

3.3.2 The maximum take-off weight of the aircraft was exceeded, which resulted in an increased rate of descent during a critical phase of flight.

4. SAFETY RECOMMENDATIONS

4.1 It is recommended that the SACAA publish a detailed article on their website and in the Safety Link magazine on the dangers associated with executing a turn back to the runway/aerodrome following an engine failure after take-off. This is referred to in aviation as the “Impossible Turn” or “Near Impossible Turn” as the change to execute this turn successfully is extremely remote, and in most cases even fatal. This recommendation was issued in the interest of aviation safety and the preservation of human life.

4.2 It is recommended that the aircraft manufacturer consider revising the emergency procedure Aeroprakt A-22 Flight Manual, Section 3, Emergency procedures pg. 15 below to include the minimum safe altitude to execute a turn back towards the airfield as it is, in many ways, the controlling factor in the successful accomplishment of an emergency landing.

3 If the engine failed during climb, set the aircraft into a steady descent at a speed of 56 mph and if the altitude is sufficient turn the airplane towards the airfield, switch the ignition off, and make a landing.

5. APPENDICES

5.1 Annexure A (Engine teardown observations).

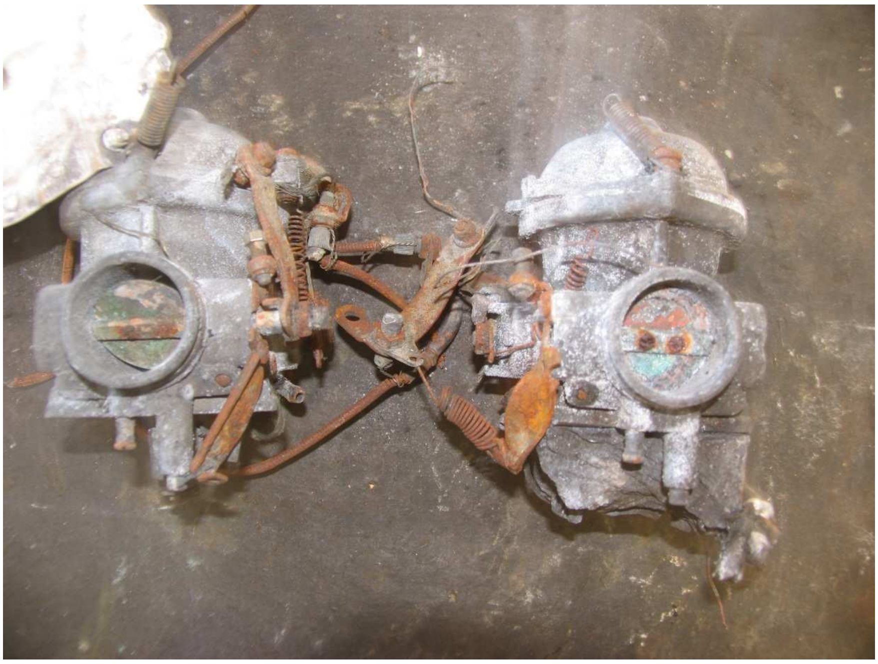
5.2 Annexure B (Engine failure after take-off - single engine).

ANNEXURE A

The engine, a Rotax 912ULS, Serial No. 6778615 was recovered from the accident site as well as the propeller, which had a section of the propeller gearbox attached to it. The engine and propeller assembly was transported to an aircraft maintenance organisation in Gauteng where a teardown inspection was performed. The engine sustained substantial fire damage. The purpose of the teardown inspection was to assess the mechanical integrity of the engine. The following observations were made:

A photo of the engine that was taken on the scene of the accident lying in an inverted attitude.

Engine Model	**Rotax 912ULS**
Serial No.	**6778615**
Spark plugs	The eight (8) spark plugs were removed and found to be in an overall good condition, they displayed a light brownish colour, which was associated with normal engine operation.
HT Leads	The high tension leads sustained fire damage.

Carburettors	The engine was equipped with two carburettors, with one unit located on the left side of the engine and the other one on the right side. Both the units sustained substantial fire damage and were found detached from the engine. The bowl of both units was removed and examined and were found not to contain any fuel. It is believed that the fuel in both the carburettor bowls had vaporized due to the heat that the units that were exposed to by the post impact fire. It was further noted that on both throttle quadrants the indication was that the throttle was in the close position. It was further noted that the choke setting displayed a partial application, with both carburettor units displaying the same choke position.  A photo of the two carburettors that was fitted to the engine.
Electronic ignition	The engine was equipped with an electronic ignition system consisting of two units A and B. The units had sustained substantial fire damage and no further testing was possible. (There was no magneto's fitted to this engine type).
Oil filter	The filter was still attached to the engine. Apart from some scoring it was undamaged. The oil displayed a dark brown colour. No metal particles were observed.

Gear drive train	The gear train sustained no damage and was found to be in a good condition.
Propeller gearbox	The propeller gearbox remained attached to the propeller hub assembly and was removed from the hub during the engine teardown inspection. A section of the outer casing as well as the main drive gear was found to have failed. The unit was opened and the gear train as well as the sprag clutch unit was found to have sustained severe impact damage. The witness marks inside the gearbox housing were consistent with a gearbox not turning at the time of impact.
Cylinders	The cylinders appeared to be in good overall condition and were within dimensional limitations.
Piston & rings	The pistons were in a good condition with very little carbon build-up visible. None of the rings were broken on any of the four pistons.
Main bearings & Big-end bearings.	The damage caused to the engine due to impact damage precluded the investigation of the connecting rods, cam shaft, and crank shaft.
Cylinder head and valve assembly	All four the cylinder heads were removed. All the valves with their associated valve springs were found to be intact and in a good condition. The hydraulic lifters were found to be in an overall good condition.
Oil pump and oil cooler	The oil pump was found undamaged and in a good condition. The oil cooler unit sustained substantial impact damage.
Observation	All the electrical wiring, fuel and oil lines were destroyed by the post impact fire and as such precluded investigation.

Conclusion	The teardown inspection of the engine did not reveal any pre or post impact mechanical failure that would have prevented normal engine operation.

ANNEXURE B

Engine failure after take-off (single engine)

Source: The Federal Aviation Administration (FAA), Pilot Flying Handbook, (Emergency procedures pg. 16-5)

The altitude available is, in many ways, the controlling factor in the successful accomplishment of an emergency landing. If an actual engine failure should occur immediately after take-off and before a safe manoeuvring altitude is attained, it is usually inadvisable to attempt to turn back to the field from where the taker-off was made. Instead, it is safer to immediately establish the proper glide attitude, and select a field directly ahead or slightly too either side of the take-off path.

The decision to continue straight ahead is often difficult to make unless the problems involved in attempting to turn back are seriously considered. In the first place, the take-off was in all probability made into the wind. To get back to the take-off field, a downwind turn must be made. This increases the groundspeed and rushes the pilot even more in the performance of procedures and in planning the landing approach. Secondly, the airplane will be losing considerable altitude during the turn and might still be in a bank when the ground is contacted, resulting in the airplane cartwheeling (which would be a catastrophe for the occupants, as well as the airplane). After turning downwind, the apparent increase in groundspeed could mislead the pilot into attempting to prematurely slow down the airplane and cause it to stall. On the other hand, continuing straight ahead or making a slight turn allows the pilot more time to establish a safe landing attitude, and the landing can be made as slowly as possible, but more importantly, the airplane can be landed while under control.

Concerning the subject of turning back to the runway following an engine failure on take-off, the pilot should determine the minimum altitude an attempt of such a manoeuvre should be made in a particular airplane. Experimentation at a safe altitude should give the pilot an approximation of the height lost in a descending 180° turn at idle power. By adding a safety factor of about 25%, the pilot should arrive at a practical decision height. The ability to make a 180° turn does not necessarily mean that the departure runway can be reached in a power-off glide; this depends on the wind, the distance travelled during the climb, the height reached, and the glide distance of the airplane without power. The pilot should also remember that a turn back to the departure runway may in fact require more than a 180° change in direction.

Consider the following example of an airplane which has taken off and climbed to an altitude of 300 feet AGL when the engine fails. (Figure 16-5 below) After a typical 4 second reaction time, the pilot elects to turn back to the runway. Using a standard rate (3° change in direction per second) turn, it will take 1 minute to turn 180°. At a glide speed of 65 knots, the radius of the turn is 2 100 feet (640 m), so at the completion of the turn, the airplane will be 4 200 feet (1 280 m) to one side of the runway. The pilot must turn another 45° to head the airplane towards the runway. By this time the total change in direction is 225° equating to 75 seconds plus the 4 seconds reaction time. If the airplane in a power off glide descends at approximately 1 000 feet per minute it will have descended 1 316 feet placing it 1 016 feet below the runway surface.

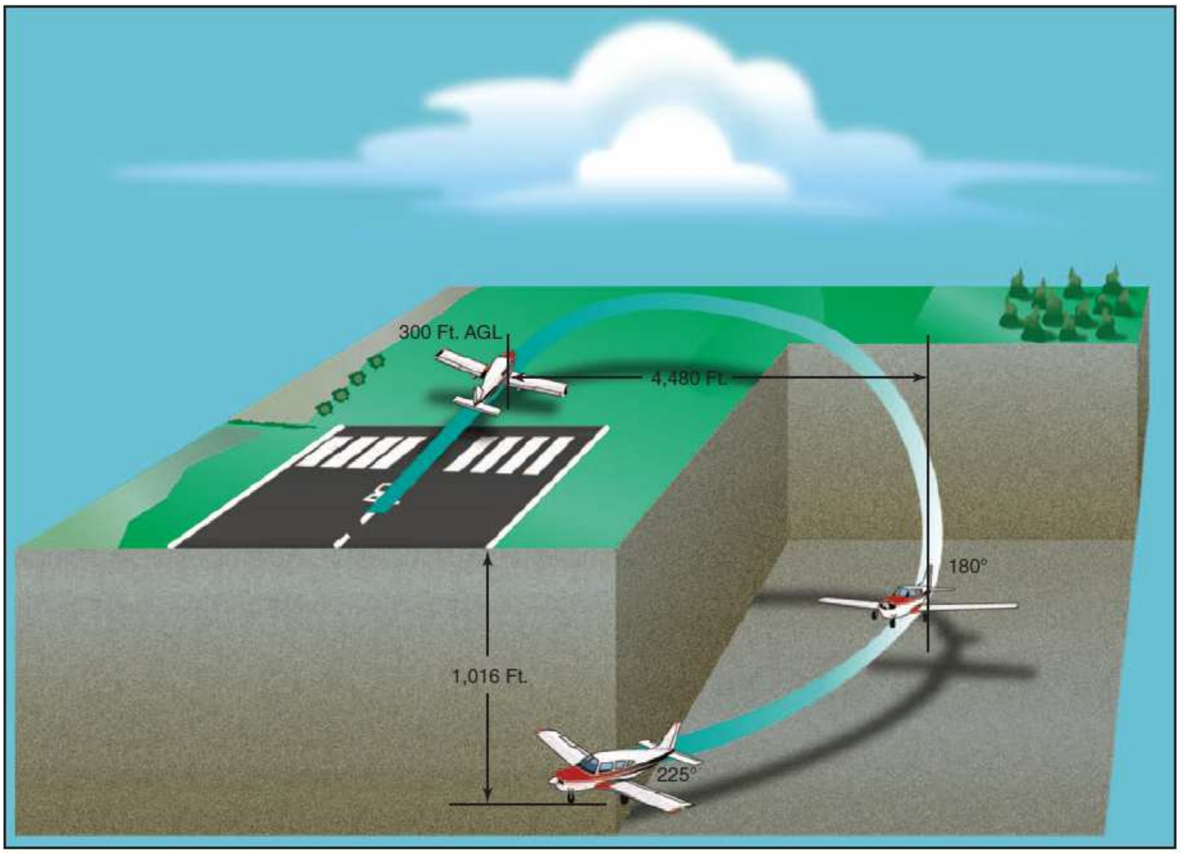


Figure 16-5. Turning back to the runway after engine failure.