SOUTH AFRICAN CIVIL AVIATION AUTHORITY

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

AIRCRAFT ACCIDENT REPORT AND EXECUTIVE SUMMARY

				Reference:	CA18/2/3/9071		
Aircraft Registration	**ZS-EET**	**Date of Accident**	14 August 2012		**Time of Accident**	0821Z	
Type of Aircraft	Cessna 337 (Aeroplane)		**Type of Operation**		Training flight		
Pilot-in-command Licence Type		Airline Transport	**Age**	31	**Licence Valid**	Yes	
Pilot-in-command Flying Experience		Total Flying Hours	9 779.2		Hours on Type	21.4	
Last point of departure	Rand aerodrome (FAGM), (Gauteng province)						
Next point of intended landing	Rand aerodrome (FAGM), (Gauteng province)						
Location of the accident site with reference to easily defined geographical points (GPS readings if possible)							
Alberton area, to the south of the N3 highway (GPS position: South 26°17.090 East 028°08.985)							
Meteorological Information	Surface wind: 350°/15 kt, Temperature: 18°C, Visibi lity: CAVOK						
Number of people on board	2 + 2	**No. of people injured**	0	**No. of people killed**	0		

Synopsis

A flight instructor, who held an Airline Transport Pilot licence, accompanied by another pilot, embarked to conduct her type conversion on the aircraft type, as well as two passengers took-off from Rand aerodrome (FAGM) with the intention to perform upper aerial work prior to returning to FAGM.

After take-off from Runway 29 the pilot flying (PF), selected the landing gear up. The landing gear cycled to the up position and an unfamiliar sound was heard. The crew decided to cycle the landing gear down again shortly thereafter the front mounted engine failed. The pilot flying broadcasted a "Mayday" call on the FAGM tower frequency; indicating that they were unable to maintain altitude on the aft engine and that they were going to perform a forced landing in an open field they had identified from the air.

The flight instructor then took control of the aircraft and landed the aircraft on an open area he had identified with the landing gear in the down position. Approximately 230 m after touchdown the nose landing gear collided with an anthill concealed in the dry grass. The nose and main gear collapsed. The cargo pod that was connected to the lower fuselage was ripped off before the aircraft skidded to a halt on its belly. The aircraft was substantially damaged. Nobody onboard the aircraft was injured.

Probable Cause

Unsuccessful forced landing following an uncontained failure of the front mounted engine in flight, with the aircraft being unable to maintain altitude on the aft mounted engine.

Contributory factor/s:

(i) Aircraft being overweight on take-off.

(ii) Unable to retract the landing gear following the failure of the engine causing additional drag.

IARC Date		Release Date	

AIRCRAFT ACCIDENT REPORT

Name of Owner/Operator : Blow-in Graphics CC
Manufacturer : Cessna Aircraft Company
Model : C337
Nationality : South African
Registration Marks : ZS-EET
Place : Alberton area, to the south of the N3 highway
Date : 14 August 2012
Time : 0821Z

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 A flight instructor, who held an airline transport pilot licence, accompanied by another pilot, embarked to conduct her type conversion onto the aircraft type, as well as two passengers took-off from Rand aerodrome (FAGM) with the intention to conduct upper aerial work and then return to FAGM.

1.1.2 After take-off from runway 29, the pilot flying (PF), selected the landing gear up. Whilst the landing gear was cycling to the up position, the crew heard an unfamiliar sound that was accompanied by white smoke entering the cockpit and felt a vibration on the airframe. The crew decided to select the landing gear down as they suspected that the nose wheel was getting stuck in the wheel well. Shortly

thereafter the engine revolutions per minute (RPM) of the front mounted engine was observed to be between 1200 and 1400 rpm. The decay in engine rpm was accompanied by a vibration. The front mounted engine was then secured. Due to the fact that the hydraulic pump was driven by the front engine they were unable to retract the landing gear.

1.1.3 The aircraft was unable to maintain altitude on the aft mounted engine and the pilot flying broadcasted a "Mayday" call on the FAGM tower frequency 118.70 MHz, advising Air Traffic Control (ATC) that they were unable to maintain altitude and they requested permission to return to FAGM runway 35, which was granted. The aircraft's rate of descent was higher than anticipated and it was not possible to land onto runway 35. At this stage the flight instructor took control of the aircraft and opted to execute a forced landing in an open field he had identified from the air. The open field was located 2,6 nm to the south of FAGM.

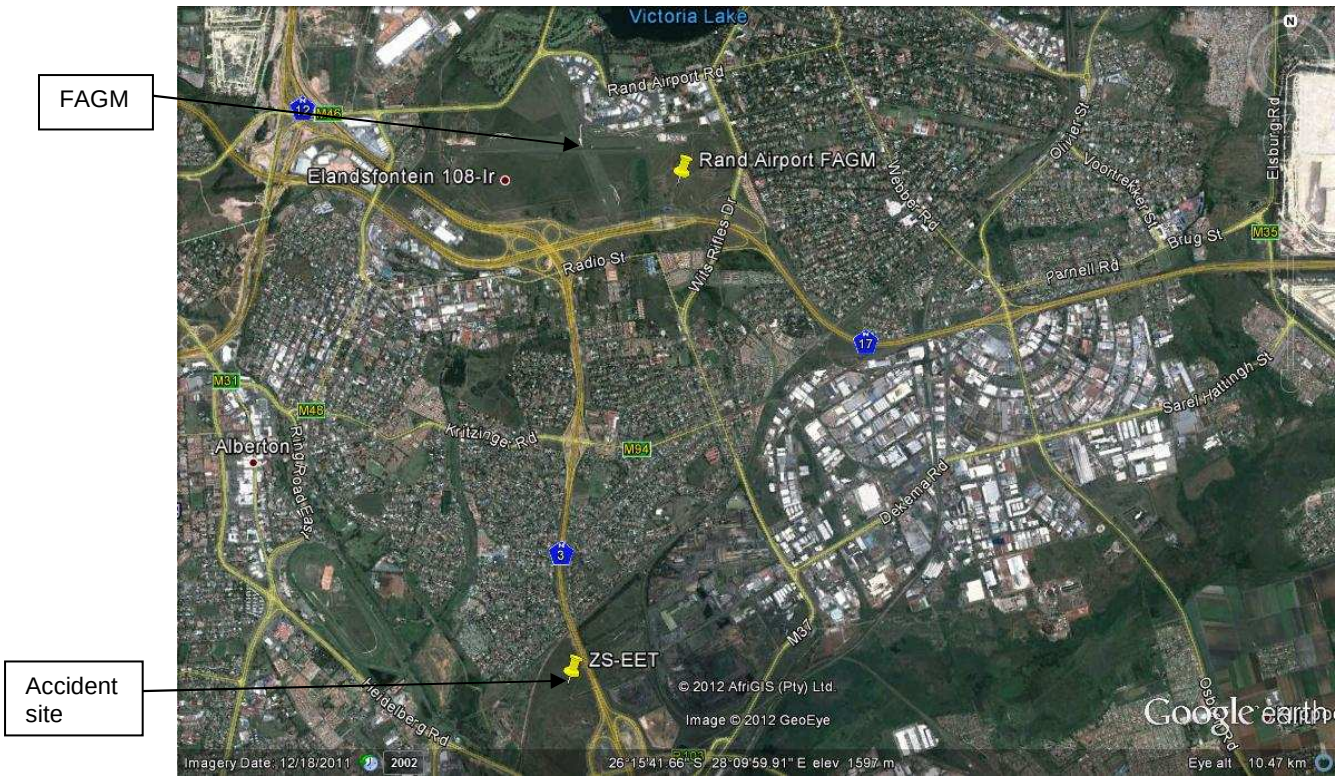


Figure 1. The Google Earth map displays the location of the accident site (ZS-EET) as well as FAGM.

1.1.4 The initial phase of the landing was uneventful, however, approximately 230 m after touchdown the nose gear collided with an ant hill that was concealed in the dry grass. The nose and main landing gear collapsed. The cargo pod that was attached to the lower fuselage was ripped off and the aircraft skidded to a halt on its lower fuselage. The aft mounted engine was still running when the aircraft came to rest and was shut down by the crew.

1.1.5 The aircraft sustained substantial damage after the landing gear collapsed. The four occupants on board the aircraft were not injured.

1.1.6 The accident occurred during daylight conditions at a geographical position that was determined to be South 26°17.090 East 028°08.985.

1.2 Injuries to Persons

Injuries	Pilot	Crew	Pass.	Other
Fatal	-	-	-	-
Serious	-	-	-	-
Minor	-	-	-	-
None	1	1	-	2

1.3 Damage to Aircraft

1.3.1 The aircraft sustained substantial damage following the collapse of the landing gear.

Figure 2. A view of the aircraft as it came to rest on its lower fuselage.

1.4 Other Damage

1.4.1 No other damage was caused.

1.5 Personnel Information

1.5.1 The flight instructor

Nationality	South African	Gender	Male	Age	31
Licence number	0270453509	Licence type	Airline Transport		
Licence valid	Yes	Type endorsed	Yes		
Ratings	Instructor rating grade 1, Instrument rating, Test pilot rating class 2.				
Medical expiry date	30 April 2013				
Restrictions	Must wear corrective lenses				
Previous accidents	None				

Flying Experience:

Total hours	9 779,2
Total past 90-days	218,5
Total on type past 90-days	0,1
Total on type	21,4

1.5.2 Pilot under instruction

Nationality	South African	Gender	Female	Age	33
Licence number	0270486731	Licence type	Airline Transport		
Licence valid	Yes	Type endorsed	No		
Ratings	Instructor rating grade 2, Instrument rating, Test pilot rating class 2.				
Medical expiry date	31 March 2013				
Restrictions	None				
Previous accidents	None				

Flying Experience:

Total hours	3 300,0
Total past 90-days	122,0
Total on type past 90-days	0,1
Total on type	0,1

1.6 Aircraft Information

1.6.1 Aircraft description

The Cessna 337 (Skymaster), is a twin-engine civil utility aircraft, built in a push-pull configuration. The aircraft's engines are mounted in the nose and rear of its pod-style fuselage. Twin booms extend aft of the wings to the vertical stabilizers, with the rear engine between them. The horizontal stabilizer is aft of the pusher propeller, mounted between and connecting the two booms. The combined tractor and pusher engines produce 'centerline' thrust, this design is to overcome conventional twin aircraft problems of poor engine out asymmetric flight handling characteristics.

A photo of a Cessna 337

Airframe

Type	Cessna 337	
Serial number	337-0215	
Manufacturer	Cessna Aircraft Company	
Year of manufacture	1965	
Total airframe hours (At time of accident)	2 861.00	
Last MPI (hours & date)	2 859,50	26 June 2012
Hours since last MPI	1,5	
C of A (Issue date)	1 August 2012	
C of R (Issue date) (Present owner)	8 March 2012	
Operating categories	Standard Part 91 (private)	

*NOTE: The Hobbs meter reading that was entered into the Airframe logbook following the Mandatory Periodic Inspection (MPI) inspection dated 26 June 2012 was 274,5. The Hobbs meter reading was found to be the same during the on-site investigation, indicating that the unit was unserviceable even though the aircraft was released to service on 26 June 2012 following a (MPI).

It was noted that a new airframe and engine logbook for this aircraft was opened on 1 June 2012, and the propeller logbooks were opened on 26 March 2012.

Engine – Front

Type	Continental IO-360-C
Serial number	50189-5-C
Hours since new	Unknown
Hours since overhaul	See note below

Propeller – Front

Type	McCauley D2AF34C59
Serial number	643697
Hours since new	Unknown
Hours since overhaul	1,5

Engine – Aft

Type	Continental IO-360-D
Serial number	55217-5-D
Hours since new	Unknown
Hours since overhaul	See note below

Propeller – Aft

Type	McCauley D2AF34C61
Serial number	*676541
Hours since new	Unknown
Hours since overhaul	1,5

*NOTE: According to available documented information, only 2,0 hours (flying time) could be accounted for since these engines were overhauled and re-installed on this aircraft in 2003. It was indeed possible that the aircraft might have been subjected to additional flights since the engines were overhauled in 2003 and installed back into the aircraft, however no documented evidence could be obtained to prove such flights.

The propeller serial number 676541 tabled in the column on page 7 (previous page) was obtained from the Propeller Logbook (CA21-27). The last CAA MPI Inspection Report (form CA43-02) dated 26 June 2012 reflects the propeller serial number to be 763925, for which no documented evidence could be found, this entry therefore appears to be in error.

Both the propellers that were fitted to the aircraft were subjected to a major overhaul as per the McCauley Manuals 710930. A Federal Aviation Administration (FAA) authorized release certificate was issued for propeller serial No. 643697 on 17 May 2011, and for propeller serial No. 676541 on 25 August 2011. Following fitment of these two propellers on the aircraft new logbooks were opened by the AMO during the MPI inspection on the aircraft and that was certified on 26 June 2012.

1.6.2 Brief history of the aircraft

The aircraft, a Cessna 337, serial No. 337-0215 was imported to South Africa in 1972 and the first Certificate of Registration was issued on 4 December 1972.

From the time it was first registered in South Africa until the time of the accident flight in question, the aircraft had thirteen (13) different owners.

The investigation team was interested in the time frame between 1994 to 2012 (the information contained below was obtained from the CAA aircraft file and aircraft logbooks following the last MPI inspection, 26 June 2012 prior to the accident flight).

On 19 July 1994 an MPI inspection was certified on the aircraft at 2 805,10 airframe hours, according to the Department of Transport maintenance inspection report (form TV2/72) the engines with serial No's. 50189-5-C and 55217-5-D was fitted to the aircraft, these were the same engines that were fitted to the aircraft at the time of the accident in question.

The next MPI inspection that was certified on the aircraft was on 30 January 1996 at 2 819,7 airframe hours. The same engines were still installed on the aircraft. (Reference: Maintenance inspection form TV2/72).

On 22 April 1999 during a routine surveillance inspection by a CAA official at Wonderboom aerodrome the aircraft was inspected and both the front propeller blades were found to be damaged beyond repair. *"Looking at the front propeller, it seems that the aircraft was involved in an incident where the propeller struck the ground."*
An official letter was forwarded to the aircraft owner at the time to provide detailed information to the CAA on the occurrence.

On 10 May 2002 the CAA received an application form from an aircraft maintenance organisation (AMO) for a special flight permit to fly the aircraft from Wonderboom aerodrome to Springs aerodrome. The permit was issued on 27 May 2002. On 3 June 2002 the aircraft was sold to the aircraft maintenance organisation that requested the special flight permit.

According to available information the engines were then removed from the aircraft sometime after it arrived at Springs aerodrome where it was subjected to an engine overhaul inspection by an approved engine overhaul facility at the aerodrome, believed to be the same AMO that had purchased the aircraft.

A certificate relating to maintenance (following an engine overhaul) for the rear mounted engine, serial number 55217-5-D was issued on 14 March 2003. At the

time of the accident in question the maintenance organisation that had performed the engine overhaul inspection had closed down.

A certificate relating to maintenance (following an engine overhaul) for the front mounted engine, serial number 50189-5-C was issued on 10 November 2003. At the time of the accident in question the maintenance organisation that had performed the engine overhaul inspection had closed down.

On 20 July 2009 during a routine surveillance inspection by a CAA official at Springs aerodrome the aircraft was inspected while it was parked in a hangar. The front mounted engine was found to be without a propeller. (Photos of the aircraft as it was found at the time were placed on record - CAA aircraft file).

On 27 July 2009 the CAA received an application from an aircraft maintenance organisation at Lanseria aerodrome for a special flight permit to fly the aircraft from Springs aerodrome to Lanseria aerodrome. The reason why a special flight permit was required was indicated as follows: *"Out of annual inspection".* Such a permit was issued by the CAA on 30 July 2009.

- *"Prior to the flight a serviceable propeller was fitted to the aircraft.*
- *The engine installations were inspected and found satisfactorily after the engines were overhauled.*
- *Extensive ground runs were carried out.*
- *All flight controls were inspected and found satisfactory.*
- *Aircraft to be flown with the gear extended (down and locked)."*

On 4 August 2009 the CAA received an application for registration and/or change of ownership for the aircraft. On 21 September 2009 the CAA issued a new certificate of registration for the aircraft.

According to available information the aircraft stood in a hangar at Lanseria aerodrome for a substantial period without being flown.

On 8 March 2012 the CAA again received an application for a change of ownership for the aircraft. A new certificate of registration for the aircraft was issued on the same day.

Following the purchase of the aircraft by the new owner it was subjected to a

mandatory periodic inspection (MPI) by an AMO based at Lanseria aerodrome.

On 20 June 2012 the CAA received an application (form CA21-08) for the issue of a new Certificate of Airworthiness (C of A).

On 26 June 2012 an MPI inspection was certified on the aircraft at 2 859,50 airframe hours.

According to available information on 20 July 2012, 80 litres of Avgas was uplifted into the aircraft and on 25 July 2012 a further 92 litres (fuel uplift invoices – Lanseria aerodrome).

On 28 June 2012 a CAA official conducted the C of A inspection on the aircraft at the AMO that had submitted the official request and the following discrepancies were noted:

1. *"Compass swing record of compliance could not be obtained.*
2. *System check flight record could not be obtained."*

Following rectification of these two discrepancies and the CAA internal review board outcome the aircraft was issued with a new C of A on 1 August 2012. The following day the CAA issued the aircraft flight manual acceptance certificate as well.

On 30 July 2012 a post maintenance acceptance flight was conducted by an appropriately rated commercial pilot. According to available information (e-mail received from the AMO, as no flight folio entry was made for this flight) the duration of the flight was 1,0 hour. The aircraft was found to be serviceable.

On 6 August 2012 a further 200 litres of Avgas was uplifted at Lanseria aerodrome.

On 10 August 2012 the aircraft was flown from Lanseria aerodrome to Rand aerodrome where the owner took delivery of the aircraft. The duration of the flight was approximately 24 minutes (0,4 of an hour).

1.6.4 Documented evidence (CAA aircraft file) indicated that during the period 30 January 1996 to 26 June 2012 approximately 50 hours were flown with the aircraft over a period of 16½ years. These dates were used as no documented evidence could be obtained that any MPI inspection was carried on this aircraft between these two dates.

It was however, noted that the CAA had issued a special flight permit for the aircraft for a flight from Springs aerodrome to Lanseria aerodrome on 21 September 2009.

1.6.5 In accordance with the Teledyne Continental Service Information Letter (SIL99-1), which was issued on 25 March 1999, and which pertain to the preservation of the engines that were fitted to this aircraft, no documented evidence could be obtained that the engines was preserved at any stage during the periods the aircraft was not in service. The service information letter could be found attached to this report as an annexure.

1.6.6 The aircraft was weighed on 19 June 2012 and the empty weight was calculated to be 2 989 pound (lbs) or 1 356 kilogram (kg).

1.6.7 A detailed weight and balance calculation was conducted by the crew prior to the flight as can be seen from the weight and balance sheet on the next page. According to the pilot's operating handbook (POH), Section 4, Operating Limitations the maximum gross weight for this aircraft type is 4 200 lbs or 1 905 kg. The weight and balance calculation makes provision for a fuel consumption of 5 US gallons for ground manoeuvring, which amounts to 30 lbs (1 US gallon = 6 lbs). If we subtract the 30 lbs from the calculated gross weight of 4 434 lbs = 4 404 lbs, the weight still exceeded the maximum gross weight limit for the aircraft by 204 lbs or 93 kg, which also resulted in a centre of gravity (CG) exceedance. It was further noted that the centre of gravity moment envelope graph used for the calculation on the next page was not the correct graph for this aircraft.

AIRCRAFT LOADING

Item	Quantity	Unit Weight (lbs)	Total Weight (lbs)	Arm (inches)	Moment (lbs-inches/1000)
Aircraft	1	2989	2989	141	422
Oil	0	0	0	42.1	0
Oil	0	0	0	205	0
Fuel	123 (gal)	6	738	150	110.7
Front	1	187	187	102.1	19.1
Front	1	187	187	102.1	19.1
Middle	2	166	332	135.1	44.9
Back	0	0	0	142.9	0
Baggage	0	0	0	170	0
TOTAL			4434	136.8	615
Total - no fuel			*3696*	*136.5*	*505*

FUEL CALCULATIONS

Unusable:		2 (gal)
Ground Manoeuvring:		5 (gal)
Flying:		
To Destination:	00 hours 00 min	0 (gal)
Approach and Landing:	00 hours 00 min	0 (gal)
Contingency (5%):	00 hours 00 min	0 (gal)
Destination to Alternate:	00 hours 00 min	0 (gal)
Reserve:	06 hours 06 min	116 (gal)
TOTAL USABLE:	06 hours 06 min	121 (gal)

Aircraft Data

Hobbs Start ..... End .....

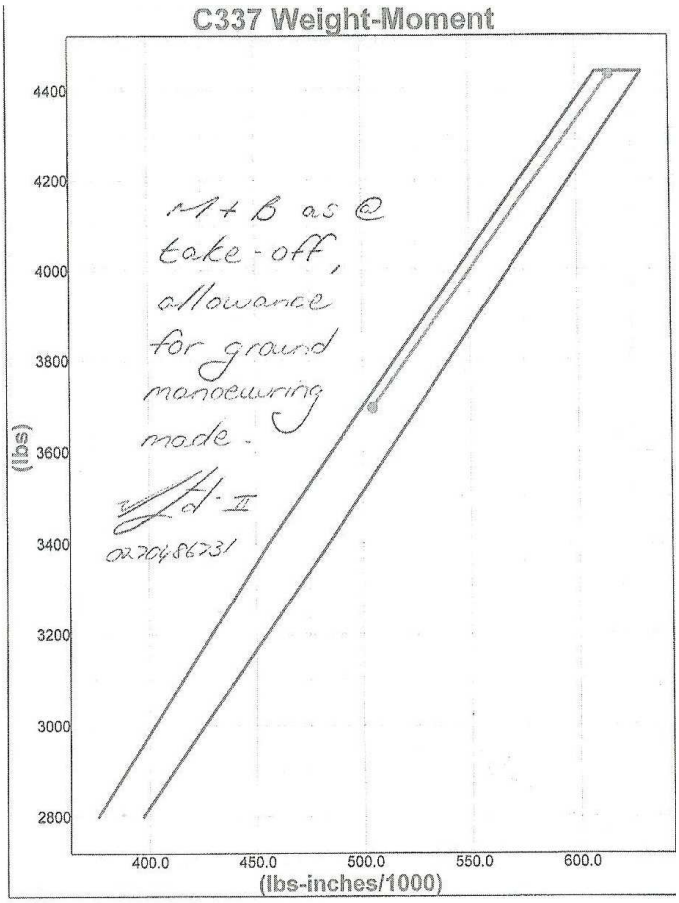
Tach Start ..... End .....

Fuel Left ..... Right .....

Fuel Pumped Litres..... Cost R.....

Oil Litres..... Cost R.....

Other Data .....



1.7 Meteorological Information

1.7.1 The weather information in the column below was obtained from both the pilot's questionnaires.

Wind direction	360°	Wind speed	15kts	Visibility	CAVOK
Temperature	18℃	Cloud cover	None	Cloud base	None
Dew point	unknown				

1.7.2 Prior to take-off from FAGM air traffic control (ATC) indicated the surface wind to be 350° at 12 knots with a pressure altitude (QNH) of 1025 Hecto pascal (hPa).

1.7.3 The calculated density altitude at the time of the flight was approximately 7 500 ft above mean sea level (pressure altitude 5 483 ft and temperature of 18℃).

1.8 Aids to Navigation

1.8.1 The aircraft was equipped with standard navigation equipment which was serviceable at the time of the accident flight.

1.9 Communications

1.9.1 The aerodrome of departure was a licensed facility with a manned control tower. The designated VHF tower frequency for FAGM was 118.70 MHz.

1.9.2 A transcript of the communication between the accident aircraft, ZS-EET and air traffic control (ATC) could be found attached to this report as Annexure A.

1.9.3 One of the crew members broadcast a “Mayday” call on the tower frequency, which ATC acknowledged. The aircraft was cleared to land runway 35, but did not make it back to the runway.

1.9.4 Following the forced landing the pilot contacted ATC at FAGM via his cell phone and informed them of the location of the aircraft.

1.10 Aerodrome Information

1.10.1 The information below was applicable to the aerodrome of departure.

Aerodrome location	Rand aerodrome (FAGM)	
Aerodrome co-ordinates	S 26°14’31.12” E 028°09’04.8 8”	
Aerodrome elevation	5 483 ft	
Runway designations	11/29	17/35
Runway dimensions	1 584 x 15 m	1 208 x 15 m
Runway used	Runway 29	
Runway surface	Asphalt	
Aerodrome status	Licensed	
Approach facilities	Runway lights VOR (Very high frequency Omni-directional radio range) DME (Distance measuring equipment)	

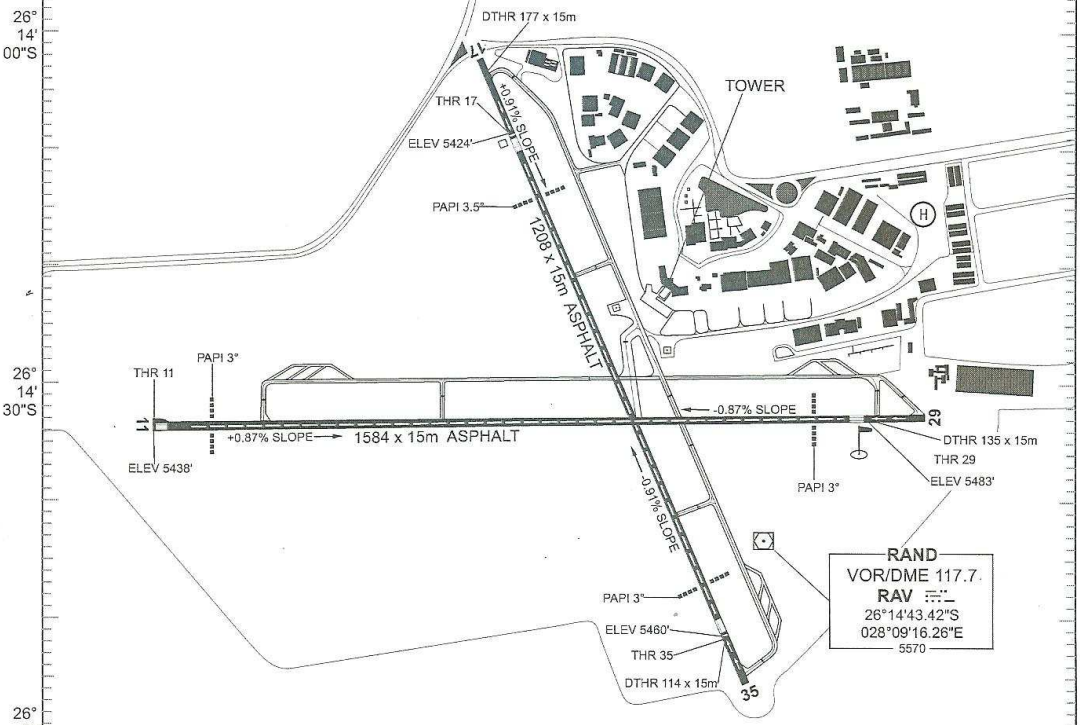
AERODROME CHART 26°14'31.12"S 028°09'04.88"E ELEV 5483'

RADAR APP 134.40 (N)
123.70 (W)
124.50 (S & E)
TWR 118.70

RAND (JOHANNESBURG) FAGM

ELEV, ALT & HGT IN FEET
DIST IN METERS
BRG ARE MAG
VAR 19°W (2009)

NOTE
1. Windshear on approach RWY 35.
2. High tension power lines on approach to RWY 17 marked with red/white spheres.
3. High trees on approach RWY 17.



RWY LIGHTING					
RWY	ALS	PAPI	RTHL	REDL	RENL
11	NIL	3°	GREEN	WHITE	RED
29	NIL	3°	GREEN	WHITE	RED
17	NIL	3.5°	GREEN	WHITE	RED
35	NIL	3°	GREEN	WHITE	RED

OTHER: OBST, TWY & AD BEACON

CHANGE: RWY Slope Angle

PHYSICAL CHARACTERISTICS

RWY	DIRECTION (T)	THR COORDINATES	THR ELEVATION	TORA (m)	TODA (m)	ASDA (m)	LDA (m)	SWY (m)	CWY (m)	SLOPE	SURFACE	BEARING STRENGTH	CIRCUIT
11	089°	26°14'33.59"S 028°08'25.98"E	5438'	1584	1584	1719	1584	135	0	0.009 U	ASPH	LCN 51	R/H
29	269°	26°14'32.85"S 028°09'27.73"E	5483'	1719	1719	1719	1584	0	0	0.009 D	ASPH	LCN 51	L/H
17	157°	26°14'07.33"S 028°08'52.01"E	5424'	1385	1385	1499	1208	114	0	0.009 U	ASPH	LCN 43	R/H
35	337°	26°14'51.92"S 028°09'13.14"E	5460'	1322	1322	1499	1208	177	0	0.009 D	ASPH	LCN 43	L/H

EFF: 03 JUN 10

SOUTH AFRICAN CIVIL AVIATION AUTHORITY

AD-01

1.11 Flight Recorders

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

1.12 Wreckage and Impact Information

1.12.1 The aircraft touched down in an open field with the landing gear in the down position, the initial phase of the landing roll was uneventful.

1.12.2 The landing roll continued for a distance of approximately 230 m when the nose gear collided with an ant hill concealed by the dry grass, this caused the nose and the main landing gear to collapse. Following the collapse of the landing gear, the cargo pod, which was attached to the lower fuselage of the aircraft became detached and separated from the aircraft. The aircraft came to rest approximately 80m from the initial impact point..

1.13 Medical and Pathological Information

1.13.1 Not applicable.

1.14 Fire

1.14.1 There was no pre- or post-impact fire.

1.14.2 The ATC at FAGM requested the Aerodrome Rescue and Fire-fighting (ARFF) personnel to contact their colleagues at the Alberton fire department and to dispatch a fire vehicle to the accident scene. They responded accordingly and remained on standby at the scene until they were released by the aircraft recovery team.

1.15 Survival Aspects

1.15.1 The accident was considered survivable as it was associated with low kinetic forces within the range of human tolerance, with the cabin / cockpit not sustaining any damage.

1.15.2 All four occupants were properly restrained by making use of the aircraft equipped safety harnesses.

1.15.3 Once the aircraft came to a halt it was possible to open the front right door, which was utilized by the occupants to exit the aircraft un-assisted.

1.16 Tests and Research

1.16.1 The failed engine, a Continental IO-360-C, serial No. 50189-5-C was removed from the wreckage and was taken to an approved engine maintenance facility where a teardown inspection was carried out on 21 August 2012 in order to determine the most probable cause for the uncontained engine failure.

1.16.2 The connecting rod on the number two cylinder was found to have penetrated the crankcase as can be seen in figure 4 below.

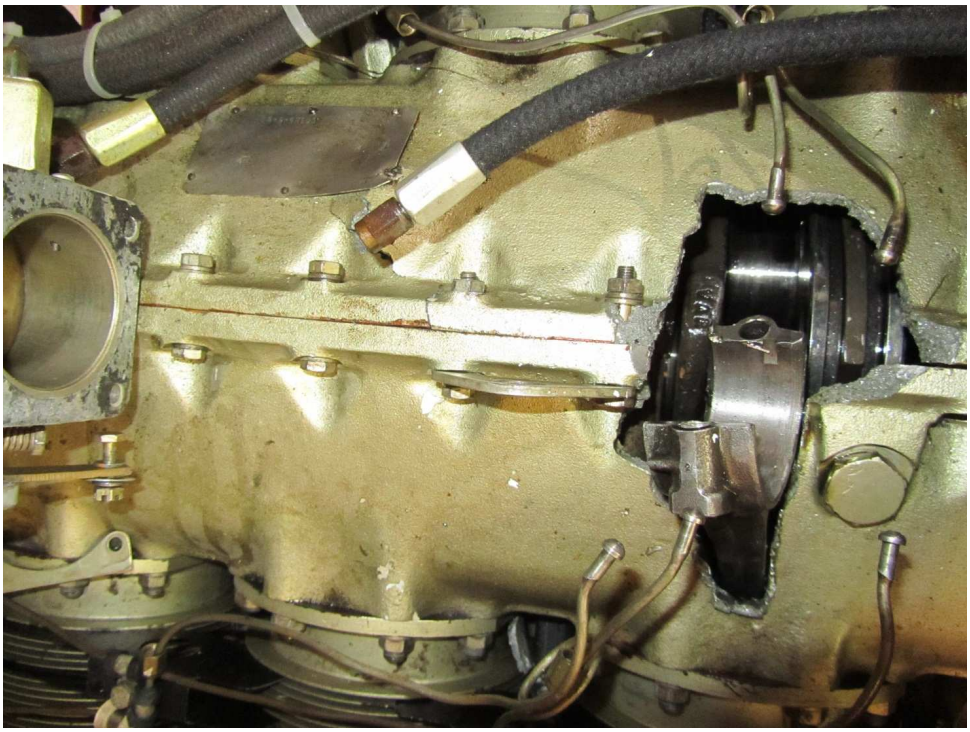


Figure 4. A view of the damage caused when the connecting rod penetrated the crankcase.

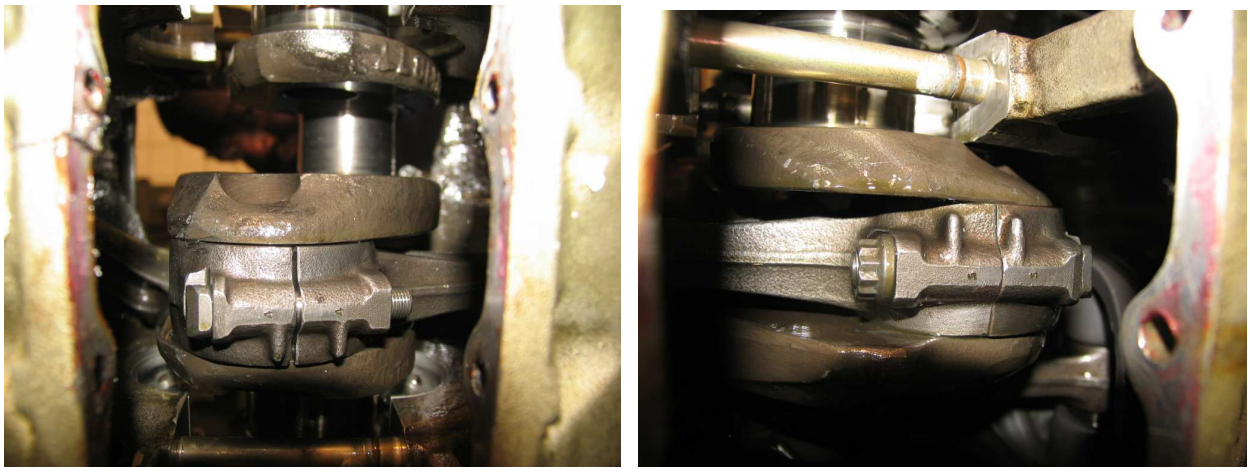
1.16.3 During the removal of the sump, the unit was found to be littered with debris from the engine, which consisted mainly of connecting rod bolts, nuts, bearings and engine casing material.

1.16.4 The connecting rod bolt displayed very little to no thread damage. Several connecting rod nuts were also recovered, they displayed very little to no thread

damage.

Figure 5. The photo shows some of the debris that was recovered from the sump of the engine.

1.16.5 The photos below were taken from the number 4 and 5 connecting rods respectively. One of the nuts securing the No. 4 connecting rod, figure 6(a) was found missing from the bolt, without any thread damage to the bolt what so ever. The photo displayed in figure 6(b) display the presence of a nut, securing the connecting rod bolt on cylinder 5 but it was not properly secured.



(a) **(b)**

Figure 6. The photo on the left (a) was taken of the connecting rod of cylinder No. 4 and (b) of cylinder No. 5.

1.16.6 Conclusion: During the teardown inspection of the engine it was concluded that the connecting rod bolts were not properly secured. The last documented evidence that maintenance was performed on the engine was during an overhaul inspection in 2003.

1.17 Organizational and Management Information

1.17.1 The flight was conducted under the auspices of an aviation training organisation (ATO) that was based at Rand aerodrome. The training facility was in possession of a valid ATO certificate and the flight was accordingly authorised.

1.17.2 The last mandatory periodic inspection that was carried out on the aircraft prior to the accident flight was certified on 26 June 2012 at 2 859,5 airframe hours. According to available records the aircraft maintenance organisation (AMO) was in possession of a valid AMO Approval certificate number 1003, which was issued on 30 March 2012 and expires on 28 February 2013.

1.17.3 The AMO that overhauled both the engines in 2003 (nine years prior to the accident flight) was found to have closed down at the time of the accident flight.

1.18 Additional Information

1.18.1 Teledyne Continental Service Information Letter (SIL99-1)

In 1999 Teledyne Continental aircraft engines issued SIL99-1 that provided guidance and instructions on engine preservation for active and stored aircraft/engines.

The service letter indicates that the best method of reducing the likelihood of corrosive attacks in the engine is to fly the aircraft at least once every week for a minimum of one hour.

SIL99-1 contains very clear guidance for *indefinite storage* (Aircraft that are not flown for 90 days and beyond). The service letter in question is attached to this report for your perusal as Annexure B.

1.19 Useful or Effective Investigation Techniques

1.19.1 None.

2. ANALYSIS

2.1 Flying Crew

The flight instructor was the holder of a valid airline transport pilot's license and held a valid instructor's rating. He held the required rating for the aircraft type and was in possession of a valid aviation medical certificate.

The pilot under instruction was also the holder of a valid airline transport pilot's license. The pilot was in the process of obtaining her conversion onto type, when the accident occurred. She was in possession of a valid aviation medical certificate with no restrictions imposed thereon.

The crew declared a Mayday on the Rand aerodrome tower frequency whereby they requested ATC if they could return to runway 35, which was granted but they were unable to return to the runway and a forced landing followed in an open field approximately 2,6 nm to the south of the aerodrome. The fact that the aircraft was approximately 5% or 204 lbs overweight on take-off had without a doubt had an effect on the performance of the aircraft as the front mounted engine failed shortly after take-off. The aircraft was not able to maintain altitude on the aft mounted engine. Conditions were aggravated by the landing gear that could not be retracted due to the failure of the engine, which caused substantial additional drag.

The flight instructor, who took control of the aircraft, made the decision to execute a forced landing in an open field he had identified from the air as the aircraft was unable to maintain altitude on the aft mounted engine, which was still operating satisfactory at the time. He had no option but to land the aircraft with the landing gear in the down and locked position due to the fact the hydraulic pump that was essential to cycle the landing gear was positioned on the problematic engine (front mounted engine), and with the failure of the engine no hydraulic pressure was available in the system to cycle the landing gear.

If there were no concealed ant hills located on the terrain they landed on the landing gear most probably would not have collapsed, which would have rendered this occurrence a serious incident.

2.2 The Aircraft

Following the overhaul of the engines and subsequent re-installation thereof into the aircraft in 2003, the aircraft was subjected to periods where it was standing for long periods without being flown. No documented evidence could be found to reflect that the engines were subjected to any form of preservation during these periods as stipulated in the Teledyne Continental Service Letter SIL99-1, dated 25 March 1999.

It was further noted that according to available information the aircraft had accumulated approximately 50 flying hours over a period of 16½ years. The investigating team attempted to try and establish how much of these hours were flown with the aircraft since the engine overhauls were performed in 2003. It was established that the aircraft was flown from Springs aerodrome to Lanseria aerodrome in September 2009, the duration of the flight was approximately 30 minutes (0,5 of an hour). A change of ownership took place in March 2012 and the new owner had the aircraft subjected to an MPI inspection, and a new Certificate of Airworthiness (C of A) inspection was conducted on 28 June 2012 by a CAA official. During the inspection two minor findings were noted, which were rectified and on 1 August 2012 the CAA had issued the aircraft with a new C of A. It would not appear that any consideration was given to the history of the aircraft as part of the C of A review procedure.

Following the maintenance inspection in June 2012 the aircraft was subjected to a post maintenance acceptance flight, the duration of the flight was 1,0 hour. On 12 August 2012 the aircraft was flown from FALA to FAGM, a flight of approximately 24 minutes (0,4 of an hour). The accident flight was approximately 5 to 6 minutes, which brings the total flight time which could be accounted for to 2,0 hours, of which 1,5 hours were post the last MPI inspection. It was indeed possible that the aircraft might have been subjected to additional flights since the engines were overhauled in 2003 and installed back into the aircraft, however no documented evidence could be obtained to prove such flights.

The engine teardown inspection revealed that most of the connecting rod bolts were not properly tightened/torque during the engine overhaul procedure. Even though most of the parts were substantially damaged some of the connecting rod bolts displayed very little to no thread damage. Some of the bolts from some of the other connecting rods in the engine were found loose to such an extent that they could be turned by hand. The connecting rod on the number two cylinder would appear to be the first to have failed within the engine operational sequence, which resulted in an uncontained failure (penetration of the engine casing) resulting in engine stoppage.

The aft mounted engine was operating satisfactory according to the crew but the aircraft was unable to maintain altitude on the engine and the pilot-in-command opted to perform a forced landing in an open field identified from the air.

3. CONCLUSION

3.1 Findings

3.1.1 The pilot-in-command (flight instructor) was properly certified and qualified according to current regulations to perform the flight.

3.1.2 The pilot flying had broadcast a Mayday call on the Rand aerodrome tower frequency 118.70 MHz, where the pilot requested to return to runway 35, which was granted. However they were unable to return to the runway.

3.1.3 The aircraft was in possession of a valid Certificate of Airworthiness at the time of the accident flight following a MPI inspection that was signed off in the logbooks on 26 June 2012, which was followed by a C of A inspection on the aircraft on 28 June 2012 by an official from the CAA.

3.1.4 The maximum gross weight of the aircraft was exceeded by approximately 5% or 204 lbs / 93 kg on take-off.

3.1.5 The density altitude on take-off was calculated to be approximately 7 500 ft AMSL.

3.1.6 The two engines were overhauled in 2003 and were then re-installed back onto the aircraft.

3.1.7 One of the connecting rods was found to have penetrated the crankcase during engine operation (in-flight), resulting in an engine stoppage.

3.1.8 The landing gear could not be retracted following the failure of the front mounted engine.

3.1.9 Several of the connecting rod bolts that were found in the sump of the engine displayed limited to no thread damage. Figure 6(a) on page 17 of the report display a connecting rod still in position but without a bolt to secure it.

3.1.10 During the teardown inspection it was found that the connecting rod bolts were not properly tightened/torque. No documented evidence could be obtained to indicate that any maintenance was performed on the engines apart from the overhaul inspection dating back to 2003.

3.1.11 The aircraft was standing for an extended period of time without being flown. No documented evidence could be obtained that the engines were subjected to any preservation treatment in accordance with Teledyne Continental Service Letter SIL99-1 (engine preservation for indefinite storage exceeding 90-days).

3.1.12 According to available documented evidence a period of 16½ years had passed between the last traceable MPI inspection that was certified on the aircraft, dated 31 January 1996 and the MPI inspection prior to the accident flight, dated 26 June 2012. During this period the aircraft had flown approximately 50 hours. A detailed breakdown of the flying hours could not be obtained.

3.2 Probable cause/s

3.2.1 Unsuccessful forced landing following an uncontained failure of the front mounted engine in flight, with the aircraft being unable to maintain altitude on the aft mounted engine due to an overweight take-off.

3.3 Contributory factor/s:

3.3.1 Poor maintenance practices (connecting rod bolts were not properly tightened / torque during the engine overhaul procedure, which resulted in the connecting rod coming loose during engine operation and as a result penetrated the engine crankcase).

3.3.2 Aircraft being overweight on take-off by approximately 5% or 204 lbs.

3.3.3 The fact that the landing gear could not be retracted following the failure of the front mounted engine resulted in a substantial amount of additional drag on the aircraft.

3.3.4 No documented evidence could be obtained to reflect that the engines were subjected to a preservation procedure at any stage during the period 2003 (engine overhaul period) until the MPI that was certified on the aircraft dated 26 June 2012.

4. SAFETY RECOMMENDATIONS

4.1 It is recommended to the Director for Civil Aviation that the Airworthiness division revise the inspection checklist used for the issue or reissue of a C of A for small aircraft below 5 700 kg (form CA 21-20).

The checklist does not make provision for the inspector or the inspectorate team to conduct a study on the history of the aircraft prior to the inspection/assessment. The content of the form was found to be lacking detail and was found to be generic in nature.

The fact that the aircraft was standing for several years and the time frame between MPI inspections and the lack of documented evidence that proper preservation measures were implemented on the engines raise a serious concern for aviation safety.

4.2 It is recommended to the Director of Civil Aviation that the regulating authority issue clear guidance material / procedures with reference to aircraft that are not being flown on a regular basis, 90-days and more. This should be to ensure the appropriate engine preservation procedures are being followed as prescribed by various engine manufacturers to ensure aviation safety and operational conformation is not compromised in any manner.

5. APPENDICES

5.1. Annexure A. (Transcript of communication between the aircraft and ATC at FAGM).

5.2 Annexure B. (Teledyne Continental Service Information Letter SIL99-1)

ANNEXURE A

Below a transcript of communication between the accident aircraft ZS-EET and air traffic control (ATC) at Rand aerodrome on the VHF frequency 118.70 MHz.

Note1: Only radio transmission to and from the accident aircraft were transcribed.

Note 2: * indicates an unintelligible word.

Time	Station transmitting	
08:05:05	ZS-EET	Rand tower good day to you Echo Echo Tango.
08:05:09	ATC	Echo Echo Tango, Rand good day go ahead.
08:05:12	ZS-EET	Good day, three correction four on-board, requesting instructions for flight to the GF * returning Echo Echo Tango, Cessna 337.
08:05:23	ATC	Echo Echo Tango, QNH 1025 taxi holding point runway three five (35) cross runway two nine (29).
08:05:30	ZS-EET	Eh request your surface wind please?
08:05:35	ATC	Echo Echo Tango say again?
08:05:37	ZS-EET	Your surface wind?
08:05:41	ATC	Echo Echo Tango surface wind three five zero degree six knots.
08:05:50	ZS-EET	Request runway two niner, with taxi holding point two niner if possible, Echo Echo Tango.
08:05:52	ATC	Echo Echo Tango taxi holding point runway two niner.
08:05:54	ZS-EET	Taxi holding point runway two niner Echo Echo Tango.
08:15:25	ZS-EET	Echo Echo Tango ready turn up.
08:15:32	ATC	Echo Echo Tango runway turn line up and wait.
08:18:12	ZS-EET	Two nine, line up and wait, Echo Echo Tango.
		Echo Echo Tango runway two niner.
08:18:37	ZS-EET	Just say * you only cleared the flight half the instruction.
08:18:44	ATC	Echo Echo Tango correction to my last, runway two niner cleared take off surface wind three five zero, one two knots. Report outbound at six thousand three hundred feet.
08:18:53	ZS-EET	Cleared take off left turn out next, Echo Echo Tango.
08:20:52	ZS-EET	Mayday mayday mayday Echo Echo Tango engine failure five thousand five hundred feet request return for runway three five.
08:21:06	ATC	Echo Echo Tango copied mayday report on approach runway three five, number one.
08:21:09	ZS-EET	Report final approach runway three five number one, Echo Echo Tango.
08:21:12	ZS-EET	Echo Echo Tango force landing at the ah at the * for ah of new market race course Echo Echo Tango.
08:21:18	ATC	Echo Echo Tango copied.

There was no further radio communication with the aircraft.

TELEDYNE CONTINENTAL ® AIRCRAFT ENGINE

SERVICE INFORMATION LETTER

CATEGORY 5

SIL99-1

Technical Portions FAA Approved
Supercedes M91-5

CONTAINS USEFUL INFORMATION PERTAINING TO THE CONTINENTAL AIRCRAFT ENGINE

SUBJECT: ENGINE PRESERVATION FOR ACTIVE AND STORED AIRCRAFT

PURPOSE: Provide current engine preservation information

COMPLIANCE: During periods as specified by this document

MODELS AFFECTED: All Continental Engine Models

GENERAL

There is no practical procedure that will insure corrosion prevention on installed aircraft engines. Susceptibility to corrosion is influenced by geographical location, season and usage. The owner/operator is responsible to recognize the conditions that are conducive to corrosion and take appropriate precautions.

ENGINE PRESERVATION

Corrosive attack can occur in engines that are flown only occasionally regardless of geographical location. In coastal areas and areas of high humidity, corrosive attack can occur in as little as two days. The best method of reducing the likelihood of corrosive attack is to fly the aircraft at least once every week for a minimum of one hour.

NOTE...
Corrosive attack may reduce engine service life. Of primary concern are cylinders, piston rings, valves, valve guides, camshaft and lifters.

TEMPORARY STORAGE (Aircraft that are not flown for 30 to 90 days)

Preparation for storage.

1. Remove oil sump drain plug and drain oil. Replace drain plug, torque and safety. Remove oil filter. Install new oil filter, torque and safety. Service engine to proper sump capacity with oil conforming to MIL-C-6529 Type II.
2. Perform a ground run-up. Perform a pre-flight inspection and correct any discrepancies. Fly the aircraft for one hour at normal operation temperatures.

WARNING

To prevent possibility of serious bodily injury or death, before moving the propeller accomplish the following:

a. **Disconnect all spark plug leads.**
b. **Verify magneto switches are connected to magnetos, that they are in the "OFF" Position and "P" leads are grounded.**
c. **Throttle position "CLOSED."**
d. **Mixture control "IDLE-CUT-OFF."**
e. **Set brakes and block aircraft wheels. Insure that aircraft tie-downs are installed and verify that the cabin door latch is open.**
f. **Do not stand within the arc of the propeller blades while turning the propeller.**

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3. After flight remove all spark plug leads and remove the top spark plugs. Protect the ignition lead ends with AN-4060 Protectors. Using a common garden sprayer or equivalent, spray atomized preservative oil that meets MIL-P - 46002, Grade 1, at room temperature through upper spark plug hole of each cylinder with the piston at bottom dead center position. Rotate crankshaft as opposite cylinders are sprayed. Stop crankshaft with none of the pistons at top dead center.
4. Re-spray each cylinder. To thoroughly cover all surfaces of the cylinder interior move the nozzle or spray gun from the top to the bottom of the cylinder.
5. Install top spark plugs but do not install spark plug leads.
6. Seal all engine openings exposed to the atmosphere using suitable plugs and covers. Attach a red "REMOVE BEFORE FLIGHT" streamer at each location.
7. Tag each propeller in a conspicuous place with the following notation on the tag: DO NOT TURN PROPELLER - ENGINE PRESERVED - PRESERVATION DATE _____

NOTE...
If the engine is not returned to flyable status on or before the 90-day expiration, it must be preserved in accordance with "Indefinite Storage" procedures in this document.

INDEFINITE STORAGE **(Aircraft that are not flown for 90 days)**

PREPARATION FOR STORAGE

1. Remove oil sump drain plug and drain oil. Replace drain plug, torque and safety. Remove oil filter Install new oil filter torque and safety. Service engine to proper sump capacity with oil conforming to MIL-C-6529 Type II.
2. Perform a ground run-up. Perform a pre-flight inspection and correct any discrepancies. Fly the aircraft for one hour at normal operation temperatures.

WARNING

To prevent possibility of serious bodily injury or death, before moving the propeller accomplish the following:

a. **Disconnect all spark plug leads.**
b. **Verify magneto switches are connected to magnetos, that they are in the "OFF" Position and "P" leads are grounded.**
c. **Throttle position "CLOSED."**
d. **Mixture control "IDLE-CUT-OFF."**
e. **Set brakes and block aircraft wheels. Insure that aircraft tie-downs are installed and verify that the cabin door latch is open.**
f. **Do not stand within the arc of the propeller blades while turning the propeller.**

3. After flight remove all spark plug leads and remove the spark plugs. Protect the ignition lead ends with AN-4060 Protectors. Install protective plugs P/N 22671 in bottom spark plug holes. Using a common garden sprayer or equivalent, spray atomized preservative oil that meets MIL-P-46002, Grade 1, at room temperature through upper spark plug hole of each cylinder with the piston at bottom dead center position. Rotate crankshaft as opposite cylinders are sprayed. Stop crankshaft with none of the pistons at top dead center.
4. Re-spray each cylinder. To thoroughly cover all surfaces of the cylinder interior move the nozzle or spray gun from the top to the bottom of the cylinder.
5. Install dehydrator plugs MS27215-1 or -2 in each of the upper spark plug holes. Make sure each plug is blue in color when installed.

6. Attach a red "REMOVE BEFORE FLIGHT" streamer to each bag of desiccant. Place a bag of desiccant in the exhaust pipes and seal the openings.
7. Seal all engine openings exposed to the atmosphere using suitable plugs and covers.
8. Tag propeller in a conspicuous place with the following notation on the tag: DO NOT TURN PROPELLER - ENGINE PRESERVED - PRESERVATION DATE _____.

INDEFINITE STORAGE INSPECTION PROCEDURES

1. Aircraft prepared for indefinite storage must have the cylinder dehydrator plugs visually inspected every 15 days. The plugs must be changed as soon as they indicate other than a dark blue color. If the dehydrator plugs have changed color in one-half or more of the cylinders, all desiccant material on the engine must be replaced.
2. The cylinder bores of all engines prepared for indefinite storage must be re-sprayed with corrosion preventive mixture every 90 days.

RETURNING AN ENGINE TO SERVICE AFTER STORAGE

1. Remove seals and all desiccant bags.
2. Remove cylinder dehydrators and plugs or spark plugs from upper and lower spark plug holes.
3. Remove oil sump drain plug and drain the corrosion preventive mixture. Replace drain plug, torque and safety. Remove oil filter. Install new oil filter torque and safety. Service the engine with oil in accordance with the manufacturer's instructions.

WARNING

To prevent possibility of serious bodily injury or death, before moving the propeller accomplish the following:

a. **Disconnect all spark plug leads.**
b. **Verify magneto switches are connected to magnetos, that they are in the "OFF" Position and "P" leads are grounded.**
c. **Throttle position "CLOSED."**
d. **Mixture control "IDLE-CUT-OFF."**
e. **Set brakes and block aircraft wheels. Insure that aircraft tie-downs are installed and verify that the cabin door latch is open.**
f. **Do not stand within the arc of the propeller blades while turning the propeller.**

4. Rotate propeller by hand several revolutions to remove preservative oil.
5. Service and install spark plugs and ignition leads in accordance with the manufacturer's instructions.
6. Service engine and aircraft in accordance with the manufacturer's instructions.
7. Thoroughly clean the aircraft and engine. Perform visual inspection.
8. Correct any discrepancies.
9. Conduct a normal engine start.
10. Perform operational test in accordance with "Operational Inspection," of the applicable Maintenance Manual.
11. Correct any discrepancies.
12. Perform a test flight in accordance with airframe manufacturer's instructions.
13. Correct any discrepancies prior to returning aircraft to service.
14. Change oil and filter after 25 hours of operation.

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