SOUTH AFRICAN CIVIL AVIATION AUTHORITY

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

AIRCRAFT ACCIDENT REPORT AND EXECUTIVE SUMMARY

				Reference:	CA18/2/3/9235
Aircraft Registration	**ZU-FLE**	**Date of Accident**	24 October 2013	**Time of Accident**	1002Z
Type of Aircraft	YAK-18T (Fixed Wing)		**Type of Operation**	Private	
Pilot-in-command Licence Type	Private Pilot	**Age**	40	**Licence Valid**	Yes
Pilot-in-command Flying Experience	Total Flying Hours	2980.0		Hours on Type	63.35
Last point of departure	Stellenbosch Aerodrome (FASH) in Western Cape Province				
Next point of intended landing	Stanford in Western Cape Province				
Location of the accident site with reference to easily defined geographical points (GPS readings if possible)					
On Ingiwi Farm, 100 m outside the boundary of Stellenbosch Aerodrome (FASH) in Western Cape Province					
Meteorological Information	Wind direction:210˚, Wind Speed: 11 knots, Temperature: 25˚C, Visibility: CAVOK.				
Number of people on board	1 + 0	**No. of people injured**	0	**No. of people killed**	1

Synopsis

The owner/pilot reported to Stellair CC the issue of an engine overheating defect with his aircraft. Apparently the overheating started after he found a loose magneto on the engine and refitted it. The refitting of the loose magneto had an effect on the engine timing causing overheating. To rectify the defect, he took the aircraft in for unscheduled maintenance inspection to Stellair CC. Engine maintenance was carried out adjusting the magnetos (L/H and R/H), timing and carburettor settings. After the maintenance was performed a ground run test was carried out to ascertain that the engine performance was within limits as required by applicable technical standards. The pilot then flew the aircraft with the intention to carry out a test flight.

The technical information of the investigation indicate that improper maintenance practice was followed. The improper maintenance was related to the combination of installation and adjustments to the magneto's, timming and carburettor fuel metering settings. Consequently the aircraft experienced technical problem which had an impact on the engine performance. As a result it eventually caused the engine to fail during take-off.

Probable Cause

The pilot experienced engine failure due to improper engine maintenance when installing and adjusting the magnetos, timing and carburettor fuel metering settings.

SRP Date	08 October 2016	Release Date	

AIRCRAFT ACCIDENT REPORT

Name of Owner/ Operator	: Conrad M
Manufacturer	: Yakovlev
Model	: Yak-18T
Nationality	: South African
Registration Marks	: ZU-FLE
Place	: Ingiwi Farm near Stellenbosch in Western Cape
Date	: 24 October 2013
Time	: 1202Z

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 (2011) this report was compiled in the interest of the promotion of aviation safety and the reduction of the risk of aviation accidents or incidents and **not to establish legal liability**.*

Disclaimer:

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

FACTUAL INFORMATION

1.1 History of Flight

1.1.1 The pilot was the sole occupant of the Yakovlev YAK-18T type of aircraft when he departed from Clanwilliam in the Olifants River Valley to Stellenbosch which are both located in the Western Cape Province. The estimated time of departure (ETD) from the private airstrip on Enjo farm was about 0445Z and estimated time of arrival (ETA) at Stellenbosch Airfield was about 0600Z (duration of 1 hour 15 minutes).

1.1.2 According to his wife, she was aware of the fact that the pilot was going to fly the aircraft on the day in question to Stellenbosch, with the intention of rectifying an engine problem. After rectifying the engine problem, he was going to return to the farm the same day. The wife received a call from the pilot prior to taking off from Stellenbosch, wherein he told her that the engine problem had been rectified and he was about to carry out a flight test. He told her to expect a call from him in ±30 minutes time, which would mean that the engine problem was still not resolved. Otherwise she had to prepare to collect him at the landing strip on the farm in Clanwilliam. The wife drove out to the landing strip to wait for the aircraft as the pilot had requested her to. When she realised that the ETA had come and gone, with no sign of the aircraft arriving, she immediately started to make enquiries at Stellenbosch and was told of the accident.

1.1.3 The subsequent investigation determined that the aircraft was taken to the maintenance organisation – Stellair CC (AMO 182) at Stellenbosch. The evidence was that the pilot made a call to AMO 182 about two days before coming to Stellenbosch. The pilot asked if he could bring his YAK-18T aircraft to them for an inspection. He was concerned about the left hand side magneto being loose, which might have affected the performance of the aircraft. The aircraft was overheating. Stellair management agreed that he should bring the aircraft to them.

1.1.4 On the morning of 24 October 2013, as indicated above, the pilot flew the aircraft to Stellenbosch. After an uneventful flight and landing at Stellenbosch Airfield, the aircraft was parked at AMO 182 facility for the requested unscheduled maintenance to be carried out. At about 1100Z, the aircraft was run-up to functionally check the operation of the engine and aircraft systems. At about 1130Z, all maintenance activities were finished.

1.1.5 According to an employee from AMO 182, an AME worked on the aircraft. He stated that he saw the aircraft taking off. It was climbing at about 20 to 30 feet AGL and with its landing gear retracted. From where the AME was standing, his observation was that the engine sounded normal. He did not notice any anomalies. He was looking at the aircraft, seeing how it entered a shallow climb and made a steep turn to the right. The attitude of the aircraft was as such that its wings were vertical to the horizon in the turn. It looked as though the aircraft was turning back to the runway. During the turn the nose was pointing to the ground. The aircraft then disappeared on the horizon with its top side “roof” clearly visible. He heard a loud bang and everyone from AMO 182 rushed to the scene.

1.1.6 A second witness stated that at about 1126Z, he was traveling on Annandale Road towards the R44 Road en route to Stellenbosch Airfield. He was a few hundred meters past the Zetler strawberry farm depot and noticed on his left above the strawberry field aircraft banking very fast to the right at a very low altitude. His observation was that the aircraft was flying too slowly to enter into such a sharp right turn manoeuvre. The turn was acute and he could clearly see the underside “belly” and bottom skin of both wings of the aircraft. The aircraft then descended in a vertical bank attitude from the sky heading toward the ground and it disappeared in the strawberry field.

1.1.7 A third witness stated that he was at De Zaltse Estate playing golf. His observation was that there was quite a bit of activity on the airstrip with planes flying circuits. He was on the green next to the airstrip and listening to all the aircraft taking off and landing. He then became aware of the aeroplane that started its take-off run. The aeroplane in question was making more noise than all the other aeroplanes. He looked in the direction of the noise and saw that it was a low- wing aeroplane, but was not sure of the type. He saw that the aeroplane was on the runway taking off. The aircraft was in the take-off run for the first 200 m on the runway. He then turned to the other golfers and commented on the aeroplane’s noise issue. He told them that the engine was running rough. He made this observation based on the fact that other aeroplanes taking off were running much more smoothly.

While he was still speaking to the golfers he could hear the affected aeroplane becoming airborne as indicated by the change in its engine noise. About a minute or so later they heard the engine “stuttering” and “cutting out” for 3 seconds, but it started running again. A second later the engine was cutting out again. He was not sure whether after this second cut out the engine started running again; however, he told the golfers that the aeroplane was in serious trouble. A couple of seconds later they heard a loud bang and five minutes later saw the cloud of smoke coming from the southern side of the airstrip. See below a picture of Google Map created to show what the witnesses have stated.

Figure 1 shows path aircraft flew when involved in the accident

1.1.8 The aircraft was involved in an accident about 110 m from Stellenbosch boundary fence inside the neighbouring strawberry farm. A fire erupted after the aircraft hit the ground. The pilot was trapped inside the aircraft when the fire erupted and he was burnt. The aircraft was destroyed.

1.2 Injuries to Persons

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

1.2.1 The pilot was a foreign national to South Africa. As per his identification documentations, his place of birth was the United States of America (USA) and nationality was Germany.

1.3 Damage to Aircraft

1.3.1 The aircraft was destroyed in the accident. See below a picture of the aircraft wreckage as it was found immediately after the accident.

Figure 2 shows damage sustained by the aircraft

1.4 Other Damage

1.4.1 Other damage was caused to the strawberry plant patch (row tunnels) and horticultural fleece covering. .

Figure 3 shows other damage caused to the horticultural fleece

1.5 Personnel Information

Nationality	German	Gender	Male	Age	40
Licence Number	0271071706	Licence Type	Private Pilot		
Licence valid	Yes	Type Endorsed	Yes		
Ratings	Flight Tests – Single Engine Piston				
Medical Issue/Expiry Date	10 October 2013	31 October 2014			
Restrictions	None				
Previous Accidents	None				

1.5.1 Information was obtained from different sources during the investigation. These include the PPL revalidation application of the pilot and the aircraft flight folio used to calculate his flying experience. The result of the calculation is shown below:

Flying Experience:

Grand Total Hours (Daul – BAe 146)	2980.00
Grand Total Hours (Daul PPL – Jabiru, C150, PA28 & YAK)	239.00
Grand Total Hours (PPL PIC – Jabiru, C150, PA28 & YAK)	645.46
Total Hours last 90 days	21.30
Total on Type	63.35

1.5.2 According to information on the pilot file at the CAA, he was in possession of a foreign pilot licence. The licence was issued in Germany. He had the BAe 146 aircraft type rating endorsed on the licence. His experience on the type was a total of 3647.0 flying hours. In relation to his foreign licence, he was an airline pilot in one of the German air transportation carriers. There were no anomalies identified with his foreign licence or experience.

1.5.3 The pilot also held a South African Private Pilot Licence (PPL). The licence was issued on 3 May 2005. He had the Cessna 150, Jabiru and Piper PA-28 series aircraft type ratings endorsed on it. He complied with all aviation licencing regulatory requirements. His PPL was revalidated by the CAA regularly without any problems.

1.5.4 Based on records which he submitted to the CAA, which are copies of his experience logbook, he travelled to Hungary during October 2010. In Hungary at Györszentiván, Böny (LHBY) airport on 29 October 2010 he went through what is called *"student pilot, transition training and check flights"* on the YAK18T type. When he successfully completed the indicated type training and was found to be competent to act as pilot in command (PIC), the Hungarian training instructor certified his logbook, as normally required by the aviation regulations.

1.5.5 He returned to South African and submitted what is called a *"class, warbird or type rating application"* to the SACAA to have the YAK18T type rating endorsed on his PPL. The SACAA did not approve the application. Due to lack of sufficient information on the file, it was not possible to determine the reason for the YAK18T type rating non-approval. However, the pilot then took the decision to go through another process of flight training on the YAK18T here in South Africa.

1.5.6 The record shows that he attended a complete syllabus of flight training on the YAK18T at one of the locally approved aviation training organisation (ATO No 0188). After he completed training for the second time and was found competent again, he submitted another application to have the YAK18T type endorsed on his PPL. This time around without any significant problem the CAA endorsed the type on PPL. The pilot then continued to fly the YAK18T type acting as PIC without experiencing any incident. The PPL was revalidated for the last time on 28 June 2013 prior to the accident.

1.6 Aircraft Information

Airframe:

Type	YAK-18T	
Serial Number	22202054812	
Manufacturer	Yakovlev	
Date of Manufacture	1 August 2003	
Total Airframe Hours (At time of Accident)	1407.73	
Last Annual Inspection (Date & Hours)	28 February 2013	1391.83
Hours since Last Annual Inspection	15.90	
Authority to Fly (Issue /Expiry Dates)	01 March 2013	24 February 2014
C of R (Issue Date) (Present owner)	Conrad M	
Operating Categories	NTCA – Part 24	

Engine:

Type	M14P
Serial Number	KR2422045
Hours since New	Unknown
Hours since Overhaul	602.24

Propeller:

Type	Veron V350TA-D35
Serial Number	300242
Hours since New	Unknown
Hours since Overhaul	151.49

1.6.1 Aircraft Documentation – CAR, Part 91 requirements:

1.6.1.1 The aircraft documentation (i.e. certificate of registration, authority to fly, mass and balance, POH and radio station license etc.) was checked during the investigation. The check was carried out to determine the validity of the documentation. No anomalies were identified.

1.6.2 Aircraft Maintenance Documentation:

1.6.2.1 The last annual inspection was carried out after the aircraft had flown a total of 1391.83 hours. The responsible aircraft maintenance organisation (AMO 151) certified all the logbooks accurate and in compliance with the applicable regulations.

1.6.2.2 Aircraft Logbooks (Airframe, Engine and Propeller) were checked during the investigation. The following information was identified:

(i) East Cape Aviation (AMO 151) opened the aircraft logbooks on 28 July 2011. According to the airframe logbook, the aircraft total hours since new (THSN) were 1316.29 at the time of the logbook being opened. Thereafter the airframe was subjected to scheduled maintenance inspections annually, which were 1340.76 hours on 28 February 2012 and 1391.83 hours on 28 February 2013.

(ii) According to the engine logbook, the engine total hours since new (THSN) were 510.0 hours. The airframe and engine maintenance were synchronised. The engine maintenance was performed at 535.04 hours on 23 February 2012 and 586.34 hours on 28 February 2013.

(iii) The Class 2 Products were identified to be as follows:

Components Description	**Serial numbers**
Magneto #1 – M9-25M	6041200326
Magneto #2 – M9-25M	1912502123
Generator	E9220035
Carburator	11010193024
Compressor	KU241050

(iv) According to the propeller logbook, the Prop total hours since new (THSN) were unknown at time the logbook was opened. The Prop hours since overhaul were 84.29 hours. The Prop maintenance was also synchronised with that of the airframe and engine. The Prop maintenance was carried out at 108.76 hours on 28 February 2012 and 135.59 hours on 28 February 2013.

1.6.2.3 Aircraft Flight Folio was found carried on board the aircraft at the time of the accident. Due to the post impact fire, the flight folio partially burned in the accident. Only portions of writing could be seen on some of its pages. The flight folio information (i.e. flight times, departure and landing locations, fuel status and the fact that there were no entries of defects) was deemed important in this regard.

1.6.3. The Aircraft Fuel Status:

1.6.3.1 According to the aircraft flight manual, the fuel is distributed in the two main tanks. The fuel capacity for each main tank is 95 Litres (25 gal). The fuel capacity in the service tank is 3.5 Litres (0.9 gal). The recommended fuel type is B-91/115 gasoline (octane number of not less than 91). Also, the range of the aircraft is calculated to be 3 hours 45 minutes. In light of the indicated fuel information, it was deemed necessary to determine whether or not the aircraft complied with the identified standards set in the flight manual.

1.6.3.2 Based on the evidence that the aircraft was last seen for maintenance by AMO182, information about the fuel status was requested from the responsible AME. He stated that he was not aware of any refuelling happening at Stellenbosch Airport. His observation was that the aircraft was flown with the quantity of fuel remaining on board at the time of landing but subtracting the fuel used in the ground run test.

1.6.3.3 During the onsite investigation it was determined that the fuel type/grade carried on the aircraft was MOGAS - 100 LL Gasoline, Octane Grade 95 and not AVGAS. Folio entries suggest that the quantity of fuel taken on prior to the flight to Stellenbosch was 90 Liters. It should be noted that no information exists of the quantity of fuel carried on the aircraft prior to and/or after the refueling.

Figure 4 shows sample of 100 LL gasoline, octane grade 95 used in the aircraft

1.6.3.4 To determine the fuel status, the AME was asked to assist. The reason the investigation thought he might help in this regard was based on the evidence that he was inside the aircraft when they carried out the ground run tests. His response was *"the aircraft had a substantial amount of fuel on board, I would say full less the last flight from departure field to FASH".*

Note: The flight time to FASH was calculated as being 1 hour 5 minutes from 0455Z to 0600Z. After the maintenance was carried out on the aircraft, a ground run was performed which lasted approximately 30 minutes from 1530Z to 1600Z.The total fuel usage time was calculated as being 1 hour 35 minutes (the sum of the flight and ground run). Taking into account that the range is 3 hours 45 minutes, the investigation can safely conclude that the aircraft still had sufficient fuel remaining which would have given the pilot about 2 hours 10 minutes of flight time. This simply means he had enough fuel for his return flight to Enjo airfield in Canwilliam.

1.6.3.5 The maintenance work packs of the aircraft were inspected during the investigation. Documents were found of East Cape Aviation (AMO 151), the Job Card 1519, dated 25 February 2013, had included on it a document labelled *"aircraft defect report"* having entries of defects. The defects were as follows:

(i) "*Aircraft was having a high r.p.m of 91%"*. The rectification was "*CSU was adjusted and low r.p.m stop adjusted to 54%".*

(ii) *"Low idle r.p.m 24%"* The rectification was *"adjusted to 27%"*. It should be noted that according to the relevant maintenance data the low idle r.p.m should be 26%, implying that the low idle r.p.m setting was adjusted to the incorrect value.

(iii) *"Oil leaking from the # 5 cylinder passes piston rings"*. The rectification was to remove, hone, fit new rings, cylinder fitted and locked.

1.6.3.6 After the engine maintenance was completed, blow-by (cylinder pressure test) was carried out. All 9 cylinders were checked and the results was as follows:

Cylinders	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Blowbys	76/**80**	74/**80**	73/**80**	72/**80**	76/**80**	75/**80**	60/**80**	75/**80**	74/**80**

1.6.3.7 After the blow-by checks an engine ground run performance check was carried out. The before and after engine performance information was recorded. The results were as follows:

Engine	**Before Inspection**	**After Inspection**	**Serviceability**
Engine Temp & Pressure CHT	150˚C	150˚C	150˚C
Oil Temp	50˚C	50˚C	50˚C
Oil Pressure	0.4	0.5	0.5
Fuel Pressure/Engine pump	0.3	0.4	0.4
GEN /GEN WARN Light/Amp	Serviceable	Serviceable	serviceable
Suction/Pressure in HG			
Propeller Response through Pitch Change and Feather/Unfeather	Serviceable	Serviceable	Serviceable
Engine Response to power change	Serviceable	Serviceable	Serviceable
Static RPM, Manifold pressure at static RPM	Serviceable	Serviceable	Serviceable
Magneto drop – check dead cut at idling speed LH Magneto & RH Magneto	3%	3%	3%

Radio interference from Magneto and GEN/Alternator	Serviceable	Serviceable	Serviceable
Idle RPM	**24%**	**27%**	**27%**
Idle Manifold Pressure	Serviceable	Serviceable	Serviceable

1.6.3.8 After the engine ground run was completed, the engine was signed out serviceable. The AMO then issued a certificate of release to service (CRS) which was to lapse at a total of 1491.83 hours flight time, or on 28 February 2014, whichever came first, or unless the aircraft was involved in an accident or became unserviceable, in which case the certificate would become invalid for the duration of the period.

Note: Based on the above information of the CRS, it should be noted that the engine low idle r.p.m was adjusted to an incorrect setting during maintenance. Improper maintenance constitutes invalid issuance of the CRS.

1.6.4 After the aircraft was released to service by AMO 151, the pilot came to collect it in Port Elizabeth with the intention of bringing it back to Canwilliam. The pilot took possession of the aircraft after the maintenance as on previous occasions, relying on the good ethical workmanship of the AMO. He flew the aircraft on a private uneventful flight back to Canwilliam. The pilot then continued to operate the aircraft on his usual routine flights without experiencing any defects and/or incident.

1.6.5 The pilot's wife stated that after about 5 months during week 8 - 13 July 2013, he identified a defect on the aircraft of a loose L/H magneto. She saw him making a call to AMO 151 and overheard him reporting the magneto loose defect to them. During the call the pilot received instructions from the AMO personnel to carry out the repair work himself. The instructions were to tighten fast the loose nuts of the affected magneto. He complied with the instructions and thereafter continued to operate the aircraft.

Note: There was no entry of the magneto loose defect on the flight folio.

1.6.6 According to his wife, about 3 months during October 2013 the pilot suspended a flight due to an over temperature engine defect he experienced. He again reported this defect to AMO 151. No information has been found to show what the response was from AMO 151. However, he then decided to contact another maintenance organisation, namely Stellair CC (AMO 182) operating at Stellenbosch airfield. The pilot made the call on 22 October 2013 and reported an intermittent high cylinder head temperature (CHT) defect.

Note: There was no entry of intermittent high cylinder head temperature (CHT) defect made on the flight folio.

1.6.7 According to AMO 182 after the call they agreed with the pilot that he should bring the aircraft for an inspection to Stellenbosch on 24 October 2013. During the inspection the AMO personnel checked the engine timing and found it to be about 4˚ out. The AMO rectified the aircraft as follows:

(i) The aircraft cowlings were removed. The pilot was asked to show which magneto was found loose and what he had done to correct the situation. The pilot did as requested. Thereafter the AMO personnel carried out their own general engine inspection. They found the timing settings of both magnetos slightly retarded. The R/H magneto timing was reading (14½˚ to 16˚) but the flange was a little out. The L/H magneto timing was reading (13˚ to 13½˚) as measured on the Prop shaft flange.

Note: The AMO personnel adjusted both magnetos to timing setting of (15˚ to 15½˚) BTDC on the Prop shaft flange.

(ii) The AMO personnel indicated that they rectified the magneto timing defect without actually having to remove the magnetos. The slotted holes provided enough movement to rectify the timing. The distributor block cover was removed to gain access to the point's cavity and the timing/points were checked and adjusted. After the magneto timings were adjusted, all items removed were refitted (i.e. magneto distributor caps and HT lead cover to distributor cap cover). The AMO personnel carried out visual inspection and everything was found satisfactory. They used the Vedeneyev M-14P maintenance manual, section 072.00.00 Engine M-14P and 074.10.01 Magneto M-9F.

1.6.8 Apart from adjusting the magneto timing settings, the AMO also carried out inspections on the engine carburettor and altitude compensator. They found the compensator bellows setting reading 9.46 mm at 740 mmHg, which was within limits. The carburettor main air bleed jet - size No 130 (1.3 mm) was checked and cleaned. The carburettor air filter plug and fuel filter screen were removed, cleaned and refitted. The fuel metering valve (mixture needle) was adjusted approximately 2 clicks richer with intention to see if the increased fuel flow would help with the high CHT defect. Thereafter the cowlings were refitted and the aircraft was ready for the ground run test.

1.6.9 The AMO personnel accompanied by the pilot then boarded the aircraft to do the engine ground run test. According to the AMO personnel, the pilot did the ground run and together they checked whether all the engine parameters were within limits. No discrepancies were identified. Apparently the pilot was happy with the engine performance. Allegedly during the ground run the engine temperature was "just outside yellow on CHT - middle of green". After the ground run was carried out, the AMO personnel disembarked from the aircraft. The pilot kept the engine running to immediately taxi out to the runway to embark on his flight back to Canwilliam.

Note: None of the above maintenance was recorded in any of the aircraft logbooks or flight folio. Also, the engine ground run parameters before and after the maintenance were not recorded. There was also no certificate relating to maintenance of aircraft (CRMA) issued by AMO 182.

1.6.10 When the aircraft was on the runway ready for take-off, a witness who was playing golf listened to the engine noise and his observation was that the engine was running rough. He explained that during the climb the engine started stuttering, cut out and restart before disappearing in the strawberry field. During the onsite investigation the wreckage was visually inspected. The preliminary findings were that the aircraft may have experienced one or both of two scenarios: an in-flight loss of engine power and/or engine failure. However, further investigation was required to come to a conclusion on either one of the two.

1.7 Meteorological Information

1.7.1 The meteorological information below was obtained from the South African Weather Service. The weather service report reference number ZU-FLE-2013-10-24 stated that the most likely weather conditions at the place of the accident were as follows:

(i) The satellite image showed mid to high level clouds in and around FASH area. FACT METAR reported CAVOK weather conditions and embedded thunderstorms more than 100 km to the north. The SIGWX Chart showed no significant weather for the area of the incident. The vertical wind profile indicated moderate 130˚/15kts, south-easterly below FL050.

1.7.2 The weather conditions recorded at Cape Town International Airport (FACT) closer to the time of the accident were as follows:

Wind direction	210˚	Wind speed	11 kts	Visibility	CAVOK
Temperature	25˚C	Cloud cover	CAVOK	Cloud base	CAVOK
Dew point	14˚C				

1.8 Aids to Navigation

1.8.1 The aircraft was fitted with standard navigation equipment. The navigation equipment was approved on the equipment list as per the applicable regulation. There was no report of any defect or malfunction experienced with the navigation equipment. The observation was that the navigation equipment was serviceable.

Note: The information on the airframe logbook of the equipment list shows that the aircraft had the following navigation equipment installed:

Navigation Equipment	Serial Numbers
Nav Com GPS Carmin	8125426
Transponder Carmin	S322748
Airspeed Indicator (ASI)	N/A
Artificial Horizon	N/A
Rate of Climb	N/A
Standby Compass & Radio Compass	597007

1.8.2 Stellenbosch airfield is used for recreational and general aviation aircraft operations. The airfield does not have any radio navigational aids installed and in terms of the applicable regulation it was also not required.

1.9 Communications

1.9.1 The aircraft was fitted with a VHF Radio Baklau type of communication equipment. The radio equipment was approved as per the equipment list. There was no report of any defect or malfunction experienced with the radio equipment. The observation was that the radio equipment was serviceable.

1.9.2 It should be noted that the aircraft did not have any cockpit voice recording equipment installed. Thus, there were no pilot communication recordings available. Also, the evidence indicates that an emergency situation developed with the aircraft. The investigation could not find any recording anywhere which indicated that the pilot called an emergency.

1.9.3 Due to the fact that Stellenbosch Airfield is an unmanned aerodrome, it had no ground communication equipment installed. Based on the fact that the airfield was unmanned, the requirement was that broadcasting should be done on the general area frequency 124.8 MHz and to comply with unmanned airfield communication procedures.

1.9.4 Based on the Aviation Directory Book, Stellenbosch airfield had a radio frequency 119.3 MHz but it was available for AFIS and on weekends only.

1.9.5 The evidence was that when the aircraft flew at the airfield, other aircraft were operating in the circuit. There was no evidence of communication from the pilot to any of the other aircraft in the circuit prior to the accident.

1.10 Aerodrome Information

1.10.1 The information below was taken form Aviation for South Africa Directory Book, Edition 2003/04 and Aeronautical Information Publication (AIP):

Aerodrome Location	Stellenbosch, Western Cape	
Aerodrome Co-ordinates	33˚ 58'50.0S 018˚ 49'22.0	
Aerodrome Elevation	321 feet (98 m MSL)	
Runway Designations	01/19	
Runway Dimensions	760 m x 16 m	
Runway Used	19	
Runway Surface	TAR	
Approach Facilities	Approach and centreline Markings	

1.10.2 According to the directory book, at Stellenbosch airfield a standard left hand (LH) circuit should be flown at all times. The book further states that during take-off /departure from Stellenbosch Airfield, aircraft should only commence the crosswind turn at 1000 ft altitude or above, but provided that terrain clearance criteria are not violated.

Note: The evidence was that the aircraft never reached the crosswind turning point or 1000 ft or flew the standard circuit. However, the aircraft was seen turning in the opposite direction – i.e to the right.

1.11 Flight Recorders

1.11.1 The aircraft did not have any flight data recorders (FDR and CVR) installed and they were not required for the aircraft type as per applicable regulation.

1.12 Wreckage and Impact Information

1.12.1 The investigation determined that the aircraft flew from Runway 19 in a north easterly (NE) direction. After rotation the aircraft started to climb to reach circuit height. During the climb witnesses saw it flying at a low altitude and bank sharply to the right in a south easterly (SE) direction. The altitude of the aircraft was estimated to be approximately 10-20 meters above the plastic strawberry covering.

Note: The strawberry farm – Polkadraai is located at GPS co-ordinates: 33˚57 45ꞌS 18˚44 35ꞌE, parameter fence is about 379 ft (115 m) from Runway 19 in north easterly (NE) direction.

1.12.2 The witnesses stated that as the aircraft was entering the RH bank/turn it was seen descending and hit the ground. The accident site was at GPS co-ordinates: 33˚59ꞌ12.71ꞌS 18˚49ꞌ22.85ꞌE, elevation (98 m).

Figure 4 shows the accident site at Polkadraai Strawberry Farm

1.12.3 An onsite investigation then followed. Information gathered during the onsite investigation showed that the aircraft first hit the semi-circular covered polytunnel or high tunnel structures before hitting the ground. Several of the polytunnel ground or anchor posts were destroyed in the impact sequence. The ropes used to hold the plastic covering close to the hoops was found tangled around the nose section (bottom engine cowling) of the aircraft.

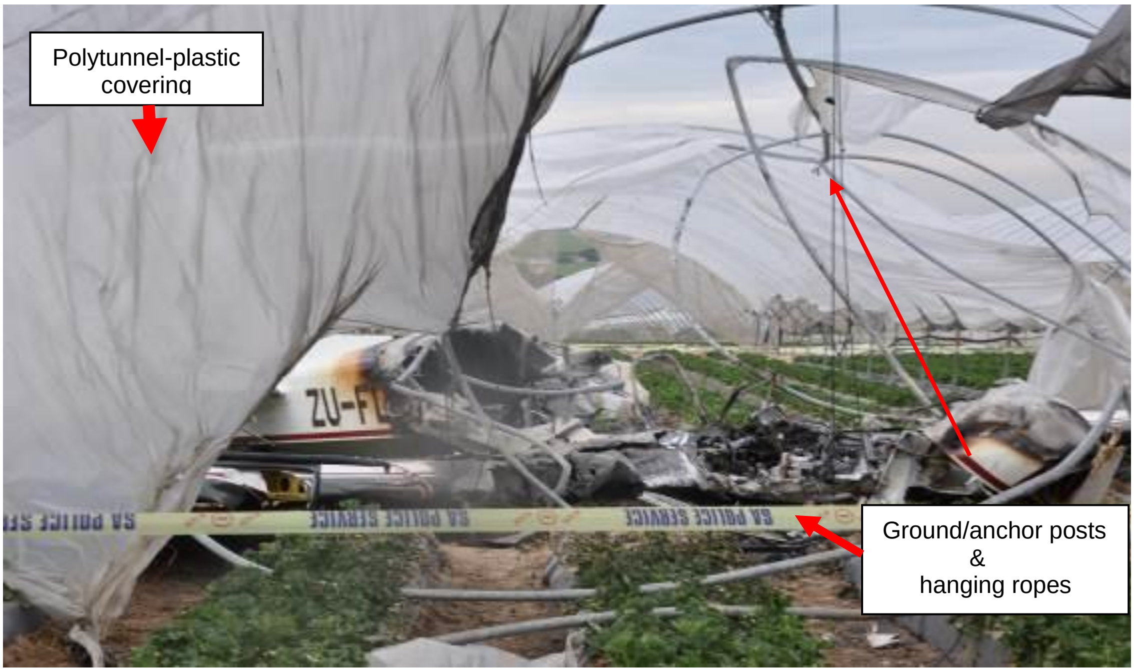

Figure 5 shows the damaged strawberry polytunnel and

1.12.4 The observation was that when the aircraft hit the ground, a post impact fire started. The witness who attempted to assist the pilot indicated that he saw a small fire at the nose section (flames coming from the engine). The fire started to spread and destroying the aircraft. The fire damage was seen predominantly on the fuselage (cockpit and cabin) and inboard wing areas.

Figure 6 shows the fire damage caused to the fuselage and wings

1.12.5 The wreckage was examined and determined that the impact sequence was as follows:

(i) All indications are that the aircraft hit the ground at a high angle relative to the ground. It was in a right- turning motion and low speed at the time. This evidence can be seen by the shallow impact crater caused by the nose section. The wreckage was still intact after the aircraft impacted the ground. The manner in which the aircraft impacted the ground is consistent with one of the witness account stating that *"an aircraft banking hard to his right at a very low altitude"* He noticed that the aircraft was flying rather slowly to attempt such a sharp turn.

(ii) There was no ground scar, which is evidence that the aircraft did not skid during the impact. This implies that the flight path angle (pitch) of the aircraft was such that it hit level ground in a nose-down attitude. The evidence for this can be seen in how the nose section (engine and propeller) of the aircraft hit the ground.

(iii) The wreckage further shows that after the high angle (nose-down) attitude impact, the airframe broke in the area of the firewall causing the fuselage to smashing down hard on the ground.

Figure 7 & 8 shows the nose section (engine and propeller) of the aircraft

(iv) The wreckage was found facing in a south westerly direction. The main wreckage was located approximately 316 m (heading 190˚) from the end of Runway 19.

Figure 9 shows the direction wreckage facing in relation to Runway 19

1.12.6 The undercarriage/landing gear impact information:

1.12.6.1 The aircraft had a retractable oleo-pneumatic double action shock-struts (oil and nitrogen) tricycle landing gear type. According to the YAK-18T Flight operations Manual, at altitude of at least 10 m retract the undercarriage and once satisfied that the lights and indicators are correct and that the undercarriage has been retracted to set the undercarriage lever to the neutral position. The evidence was that the pilot did comply with these procedures.

1.12.6.2 The wreckage investigation showed that the main landing gear was still in the retracted (up and locked) position.

Figure 9 shows the undercarriage still in the retractable position

1.12.6.3 A similar finding, as with the main landing gear, was made with the nose gear strut assembly. The wreckage investigation showed that the nose gear was also still retractable in up-locked position.

Figure 10 shows nose gear

1.12.6.4 The investigation concluded, based on the evidence of the main and nose gear in retractable position, the aircraft was not configured for landing at that point in the flight.

1.12.7 The propeller impact information:

1.12.7.1 The aircraft had a variable – pitch tractor, two wooden blade type propeller installed. The propeller diameter was 2.4 m, direction of rotation being to the left (anti-clockwise). The YAK-18T Flight operations Manual states that at an altitude of 300 ft the engine conditions should be altered from the take-off regime to the Nominal I regime for the climb to circuit height. Pilots are warned to achieve a crankshaft rotational speed of 82%-84% by first reducing the propeller pitch to achieve the desired r.p.m. The propeller pitch reduction should be carried out swiftly as per the manual.

1.12.7.2 Based on the above propeller information, during the wreckage investigation the following observations were made:

(i) The propeller sustained substantial impact damage. Both propeller blades were destroyed.

(ii) One of the blades broke off at the hub after hitting the ground and was subsequently also squashed under the weight of the engine as the aircraft ploughing nose-first into the ground. The blade seems to have broken in half during the impact, coupled with tensioning pulling force of a rope from the strawberry patch, which resulted in its breaking into pieces.

Figure 10 shows broken propeller blade

(iii) The other propeller blade was still intact at the hub, but its tip broke off. There appears to have been a propeller blade strike during the impact sequence. The prop tip probably hit the metal tubing structure of the strawberry patch or the ground. This resulted in the blade tip shearing off. The prop blades are made of wood; there were a few pieces of wooden threats sharp ends pointing. The opposite side (trailing edge) of the blade was torn due to the tip shearing off.

Figure 11 shows damage blade (tip strike)

1.12.7.3 The damage caused to the two propeller blades suggests that it did not rotate at full r.p.m at the time of the impact. Also, it was set at a reduced angle (probably more coarse pitch) to maintain the crankshaft rotational speed of 82%-84%, as directed by the flight operations manual.

1.12.8 The engine gills impact information:

1.12.8.1 According to the aircraft technical data, the YAK18T aircraft radial gills are there to keep the engine at its optimum temperature during flight. The gills are operated manually from the cockpit by the pilot. Therefore it is extremely important for the pilot to check the cooling gills, whether open or closed. Ideally the gills should never be forgotten in the closed position, especially during the take-off. It may result in the engine quickly experiencing high cylinder temperatures which is not safe for any flight condition.


Figure 12 shows the open position of the cooling gills

1.12.8.2 The cooling gills were also inspected during the wreckage investigation to determine their condition. The evidence indicated that the pilot had the gills open during take-off, hence reducing the risk of an unsafe rise in the cylinder temperature.

1.12.9 The split flaps

1.12.9.1 The wreckage was also inspected to determine the position of the flaps. The evidence was that as a result of the extent of impact damage caused to the "belly" section of the airframe and fire damage caused to the cockpit area, it was not possible to conclusively determine the position (retracted/extended) of the flap at time of impact. This information is important as it assists in determining the last intention of the pilot.

Note: However, according to the YAK -18T Normal Checklist the flap position prior to take-off should be RETRACTED/UP.

1.13 Medical and Pathological Information

1.13.1 The pilot held a valid Class 2 Aviation Medical Certificate. The medical certificate did not have any restrictions to which the pilot was required to adhere. There was no evidence or report of the pilot suffering any medical condition that may have impacted negatively on him when flying the aircraft.

1.13.2 In a document identified as WC/12/0398/2013 submitted by Department of Health: Provincial Government of the Western Cape Forensic Pathology Services, Stellenbosch. The Pathology report indicates that the Post-Mortem medical examination was conducted on 25 October 2013. The Post-Mortem examination report concluded that the cause of death was multiple injuries.

1.13.3 Specimens identified as 1015:BA03095R were retained during the post-mortem examination for the purpose of conducting toxicological analysis. The specimens were taken to Path Care Laboratory for the analyses. A report with reference number 692072876 was issued by the Laboratory on 15 October 2013. No anomalies were identified.

1.14 Fire

1.14.1 The aircraft was destroyed by post-impact fire. The pilot was inside the aircraft when it started burning.

(i) A witness working at Stellenbosch Airfield – Stell Flight Academy stated that he received a call about the accident. He immediately drove to the location of the accident where he found the aircraft on fire. However, due to security fencing of Polkadraai Strawberry Farm he could not get to the burning aircraft.

Figure 8 shows aircraft on fire, parameter fence and people standing looking helplessly unable to assist the pilot

1.14.2 Another witness working at Polkadraai Strawberry Farm rushed to the accident scene. He also found the aircraft on fire. The fire was at the engine and moving backward. He found the pilot having a safety harness on, bended/leaning over facing forward onto the control yoke. He attempted to help the pilot. He cut the pilot's safety harness with the intention of pulling him out of the disabled aircraft but he was unsuccessful.

Note: According to the YAK-18T aircraft flight operations manual, the fuel is distributed from two main tanks (in the wings) fed through fuel lines to the service tank (in the fuselage – belly) to the engine (rotary pump). There are no fuel lines distributed aft of the fuselage toward the empennage (tail section) of the aircraft. Also, the oil circulation system which is engine mounted gear oil pump, oil tank and cooler are located in the engine compartment. Both fuel and oil systems carry flammable liquids.

1.14.3 Based on the above information and evidence of the fire damage sustained, the observation is that the fire damage was mainly in the fuel distribution area. This is also the area where the majority of material (i.e. Fabrics and Leather products, Avionics/Instrumentation equipment etc.) are located that can sustain a fire.

1.15 Survival Aspects

1.15.1 The pilot did not survive the accident even though the aircraft was still intact after hitting the ground. The aircraft ended up being destroyed by the post- impact fire. Witnesses reported that the pilot was trapped inside the wreckage and his body was burned in the post- impact fire.

1.15.2 Another witness said that he was on lunch at about 1128Z. His employer contacted him and told him about the accident. He drove to the scene which was in block 6 of the strawberry farm. Within a minute or so he arrived at the aircraft. He saw that the aircraft had smoke coming from it. He called the employer requesting that the authorities be notified. He found the pilot seated on the right side seat, restrained with the safety belt. His observation was that the pilot was unconscious at the time. He attempted to assist the pilot to pull him out of the wreckage and found that he was trapped inside. He was unable to pull the pilot from the wreckage. There was a small fire on the nose area of the wreckage. The fire quickly started to spread towards the right side of the wreckage where the pilot was seated. Due to the intensity of the fire, the witness left the wreckage with the pilot inside and ran to safety.

1.15.3 Stellenbosch Airport Flight Safety Officer:

1.15.3.1 According to the Stellenbosch Airport Flight Safety Officer, in terms of their licensing requirements the aerodrome is not required to have its own rescue and fire fighting services available. However, in the interest of aviation safety the aerodrome management work together with Cape Town Municipal Disaster Management Services whenever they experience an emergency situation.

(i) The emergency was reported to Western Cape Disaster Management Service. The evidence was that both Stellenbosch Local Municipality and Cape Winelands District Municipality rescue and fire fighting services dispatched to the scene. Based on information obtained during the investigation process, they arrived on the scene at about 1138Z time.

(ii) Some of the rescue and fire fighting service managed to gain entry to the strawberry farm through the main entrance. However, due to the nature of the strawberry plantation infrastructure they were unable to get close to the burning aircraft.

(iii) Other rescue and fire fighting service vehicles unfortunately could not gain access to the strawberry farm. These were the rescue and fire fighting vehicles which used the aerodrome entrance and service road to reach the scene. They could not gain easy access due to the electrical security fence installed around the farm.

1.15.4 Stellenbosch Municipality Fire Incident Report:

1.15.4.1 The Assistant Chief Officer (ACFO) of Stellenbosch Local Municipality from the Safety and Security Department, the Report No F131024/0002 states:

(i) The municipality received a call at 1115Z about the accident. The response time to the scene was 1117Z and arrival at 1155Z. When arriving they found Cape Winelands District Municipality (CWDC 6), Stellenbosch Municipality 7 fire fighting services crew was in attendance. The rescue and fire fighting vehicles used on the scene were 2x Heavy Fire Appliances, 2x Service Cars and 1x Rescue Vehicle. When they arrived on the scene the aircraft had already caught fire. The fire was coming from the engine compartment and moving rearward. The equipment used was 1x jet from CWDC water tender. The extinguishing media was 1x jet plus foam. They managed to extinguish the fire at about 1240Z and departed from the scene back to base at 1307Z.

Figure 9 shows the emergency rescue services vehicles at the scene

Note: According to the report, it was determined that the supposed cause of the fire was leaking fuel igniting the fuselage after the aircraft crash- landed.

1.15.5 Cape Winelands District Municipality (CWDC):

1.15.5.1 The Duty Officer of CWDC, Immediate Incident Report REF No 933/10/2013 states:

(i) They received a telephone call at 1128Z from Stellair CC reporting the accident. After receiving the call, they responded driving about 24km - 27km to the accident site. The response time to the accident scene was at 1129Z. They arrived on scene at 1147Z.

(ii) When arriving on the scene, they found Stellenbosch Local Municipality fire fighting services crew was also in attendance. Upon their arrival they found the aircraft alight. They immediately started to extinguish the fire. The time spent on the scene to extinguish the fire and secure the area safe was (about 30 minutes) until 1243Z. They departed from the scene back to base at 1310Z.

1.15.6 Cape Town International Airport (FACT) Rescue and Fire Fighting (RAFF):

1.15.6.1 According to FACT RAFF Chief Officer, they also responded to Stellenbosch Airport when the accident was reported. The purpose of their response was to observe, in order to ensure that aviation standards were adhered to by the municipal rescue and fire fighting services.

1.16 Tests and Research

1.16.1 The investigation team did not recover any of the parts or components to conduct further investigation.

1.17 Organizational and Management Information

1.17.1 Owner/Pilot Management issues:

1.17.1.1 The pilot was also the owner of the aircraft. He operated the aircraft privately. All the flights flown were at Clanwilliam and to Stanford which are both in the Western Cape Province.

1.17.2 Aircraft Maintenance Organisations (AMO):

1.17.2.1 East Cape Aviation (AMO 151)

(i) AMO 151 maintained the YAK-18T aircraft. The pilot used to fly the aircraft over to Port Elizabeth to the AMO facility. All annual inspections were carried out. It had a valid AMO approval certificate issued with appropriate ratings to carry out scheduled and unscheduled maintenance activities on the aircraft type.

(ii) Based on East Cape Aviation Operations Specifications, the evidence was that the AMO were authorised to carry out maintenance on all aircraft listed under the prescribed Categories: Category A – Class 4 the YAK-18T aircraft type and Category C – Class 04 the M-14 engine type.

(iii) According to the aircraft logbooks, the evidence was that the AMO was responsible for maintaining the YAK-18T, ZU-FLE after its importation to South Africa. All maintenance was carried out according to applicable regulations and in accordance with manufacturer's requirements.

(iv) According to the AMO records, the evidence was that it had a sufficient number of appropriately qualified maintenance personnel with required experience and properly authorised to carry out maintenance on the aircraft type.

1.17.2.2 Stellair CC – AMO 0182

(i) Stellair was the last AMO to carry out maintenance on the YAK-18T aircraft on 24 October 2013. According to the SACAA records, Stellair had a valid AMO approval certificate.

(ii) Based on Stellair Operations Specifications dated 23 September 2013, the evidence was that as an AMO they were authorised to carry out work on all aircraft listed under the prescribed Category – Ratings. However, under Category A – Class 4 they had the YAK 52 and 65 series aircraft type; and under Category C – Class 04 they had the M-14 series engine type included.

(iii) Stellair audit information was considered to be relevant in the investigation. The evidence was that the AMO was audited by the SACAA during 13 – 14 February 2013. It was an audit to renew their AMO approval certificate. The SACAA Southern Region (location – Cape Town Office), Airworthiness Department carried out the audit. During the audit process they identified a total of 5 findings and 4 observations. For the purpose of the investigation, the finding E4 was deemed to be important:

(iv) It states *"Work Packs, Ground Run Checks and Flight Test/Acceptance"* which root cause analysis states that *"More stringent checking needed"* and corrective/preventative action *"Before and after ground run checks have recently been put in place and more rigid requirements for test flight and acceptance"*.

1.17.3 Stellenbosch Airport:

1.17.3.1 According to Stellenbosch Airport (FASH) File: CA15/1/1265 of the CAA, the aerodrome was issued on 17 September 2013 with a Category 2 Licence. The licence was valid from 01 October 2013 to 30 September 2014. The licence specifies that in terms of AIC 50.4 dated 02 October 2015, Stellenbosch Airport was exempted from complying with CAR, Part 139.02.7 requirements in that it is considered to have a sufficiently low movement rate to justify the risk associated with the exemption.

1.17.3.2 Based on the information included on the CAA File, the evidence is that Stellenbosch Airport are being privately operated under the management of Stellenbosch Flying Club. The Flying Club appointed an Airfield Safety Officer charged with applicable responsibility to carry out oversight in the scope of his appointment.

1.17.3.3 The CAA File was reviewed in the investigation. The purpose of the review was to determine if information exists on rescue and fire fighting services in relation to easy access to Polkadraai Strawberry Farm property. The CAA documents reviewed on the file were from August 1998 to July 2015. There was no evidence of information relevant to easy access to Polkadraai Strawberry Farm by the CAA and/or the Airfield Management.

1.17.3.4 The issue about easy access to Polkadraai Strawberry farm relates to an emergency situation being experienced during take-off from RWY 19 and the aircraft ending up conducting an emergency or forced landing on the grounds of the farm. The issue is whether or not the rescue and fire fighting services would have easy access to the farm in a timely manner. The question is raised on the basis of the evidence of the security parameter fence erected around Polkadraai Strawberry farm land.

1.17.3.5 According to the Airfield Safety Officer, he is not aware of any emergency access gates being provided specifically for the purposes of rescue and fire fighting services to accident aircraft on Polkadraai Strawberry farm.

Note: It is important to be aware that Polkadraai Strawberry Farm management advertises that they are open to the public for strawberry picking during October to December from 9am to 4pm daily. This is when the public will be roaming around the strawberry field open to risk of being injured during an unexpected emergency or forced landing on the farm. Hence the importance of rescue and fire fighting services gaining easy access.

1.17.3.6 CAR, Part 139.02.7, states the following:

(i) Emergency access roads shall be provided on an aerodrome where the minimum response times as prescribed in Document SA-CATS 139 cannot be achieved and where the terrain conditions permit their construction.

(ii) Where the airport is fenced, access to the outside areas shall be facilitated by the provision of emergency gates, which shall be marked to indicate their purpose and the prohibition of vehicle parking and obstructions in their immediate vicinity control of these gates shall be under the direct control of the fire-fighting services.

1.18 Additional Information

1.18.1 None.

1.19 Useful or Effective Investigation Techniques

1.19.1 None.

2. ANALYSIS

2.1 The owner/pilot involved in the accident was a foreign national to South Africa. His place of birth was the United States of America (USA). Based on information obtained from the NTSB through the FAA, he did not hold a US pilot licence. The information which he provided to the SACAA indicates that his nationality was German. In Germany he was issued with an Air Transport Pilot Licence (ATPL) and the BAe 146 type rating was endorsed on it. His total number of flying hours approximately 2980.0 on the BAe 146 was evidence of the level of training he received and experience he possessed in the civil aviation industry.

2.2 Based on the fact of his having a foreign pilot licence, he could qualify to get a temporary validation or permanent conversion approved by the SACAA. Obtaining either one of the two could have given him the opportunity to be issued with equivalent licence issued in South African. He could have than added any other aircraft types to the licence if so required.

2.3 The evidence was that instead he decided to go the whole nine-yards and completed the full private pilot licence (PPL) training in South Africa. During the PPL training he got the opportunity to fly Cessna and Piper aircraft. The type ratings of the two aircraft were then endorsed on his PPL later. During the time that he was in possession of the South African PPL, he managed to keep a clean safety record. There was no evidence of any incidents and/or accidents written against his name at the SACAA.

2.4 A few years down the line he decided to buy himself a YAK-18T aircraft. In order to take ownership of the aircraft, he flew to Hungary to undergo a student pilot, transition training and check flight training on the type. The investigation determined that the training was carried out at Györszentiván – Böny (LHBY) airport in Hungary. After he successfully completed the pilot training to type, his logbook was signed out by the Hungarian Instructor. He then took ownership of the aircraft and flew it on a long navigational flight from Hungary to South Africa. When arriving in South Africa, he submitted an application and requested that the YAK-18T be endorsed on his PPL. His application was received but for an unknown reason the CAA decided not to approve it.

2.5 This is when he decided to do a South Africa type conversion on the YAK-18T. He was tested in terms of applicable regulations and found to be competent. His logbook was certified by the South African Instructor and a new application to have the type endorsed on the licence was resubmitted. According to available flight folio information, after the YAK-18T was endorsed on the licence, he used it flying private flights in Western Cape Province predominantly. Most of the flights he embarked on were with his family in the area of Clanwilliam. The flight folio shows that he flew on average per month about 5 to 10 hours with the intention to have flown about 100 hours before the aircraft was due for the next annual inspection.

2.6 The YAK-18T was an ex-military aircraft *"war-bird"* which he imported to South Africa. During the time of being registered, the CAA classified it as a non-type certificated aircraft (NTCA). The CAA classified it this way because it no longer meets the certification standards and did not qualify to be issued with a certificate of airworthiness (C of A). Also, the CAA has instituted different maintenance requirements for all NTCA aircraft.

2.7 To comply with these different maintenance requirements, he entered into a contract with East Cape Aviation – AMO 151 from Port Elizabeth based in Eastern Cape Province. The identified AMO was charged with the responsibility to carry out all required maintenance (scheduled and unscheduled) in terms of the applicable aircraft manufacturer maintenance documentation. Due to the accident, the investigation deemed it necessary to review the AMO documentation. The investigation wanted to determine if the AMO was appropriately authorised in terms of applicable regulations to carry out maintenance on the YAK-18T. The evidence was that the AMO had a valid approval certificate and its operations specification had both the airframe (YAK-18T) and engine (M 14P) approved on it. The conclusion was that no anomalies were identified with the AMO documentation.

2.8 This is when East Cape Aviation – AMO 151 was requested to submit the aircraft maintenance documentation. All the aircraft maintenance documentation such as the logbooks and work pack were reviewed in the investigation. The aim of the review was to determine the level of compliance in terms of the aircraft manufacturer's requirements by the AMO. The evidence found during the review was that the AMO was responsible for the last annual inspection (scheduled maintenance) carried out on the aircraft. And based on the flight folio, the evidence was that the annual inspection was carried out during February 2013 at Port Elizabeth, which is the principle place of business of the AMO. During the inspection it is identified that the following engine defects were rectified by the AMO:

(i) The first defect listed was a high engine speed rating of *91% (approximately 2730 r/min)* which required adjustment. According to the applicable manufacturer's maintenance manuals, the high speed rating should be at least *99% (2900 r/min).* It means that the high engine speed rating was out by *8% (about 240 r/min)*. The engine speed rating was adjusted to correct setting by the AMO. Also, the AMO made an adjustment (information is unknown) on the constant speed unit (CSU). Due to the high engine speed defect the AMO decided to check and rectify also the low engine speed rating to *54% (about 1620 r/min).*

Note: Of importance in this regard, it should be noted that the M14P engine operations and technical requirements reads as follows *"the adjustment of the governor on engine is regarded complete if with throttle fully open and the governor control lever is shifted to the low pitch stop, the engine gains a speed of 99% (±2900 r/min) and when the lever is shifted to the high pitch from nominal rating II 70% (±2050 r/min), the speed of rotation drops drastically to 53% (±1590 r/min)".*

(ii) The second defect listed was of the engine idling speed rating reading *24% (±720 r/min)*. The idling speed required to be adjusted to *26% (± 770 r/min).* Instead the AMO adjusted it to *27 % (±800 r/min).* The implication was that they maladjusted the carburettor idle stop (idle needle). Whenever the idling speed is maladjusted lower *(– 26%)* or higher *(+ 26%)* it will have an impact on the engine operation. In this case the impact was that the engine would have an excessive idling speed.

Note: Of importance in this regard, it should be noted that according to the M14P operations and technical requirements*, "the maladjustment could be rectified by adjusting the carburettor throttle stop screw to accuracy of 1.5 mm",* meaning that in this instances a low (slower) or higher (faster) idling speed is not necessarily a terrible thing. This comment is made because at idling speed the engine has enough power to run smoothly. However, the conclusion was that the AMO did not comply with the maintenance requirements.

(iii) The third defect listed was that of oil leaking and passing through the rings on number #5 cylinder. The AMO indicated that they removed the cylinder from the engine for repairs. The cylinder was honed and new rings were fitted..

Note: Of importance in this regard, it should be noted that according to the M-14P engine operations and requirements, *"oil leakage from the cylinders is not allowed"*. Thus, the necessary repairs as stipulated in the maintenance manuals should be carried out. The conclusion was that the AMO had complied with the repair requirements to stop the cylinder oil leakage.

2.9 After the AMO 151 completed the scheduled maintenance, the aircraft was subjected to a ground run test. The AMO was satisfied with the maintenance, performance and condition of the aircraft. The aircraft was flown on a test flight by the owner/pilot himself and no anomalies were identified. The AMO then certified the certificate of release to service (CRS), declaring that the aircraft was airworthy. The issuance of the CRS was on the 28 February 2013.

Note: Of importance in this regard, it should be noted that the AMO maladjusted some of the engine speed settings as identified above. Hence in terms of applicable regulations such a part or component is considered to be unserviceable until the time that the necessary rectification action is taken to ensure the continued serviceability of the part or component prior to releasing the aircraft to service. Based on this fact, it would appear that the certificate of release to service (CRS) issued by AMO 151 was in fact invalid. Thus, by implication the authority to fly (ATF) was also invalid. And consequently too the aircraft should have never been returned to the owner/pilot to fly with the identified unserviceable condition.

2.10 On the 1 March 2013 the owner/pilot received the aircraft from AMO 151. He flew it unaware of the maladjusted engine speed ratings back home to Clanwilliam. After his arrival at Clanwilliam, he embarked on several other flights *(17.20 hours)* from the 1st March 2013 to 5th May 2013.

2.11 Due to the fact that both the flight folio and pilot logbook were destroyed in the post impact fire, it was not possible to get information of the flights flown from the 6th May 2013 to 11th September 2013. As a result it was difficult to give the exact flight time when the owner/pilot experienced the L/H magneto loose defect during July 2013, however, based on the information received from the spouse (wife) of the owner/pilot. She overheard a telephone conversation between her husband and East Cape Aviation – AMO 151 held on *8th or 13th July 2013.* Her husband was reporting to AMO 151 the L/H magneto loose defect. The husband was given information telephonically on how to rectify the identified defect. He was told to *"tighten the nuts"* of the L/H magneto. Supposedly after he tightened the nuts it would appear to him as though the defect was rectified.

Note: Of importance in this regard, it should be noted that in terms of Part 44, it states that *"when during maintenance or at any other time any part, product, component, equipment or item is found to be unserviceable or is unlikely to remain serviceable under normal operating conditions during the period preceding the next inspection, such rectification action as considered necessary shall be taken to ensure the continued serviceability of the part, component or item prior to releasing the aircraft to service".*

Based on the above regulation, the information shows that *"maintenance to rectify as considered necessary to ensure continued serviceability was not carried out in accordance with the applicable provisions".* The applicable provisions states that in case *"it is the owner of the aircraft carrying out the maintenance, he shall do so provided that an appropriately rated approved AMO, AME or AP, rated on the type performs a dual check on the maintenance which was carried out".* The latter requirement to carry out a dual check was not done. Also, the L/H magneto loose defect had rendered the aircraft unsafe for flight. So, by implication, the aircraft could not have been considered to be airworthy and flown.

2.12 After the owner/pilot rectified the L/H magneto loose defect, he flew the aircraft again on more flights (total 4.55 hours) in Clanwillian area. According to his wife, she witnessed the owner/pilot flying the aircraft on 17 October 2013. He was forced to suspend the flight after about 25 minutes from 15:40Z to 16:05Z. He again was experiencing another condition which makes the aircraft unsafe for flight. It was an engine overheating condition. However, this time it does not appear as though he reported it to AMO 151. He instead reported it to Stellair CC - AMO 182.

2.13 On 22 October 2013 he called Stellair CC – AMO 182 and reported to them the engine overheating defect. He made a request to AMO 182 to assist him to rectify the defect. He was asked to explain whether or not he knew what the source of the defect could be. His response was that it may have been caused as a result of the L/H magneto loose and tightening thereof during July 2013. All this information was again verified and confirmed by the wife of the owner/pilot. She indicated that this was the main reason why her husband (owner/pilot) flew the aircraft to Stellenbosch on 24 October 2013.

Note: Based on the above information, it should be noted that yet again the provisions of Part 44 prevail. The engine overheating defect was identified under normal operating conditions during the period preceding the next inspection. As such again in this case the requirement was that rectification action as considered necessary should have been taken to ensure the continued serviceability of the engine operation prior to the next flight, however, the latter was not done. The evidence is that the owner/pilot decided to fly the aircraft with the unsatisfactory engine condition not rectified.

Of importance in this regard, as previously indicated that the CRS issued by AMO 151 was considered to be invalid. And now with this new engine overheating defect, the invalid CRS became *"invalid yet again".* One can say that the defective status of the aircraft had aggressively heightened its unsafe condition. The identified defects made it quite dangerous to embark on any future flights. Also, in the interest of aviation safety, there is no information which seems to suggest that AMO 182 ever attempted to sway the owner/pilot not to flying the aircraft with the unsatisfactory condition.

2.14 When reviewing the aircraft and maintenance documentation the evidence found showed that none of the identified defects (i.e. L/H magneto loose and Engine Overheating) was not certified "snagged" in the relevant aircraft or maintenance documents as required by applicable regulations.

2.15 The question was asked in the investigation, to explain why the owner/pilot decided to fly to Stellenbosch – AMO 182 and not to Port Elizabeth – AMO 151 to rectify the engine overheating defect. His wife explained that he did not want to take the chance to fly *(2.45 hours)* to Port Elizabeth with the defect. He preferred the much safer option to fly the shorter distance which is to Stellenbosch. Based on available information he flew (about*1.05 hours*) from *0455Z to 0600Z* to Stellenbosch. The other issue to consider was that there are not too many maintenance organisations authorised to carry out maintenance on the YAK-18T in the Southern Region. He could only choose one of the two, either Eastern Cape Province (AMO 151) or Western Cape Province (AMO 182). The other authorised maintenance organisations are located within the Gauteng Province.

2.16 With reference to the engine overheating defect, it should be noted that engines are designed and manufactured to operate within a specific temperature range. And based on the YAK-18T Flight Operation Manual, the temperature range of the aircraft is "*recommended = 140˚C to 190˚C, minimum normal operation = 120˚C, minimum continuous operation = 140˚C and maximum continuous operation = 220˚C"*. Thus, in the interest of safety it is important to operate the aircraft within the identified temperature ranges. The risk being should the pilot neglect to operate the aircraft in the identified temperature ranges; it may result ultimately in his actually compromising the engine operation. Also, the engine may end up having one or a combination of the following *(improper emissions, fuel consumption and ultimately degraded performance)* conditions. These conditions could lead to a risk of causing catastrophic internal damage. It is the opinion of the investigation that the owner/pilot was aware of the identified dangers hence his decision to have the engine overheating defect rectified.

Note: The investigation found that during the annual inspection which AMO 151 carried out, the finding was that the engine temperature and pressure cylinder head temperature before and after the inspection was determined to be *150˚C.* It means that at the time when the owner/pilot experienced the overheating defect the temperature regime of *150˚C* had increased to beyond the recommended limits as indicated above. The specific information (parameters) of the increase (degrees) prompting that an “engine overheating” defect reported are readily known or it was never formally communicated. It was not possible to come to a conclusion on the matter (parameter).

2.17 With reference to the L/H magneto loose defect, it is important to note that AMO 151 was the last to carry out maintenance on the aircraft. The investigation looked into the sequences of events and determining whether or not any of the maintenance carried out was to the magnetos.

Note: The evidence found on Engine M-14P Inspection Sheet, specifically the Item No: 74.10.01 b, Task Card No: 260 requiring the following *“Accomplishment of magneto scheduled maintenance according to magneto maintenance manual”* and Item No: 72.70.00 b, Task Card No: 256 *“Drainage of oil from magnetos”*. The observation was that AMO 151 worked *(3 hours and 20 minutes)* on the magnetos. It is the opinion of the investigation that the possibility exists that it was during the accomplishment of the two identified inspections that the AMO did not check or did not properly tighten the L/H magneto, leading to it being loose. Also, based on M-14P Trouble Shooting Table, Item No: 9 *“Engine overheats, excessive temperature of oil and cylinder heads”* the probable cause might be a result of “*Incorrect magneto timing”* which action to correct is *“Adjust spark advance”* in terms of Ref: 074.10.01, Task Card No: 202.

2.18 On 24 October 2013, the owner/pilot was the sole occupant on board the aircraft and was flying it to Stellenbosch Airport. He was going to AMO 182, so they could rectify the overheating defect as agreed on 22 October 2013. When he arrived at Stellair, he was greeted by an AME charged with the responsibility to assist to rectify the engine overheating defect. The AME requested that he should physically show the magneto which was loose and to explain again the issue of him tightening it. He realised that the owner/pilot pointed out to him the L/H magneto.

2.19 Thereafter the AME continue to do the following: *“He prepared to check the magneto timing including removal of #4 cylinder forward sparkplug, magneto distributor cap removal, cleaning of points and checking of points gap. The points gap was found within limits and general internal condition of the magneto distributor cap and points cavity area was clean with no defects. The timing was checked and both magnetos were found to be slightly retarded at 13˚ to 13.5˚ BTDC measured on the Prop shaft flange (normally would be 14.5˚ to 16˚ on the Prop shaft flange). Both magnetos were adjusted at settings of 15˚ to 15.5˚ BTDC on Prop shaft flange. The engine timing was accomplished without removal of the magnetos as the slotted holes provided enough movement to correct the timing”.*

2.20 He made reference to the Vedeneyev M-14P engine maintenance manual during the maintenance.

Note: Of importance in this regard, it should be noted that the identified maintenance manual was also referred to in the investigation. The aim was to determine if the AME complied with all the requirements. Thus, as far as his checking the magneto timing the following was observed:

(i) As indicated above the AME reported that he made the adjustments on the magnetos while they were still installed on the engine. According to the engine maintenance manual it is possible to adjust the magneto while it is installed on the engine. The manual states that *"if it is that the normal adjustment is not achieved, adjust the sparking moment by turning the magnetos on the studs extending through the slots in the magneto flange".* However, it does not mean that other items in the sequence should not be adhered to, because they are equally important. In particular the items listed in Task Card No: 202, Item 9 which requires when adjusting the magnetos use of a feeler gauge, 0.03 mm thick. To insert the feeler gauge between the magneto breaker points and turn the Prop in its normal direction to check breaker points opening at Prop shaft flange angle of 14˚30' to 16˚ (is really about 23±1˚ of crankshaft rotation) before the piston gets to the top of its compression stroke called "top dead centre" (TDC). The breaker points gap shall be 0.25 mm (0.010 inch) to 0.35 mm (0.014 inch). The evidence was that he after the magneto settings adjustment was completed and the AME certified it to be within required limits.

NB: As indicated by the timing diagram, the difference in Prop shaft flange angle (14.5˚ to 16˚) and crankshaft rotation advance angle (23±1˚) may be mathematically explained as follows. Based on the M-14P engine manual, the magneto points should open at maximum 16˚ - [(24)/1.125] = -5.33˚past TDC of crankshaft angle. Thus, -5.33˚ x 0.658 (propeller gearbox ratio) = -3.5˚. The calculation shows that the proper place for the points to open is in fact 3.5±.0.5˚after TDC.

(ii) The AME indicated he then checked the timing of both magnetos. In terms of the engine manual, he could achieve this by inserting a feeler gauge (0.03 mm thick) between the breaker points and turn the Prop shaft first in the opposite direction through 10 to 15˚ before turning it in its normal direction to check the synchronous beginning of the points opening in both magnetos. This is when he observed that both magnetos were slightly retarded "drifted". The L/H magneto was retarded to 13˚ to 13.5˚ which was about 2.5-3˚ off. The R/H magneto was fine at 14.5˚ to 16˚ but with the fault of its flange being out. To correct the situation, in terms of the operations and requirements procedure he set the piston in cylinder #4 to position 15˚ to 15.5˚ before the TDC in the compression stroke. At this position the magnetos points were corresponding to the supply of spark in cylinder #4 (it is the master rod), meaning that he achieved the synchronous beginning of the points opening in both magnetos. He then securely tightened the adjusted magnetos to the engine.

NB: The M-14P engine manual states that the magnetos points to open at Prop shaft flange angle *(14.5˚ to 16˚).* However, the evidence is that the AME adjusted that the magneto points open at Prop shaft flange angle *15˚to 15.5˚)* But based on the timing diagram information, the difference in Prop shaft flange angle *15˚to 15.5˚* and crankshaft rotation advance angle *(23±1˚)* may be mathematically explained as follows. Therefore the magneto points should open at maximum *15.5˚ - [(24)/1.125] = -5.83˚*past TDC of crankshaft angle. Thus, *-5.83˚ x 0.658* (propeller gearbox ratio) = -3.83˚. The calculation shows that the proper place for the points to open is in fact *3.83±.0.5˚*after TDC.

2.21 Thus, based on the above information about the magneto and engine timing adjustment, as per the timing diagram the expectation was that the engine would operate as follows *"timing angle (Cylinder No 4), beginning of admission before TDC should be (20±4)˚; end of admission after BDC to be (54±4)˚; beginning of exhaust before BDC to be (65±4)˚ and end of exhaust after TDC to be at (25±4)˚. The advance angle for LH and RH magneto before TDC at end of compression stroke should be (23±1˚)"*.

2.22 It is important to remember that the L/H magneto loose condition was for a duration of about 17.2 hours flight time from 28 February 2013 to 17 July 2013 (about 4 months long). Ideally such a condition cannot be left unattended for so long, especially in an operation critical component like a magneto. Factors to consider would be the unidentifiable loads (radial and/or axial) which could result in an element of play developing on the magneto shaft and bearings. This may cause effects such as weak sparks, drift in the internal timing, points not opening at the required Prop shaft flange angle etc. Dependant on extent or nature of play the fact is that the magneto capability will be affected. The magneto possibly will not generate adequate high-tension current to the sparkplugs for ignition in operation. As we know the L/H magneto did experience a drift in its internal timing (13˚ to 13.5˚) possibly due to the play caused by one or combination of the identified loads. Thus it implies that 13.5˚ - (24/1.125) = -7.83˚ x 0.658 = 5.15±0.5˚ after TDC. This shows that indeed there was some element of play on the magneto shaft or bearing resulting in a somehow weaker spark to the relevant front sparkplugs in the cylinders. The AME did make an adjustment to get the magneto timing right to 14.5˚ to 16˚ before TDC, but he could reset both to 15˚ to 15.5˚ which is about 3.83±.0.5˚after TDC. Meaning he slightly improved (higher) the quality of the sparks provided by the L/H magneto, but reduced (lower) the R/H magneto from 14.5˚ to 16˚ where AMO 151 set it.

Note: Based on the information above, the advice to the AME could have been to first remove the affected L/H magneto. To inspect or send it for a bench test to check if any wear to the shaft or bearings exist. And most probably by doing so he might have come to realise that the L/H magneto required being overhauled first. However, the latter procedure was not done. However, most importantly the requirement is that *"an entry be made in the magneto-certificate (log card) after each adjustment of breaker contacts"* supposedly to preserve the information for future benefit. This was not done by the AME.

2.23 After the AME finished adjusting the magneto and engine timing, he continued to make adjustments to the engine carburettor settings. The carburettor main air bleed jet was checked, the size was recorded as a No 130 (1.3 mm) and it was cleaned. The carburettor air filter plug and fuel filter screen was removed, cleaned and refitted. He adjusted the fuel metering valve (mixture needle) to 2 clicks richer with the intention to see if the increased fuel flow would help with the high CHT problem.

Note: Based on M-14P engine maintenance manual, Task Card No. 205 it is explained that the carburettor main air bleed jet (diameter 1.3 mm to 2.0 mm) is responsible for leaning out or enriching the mixture. Changes to the jet will have an effect on the specific fuel consumption at take-off and nominal rating for 2 to 5 g/hp-h. The AME carried out the necessary checks to ensure compliance. He did not find any fault and was satisfied. The evidence is that the main air bleed jet settings were left as per AMO 151 previous adjustment.

As far as the fuel metering needle is concerned, the evidence is that the AME adjusted it to 2 clicks richer. According to the Task Card, to adjust the engine in cruise rating II are done through the metering needle. Also, the adjustment range to stop is eight clicks, where one click changes the specific fuel consumption from 4 to 8g/hp-h.

However, it should be noted that the last initial adjustment setting before the AME had done his is not known. It means that the specific fuel consumption of the engine in cruise rating II are unknown at that time. This said, based on the information that one click will change the fuel consumption from 4 to 8g/hp-h, it means that the two clicks have increase “enriches” the specific fuel consumption more but to the AME desired “unknown” fuel consumption.

To ensure that the engine operates efficiently as per the specification, the air-fuel ratio must be set right. If not right it will affect the combustion ratio “volume” in combustion chamber. Also, a richer mixture “more fuel” will render the engine less efficient. The type of fuel “higher or lower octane-rating” also plays a significant role. It was determined in the investigation that MOGAS - 100 LL gasoline, octane grade 95 and not AVGAS was used. All the identified factors may result in the engine experiencing “detonation” causing the engine to fail.

The AME indicated that he increased (“enriched”) the specific fuel consumption with the intention to see if the increased fuel flow would help with the high CHT problem. Based on the M-14P engine trouble-shooting table, troubles which include amongst others (i.e. Engine overheats, excessive temperature of oil and cylinder heads), a list of 18 different possible causes with corrections are presented to resolve. In particular, the issue of enriching the specific fuel consumption with the intention to correct the high CHT are not found amongst the possible causes. Most of the possible causes relate to the oil system. However, in relation to the previous issues identified in the investigation, there were two possible causes (incorrect magneto timing and low – octane fuel) which in this instance are considered to be most probable possibility. The engine manual instructs that the corrective action for both the two possible causes is to adjust the spark advance as per Task Card No. 202. Above all, most importantly it should be noted that the aircraft was not fitted with a fuel flow indicator (g/hp-h) for the owner/pilot or AME to also check how the enrichment would have affected the fuel flow. When asked by the owner/pilot to give his thoughts about whether or not the intermittent high CHT problem was caused as a result of the retarded magneto timing, the AME response was he did not believe it to be the cause.

2.24 Based on the above information, the observation is that the AME was making adjustments to the engine timing and carburettor metering systems. It goes without saying that both these systems are quite critical to the engine performing efficiently. Hence it was considered important that a duplicate "dual" inspection should be carried out . The applicable regulations require the following: *"No person shall certify an aircraft component for release to service after the initial assembly, subsequent disturbance or adjustment of any part of an aircraft or component control system".* However, the AME was of the opinion that there was no requirement for a duplicate inspection which in effect shows that he did not comply with the identified regulation.

2.25 After the AME accomplished the engine maintenance, he carried out an engine test run. According to the engine manual, he was required to make reference to Task Card No. 202 when carrying out the test run. In doing so he had to check the engine operation at different ratings by smoothly moving the carburettor throttle control lever to the stop and increasing the Prop pitch simultaneously. The engine should run steadily and without any vibration and instrument readings to correspond to the necessary specifications. And based on the information provided by the AME, there were no discrepancies with the engine performance identified by him and the owner/pilot was satisfied.

2.26 According to the AME, after he and the owner/pilot completed the test run the observation was that the owner/pilot was in quite a hurry, thus requesting that he leave immediately after the test run was completed. And after the test run was completed, the AME disembarked from the aircraft leaving the engine still running so that he could get going without having to do an engine shutdown. When he was asked about an acceptance test flight being carried out, he responded as follows: *"I believe there was no requirement for an acceptance test flight to be carried out, the aircraft did not undergo an annual/MPI type of inspection".* The AME's response is quite concerning, because he was not complying with the applicable regulations.

3. CONCLUSION

3.1 Findings

3.1.1 The pilot being the sole occupant, he flew the aircraft from Canwilliam - Eagle Airfield to Stellenbosch Airfield the morning of 24th October 2013.

3.1.2 The intention of the flight was carry out unscheduled maintenance on the aircraft. The aircraft was experiencing an engine overheating problem.

3.1.3 The pilot brought the aircraft to an aircraft maintenance organisation (AMO) called Stellair CC, which facility is at Stellenbosch Airfield. Stellair was the last to carry out maintenance to resolve the engine overheating problem on the aircraft.

3.1.4 Stellair carried out a troubleshooting inspection into the engine overheating problem, checking first the engine timing and found the timing 4˚ out, as a result of both magnetos (LH & RH side) flanges being slightly out by (14½˚ to 16˚) and (13˚ to 13½˚).

3.1.5 Stellair then rectified the flange slightly out problem of the magnetos by adjusting both to (15˚ to 15½˚).

3.1.6 In order to correct the timing problem completely, additional to the magnetos adjustment, Stellair also had to carry out maintenance on the engine carburettor. Checking the carburettor setting, they found that the compensator bellows required to be adjusted to 9.46 mm at 740 mm of HG, the main air bleed jet had to be cleaned and fuel metering valve (mixture needle) had to be adjusted about 2 clicks richer.

3.1.7 After the engine timing problem was rectified through adjustments made on the magnetos and the carburator settings, Stellair performed an engine performance ground run check to ascertain whether or not they managed to correct the engine overheating problem. During the ground run the evidence was that the engine temperature was *"just outside yellow on CHT*" and in the *"middle of green"* and the aircraft was considered to be serviceable.

3.1.8 The investigation view is that several more activities of the AMO was not satisfactorily.

3.1.9 The pilot then boarded the aircraft, taxied to Runway 19 and took off with the intention to fly back to Canwilliam – Eagle Airfield. The aircraft was seen by witnesses taking off, landing gear being retracted, entering into a shallow climb over Polkadraai Strawberry Farm, followed by a steep right turn (bank) and then the crash into the strawberry plantation.

3.1.10 Immediately after the aircraft hit the ground, smoke was seen rising into the atmosphere from it. This is when people rushed to the scene for the purpose of rendering search and rescue assistance to the pilot. .

3.1.11 The aircraft was consumed by post- impact fire which was seen first in the engine compartment section, then moving on rearward to the cockpit, cabin and wings areas of the aircraft. The first responders to the scene, those having access to the strawberry farm grounds, struggled to rescue the pilot as he was trapped sitting in his seat inside the wreckage, hence his body was burned in the fire.

3.1.12 The evidence was that Polkadraai Strawberry Farm security fence was a barrier to many other first responders, preventing them from gaining access to the burning aircraft. They were left standing hopelessly watching how the body of the pilot eventually started burning inside the aircraft.

3.1.13 The local fire department (Stellenbosch) was called to the scene to do fire fighting to stop the post- impact fire. The fire department arrived at 1138Z , but suffered the same fate as all the other first responders did with the security fence. They did not have direct access to the burning aircraft.

3.1.14 The body of the badly burned remains of the pilot was later removed from the wreckage and taken to the Department of Health Provincial Government of the Western Cape Forensic Pathology Services in Stellenbosch for post mortem examination. The Medico-Legal Post-Mortem examination report concluded that the cause/causes of the pilot death were multiple injuries.

3.1.15 During the onsite investigation, it was determined based on the wreckage and impact information that the aircraft hit a level terrain in a high angle nose-down attitude wherein the propeller, engine and airframe structure sustained substantial damage. This caused the pilot’s death through multiple injuries as identified in the post mortem report.

3.2 Probable Cause/s

3.2.1 The pilot experienced engine failure due to improper engine maintenance when installing and adjusting the magnetos, timing and carburettor fuel metering settings.

3.3 Contributory Factors

3.3.1 The aircraft had a technical defect of intermittent high cylinder head temperature (CHT) defect caused by a loose magneto which resulted in a timing problem.

3.3.2 There was inappropriate (not following the proper procedure) engine maintenance carried out to correct the timing by means of refitting the magnetos and adjusting to the right settings in order to rectify the intermittent high cylinder head temperature (CHT) defect.

3.3.3 The AME who performed the engine maintenance neglected to follow all the crucially important steps directed by the applicable Task Card to correctly fit the magnetos with the aim of achieving the advance angle (before TDC at end of compression stroke) to be 23±1˚.

3.3.4 The fact that the advance angle before TDC at end of compression stroke of 23±1˚ was not achieved resulted in an inappropriate or uneven ignition firing sequence (power delivery of each cylinder) which affected the engine balance, vibration, noise/sound and smoothness during the climb.

3.3.5 Also, added to the uneven ignition firing sequence (power delivery of each cylinder) were such factors as improper grade of fuel (MOGAS), the high (27%) adjusted idling r.p.m setting, fuel metering valve (mixture needle) to ±2 clicks richer and unresolved high CHT causing failure of engine to develop full power.

3.3.6 All the above combined resulted in engine failure at the time when the undercarriage was retracted, the altitude of 300 ft having been achieved and pilot attempting to alter the engine condition from the take-off to the Nominal I regime to climb to circuit height.

4. SAFETY RECOMMENDATIONS

4.1 It is recommended that the Director of Civil Aviation (DCA) through the ASI Department have an engagement with Stellenbosch Airport management about resolving the issue of free easy access with its neighbours for search and rescue fire fighting services.

4.2 It is recommended that the Director of Civil Aviation (DCA) through the ASI Department have an engagement with Stellenbosch Airport management to ensure that they provide at least basic aviation fire fighting training to municipal fire fighting services. The aim is to equip them with relevant skills empowering them to appropriately and effectively combat hazardous fires in aircraft as required by the applicable SACAR, SACATS and ICAO Standards and Recommended Practices.

4.3 It is recommended that the Director of Civil Aviation through the relevant SACAA department conduct oversight of Stelair AMO 182 in light of the findings raised with the intention to ensure that they conduct maintenance as per the manufactures requirements and applicable regulations.

5. APPENDICES

5.1 Appendix 1

Appendix 1

According to the YAK-18T, M14P MS Manual, Task Card No: 202, the operations and technical requirements for magnetos installation and adjustments are as follows:

Inspect the magnetos, make sure the arrow on the front cover shows LH rotation and that the gaps of the breaker are properly adjusted. Drive out the front spark plug from cylinder No 4 and drive in the piston TUC indicator in its hole. Set the piston of cylinder No 4 to the top dead centre (TDC) position in the compression stroke using the TUC indicator.

Fix the propeller shaft position by securing a pointer to one of the studs for attachment of the propeller shaft thrust bearing cover and bring it to the zero scale division applied to the propeller shaft flange. Upon accuracy of magneto setting, turn the propeller shaft through 40 to 50˚ in the opposite direction which is more than the setting angle. Slowly turn the propeller shaft in its normal direction to set the piston in cylinder No 4 to position 14˚30' to 16˚ before the top dead centre (TDC) in the compression stroke.

Loosen the coupling bolt, remove the adjustment screw of the coupling and install the magneto on the engine so that its attachment studs are at the centre of the slots made in the magneto flange, then screw nuts on the studs, tightening them fully.

Turn the magneto distributor rotor in the direction of its rotation till its electrode is aligned with the mark applied to the end face of the magneto housing rear cover. The breaker cam with the mark should start opening the breaker points which corresponds to supply of the spark to cylinder No 4 in operation.

Remove the magneto from the engine, insert the adjustment screw, tighten and lock the nuts of the coupling bolt and adjustment screw of the coupling, precluding turning of the latter.

Place a gasket under the magneto flange; install the magneto on the engine. Insert a feeler gauge (0.03 mm thick), between the breaker points and turn the propeller through 10 to 15˚ opposite to the direction of rotation. Rotate the propeller shaft in its normal direction to check the moment of breaker point opening initial moment by the scale applied to the propeller shaft flange. The breaker points should start opening at a propeller shaft turning angle of 14˚30' to 16˚ before top dead centre (TDC). The breaker point gap should be 0.25 to 0.35 mm. If the normal adjustment is not achieved, adjust sparking moment by turning the magneto on the studs extending through the slots in the magneto in the magneto flange.

And finally secure the adjusted magneto on the engine. Then follow the same installation procedure on the second magneto by performing (iv, v, vi, vii and viii). After check synchronous beginning of point opening in both magnetos.

Note: According to Task Card No 202, the Timing Diagram shows the following:

Timing Angle (Cylinder No 4), beginning of admission before TDC should be (20±4)˚, end of admission after BDC to be (54±4)˚, beginning of exhaust before BDC to be (65±4)˚ and end of exhaust after TDC to be at (25±4)˚.

NB: The advance angle for LH and RH magneto (before TDC at end of compression stroke) should be (23±1)˚.

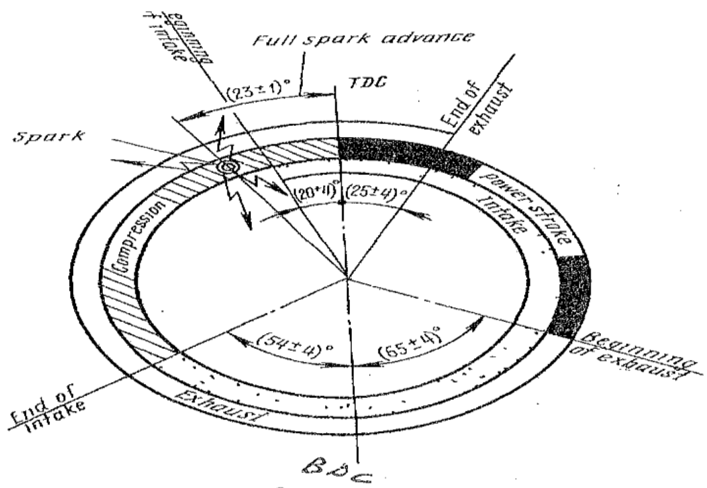

Figure 10 shows the timing diagram illustrating the engine operation

Procedures when preparing to embark on a flight:

According to the YAK-18T flight operations manual, the following procedure is required when preparing to embark on a flight:

The pilot to press the start button, after which the propeller will start to turn. He then is to switch on the magnetos. After a stable engine start is obtained, he is to release the start button, then set the thrust lever to position corresponding to 38% - 41%. With the engine start complete, he ought to lock the priming pump handle, move start button to lock position at generator and warm up the engine.

The engine warm up should be at crankshaft speed of 41% - 48%. As oil temperature increases, accelerate engine up to 44% - 48% (summer) and 51% (winter). Warm- up should be until temperature is at least 120˚C of cylinder heat temperature (CHT), oil temperature across inlet + 40˚C and into carburettor + 10˚C. After the warm up, the pilot to alter the propeller pitch from fine to coarse (high to low) twice. Thereafter decelerate the engine power r.p.m to minimum with the thrust lever. At this point he'll be ready to taxi the aircraft to the holding point.
Before the taxi, the pilot to apply brakes, accelerate the engine power to 64% - 68%. Then decelerate again to minimum r.p.m for to start the taxi phase, he is not to exceed 15 km/h (on natural surface) or 30 km/h (on concrete surface).

When at the holding point, he ought to carry out engine run-up checks with the cowling gills and radiator shutter closed. Prior to accelerating, the controls to be set to neutral and brake on and run-up to Norminal II pushing throttle fully forward increasing the propeller pitch simultaneously. The engine readings should be:

Engine Power Settings	**Meter Readings**
Crankshaft Speed	70%
Supercharger Pressure	Po + 75±15 mm of HG
Oil pressure	4 – 6 kgf/cm²
Petrol pressure	0.2 – 0.5 kgf/cm²
Oil temperature (inlet)	40 - 75˚C
Cylinder head Temperature (CHT)	≤ 190˚C
Carburettor Temperature (inlet)	≥ + 10˚C

Note: The engine should run steadily and without shaking or abnormal vibration. To avoid overheating as a result of insufficient airflow, the engine should not be operated continuously on the ground at the Norminal rating condition.

During the run-up sequence, the following checks are important:

Magneto and Spark Plugs Check – the propeller to be set at fine pitch, the thrust to 64% - 70% and to switch one magneto off and compare drop in r.p.m to previous settings. Then both magnetos on again until initial speed of 64% - 70% is recovered. Now switch second magneto off, do drop check again similar to the first and compare previous settings (drop in r.p.m/drop between magnetos). The engine r.p.m/drop with one magneto should not exceed 3%, because if it does exceed this amount, the procedure to be repeated. During the repeat, if there is no change the pilot is advised to do engine shutdown immediately.

Take-off and Climb Sequence are as follows:

Upon receipt of appropriate take-off clearance, enter runway to about 3-5m into the centreline in order to set the nose wheel straight for the take-off and hold the brakes ON.

Immediately place the engine into the Nominal I regime. Hold the aircraft with brakes ON, check readings of the instruments controlling the engine operation. The instrument readings must be as follows:

Engine Power Settings	Meter Readings
Crankshaft Speed	70%
Oil pressure	4 – 6 kgf/cm²
Fuel pressure	0.2 – 0.5 kgf/cm²
Oil temperature (inlet)	50˚C - 65˚C
Cylinder head Temperature (CHT)	140˚C-190˚C

Note: The engine must run without undue vibration or shaking. Switch ON the warning indicator dangerous speed.

On making sure that the engine operates properly, clearance has been given and no obstacles are present on the runway, the pilot may TAKE-OFF by selecting the engine TAKE-OFF regime. Release the brakes to continue with the take-off run and when the indicated airspeed (IAS) has reached 80 – 90 km/h, pull the yoke backward to start the take-off until the aircraft rotates naturally upon increase in airspeed. After rotation, INCREASE IAS to 160 – 170 km/h for gradual climb.

At an altitude of at least 9.144m (30 ft) the pilot to level off the nose to the horizon so as to gain maximum amount of airspeed.

At an altitude of at least 10m (35 ft) the pilot to retract the undercarriage. By the time the undercarriage has been retracted and an altitude of 91.44m (300 ft) has been achieved, alter the engine condition from the take-off regime to the Nominal I regime for the climb to circuit height.

The climb is to be performed at (IAS of 170km/h at ambient temperature up to +20˚C) or (IAS of 180km/h at ambient temperature over +20˚C). The pilot to carry out the usual 152.4m (500ft) checks.

To prevent the engine from overheating, after having achieved circuit height, the pilot to perform the rest of the climb at the Nominal II regime with the engine set at 70% and (IAS at 170km/h at ambient air temperature up to 20˚C) or (IAS at 180km/h at ambient air temperature over +20˚C). While climbing constantly observe the engine temperatures and that they fall within the recommended limits:

Engine Power Settings	Meter Readings
Oil pressure	4 – 6 kgf/cm^2
Fuel pressure	0.2 – 0.5 kgf/cm^2
Oil temperature (inlet)	50˚C - 65˚C
Carburettor Temperature (inlet)	≥ + 10˚C
Cylinder head Temperature (CHT)	140˚C-190˚C

Airfield Performance Information at mean conventional bearing power of soil 4 – 6 kgf/cm^2 :

Take-off Weight	Rotation Speed	Take-off Run	Take-off Distance to 10m (35 ft)	Length of Aborted Flight	Touch-down Velocity with Flap	Landing Run	Landing Distance from 15m (50 ft)
1,650kg	125km/h	500m	920m	700m	125km/h	350m	650m