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MINISTÉRIO DAS OBRAS PÚBLICAS, TRANSPORTES E COMUNICAÇÕES

GABINETE DE PREVENÇÃO E INVESTIGAÇÃO DE ACIDENTES COM AERONAVES

FINAL ACCIDENT REPORT

AERONORTE Transportes Aéreos, S.A.

AIR TRACTOR 802-F

VH-LIH

Vale Monteiro, Capinha

Fundão, Portugal

12th of August, 2009

FINAL ACCIDENT REPORT N° 28/ACCID/2009

NOTE

The only aim of this technical report is to collect lessons which may help to prevent future accidents.

Safety investigation is a technical process aiming to accident's prevention and comprises the gathering and analysis of evidences, in order to determine the causes and, when appropriate, to issue safety recommendations

In accordance with Annex 13 to the International Civil Aviation Organisation Convention, Chicago 1944, EU Regulation Nr. 996/2010, from European Parliament and Council, 20th OCT 2010 and article 11th nº 3 of Decree-Law nº 318/99, 11th AUG 1999, the sole purpose of this investigation is to prevent aviation accidents. It is not the purpose of any such investigation process and the associated investigation report to apportion blame or liability.

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SYNOPSIS

On the 12th of August, by 11:48 UTC[1], Air Tractor 802-F, s/n 289, Australian registration VH-LIH aircraft, owned by Pays Air Services, Pty Ltd and operated by AERONORTE - Transportes Aéreos, S.A., when returning from a wild fire fighting mission, with two crew on board, suffered an engine power partial failure. The pilot tried to restore power, without success, opting for an emergency landing on a vegetation free farming field. The manoeuvre was not succeeded and the aircraft over passed the field and crashed on a pine forest in front.

Both people on board suffered no injuries, but the aircraft sustained substantial damage and the engine & its cowlings were partially burnt by the fire that started after the ground impact.

GPIAA has been notified by the local police authority (GNR) and the operator, the same day, afternoon, and the Investigator in Charge travelled to the site, next day, in the morning, in order to continue with investigation.

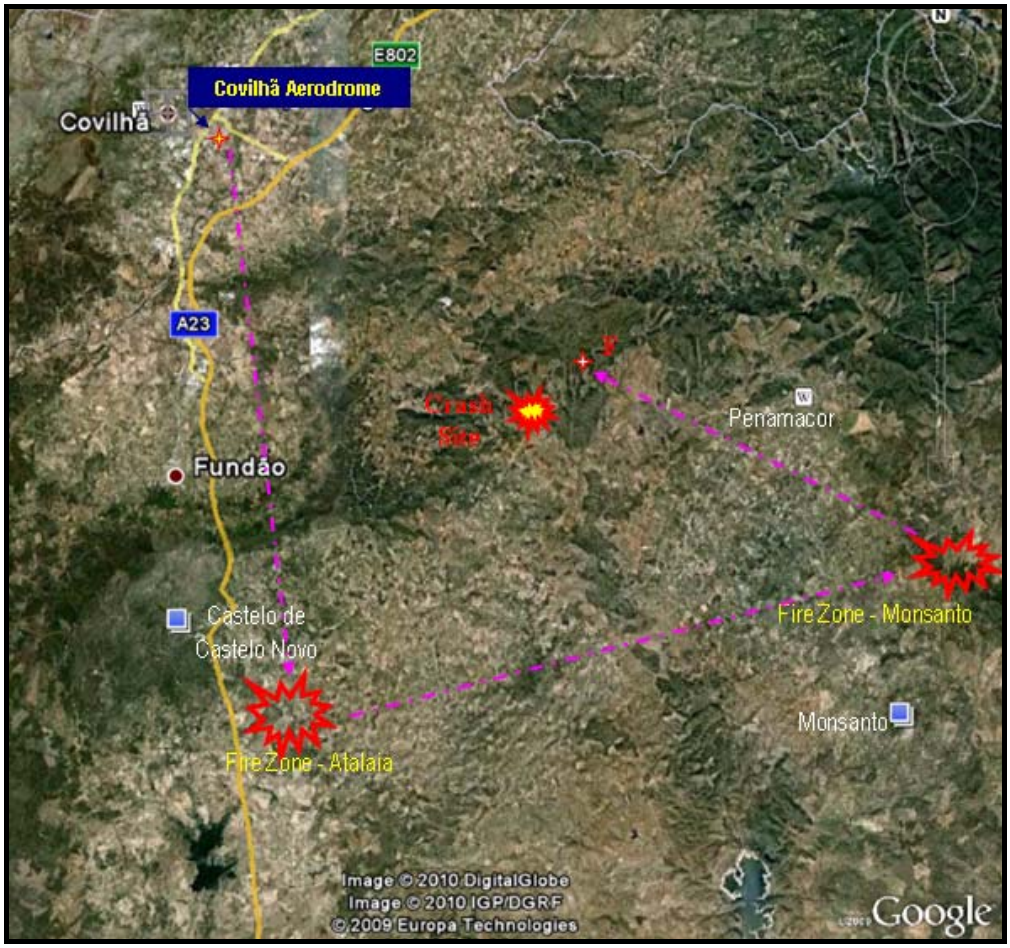
This report has been written in two languages, Portuguese and English. In case of conflict, Portuguese version will take precedence.

1 - All timings referred in this report, unless other indication, are UTC timings (Universal Coordinated Time). By that date, local time was equal to UTC + 1.

1. FACTUAL INFORMATION

1.1 History of Flight

On the 12th of August, 2009, there were several wild fires burning in Castelo Branco district, namely in Atalaia do Campo (Fundão) and Monsanto (Penamacor) regions. Support aircrafts based at Covilhã airfield were called for fire fighting, taking off, by 10:45, two *Airtractor aircraft*, with registrations VH-LIC e VH-LIH, and call signs A-13 e A-14, respectively, heading to Atalaia fire scene (*picture nr 1*).

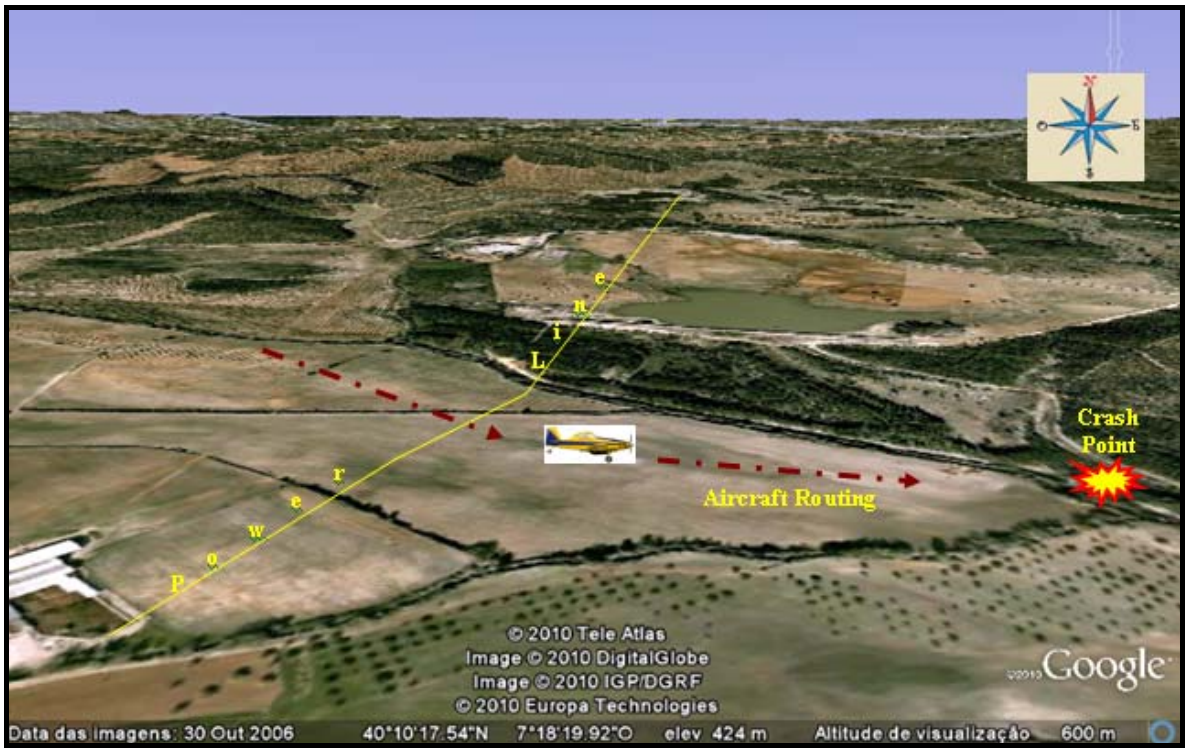


Picture Nr 1

Approaching that area, because the fire was under control and almost extinguished, both aircrafts were rerouted to another fire focus burning in the proximity of Monsanto.

After a selective discharge, A-14 climbed to 2500ft (AMSL) and proceeded back to Covilhã aerodrome, for refuelling & reloading. Approximately half way (*about 18km to Covilhã*), it suffered an unexpected power reduction, which could not be altered with throttle forward & back movement. The pilot switched ignition ON and checked fuel selection, trying to recover lost power. In spite of his efforts the pilot couldn't get more than 62%Ng, deciding for an emergency landing. He started looking for a suitable area and noticed a farm land, without high vegetation, at an average altitude of 1500ft (AMSL), and planned its flight for that place.

Unsure about the possibility to reach the chosen field, the pilot feathered the propeller (to increase gliding capability) and, after avoiding a power line, he managed to touch the ground but was unable to stop the aircraft in the available distance, jumped over a gully and crashed into a pine forest, the other side (*picture nr 2*).



Picture Nr 2

It was a violent collision, causing the propeller reduction box case to break apart and heavy damage on wings leading edge and landing gear. After the impact, the pilot selected OFF all switches, positioned fuel condition lever to OFF position and left the plane, together with passenger. Aircraft cabin resisted to the impact and both people on board left the plane by themselves and run away the aircraft, which caught fire in engine's front zone.

The presence, nearby, of a fire fighting helicopter, provided an opportune water discharge over the aircraft and the fire was extinguished at the beginning, before it could reach the spilled fuel and propagate to the adjacent forest.

1.2 Injuries

Both people on board suffered no injuries.

1.3 Aircraft Damage

The aircraft suffered light damage on the fuselage and tail, and heavy damage on the wings, landing gear and power plant (*picture nr 3*).

Picture Nr 3

1.4 Other Damage

There were some pine trees destroyed by the aircraft collision.

1.5 Personnel

The Pilot in Command was an Australian citizen, 32 years old, male, with following qualifications & experience (*table nr 1*):

Flying License		Flight Experience		
			Total	On Type
Type:	CPL (A)	Total:	3496:00	N/D
Validity:	Vitalícia	Last 90 days:	60:00	60:00
Qualifications:	SEP; Ayres Turbo	Last 28 days:	22:00	22:00
Last Medical Examination:	09-06-2009	Last Week:	04:00	04:00
Limitations/Restrictions:	Nil	Last 24 hours:	01:00	01:00

Table Nr 1

Travelling as a passenger, there was another pilot, Portuguese citizenship, acting as translator and operating the communications with ground stations (because the PIC didn't speak Portuguese). He was not qualified on the aircraft and was acting as communications operator, only.

1.6 Aircraft

1.6.1 General

The Air Tractor AT-802F has been designed as a wildfire fighter aircraft. It is a low single wing aircraft with a conventional non-retractable landing gear, equipped with a 1350SHP turbo-prop engine and a five blade variable pitch propeller. Capable of a high speed & manoeuvrability, carrying 820USG (3104 litres) of water & fire retardant it may be displaced quickly and extinguish any fire at its beginning.

Figura Nº 4

VH-LIH aircraft belonged to Australian enterprise "Pays Air Service Pty, Ltd", had an Australian registration and a valid Airworthiness Certificate issued by Australian Civil Aviation Safety Authority (CASA). It had seating for two people and a certified Maximum TakeOff Mass (MTOM) of 16000Lbs (7512kgs) with following references (*table nr 2*):

Reference	Airframe	Engine	Propeller
Manufacturer:	Air Tractor Inc.	Pratt & Whitney Canada	Hartzell Propeller Inc
Model:	AT-802F	PT6A-67R	HC-B5MP-3F
Serial Number:	0289	PCE-105117	K61015
Year of Manufactory:	2008	N/A	N/A
Flight Time:	110:41	110:41	110:41
Landings/Cycles:	N/A	N/A	N/A
Last Inspection:	25-06-2009	25-06-2009	25-06-2009

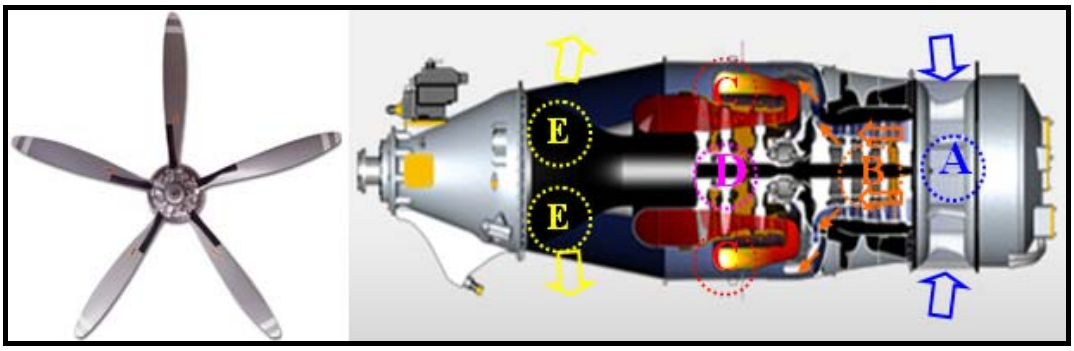
Table Nr 2

The aircraft was equipped with one 820USG (3104 litres) capacity water/fire retardant tank, with a computerized discharging system (allowing selective & partial discharges according the needs and conveniences), with a manual back-up and an emergency discharging system, actuated by the pilot.

1.6.2 Power Plant

1.6.2.1 Identification

The aircraft was equipped with a Pratt & Whitney Canada *PT6A-67R* turboprop engine, coupled to a *Hartzell HC-B5MP-3F* five blades variable pitch propeller, with feather and reversion pitch capability (*picture nr 5*).



Picture Nr 5

Running cycle of this type of engine follows a simple process. Air is sucked from atmosphere through air intake (**A**), passes the compressor (**B**) where its temperature & pressure are increased, enters the combustion chamber (**C**) where fuel is added and ignited, increasing more its pressure and temperature, after which it passes through the turbines (**D**) being extracted the energy for accessories & propeller to be powered, escaping back to the atmosphere through exhaust (**E**).

This is a continuous process and only an initial spark is needed to start the engine. From then on, it's enough to have air and fuel for the engine to keep running. In view of this operation process, these engines never stop, provided fuel is fed into combustion chamber.

During a critical phase of turbulence or ice accretion the air flux may suffer some disturbance and the engine flame-out. During such periods it's a normal procedure to keep ignition selected, to avoid engine stoppage. If it stops, pilots should be aware for immediately switch "ON" fuel pump and select ignition switches to "CONTINUOUS".

1.6.2.2 Limitations

As per Aircraft Flight Manual (AFM), main limitations for PT6A-67R engine, installed on this aircraft, were (*table nr 3*):

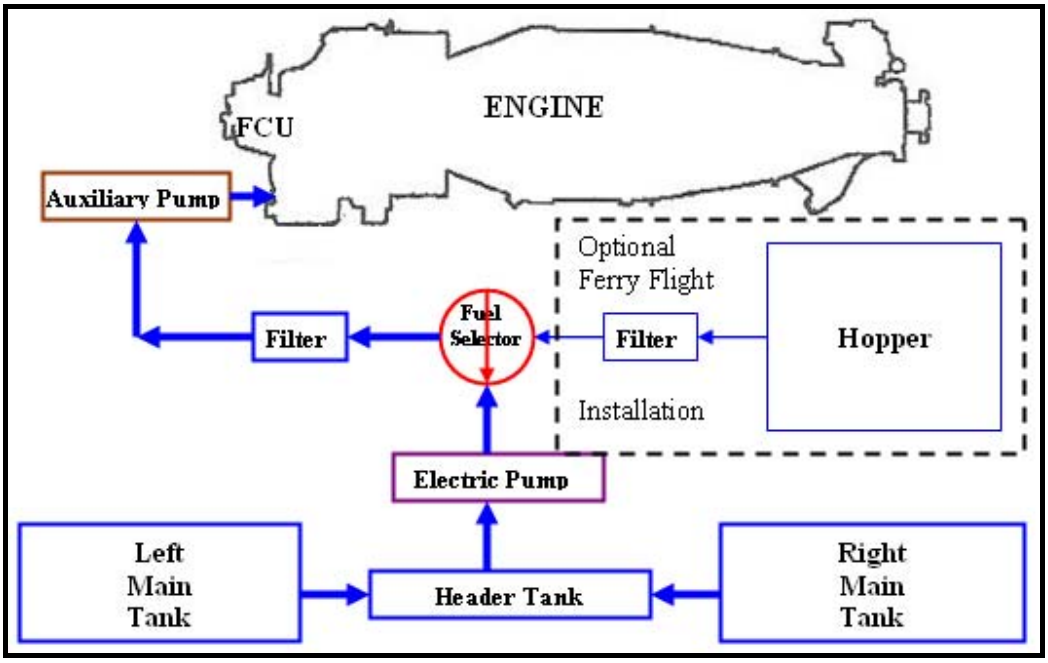
Power Setting	SHP	Torque Lb / ft	Max ITT ºC Nominal	Max ITT ºC Observed	Ng RPM %	Np RPM	Oil Press psi	Oil Temp ºC
TOFF	1424	4400	835	855	104.0	1700	90/135	10/99
Max. Cont.	1220	3770	820	840	104.0	1700	90/135	10/99
Recommended Climb/Cruise	1020	3150 3350 3570	725	790	104.0	1700 1600 1500	90/135	10/99
Min. Idle (run) (flight)				755	68 68		60 (minimum)	-40/99
Starting			700	1000			0/200	-40/99
Transient		5100		870	104.0	1870	40/200	0/110
Max. Reverse	900			765		1650	90/135	10/99

Table Nr 3

1.6.3 Fuel System

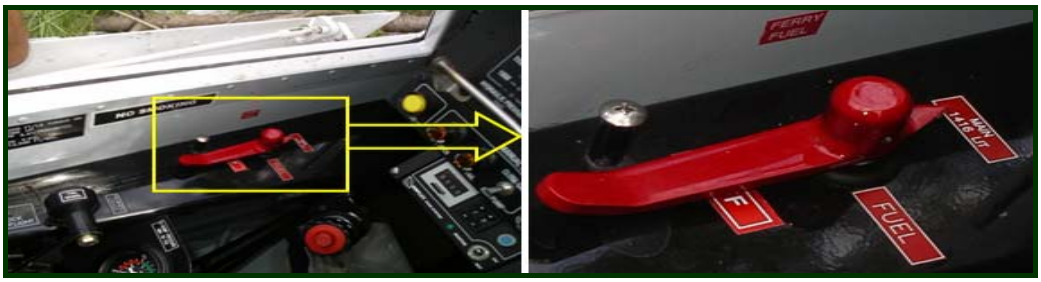
Air Tractor AT-802 may carry 380USG (1438litres) of fuel stored in two main tanks (in the wings), feeding by gravity a central tank (in the fuselage), from where it flows to the engine *fuel control unit* (FCU), through an *electric fuel boost pump*, a *fuel selector*, a *fuel filter* and an engine driven *airframe fuel boost pump* (*picture nr 6*).

Connection from wing tanks to central tank is provided by a straight line, without check valves, which allows the fuel to migrate from one main tank to another.



Picture Nr 6

For long distance flights, specially "ferry" flights, the aircraft has the capability to carry fuel in the "*hopper*", increasing its endurance. A fuel selector valve, situated in front cockpit left side, enables the pilot to select normal tanks or "*hopper*", besides a fuel shutoff position (*picture nr 7*).



Picture Nr 7

Two fuel quantity indicators (**A**), located on instrument panel left side (*picture nr 8*), show fuel remaining quantity in tanks, while the "*fuel flow meter*" (**B**), more to the left and bellow, may provide other information relating to fuel consumption and endurance. A switch (**C**)

commands electric fuel *boost pump* operation and a pressure indicator (**D**) shows fuel pressure in engine fuel feeder line (± *15psi*).

Picture Nr 8

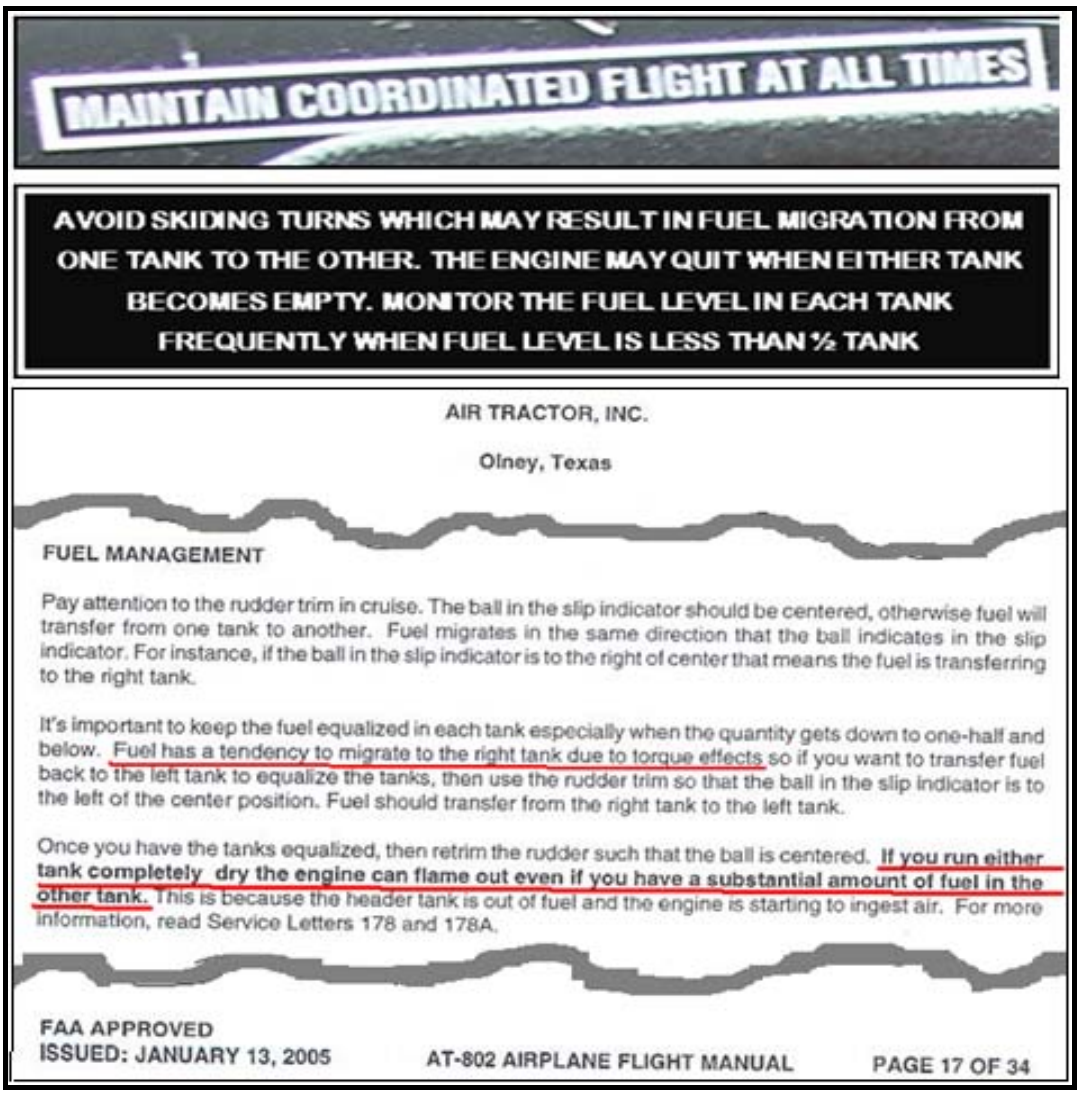
On lower centre panel there's a set of warning lights, being two of them dedicated to fuel system warning, "LOW FUEL" and "FUEL FILTER".

"LOW FUEL" quantity warning light is activated by two sensors, one in each main tank, when usable fuel quantity, in horizontal coordinated flight, becomes less than 28USG (105litres). In case of uncoordinated flight, or after several turns on the same direction, warning light may come up with a smaller quantity in tanks, so the primary system for remaining fuel control should be the fuel quantity indicators. If light comes on, pilot should fly straight & level and monitor fuel gauges. If necessary, allow fuel to transfer from tank with greater quantity or land as soon as possible.

"FUEL FILTER" light indicates that fuel filter is partially blocked and fuel electric boost pump should be turned ON, landing as soon as possible and servicing fuel filter.

Complementing AFM information, several stickers, relating fuel management procedures, have been spread on instrument panel (*picture nr 9*). Special attention is called for the fact that the high torque force present in this aircraft may force the fuel to migrate from left wing

tank to right wing tank, even with aircraft wings levelled, which could be enough to cause an engine stoppage, even if there is fuel enough in right wing tank.



Picture Nr 9

1.7 Meteorology

The weather was hot & dry, with temperatures rounding 35ºC and relative humidity of 15%. The wind was reported Easterly with less than 5Kts and good visibility, with few clouds at 2700ft above ground.

1.8 Navigation Aids

Not applicable.

1.9 Communications

Not applicable.

1.10 Landing Site

When power loss was detected, the aircraft was flying over a rough terrain, on its way back to home aerodrome. On its left side there were some farm fields, almost planes, without trees or other natural obstacles and with more than suitable dimensions for an emergency landing (*see picture nr 2*). The pilot elected one of them as its landing site and acted in accordance to its plan.

During the manoeuvre he discovered there was a power line across the field, which forced him to perform some avoiding manoeuvres. These manoeuvres delayed landing preparation procedures, specially flap's selection, keeping high speed until the aircraft touched the ground, becoming impossible to stop the plane in the cleared field available, to avoid aircraft nose over, and forcing it to go back to the air, pass over a gully and fly straight into a pine forest (*picture nr 10*).

Picture Nr 10

1.11 Flight Recorders

The aircraft was not equipped with flight recorders, they were not mandatory for that type of aircraft, but a Data Acquisition and Alarm Monitoring System (DAAM) was installed. That system was capable of monitoring, presenting and recording critical engine & aircraft parameters, flight & engine times and engine performance tendency, activating an alarm in case of exceedance of any of those parameters.

A copy of such recordings was requested to the operator but it was not provided, alleging the equipment had been partially destroyed by fire and information couldn't be retrieved by normal means. The equipment was sent to Australia to try a different form of reading but there was no further news.

1.12 Wreckage & Impact

Approaching the wreckage an intense fuel smell could be scent, well justified by the heavy damage suffered by the wings, with total rupture of fuel tanks. On the ground, a big stain could be seen under the right wing, resulting from fuel leakage. By the contrary, under the left wing the soil showed no fuel spillage evidence.

Wreckage observation gives the impression that the aircraft was travelling at high speed when impacted with the trees. It was a frontal collision, the aircraft nose penetrating through the pine trees that wing leading edge was cutting and knocking down as the aircraft kept moving forward. Wing trailing edge suffered no damage (*picture nr 11*).

Picture Nr 11

The nose got damaged when impacting the ground, the propeller separated (*due reduction gear box breakage*) and the engine got fire (*picture 12A*). On engine surrounding soil there were no signals of engine liquids spillage, only water and fire-retardant product.

Picture Nr 12

Fuselage and tail section suffered no significant damage, as they never impacted directly with obstacles and were not subjected to forces that could cause heavy deformations or fractures (*picture nr 12B*). Landing gear failed when it contacted the ground vertically, without presence of horizontal movement marks on the soil (*picture 12C*).

Flaps were extended to 10º position (*picture nr 12D*) and Flap position selector switch (inside cockpit) was selected OFF (*picture nr 13A*). Inside forward cockpit all switches were selected "OFF" (*picture nr 13B*), engine & propeller control levers set to engine shutdown and feather position (*picture nr 13C*), but fuel selector valve was selected to wing tanks and not to OFF (*picture nr 13D*).

Picture Nr 13

1.13 Medical or Pathologic

Both people on board suffered no injuries and no special medical assistance was provided but they were transported to hospital to be observed.

1.14 Fire

After the impact, engine front zone caught fire. As the fire was of small intensity and a fire fighting helicopter was nearby, it discharged some water & fire retardant product, extinguishing the fire at its beginning.

1.15 Survival Aspects

There was an immediate action in stopping the fire and giving assistance to the crew. Even if they left the aircraft unharmed, crewmembers were taken to hospital for observation.

1.16 Tests & Research

1.16.1 General

In every turbine engine the operating cycle is a continuous process, since it is started, varying the delivery power in accordance with air mass and fuel quantity metered by Fuel Control Unit (FCU), which calculates the right amount of fuel to be sent to combustion chambers, according received inputs from engine control lever's position, compressor speed, intake & exhaust compressor pressure, air temperature, atmospheric pressure and torque pressure, among others.

Accepting that the engine kept running, having only a partial power loss, it was necessary to detect if there was a mechanical failure, a fuel restriction or any other engine control system malfunction.

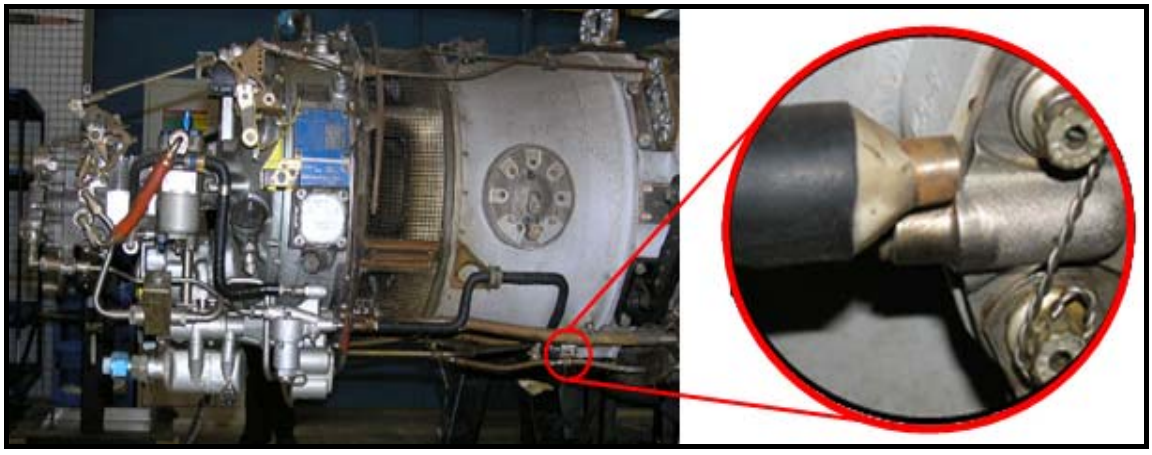
Engine has been removed from the aircraft and sent to the manufacturer, Pratt & Whitney Canada (PWC), for investigation, in order to determine the possible causes for that partial power loss. Engine controls and some accessories were tested as well.

The results of such inspection are shown bellow, supported by PWC report and associated images.

1.16.2 Engine Inspection

Engine assembly was in good shape and without visible damage, be it previously or after impact, except propeller reduction gear box case, which had been fractured on impact. Gear box interior inspection showed no damage to reduction and transmission gear system.

Engine exterior detailed inspection revealed a "P3" (*compressor outlet pneumatic pressure*) line fractured adjacent to the juncture to the tube and gas generator case fitting, at the brazed joint (*picture nr 14*).



Picture Nr 14

Analysis of this fracture surfaces indicated it has been produced by low stress forces acting for long periods, with a low propagation rate, until total rupture was attained. It could not be established with certainty the fracture causes, once the parts and the braze joint met drawing requirements.

Fracture microscopic examination showed there was a hammering process between mating surfaces, which could indicate there was a fissure previous to the event but parts were maintained together and granting the pressure inside the line.

Anyway, it was found that the installed line (*p/n 3031829-A*) didn't correspond to the last manufacturer specification, referred by P&WC SB Nr 14269, from 23-11-1999, which recommended the line to be replaced by a more durable one (*p/n 3123019-01*) as soon as the subassembly was disassembled and access to that part was available. Checking engine records, last heavy work was done in June 2006, but that SB was not incorporated.

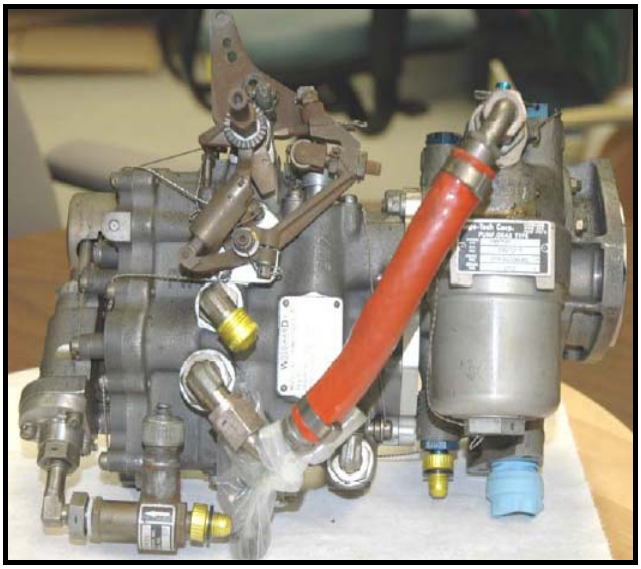
1.16.3 Engine Accessories & Controls' Inspection

For better clarification and in order to confirm and isolate the partial power failure, more significant engine accessories & controls, especially those directly connected to fuel system and propeller control system, were submitted to shop examination, some of them by equipment providers.

1.16.3.1 Fuel Pump & Fuel Control Unit

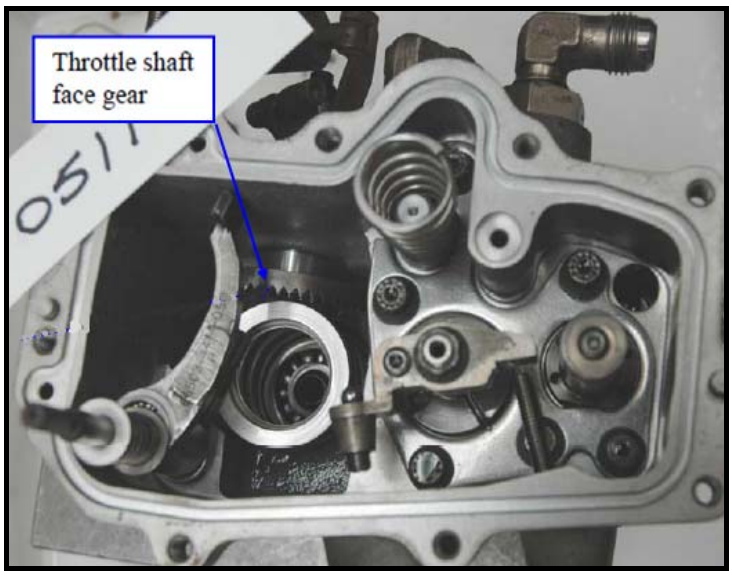
In face of pilot in command (PIC) information, declaring that throttle forward and back movement caused no change on engine RPM, fuel control unit and fuel pump (*picture nr 15*) were disassembled and examined.

In fuel filter inlet screen some metallic debris were found, but fuel pump body and outlet filter showed no solid contamination or water mixed with fuel. Fuel pump performance was considered normal.



Picture Nr 15

Fuel control unit (FCU) was tested and a significant disagreement was noted between reading values and factory settings.



Picture Nr 16

FCU was disassembled and, besides a lack of tightness of cover screws and some wear on fly-weight toes, it was discovered that throttle shaft face gear had jump a tooth on the 3D cam gear surface (*picture nr 16*), which could be caused, most probably, by the impact with the ground.

Shaft face gear was repositioned and free throttle movement was recovered.

A new FCU test was performed and a slight disagreement from factory settings were confirmed, attributable to operator's field settings for the aircraft manufacturer recommended values (*idle of 68% instead of 73%*). Once the FCU was re-adjusted to engine manufacturer settings, new values were found, with a disagreement of 1% or less.

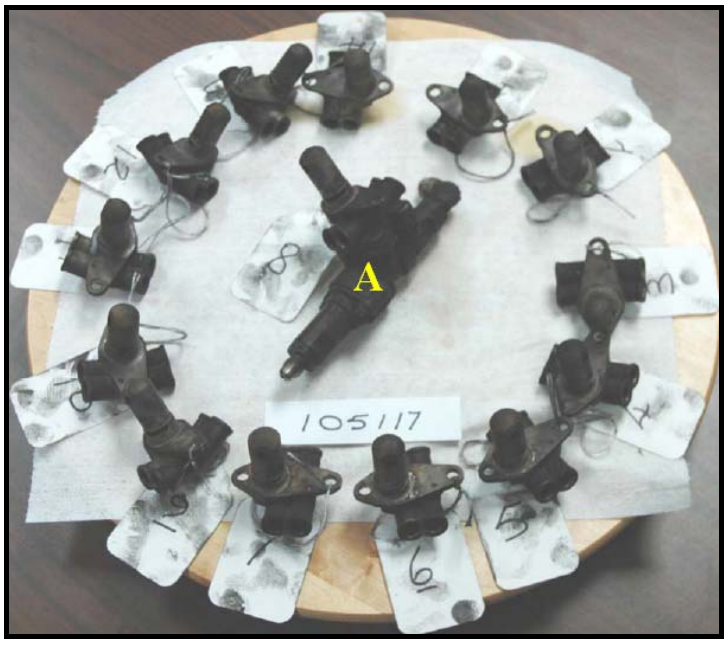
1.16.3.2 Oil/Fuel Heat Exchanger

This heather exchange unit (*picture nr 17*) was sealed and there was some fuel and oil inside its body and connecting pipes. Operational tests carried-out showed nothing abnormal on its performance.

Picture Nr 17

1.16.3.3 Flow Divider Valve & Fuel Nozzles

Flow divider valve and fuel nozzles (*picture nr 18*) have been disassembled and individually tested.



Picture Nr 18

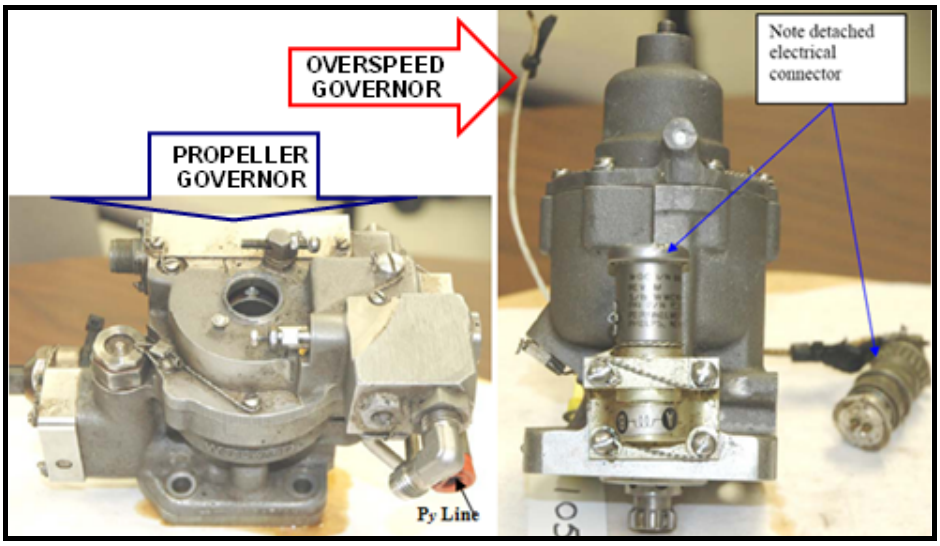
Flow divider valve (A) presented a fuel leak considered to be a consequence of the fire declared after the incident, which destroyed the seals near discharge valve and check valve rubber stop. As a consequence of heat and deterioration in flow divider valve, fuel nozzles became total or partially blocked, as described bellow (*table nr 4*).

Fuel nozzles test observations	
Nr	**Observation**
1	Not tested due to obstruction in the inlet passages.
2	Primary spray quality unacceptable. Combined primary and secondary flow rate 37.2pph (minimum limit is 38.3pph). Secondary spray quality unacceptable.
3	Primary spray quality unacceptable. Primary spray angle 74 degrees (minimum limit is 75 degrees). Secondary spray quality unacceptable.
4	Primary spray quality unacceptable. Primary spray angle 70 degrees (minimum limit is 75 degrees). Secondary spray quality unacceptable.
5	Primary spray flow rate 7.6pph (minimum limit is 8.5pph). Primary spray angle 69 degrees (minimum limit is 75 degrees). Primary spray quality unacceptable. Combined primary and secondary flow rate 36.2pph (minimum limit is 38.3pph). Secondary spray quality unacceptable.
6	Primary spray flow rate 8.1pph (minimum limit is 8.5pph). Primary spray angle 70 degrees (minimum limit is 75 degrees). Primary spray quality unacceptable. Secondary spray quality unacceptable. Combined primary and secondary flow leaking at the nozzle tip.
7	Primary spray quality unacceptable. Secondary spray quality unacceptable.
8	Primary spray quality unacceptable. Combined primary and secondary flow rate 35.5pph (minimum limit is 38.3pph). Secondary spray quality unacceptable.
9	Not tested due to obstruction in the inlet passages.
10	Not tested due to obstruction in the inlet passages.
11	Not tested due to obstruction in the inlet passages.
12	Not tested due to obstruction in the inlet passages.
13	Incomplete flow at primary and no flow at secondary due to internal obstruction.
14	No flow at primary or secondary due to internal obstruction.

Table Nr 4

1.16.3.4 Propeller Governor & "Overspeed" Governor

Propeller governor "Py" pressure line was found cut and overspeed governor electrical connector was found detached from the solenoid (*picture nr 19*).



Picture Nr 19

Examination of these units, regarding their condition and operation, didn't find any defect or abnormality (prior to the event), which could influence engine performance and cause any loss of power.

1.16.4 Fuel Management

In face of aircraft characteristics and type of operation involved, it was not possible to attribute a correct fuel consumption value for each flight hour, once it was dependent of flight phase and engine regimen to be used. Considering that take-off and initial climb consumption was greater than cruise consumption and even this one could vary with altitude and aircraft total mass, average hourly fuel consumption should be different four short or long distance missions. In order to determine the fuel quantity on board of the aircraft, at event's time, in the absence of a pilot registry and due the rupture of fuel tanks on impact, it became necessary to establish a ponderable average of hourly fuel consumption.

Technical Logbook registries were consulted and all those relating to the operation from Covilhã aerodrome, from the first of July to the 10th of August (last refuelling before accident), were taken into account. In face of the diversity of flown sectors, during that period, with flying times varying from 6 to 74 minutes, being used 13300 litres of fuel to fly 31.17 hours, an average fuel consumption of 426.7 l/h, or 7.1 l/mn, was calculated.

After last refuelling (1400 litres) the aircraft flew 105 minutes (equivalent to 745 litres of fuel), so 655 litres should remain in tanks, at the moment of the accident (quantity enough to be stored in one tank only).

1.17 Organization & Management

The operator didn't have this type of aircraft on a permanent basis in his Air Work Operator Certificate (AWOC), being included on a part time basis, only during fire fighting season. For the same reason he didn't recruit qualified technical personnel to provide operational and maintenance assistance to this fleet, being these needs covered by pilots and maintenance engineers recruited by the lessor and owner of the aircraft, the Australian enterprise "Pays Air Services". Operator's responsibility was limited to logistic support and accountability towards Portuguese Civil Aviation Authority (INAC).

1.18 Additional Information

There is no other complementary information to refer.

1.19 Special Investigation Techniques

No special investigation techniques were used for this investigation.

2. ANALYSIS

2.1 Flight Planning

When engaged in this type of operation, wild fire fighting, crews and aircrafts are always in alert, with programmed fuel and fire fighting product on board, ready to fly to the point where the fire starts. Usually they operate on pairs of aircrafts, according the daily briefing made at operational base.

In this case the aircraft involved was operating together with another similar aircraft. This was the second sortie of that day, to the same place, and no special preparation has been done but water replenishment, once the fuel on board was more than enough for the flight.

2.2 Flight Progress

Like on first sortie, the pilot followed the other aircraft to fire area and, being that fire considered extinguished, he was diverted to a second place where fire was active and where he made a selective discharge of water & fire retardant.

On the way back to base (LPCV) an engine partial power loss occurred. Pilot acted on throttle forward & back but no change on engine acceleration was felt. He, then, selected ignition to “CONTINUOUS” and switched “ON” starter motor, but didn’t actuate electric fuel pump.

AFM recommends:

> Remember that turbine engines seldom fail so long as fuel is being provided. An important procedure in this respect is to know the location of the fuel boost pump switch and the CONTINUOUS position for the ignitor switch. You should have a solid reaction to do two things anytime there is an indication of a power loss:
>
> 1. Put the ignitor on CONTINUOUS
> 2. Turn ON the fuel boost pump switch.
>
> At the same time you should be pushing the stick forward to get the nose down to make sure the airplane doesn't stall while you are in the process of finding out what is wrong.

Even so, tachometer showed 62% Ng, confirming the engine was running at idle power, but being impossible for the pilot to increase power for normal cruise values.

Unable to maintain altitude and speed, in order to proceed to base, the pilot was forced to opt for an emergency landing, for which he identified a farm field, nearby, suitable for a landing site.

AFM recommends:

> **FORCED LANDING: (Engine Power Remains)**
>
> 1. Maintain 125 to 130 mph (109 to 113 kts) airspeed with approximately 10° flaps.
> 2. Select a safe dump area if possible.
> 3. Dump the hopper load and move the control stick forward as the dump is made to control nose pitch-up.

Flight track calculation and speed & altitude control, even considering the existence of power lines across the field, was not accurate enough. Approach was flown at high speed and flaps were selected to first position (10º) only. That contributed for the aircraft to cover the entire available landing field without being able to stop and continued flying, still at high speed, against a pine forest, where it crashed.

AFM recommends:

FORCED LANDING: (Engine Failure - Proceed as time and altitude permit)

IF CARRYING LIQUID IN HOPPER PROCEED AS FOLLOWS:

1. Dump hopper load. Feather prop to extend glide.
2. If a re-start is to be attempted, proceed with AIR-START Procedures as described earlier.
3. Maintain 90 to 100 mph (78 to 87 kts) (IAS) and look for suitable landing area.
4. Tighten seat belt and shoulder harness.
5. If landing is to be made on road with a strong cross-wind, leave flaps retracted.
6. If landing in open field extend flaps and maintain at least 80 mph (70 kts) (IAS) until flare for landing.
7. Turn OFF fuel valve once air-start procedure is abandoned.
8. Pull Start Control Lever "S" aft to fuel cut-off position "C".
9. All switches OFF.
10. Open both canopy doors during approach.

2.3 After Impact Evaluation

2.3.1 Wings

More significant damage was caused to the wings, which absorbed the major impact forces.

Wing collision with pine trees caused the leading edge to be destroyed and fuel tanks to rupture. When the investigator arrived in place, a heavy fuel smell could be sensed in the air, there was a big stain on the ground, under right wing, but the soil was clean under left wing, which may indicate that left wing tank was empty or with a minimum quantity of fuel.

This assumption could be supported by the fact that the calculated total amount of fuel on board could be contained in one wing tank only (*see 1.16.4*) and engine torque forces could cause a fuel migration to right wing tank, if required control measures were not taken to avoid it (*see 1.6.3*).

In such conditions an engine power loss was possible (even its stoppage) with enough fuel on board.

2.3.2 Fuselage

Fuselage and tail suffered only minor damage because it didn't impact obstacles. Wing leading edge impacted directly with the trees and dampened the crash forces, reducing the aircraft speed and causing the fuselage to contact the ground vertically, which broke main landing gear.

Cabin stiffness and the use of safety belts contributed for the absence of injuries.

2.3.3 Power Plant

Propeller reduction gear box was found fractured and separated from the engine due the propeller blades collision with the ground. Reduction gear and shafts showed no damage or cracks.

Fire deflagration on engine front zone (near exhaust) suggests there was fuel in engine feeding line, together with an ignition source. The way it was promptly extinguished shows it was a small quantity and under low pressure. No other fuel spillage evidences were found in the vicinity of the engine.

2.4 Engine Operation

Under normal cruise conditions, engine indications should be similar to those values shown on table nr 5, bellow:

Power Setting	SHP	Torque Lb / ft	ITT ºC	Ng RPM %	Np RPM	Oil Press psi	Oil Temp ºC
Cruise	≤1020	≤3570	<725	58<104.0	1425/1700	90/135	10/99

Table Nr 5

Pilot report didn't refer registered values but engine rotation speed (62% Ng), which is equivalent to idle speed, obtained after an in-flight restart was attempted (starter and ignition ON).

Throttle movement forward & back produced no effect on engine regimen, which means fuel quantity delivered to the engine didn't change, once there was no mechanical restriction to engine operation.

Considering there was enough fuel on board (fuel pump and oil/fuel heather examination confirmed the presence of fuel in these units and, after impact, the engine caught fire) one should infer that FCU was not providing the fuel required to sustain the power equivalent to throttle position.

Tests carried on FCU concluded it was operating according expected field selected values and, on engine examination, only "P3" line was found cut, preventing compressor outlet pressure signal to reach FCU. That pressure information was fundamental for the unit to calculate fuel amount to be delivered to fuel nozzles. Loosing that information and receiving atmospheric pressure value, instead, FCU would meter a fuel quantity appropriate for a lower regimen (consistent with that equivalent compressor outlet pressure), independent of throttle selection.

Microscopic analysis of fracture surfaces showed hammering marks between both surfaces, denouncing there was a fissure prior to the event, but parts were kept together, allowing compressor pressure to reach FCU. With part's separation, due to any manoeuvre or vibration, pressure feeding stopped and FCU ceased to deliver throttle position required fuel.

On the other hand, presuming left wing tank was depleted, being electric fuel pump switched OFF, it was possible that fuel pressure in FCU fuel feed line to be insufficient to sustain engine acceleration, situation foreseen by aircraft manufacturer.

AFM states:

FUEL MANAGEMENT

Pay attention to the rudder trim in cruise. The ball in the slip indicator should be centered, otherwise fuel will transfer from one tank to another. Fuel migrates in the same direction that the ball indicates in the slip indicator. For instance, if the ball in the slip indicator is to the right of center that means the fuel is transferring to the right tank.

It's important to keep the fuel equalized in each tank especially when the quantity gets down to one-half and below. Fuel has a tendency to migrate to the right tank due to torque effects so if you want to transfer fuel back to the left tank to equalize the tanks, then use the rudder trim so that the ball in the slip indicator is to the left of the center position. Fuel should transfer from the right tank to the left tank.

Once you have the tanks equalized, then retrim the rudder such that the ball is centered. **If you run either tank completely dry the engine can flame out even if you have a substantial amount of fuel in the other tank.** This is because the header tank is out of fuel and the engine is starting to ingest air. For more information, read Service Letters 178 and 178A.

3. CONCLUSIONS

3.1 Findings

Based on facts referred in **1.** and considerations expressed in **2.** the following conclusions may be formulated:

1st The flight was part of a wildfire fighting mission, in coordination with National Civil Protection Authority;

2nd The pilot owned a valid Pilot License, which granted him the right to fly that aircraft, and was qualified for that type of mission;

3rd Aircraft Airworthiness Certificate, issued by state of registry's Civil Aviation Authority, was valid, manufacturer recommended maintenance programme had been complied with and there was no report of any restriction or anomaly impairing its operation;

4th The aircraft carried fuel enough for the entire flight, including reserves;

5th Aircraft engine performed normally during the fire fighting mission and only on the way back to base it suffered a power loss, becoming stagnated at 62%Ng;

6th Pilot was unable to recover normal engine power, using Aircraft Flight Manual recommended procedures, and tried to make an emergency landing on a devoid agricultural field;

7th The manoeuvre was rendered more difficult by the presence of power lines across the field and the pilot finished by missing the intended landing area, crashing in a pine forest, the other side of the field;

8th In the crash the aircraft suffered substantial damage, but both people on board got out unharmed;

9th Local inspection detected absence of fuel evidences in left wing fuel tank;

10th This lack of fuel could, according manufacturer issued AFM, lead to engine partial (or even total) power loss;

11th Engine examination revealed the fracture of compressor outlet pressure (P3) line connection, near compressor case, leading to Fuel Control Unit (FCU);

12th Loss of such information, by FCU, was sufficient cause for the engine to become stagnant and not deliver throttle position required power;

13th Other examinations to engine and main accessories couldn't find evidence of any other cause for engine malfunction.

3.2 Causes of the Accident

3.2.1 Primary Cause

Fracture of pressure line from P3 to FCU could be the probable cause for the engine to loose normal power control and revert to idle power, forcing the pilot to try an emergency landing on unprepared terrain, which was not well succeeded.

3.2.2 Contributive Factors

For the inadequate outcome of the issue, may have contributed the following factors:

1st Non compliance of P&WC SB Nr 14269, from NOV-23-1999, recommending to replace pressure line p/n 3031829-A by p/n 3123019-01, when subassembly was disassembled and access was available to the part;

2nd Pilot concentration on engine power recovering actions let him with less time to dedicate to track and speed calculations, making him to miss the intended landing field;

3rd The presence of power lines crossing the field forced the pilot to performed some avoiding manoeuvres and an unstabilized approach with an inaccurate speed control;

4th The use of a small flap position selection gave more gliding capability but the pilot had to keep higher speed, which contributed to fly beyond the field, without stopping the aircraft on available distance and hitting the trees violently;

5th Engine stoppage before the impact could probably minimize crash consequences and avoid the fire after the accident.

4. SAFETY RECOMMENDATIONS

It was considered to be neither relevant nor opportune to issue any safety recommendation, so much so that P & W Canada has advised that they plan to revise SB 14269, increasing compliance code from 6 to 3, establishing that part to be exchanged after a certain time interval.

Lisbon, June / 09 / 2011

The Investigator In Charge,

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