SOUTH AFRICAN CIVIL AVIATION AUTHORITY

Section/division **Occurrence Investigation** Form Number: CA 12-12a

AIRCRAFT ACCIDENT REPORT AND EXECUTIVE SUMMARY

Reference:	CA18/2/3/8923

Aircraft Registration	**ZS-PGT**	**Date of Accident**	18 April 2011	**Time of Accident**	09:00Z
Type of Aircraft	Air Tractor 401	**Type of Operation**	Agriculture (Aerial Crop Spraying)		
Pilot-in-command Licence Type	Commercial	**Age**	33	**Licence Valid**	Yes
Pilot-in-command Flying Experience	Total Flying Hours	2458.0		Hours on Type	1841.0
Last point of departure	Monzi – FAMU (Mkuze)				
Next point of intended landing	Monzi – FAMU (Mkuze)				

Location of the accident site with reference to easily defined geographical points (GPS readings if possible)
At a soccer field approximately 5 NM north of FAMU

Meteorological Information	Wind: Light & Variable, Temperature: 22˚C, Cloud cover: 6/8, Cloud base: 2500 ft, Dew point: 20˚C, Visibility: Good.

Number people on board	1 + 0	**No. of people injured**	0	**No. of people killed**	**0**

Synopsis

The pilot flew the aircraft on an agriculture - crop spraying detail. The pilot completed five spray runs which were uneventful with the aircraft performance being satisfactorily. The pilot reported that during the sixth spray run, the aircraft suddenly developed a severe vibration. The pilot suspected that the malfunction may have been caused by the spray pump and thus closed the spray valve and turned the spray pump off. However, the vibration continued and became more severe.

Due to the nature of agriculture operations of aircraft flying at low altitude, the aircraft was at approximately 50 to 100 feet above ground level (AGL) when the vibration initially started. The vibration on the aircraft continued and the pilot decided to dump the load and to increase the engine power in order to gain sufficient height. The pilot however, experienced a loss of engine power and was thus unable to maintain height. The pilot then elected to execute a forced landing on a soccer field, but during the approach to execute the forced landing, the aircraft impacted a row of tree tops bordering the soccer field. The aircraft then landed heavily on the ground causing substantial damage to the aircraft on impact. The pilot survived the accident without any injuries

Probable Cause

Engine failure due to a contained engine failure in flight which resulted in an unsuccessful forced landing being executed on a soccer field.
Contributing Factor: Cylinder piston rod #5 and #6 failed due to fatigue mechanism initiate through wear in the main bearing pins.

IARC Date		Release Date	

AIRCRAFT ACCIDENT REPORT

Name of Owner/Operator	**:** Rautenbach Aerial Spraying (Pty) Ltd
Manufacturer	**:** Air Tractor Inc.
Model	**:** AT 401
Nationality	**:** South African
Registration Marks	**:** ZS-PGT
Place	**:** Approximately 5 NM north of FAMU
Date	**:** 18 April 2011
Time	**:** 09:00Z

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

Purpose of the Investigation :

*In terms of Regulation 12.03.1 of the Civil Aviation Regulations (1997) this report was compiled in the interest of the promotion of aviation safety and the reduction of the risk of aviation accidents or incidents and **not to establish legal liability**.*

Disclaimer:

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

1. FACTUAL INFORMATION

1.1 History of Flight

1.1.1 The pilot was the sole occupant on board the aircraft during the flight. He flew the aircraft on an agriculture crop spraying detail at the Monzi area. The pilot reported that while spraying the sixth load of chemicals, severe vibration was felt on the aircraft. The pilot immediate response was to close the spray valve and turn spray pump off as he assumed the vibration was coming from the pump. The vibration continued and became more severe, causing the aircraft to shake and shudder.

1.1.2 The pilot decided to dump the load and attempted to apply full engine power in order to gain more height, but as he experienced problems in maintaining height, he diverted the aircraft away from Monzi town in an event of a forced landing.

1.1.3 The pilot then observed a soccer field as the only option to carry out a forced landing. He then selected full flaps in an attempt to extend the gliding distance to reach the soccer field. During final approach, the aircraft impacted a row of tree tops bordering the soccer field. The aircraft touched down heavily on the soccer field causing substantial impact damage. The aircraft came to rest facing in the direction it came from.

1.2 Injuries to Persons

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

1.3 Damage to Aircraft

1.3.1 The aircraft sustained substantial damage in the accident.

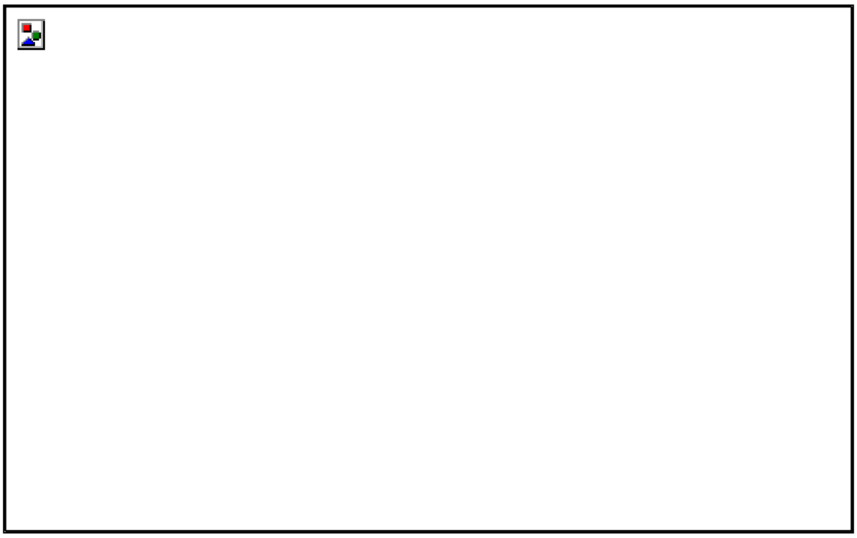

Figure 1, shows damage caused to the aircraft.

1.4 Other Damage

1.4.1 None.

1.5 Personnel Information

Nationality	South African	Gender	Male	Age	33
Licence Number	0270440761	Licence Type	Commercial		
Licence valid	Yes	Type Endorsed	Yes		
Ratings	Night, Flight Test – Single Engine Piston				
Medical Expiry Date	31 January 2012				
Restrictions	Corrective Lenses				
Previous Accidents	None				

Flying Experience:

Total Hours	2458.0
Total Past 90 Days	116.0
Total on Type Past 90 Days	116.0
Total on Type	1841.0

1.5.1 The documentation on the pilot file was reviewed and following was observed:

(i) According to the pilot file, the pilot did not have agriculture rating endorsed on his license. The SACAA licensing data base reflected a conflict with the records which the pilot forwarded to the investigator. However, the pilot forwarded records issued to him by SACAA which indicate that the agriculture rating was indeed endorsed on the license.

(ii) According to the pilot flying logbook, the evidence shows that the pilot flew the agriculture aircraft frequently on agriculture operations of aerial crop spraying at Monzi. The pilot accumulated total of approximately 222.75 hours during the last 12 months.

(iii) Apart from the agriculture rating issue, there was no anomaly identified with the way in which he flew the agriculture aircraft, handling of the emergency situation and forced landing.

1.6 Aircraft Information

1.6.1 Airframe :

Type	Airtractor 401	
Serial Number	401-0934	
Manufacturer	Air Tractor Inc.	
Date of Manufacture	1993	
Total Airframe Hours (At time of Accident)	4589.38	
Last MPI (Date & Hours)	8 March 2011	4514.4
Hours since Last MPI	64.98	
C of A (Issue Date) (Expiry Date)	29 March 2004	28 March 2012
C of R (Issue Date) (Present owner)	05 March 2004	
Operating Categories	Standard - Part 137	

1.6.2 Engine :

Type	Pratt & Whitney R-1340
Serial Number	ZP 102087
Hours since New	Unknown
Hours since Overhaul	739.48
Date Overhauled	11 March 2008

1.6.3 Propeller:

Type	Hamilton Standard 22D40/AG200-2
Serial Number	12600
Hours since New	Unknown
Hours since Overhaul	739.48
Date Overhauled	17 January 2008

1.6.4 According to the aircraft file, the aircraft was imported to South Africa from United States of America (USA). The aircraft was then registered on the South African Civil Aircraft Register which was approved for special operations – agriculture (aerial crop spraying) in accordance with applicable regulations. The aircraft was utilised on commercial agriculture operations by its owner from 28 March 2005 to date.

1.6.5 The aircraft documentation (e.g. certificate of registration, certificate of airworthiness and certificate of release to service etc.) which are required to be carried on board was reviewed during the investigation. The evidence found showed that the identified aircraft documentation was valid in compliance with applicable regulation.

1.6.6 Aircraft Maintenance: The last maintenance carried out of the aircraft was a mandatory periodic inspection (MPI). The interval of the MPI was within 12 months or 100 hours whichever came first. After the MPI was completed, the aircraft maintenance organisation (AMO) responsible for its maintenance certified the aircraft airworthy and a certificate of released to service issued. The aircraft was then flown on agriculture flights in Monzi area flying without any incident.

1.7 Meteorological Information

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

Wind direction	Variable	Wind speed	Light	Visibility	Good
Temperature	22˚C	Cloud cover	6/8	Cloud base	2500 ft
Dew point	20˚C				

1.8 Aids to Navigation

1.8.1 The accident occurred outside the boundaries of an aerodrome. The pilot executed a forced landing on a soccer field.

1.8.2 The aircraft had standard navigation equipment installed which was approved for the type. The additional navigation equipment installed was included on the approved equipment list. The pilot reported that all the navigation equipment was in a serviceable condition.

1.9 Communications.

1.9.1 The aircraft was operated in uncontrolled airspace. He operated the aircraft in the general flying area and transmitted his intentions on the VHF radio frequency 120.65 MHz.

1.9.2 The aircraft was fitted with King KY96A type of VHF transmitter radio communication equipment. The pilot did not report experiencing any defect or malfunction with the radio equipment. The radio equipment of the aircraft was serviceable.

1.10 Aerodrome Information

1.10.1 The aircraft was involved in the accident outside the boundaries of an aerodrome. The pilot executed a forced landed on a soccer field.

1.11 Flight Recorders

1.11.1 The aircraft was not fitted with a flight data recorder (FDR) and cockpit voice recorders (CVR), nor was it required by regulation.

1.12 Wreckage and Impact Information

1.12.1 The pilot completed five spray runs which were uneventful with the aircraft performance being satisfactorily, but during the sixth spray run, the aircraft suddenly developed a severe vibration. The pilot then closed the spray valve and turned the spray pump off but the vibration continued and became more severe. The pilot then decided to dump the load and to increase the engine power in order to gain sufficient height but experienced a loss of engine power and was thus unable to maintain height. The pilot then elected to execute a forced landing on a soccer field, but during the approach to execute the forced landing, the aircraft impacted a row of tree tops bordering the soccer field. The aircraft then landed heavily on the ground in a south westerly direction. The aircraft sustained substantial damage to the undercarriage wings fuselage and tail section.

Figure 3, shows wreckage after the ground loop.

1.12.3 The aircraft had sustained substantial damage in the accident sequence. The damage caused was limited to the wings, undercarriage, tail section, propeller and engine.

1.13 Medical and Pathological Information

1.13.1 The pilot had a valid Class 1 aviation medical certificate with no waivers. He had no medical condition which may have prevented him from flying the aircraft.

1.13.2 The pilot was the sole occupant of the aircraft and he did not sustain any injury in the accident.

1.14 Fire

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

1.15 Survival Aspects

1.15.1 The accident was considered to be survivable. Though substantial damage was sustained in the impact sequence, the cockpit and cabin area of the aircraft was still intact after the accident. The pilot was properly restrained with the safety belts and safety harnesses of the aircraft. The pilot evacuated from the wreckage and did not sustain any injury.

1.16 **Tests and Research**

1.16.1 The aircraft maintenance documentation such as the logbooks, flight folio and work pack regarding latest maintenance activities were reviewed during the investigation to determine if there was any item carried out which could have contributed to the probable cause of the accident:

1.16.1.1 Logbooks: All maintenance activities carried out on the aircraft was recorded and certified appropriately in the logbooks in compliance with applicable regulations. In relation to the engine failure defect which was reported by the pilot, the evidence found shows that a low compression was experienced with the aircraft. The low engine compression defect was resolved through maintenance carried out on cylinder # 5. After the maintenance was completed the responsible AMO issued a CRMA certifying that the aircraft was serviceable.

1.16.1.2 Flight Folio: The flight folio did not have any open or deferred defects. All the entries made in the flight folio were in accordance with applicable regulation. There was no anomaly identified with the flight folio during the investigation.

1.16.1.3 Work Pack: According to the CRMA of work performed # 5 cylinder indicated a low (35/80) compression reading. The AMO responsible for maintenance then removed #5 cylinder for repairs and refitted it back on the engine after work was done on the cylinder. The maintenance also included removal of engine nose case which was replaced with a serviceable nose case. After the identified maintenance was carried out, the engine was tested for serviceability and certified airworthy in accordance with manufactures requirements and in compliance with applicable regulations.

1.16.1.4 Pre-flight Inspection: According to the pilot, he conducted a pre-flight inspection prior to the flight and the aircraft was in a serviceable condition. The pilot did not identify any malfunctions with the aircraft during the pre-flight inspection; hence the decision to continue with the previously planned flight.

1.16.1.5 Defects: The pilot experienced a severe vibration on the aircraft, followed by a loss of engine power during the sixth spray run He then elected to execute an forced landing on a soccer field. Evidence found during the investigation showed that the vibration on the aircraft was caused by a contained engine failure.

1.16.1.6 The history of the engine during the research is as follows: According to an Export Certificate of Airworthiness, the engine was a newly overhauled product during fitment on the aircraft. The overhaul was carried out when engine reached 10583.00 hours total time since new (TTSN). The engine was then fitted to the aircraft from 3836.16 total airframe hours from 8 May 2008. The engine operated for total of 493.08 hours after the overhaul until low compression defect.

1.16.1.7 Failed Engine Components and/or Parts: The engine was removed from the wreckage for examination to determine what may have caused the failure. The engine examination showed that a contained mechanical failure was sustained. The parts (#5 and #6 piston rods) failed.

Figure 2 : Evidence of the piston rods failure.

1.16.1.8 The identified part failed (#5 and #6 piston rods) which resulted in the engine not being able to produce the required power to maintain the intended altitude. Due to the part failure, the engine eventually stopped during the flight.

1.16.1.9 Fuel Status: The aircraft fuels status was that it had total of 250 Litres of fuel on board before take-off. The aircraft flew for approximately 20 minutes from 0840Z to 0900Z on the day of the accident. The fuel still remaining in the fuel tank after the accident indicated that the aircraft had a sufficient quantity of fuel for the flight.

1.16.1.10 Engine Teardown: The wreckage was recovered from the accident site and then recovered to an Engine Overhaul Facility. The Engine Overhaul Facility conducted a visual inspection on the engine to determine the cause of the engine failure. As evidence showed that a contained engine failure occurred, a complete engine teardown examination was carried out with the findings as follows:

(i) During the visual and teardown examination, the evidence found shows that both cylinders # 5 and # 6 pistons connecting rods (conrods) failed during operation. The piston conrods failed due to severe mechanical damage caused to the components and parts of the engine.


Figure 6 and 7, shows fractured master link rod on #5 & #6 cylinders.

Figure 8, shows broken piston (#5 and #6) skirts.

1.16. 1.11 The engine teardown examination was concluded as follows: The master rod was the first part to fail. The reason is that the piston skirts were all damaged due to the scraper rings of each piston pulled out of the cylinder barrels. This situation can only occur during master rod failure.

Figure 10, shows number, K11187, believed to be a serial number, stamped on master rod.

1.16.1.12 Metallurgical Examination: The master rod together with seven connecting rods, seven big-end pins and #5 cylinder were taken for metallurgical examination to determine cause of failure after the engine failed in operation. After all the parts were examined, the metallurgical report concluded the cause of failure as follows:

(i) The master rod had broken adjacent to the big-end bearing housing, and the fracture surface had been almost completely obliterated following the failure. A sector of the crack extended longitudinally along the rod itself and this was carefully removed for further examination. When examined, the evidence found showed that it too was damaged beyond recognition.

Figure 11, shows longitudinal and obliterated crack surface of master rod.

(ii) One of the secondary connecting rods had fractured and the fracture surface appeared to be ductile. The failure was consequential to the master rod failure.

Figure 12, shows secondary connecting rod ductile features.

(iii) Additional cracks were observed in the master rod in the big-end hole of #6 cylinder. The crack surface exhibited features typically of fatigue. The crack initiated within the big-end pin hole for #6 cylinder, and presence of both corrosion product deposits and scoring of the big-end hole in the axial direction with respect to the big-end pin. Examination of the pins showed a distinct step at the master rod – connecting rod interface on all the pins, and signs of fretting on at least one pin. The copper plating on the pins had been worn away one pin. It infers that the pin had been moving within the master rod during ~~in~~ operation.

Figure 13 and 14, shows features typical of fatigue on the secondary crack and fretting corrosion deposits and scoring on secondary rod big-end hole on master rod.

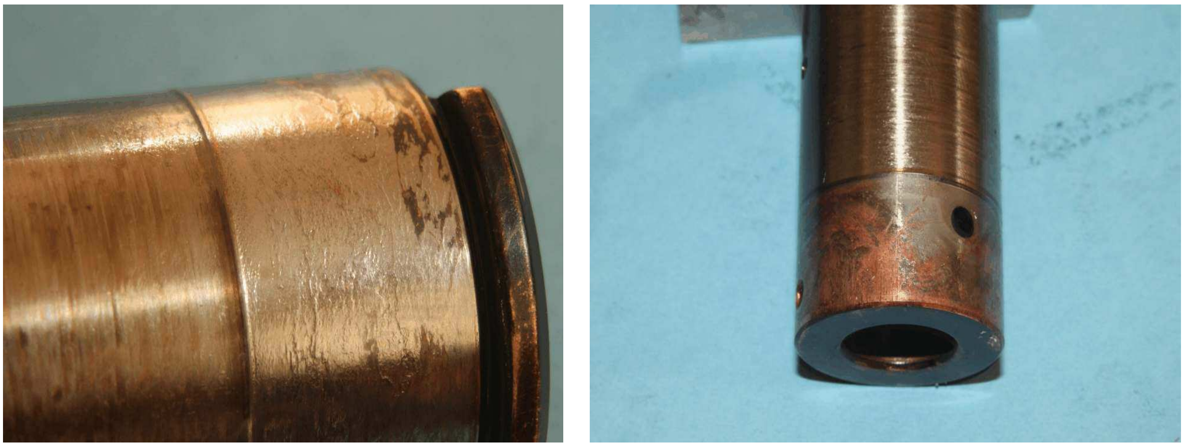

Figure 15 and 16, shows fretting damage on secondary rod big-end pin and loss of copper plating through wear on pin end.

(iv) The piston of #5 cylinder showed no signs of seizure of the skirt or wrist pin pads. The carbon layer on the crown of the piston indicated normal combustion. The rings appeared in a good condition, showing the expected wear. All the rings were loose and free to move, with the exception of the top ring which seized in its groove.

Figure 17, shows piston.

1.16.2 The metallurgical report was concluded as follows: "*The master rod has failed through a fatigue mechanism initiate through wear in the bearing pins due to extended use and which should have been replaced at last overhaul".*

1.16.3 Agriculture aircraft accident history involving engine or mechanical failures that occurred in South Africa were the following:

1.17 Organizational and Management Information

1.17.1Operation: The Operator had a valid Class II Air Service license issued by South Africa Air Service Licensing Council. The Operator was authorised to operate the types: G3, G4, G5 and G9 air services; and category: A3 and A4 of aircraft.

1.17.2The Operator also had a valid Part 135, Air Operating Certificate (AOC). The Operator's Operations Specification (Ops Spec) authorised them to operate the same type of air services and category of aircraft as on the Air Service License with the provision that they do so in compliance of applicable regulation. Included on the AOC was aircraft registrations approved for utilisation. The evidence shows that the registration of ZS-OAJ and ZS-OZB was listed and not ZS-PGT on the Ops Spec. was purely a typing error by the SACAA .

1.17.3 Aircraft Maintenance Organisation (AMO): The aircraft was maintained by a South African approved AMO. The AMO had a valid approval certificate issued on 1 March 2011 and expires on 29 February 2012. The AMO was appropriately rated to maintain the aircraft.

1.17.4 South African Civil Aviation Authority (SACAA): The SACAA was responsible for carrying out proper oversight over the Operator's operational activities. The oversight responsibility required that the SACAA should ensure that all aspects of the operation are conducted in accordance with applicable regulation. In order to execute this responsibility effectively and efficiently, the SACAA had to ensure that internally their quality processes were managed properly. The two findings of the *"agriculture rating not endorsed on the pilot license and aircraft registration (ZS-PGT) not approved on the AOC"* was proof that the SACAA quality processes were compromised. Both findings were found to be an administrative error on the side of SACAA which could have been avoided.

1.18 Additional Information

1.18.1 In order to reduce drift of the sprayed materials, agricultural pilots will attempt to fly as low as possible, usually just above the crop being treated. As the field are often surrounded by obstacles such as trees, telephone lines, and farm buildings, the pilot have to switch quickly from the task of dropping chemicals accurately and smoothly to the task of dodging obstacles.

1.18.2 The aircraft carries a chemical hopper between the engine firewall and the cockpit.

1.18.3 The Air Tractor AT – 400 series aircraft are built or converted for agriculture aerial spray application such as pesticides (crop dusting) or fertilizer (topdressing). The aircraft type is an all metal; low wing monoplane tail dragger configuration which has a single radial piston engine and it is equipped with only one crew seat.

Note: The information below was taken from the internet at following websites: **Wikipedia - radial aero engines of World War One, Wikipedia** - Master connecting rods in piston engines, Metal Forming Virtual Simulation Lab - Dayalbagh Educational Institute Agra.

1.18.4 A P&W R1340, 600 S.H.P/2250 RPM radial, reciprocating type internal combustion engine was installed on the aircraft. The 9 cylinders of the engine points outwards from the central crankshaft. The pistons are connected to the crankshaft. The uppermost piston has the master rod with a direct attachment to the crankshaft. The rest of the pistons pin their "connecting rods" attachments to rings around the edge of the master rod.

1.18.5 Engine Materials: Engine designers always strive for low weight; typically they make everything out of lighter materials. Commonly the use of aluminium for bulky components (pistons, cylinder heads and crankcases) and steel for highly stressed components (crankshafts, connecting rods and gears). Over time, designers created lighter and stronger alloys, developed ways to harden materials so they lasted longer, most importantly learned ways of forming metal components so that the "grain" of the metal was correctly aligned to handle the stresses imposed on the part. This process, called forging, vastly improved the strength of almost all the engine components.

(i) *Connecting Rods: The connecting rods connect the pistons to the crankshaft. It is fastened to the piston at its small end, by a piston pin, also known as a gudgeon pin. Together with the crank, they form a simple mechanism that converts linear motion into rotating motion. The big end is attached to the crankshaft at the crankpin journal. Connecting rods convert rotating motion into linear motion. A connecting rod is rigid, it may transmit either a push or a pull and so the rod may rotate the crank through both halves of*

(ii) *revolution, i.e Piston pushing and piston pulling. They are cast or forged to form an H near the small end and an I near the big end. This shape provides greater strength to resist the stresses than a solid rod of the same mass.*

(iii) *To maintain engine balance, all the connecting rods in an engine are a matched set. It carry the engine motive energy directly to the crank, attaining high level performance. Connecting rods must be light and yet strong enough to transmit the thrust of the pistons to the crankshaft. The connecting rod is under tremendous stress from the reciprocating load represented by the piston, actually stretching and being compressed with every rotation, and the load increases to the square of the engine speed increase. Failure of connecting rod, usually called "throwing a rod" is one of the most common causes of catastrophic engine failure. The failure of the*

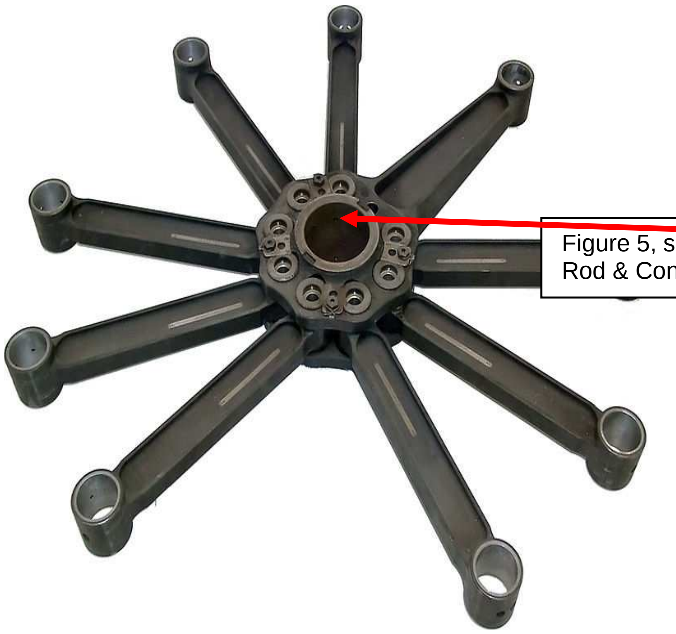

Figure 5, shows Master Connecting Rod & Connecting rods.

connecting rod can result from fatigue, lubrication failure, or failure of the rod bolts and improper tightening.

(iv) *Master connecting rod: In radial piston engines there is a single hub where all the pistons connecting rods connect to this hub. One rod is fixed, and it is generally known as the master rod. The others are called the articulating rods. They mount on pins that allow them to rotate as the crankshaft and the pistons move. The master rod is similar to any other connecting rod except that it is constructed to provide for the attachment of the articulated rods on the big end. The articulated rods are fastened by pins to a flange around the master rod.*

1.19 Useful or Effective Investigation Techniques

1.19.1 None.

2. ANALYSIS

2.1 The agriculture aircraft involved in the accident was commercially operated. The operator of the aircraft had a close corporation company registered in South Africa. The evidence shows that the operator had valid operator's certification (air service license and air operating certificate). The operator were appropriately authorised to conduct agriculture - aerial crop spaying operations which was in accordance and in compliance with applicable regulation. The agriculture aircraft registration (ZS-PGT) was approved for utilisation on the operator′s air operating certificate (AOC).

2.2 The pilot in command (PIC) that flew the aircraft had a valid Commercial Pilot License (CPL) and the Air Tractor 401 type rating was endorsed on it. The pilot also had a valid Class 1 aviation medical certificate with no waivers. The pilot had no medical condition which may have prevented him from flying the aircraft on the day. The pilot was the sole occupant onboard the aircraft.

2.3 Evidence found shows that the pilot did have an agriculture pilot rating endorsed on the license, and exercised the privileges of the agriculture rating and acted as pilot in command (PIC) of the agriculture aircraft.

2.4 During normal circumstances agriculture aircraft are exposed to an extreme operating environment. The effect of this environment on the performance and operation of the aircraft must be clearly understood by the pilot. The aircraft are used in aerial crop spraying operations flights consists of multiple takeoffs, landings and low level – heavily loaded flying with tight manoeuvres being executed. Due to the nature of the operations, specialised equipment and training is required.

2.5 In this case, the most important factor/s for any agriculture pilot/s would be to understand the unique requirements of low level flight, the physiologic demands of high frequency, short flights in demanding conditions of high heat and repeated acrobatic activities which he/her will be operating under. Other dangers normally involve with the operation are the spray load - toxic hazardous pesticides and herbicides carried onboard the aircraft. Due to the continuously low level flying, a collision with the obstacles (trees or wires) is thus a constant risk in the operation.

2.6 The aircraft was flown on six spray runs on the day. The first five spray runs were all uneventful, but during the sixth spray run, the aircraft suddenly developed a severe vibration and loss of engine power. The vibration became more severe causing the aircraft to shake and shudder. As the aircraft was flying at a low level of approximately 50 to 100 feet above the ground at the time and the pilot struggling to maintain height due to the loss of engine power he attempted to gain height by increasing engine power to reach sufficient airspeed but was unsuccessful as the engine was not producing the required RPM and engine power. The pilot was then committed to execute an emergency/forced landing on a soccer field as the best option. The aircraft sustained substantial damage during the ground impact sequence.

2.7 The wreckage was recovered to the facility of an AMO. The AMO conducted preliminary examinations to determine the cause of the vibration and loss of engine power. Evidence showed that was due to a contained engine failure as evidence found showed that both cylinders # 5 and # 6 pistons conrods failed inside the engine. The piston connecting rods (con-rods) fractured resulted in severe mechanical damage being caused inside the engine with a subsequent loss of power and severe vibration coming from the engine.

2.8 All affected engine components and parts were removed in an engine teardown investigation process. The items were taken for metallurgical examination to determine the cause of the failure. The metallurgical examination report concluded the following: "*The master rod has failed through a fatigue mechanism initiate through wear in the main bearing pins due to extended use and which should have been replaced at the last overhaul".*

2.9 The defect and maintenance history of the aircraft was reviewed during the investigation with the aim to find information that may be the contributing factor of the identified contained engine failure. There was evidence found showing that the engine had a #5 cylinder low pressure condition prior to the last MPI. Corrective action was taken to service the affected cylinder according to manufacture requirements and in accordance with applicable regulations. The engine was tested and found to be serviceable. The aircraft was certified airworthy and flown without any defect and/or malfunction being reported by the pilot.

2.10 The engine maintenance history shows that it was installed on the aircraft as a newly overhauled product. The responsible overhaul service centre certified a maintenance release indicating that the engine was overhauled in accordance with engine manufacturers' maintenance data and engine run test was satisfactory thereafter. In respect of work performed, the engine and components were approved for return to service.

2.11 After the engine was installed to the aircraft, there was no defect or malfunction experienced until a low cylinder compression defect was encountered on the engine. The Engine Overhaul Facility then carried out maintenance on the engine and refaced (reconditioning the valve face for proper seating/matting of the valve and valve seat to ensure they fit tightly) and also honed the cylinder barrel. After cylinder was re-assembled using new parts, the low pressure condition was resolved.

2.12 Based on the evidence of the metallurgical report, stating that the failure occurred due to fatigue mechanism initiation through wear, it is evident that a contained engine failure was inevitable. The AMO carried out all the maintenance required to ensure that the aircraft was maintained properly. There was no engine indication at all that the *master rod is failing due fatigue mechanism initiate through wear in the main bearing pins* unless an complete engine teardown was carried out and all components and/or parts subjected to metallurgical examination. The cylinder low compression condition showed some malfunction but after it was rectified and engine operated satisfactorily in all respects.

3. CONCLUSION

3.1 Findings

3.1.1 The pilot had a valid commercial pilot license (CPL) and the aircraft type rating was endorsed on it as well as a valid agriculture rating. .

3.1.2 The pilot had a valid aviation medical certificate and he had no medical condition which may have prevented him from flying on the day.

3.1.3 The pilot was the sole occupants of the aircraft on the day of the accident.

3.1.4 The aircraft was utilised in a commercial operation. The pilot flew the aircraft on an aerial crop spraying flight when the accident occurred.

3.1.5 The pilot experienced a vibration on the aircraft which resulted in him executing an emergency forced landing on a soccer field.

3.1.6 During final approach the aircraft sustained major damage to its wings when it impacted some tree tops bordering the soccer field.

3.1.7 The aircraft landed hard causing damage to the undercarriage and followed by a ground loop resulted in it coming to a stop facing in the direction it was coming from.

3.1.8 The pilot did not sustain any injury in the accident.

3.1.9 The aircraft documentation carried on board the aircraft was reviewed and found to be valid.

3.1.10The quantity of fuel carried on board the aircraft was sufficient for the flight.

3.1.11The aircraft sustained substantial damage during the forced landing.

3.1.12The engine was removed from the wreckage and taken for teardown examination. The evidence found was that # 5 and #6 cylinder piston rods had failed. The investigation determined that the aircraft sustained a contained engine failure.

3.1.13The cylinder piston rods were removed and taken for metallurgical examination. According to the metallurgical report, the cylinder piston rods failed due to fatigue mechanism initiate through wear in the bearing pins from extended use and which should have been replaced at last overhaul.

3.1.14 The maintenance records of the aircraft was reviewed an evidence found of a defect of # 5 cylinder low compression being experienced. There was corrective action taken which entailed maintenance to reface, lapping and the applicable cylinder barrel honed, tested and certified serviceable.

3.1.15 The overhaul history of the engine was reviewed and evidence found showing that all new parts and components were used during the overhaul process.

3.1.16 It is evident that #5 and #6 piston rod failure caused severe vibration and loss of engine power experienced by the pilot during the crop spraying detail.

3.1.17 The aircraft impacted obstacle of trees bordering the soccer field followed by hard landing during the forced landing. The aircraft then ground looped through 180° before it came to rest.

3.2 Probable Cause/s

3.2.1 Engine failure due to contained engine mechanical failure which resulted in an unsuccessful forced landing being executed.

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Contributory Factors

3.2.2 Contained engine failure due to #5 and #6 piston rods failing catastrophically in flight.

3.2.3 Piston rod failure due to fatigue mechanism initiate through wear in the bearing pins.

4. SAFETY RECOMMENDATIONS

4.1 It is recommended that the Director of Civil Aviation (DCA) through the relevant SACAA department to correct the administrative situation of the agriculture rating not found being endorsed on the pilot license.

4.2 It is recommended that the Director of Civil Aviation (DCA) through the relevant SACAA department should review the maintenance program (Mandatory Periodic Inspection) of agriculture aircraft based on the operational requirements of the aircraft. The aim should be to subject agriculture aircraft to more progressive maintenance program suitable for its operations.

5. APPENDICES

5.1 None.

Compiled by:

.... Date: …………………………….
For: Director of Civil Aviation

Investigator-in-charge: ……………………………… Date: …………………………..

Co-Investigator: ………….………………………… Date: …………………………