## DATA SUMMARY

### LOCATION

| | |
|---|---|
| Date and time | **Sunday, 13 January 2008; 11:25 local time[1]** |
| Site | **1 km west of the municipality of Abay, near Jaca (Huesca)** |

### AIRCRAFT

| | |
|---|---|
| Registration | **G-BYIC** |
| Type and model | **CESSNA TU206G** |
| Operator | **Private** |

#### Engines

| | |
|---|---|
| Type and model | **TELEDYNE CONTINENTAL MOTORS TSIO 520 M7** |
| Number | **1** |

### CREW

#### Pilot in command

| | |
|---|---|
| Age | **56 years old** |
| Licence | **PPL(A)** |
| Total flight hours | **1,400 h** |
| Flight hours on the type | **1,000 h** |
| Flight hours in last 24 h | **2 h** |

| INJURIES | Fatal | Serious | Minor/None |
|---|---|---|---|
| Crew | | | **1** |
| Passengers | | **2** | **3** |
| Third persons | | | |

### DAMAGE

| | |
|---|---|
| Aircraft | **Significant** |
| Third parties | **None** |

### FLIGHT DATA

| | |
|---|---|
| Operation | **General aviation – Private** |
| Phase of flight | **Cruise** |

### REPORT

| | |
|---|---|
| Date of approval | **26 January 2011** |

[1] All times in this report are local unless otherwise specified. To obtain UTC, subtract 2 hours from local time.

# 1. FACTUAL INFORMATION

## 1.1. History of the flight

On 13 January 2008, a CESSNA TU 206G aircraft, registration G-BYIC, was scheduled to make between 4 and 6 parachute jumping flights, departing from the Santa Cilia aerodrome (Huesca).

On the second flight of the day, which took off at 11:04, after the aircraft had been airborne some 12 minutes, the pilot and the remaining people onboard (3 parachuting instructors and 2 passengers, who were going to make a tandem jump) heard a loud noise and saw the aircraft's windshield fill with oil. The engine power immediately dropped off until it stopped. The aircraft's pilot notified the Santa Cilia aerodrome of the engine failure and reported that he was going to ask the parachutists to jump, since he would have to make an emergency landing and did not have enough time to return to the airport.

When the engine failed, the aircraft was 2,500 ft above the takeoff point, which itself was at 2,250 ft MSL (mean sea level), and west of the town of Jaca. After the parachutists jumped from the aircraft, the pilot reported this fact by radio.


**Figure 1.** Final aircraft position

The aircraft landed in a muddy area west of Abay, a town near Jaca. The nose gear detached during the landing, leaving the aircraft resting on the propeller blades, the bottom engine cowl and the main gear. The coordinates of the aircraft's stopping point were 42°34'18.6"N 000°37'14.16"W.

The airplane was found by emergency services some 15 minutes after the accident. The pilot and three of the passengers (one instructor carrying a video camera and two individuals making a tandem jump) were uninjured. The members of the other tandem team fell in rough, rocky terrain and were seriously injured.

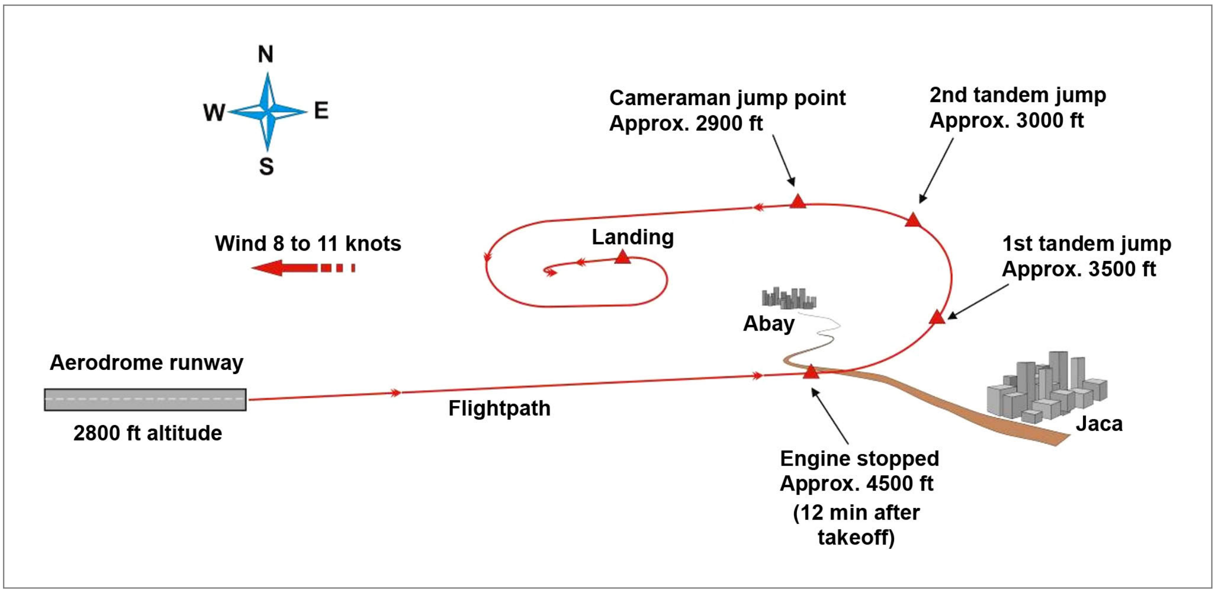


Figure 2. Path taken by the aircraft (not to scale)

## 1.2. Personnel information

The pilot, a French national, had a private pilot license with a single-engine land rating (valid until 31 January 2009) and a Pilatus PC6 rating (valid until 31 July 2008). He had been given a class 2 medical exam in September 2007 that was valid for 12 months.

The pilot had a total flight experience of 1,600 h, plus over 1,000 h on the aircraft type. He normally flew parachutist dropping flights without remuneration.

In the days before the accident, he had made a ferry flight with the accident aircraft. The aircraft that was normally used for this activity was undergoing maintenance, so the owner of said aircraft offered the parachuting club the use of aircraft G-BYIC, which was the same model, a CESSNA TU206G. This aircraft arrived at the Santa Cilia aerodrome the day before the flight from the Ampuria Brava aerodrome (Girona), where it had stayed overnight during its ferry flight from Saint Galmier (France) after making intermediate stops in Avignon Pujaut and Lesignant, also in France. The pilot stated that the ferry flight had been uneventful.

## 1.3. Aircraft information

The aircraft, a CESSNA TU206G "Turbo Stationair", had a valid airworthiness certificate and a total of 3,419:32 flight hours.

The aircraft was powered by a TELEDYNE Continental Motors TSIO 520M7B engine, S/N 825657. This is a fuel-injected, turbocharged reciprocating engine with six cylinders driving a Hartzell PHC-J34F-1RF propeller.

The engine had been installed on the aircraft on 13 February 2004 with 0 flight hours and with 2,762:30 flight hours on the aircraft. The engine had 657 h when the accident occurred.

### 1.3.1. *Engine lubrication system*

The diagram below shows the operation of the engine lubrication system.

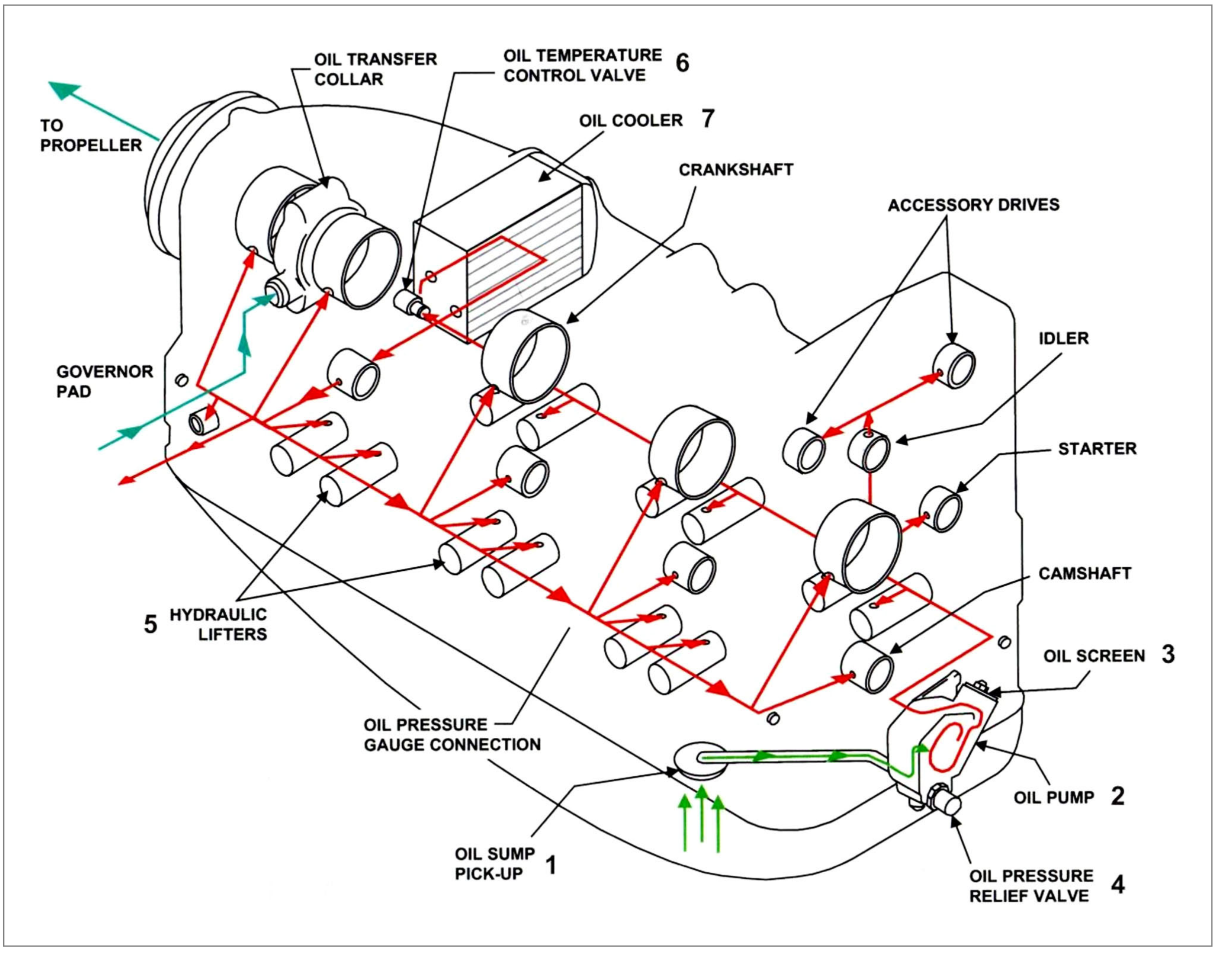


**Figure 3.** Diagram of engine lubrication system

The oil is drawn from the sum (1, fig. 3) through the oil suction tube to the intake side of the engine driven, gear type, oil pump (2, fig. 3). From the outlet side of the pump, oil is directed to the integral oil filter screen chamber (3, fig. 3). An oil by-pass valve is incorporated in the oil pump housing in the event that the filter becomes clogged. An oil pressure relief valve (4, fig. 3) is incorporated in the oil pump housing. The pressure relief valve opens when pump pressures exceed the adjusted limit.

As shown in the figure, from the oil filter discharge port, oil is directed through a crankcase passage to the right crankcase oil gallery. Right side tappets, tappet guides (5, fig. 3) and valve mechanisms are lubricated by passages leading off this gallery.

An oil temperature control valve (6, fig. 3) is located at the front end of the right crankcase oil gallery. When the oil reaches a temperature high enough to require cooling, the oil temperature control valve expands and blocks the passage, directing oil flow through the oil cooler (7, fig. 3). Then oil is directed to the camshaft passage. A groove around the front of the camshaft directs oil to the front camshaft bearing and left crankcase oil gallery. Left side tappets, tappet guides and valve mechanisms are lubricated by passages leading off this gallery.

Hydraulic valve tappets transfer oil from the main oil galleries to the cylinder overhead. Oil flows through the hollow push rods to a drilled oil passage in the rocker arms. Oil that flows through and exits the rocker arms lubricates the valve stems, springs, rotocoils and retainers.

Oil from the left main crankcase gallery is also directed upward through crankcase oil passages to the crankshaft main bearings. Oil lubricating the crankshaft main journals is directed through the upper main bearing oil holes, through crankcase passages to oil squirt nozzles that spray oil onto the underside of the pistons. This oil spray aids in lubrication and heat dissipation. Oil falls from the pistons through the crankcase cavity back to the oil sump.

### 1.3.2. *Maintenance and history of the engine*

The engine, installed with 0 hours on the aircraft, had been remanufactured by TELEDYNE CONTINENTAL MOTORS in March 2003 and installed on the aircraft in February 2004.

The aircraft, registered in the United Kingdom, followed a maintenance program for light aircraft (maximum takeoff weight under 2,730 kg) with reciprocating engines approved by the CAA, CAP 766 Light Aircraft Maintenance Program. This program includes tasks specific to the aircraft's engine.

The maintenance program listed the following inspections:

1. Pre-flight check in accordance with the aircraft's flight manual.
2. An "A" inspection before each flight that included, among the tasks specific to the engine, an oil level check, oil filler cap adjustment, air filter check and a check of the engine for possible leaks or signs or overheating.
3. 50-hour or 6-month check (whichever comes first). The engine-related tasks involve the powerplant installation, air intake and exhaust system, engine lubrication (including an oil change), check of the oil filter and inspection of the spark plugs.
4. 150-hour inspection. Includes the engine-related tasks in the 50-hour inspection and also a check of the installation elements, the operation of the valves, cylinder compression, check of intake systems, check of the ignition, exhaust and turbo systems, lubrication system (tank, coolers, lines, etc.).
5. Annual inspection, Includes all the items in the 50- and 150-hour inspections and some specific to the annual inspection, such as a check of the battery on the emergency beacon.

According to the Engine Logbook (CAP 399), the engine was inspected in keeping with the maintenance program. Some unscheduled tasks were also completed, such as:

- Repair of the engine between 15 November and 14 December 2004. The fuel system was checked after contamination was found in the fuel.
- Repair of the engine on 5 and 6 September 2005. The fuel was checked for contamination.
- Replacement of the number 2 cylinder with 397 h on the engine on 19 December 2005.
- Check for oil loss on 9 June 2006.
- Repair of the engine on 13 December 2006 with 507 h on the engine. Two cylinders (5 and 4) were replaced. The workshop reported that the inspection had been conducted after the operator noted that the engine was overheating.
- Check for oil loss and check of the propeller governor in April 2007.
- Replacement of cylinder head temperature sensor and annual inspection with 577 h on the engine on 29 June 2007.

## 1.4. Wreckage and impact information

The aircraft landed in mud in a hilly and rocky area to the west of Abay, a town less than 1 km away from Jaca (Huesca).

The landing was in an east-west direction. The aircraft traveled 177 m on the ground, ending its run with a turn to the right of almost 180°.

During the on-site inspection, it was noted that the nose gear broke 113 m into the landing run, after which two propeller blades impacted the ground.

The aircraft continued moving, resting on said blades, on the main gear and on the bottom engine cowl. There were marks 145 m into the landing run where the aircraft's left wing tip had touched the ground, causing its leading edge to break off.

Part of a connecting rod (Figure 4) was found 154 m into the landing run, and some 8 meters further, the pin that attached the rod to the piston. Both components were from the no. 4 cylinder.

The connecting rod had broken where the yoke arms join the body of the connecting rod and was missing the head and cover. It had also been deformed by what must have been impacts against the crankshaft before being ejected from the engine.

There were impact marks on the ends of the pin, also produced before being ejected from the engine, and in the center.

**Figure 4.** Connecting rod and pin found along the landing run

The aircraft did not exhibit any outward structural damage of any significance. Only the damage to the bottom of the fuselage, the left wing tip, the propeller blades and the fracture of the nose gear were visible. A loss of oil was noted from the top and bottom engine cowls. There was also a hole measuring about 10 × 10 cm at the top left of the crankcase, in the area of the no. 4 cylinder, through which the piece of connecting rod and pin mentioned above must have been ejected.

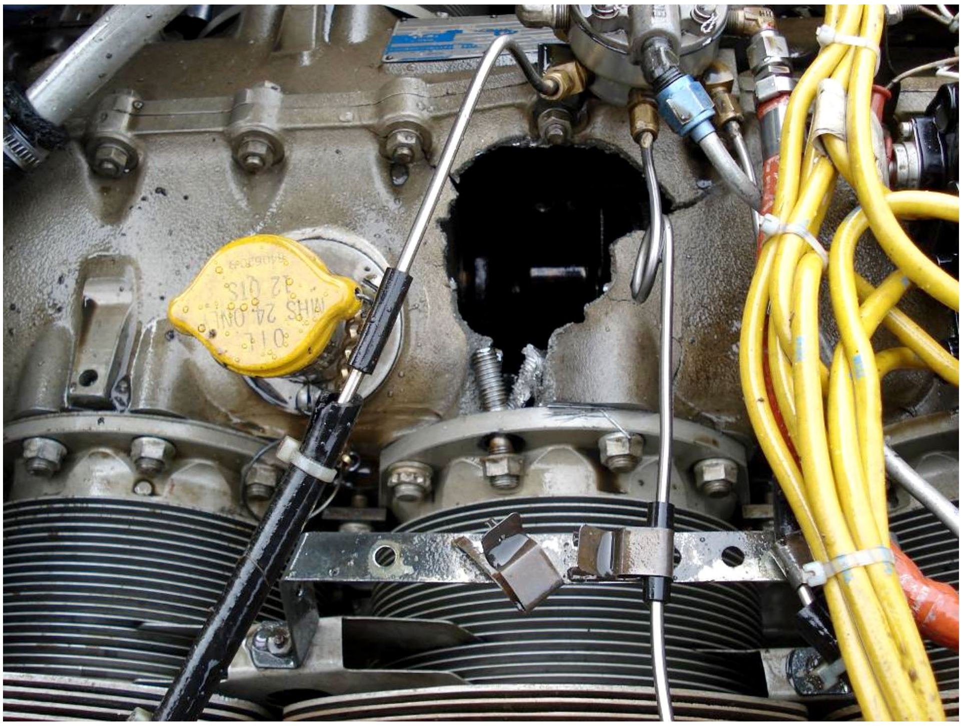

**Figure 5.** Damage to the left side of the crankcase

The engine was difficult, but not impossible, to turn. There was sufficient fuel in the tanks and no signs of water or dirt.

A total of 8.5 liters of oil was drained from the engine (maximum capacity 11 liters).

## 1.5. Inspection of aircraft engine

The engine was removed with help from a representative of the engine manufacturer. An analysis of the zinc chromate primer on the fixed metal part of the deflectors or baffers (metal and rubber diffusers located in the engine nacelle to direct airflow and optimize cooling of the engine cylinders) revealed that friction had worn away the primer from the right part of the engine (nos. 1, 3 and 5 cylinders), whereas the primer on the left side (nos. 2, 4 and 6 cylinders) did not show any signs of friction.


**Figure 6.** Marks on the zinc primer caused by the deflectors

The main damage to the engine was to the no. 4 cylinder and its piston. The connecting rod and pin that joins the rod to the piston were not in the engine, since they had been ejected through the hole found in the crankcase. The edges of this cylinder's liner were damaged and although signs of friction were evident, the piston was not jammed. The piston had broken below the segments. Pieces from connecting rod and its bushings were found in the crankcase.

**Figure 7.** No. 4 cylinder piston

There were various impact marks on both the crankshaft and the camshaft. One of the crankshaft counterweights was particularly damaged.

When the crankshaft was removed, its main bearings and one of the connecting rod cap were found to have suffered from a lack of lubrication, as shown in the figures.

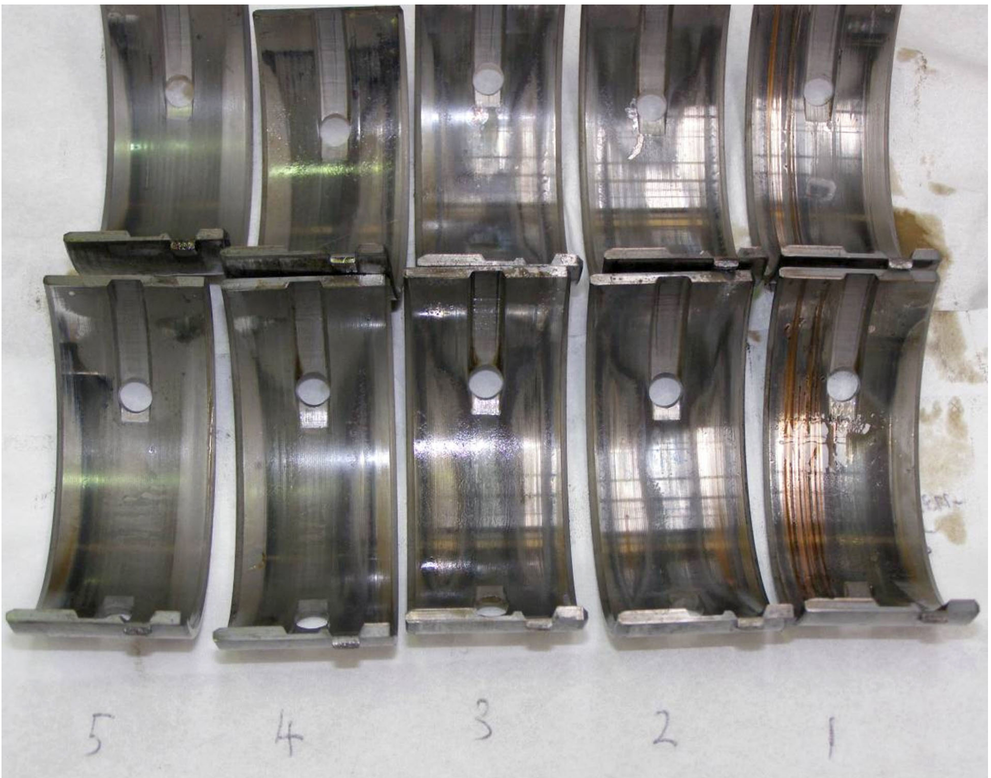


Figure 8. Crankshaft main bearings

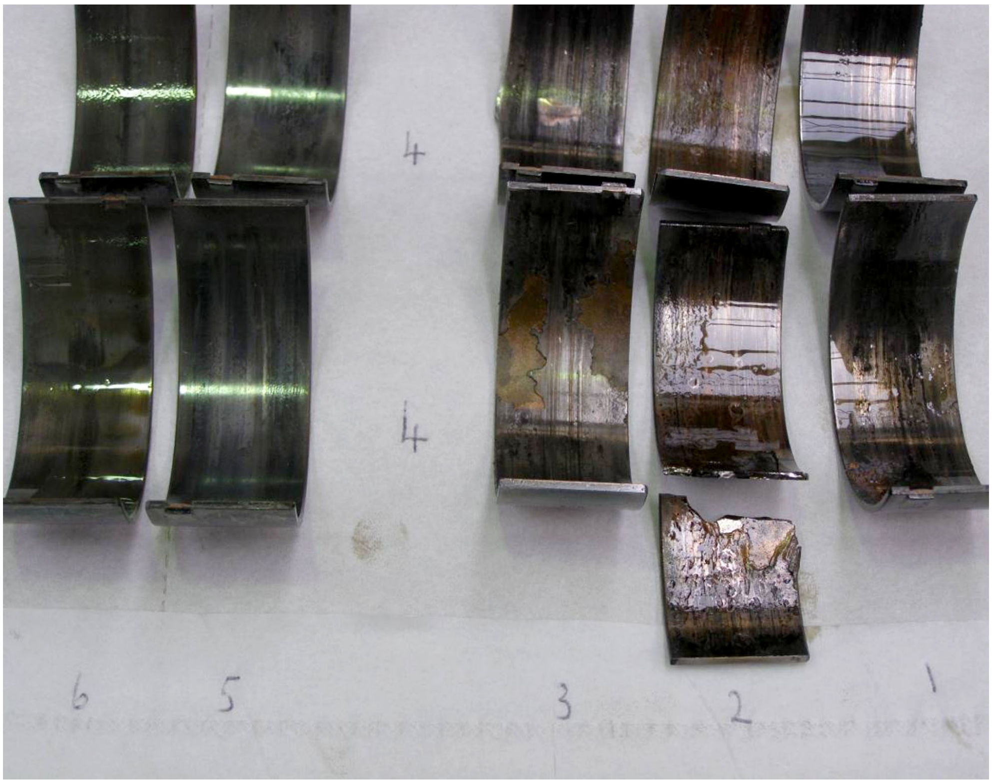


Figure 9. Conecting rod cap bearings

The bearing for the no. 4 conecting rod was not found, though parts from it were recovered from the crankcase. The remaining connecting rod bearing were bent and showed signs of rubbing from a lack of lubrication.

After the engine was removed, it was sent to the manufacturer's facilities for a more detailed inspection intended to establish the reasons that could have resulted in its improper lubrication.

The analysis conducted at the manufacturer's facilities revealed that the damage present in the crankshaft main bearings and in the connecting rods were consistent with improper lubrication. It was also concluded that:

- The cylinder overhead components (valves, rocker arms, guides spring, retainers and shafts) were lubricated and undamaged. It indicates that they had been properly lubricated until the engine was stopped, as confirmed by the fact that the damage to the components resulted from normal operation.
- The crankshaft showed signs of improper lubrication, but it could be turned. It had grooves and mechanical damage, in particular to the counterweight near the connection for the no. 4 cylinder.
- The pistons and connecting rods were in good overall condition. The connecting rod ends assemblies were intact and secured. The no. 4 cylinder connecting rod, as already mentioned, had broken at the yoke arms and the corresponding piston had broken below the segments.
- The two crankcase halves, in addition to the 10 × 10 cm hole in the area of the no. 4 cylinder, showed impact marks and mechanical damage in that area, but the crankshaft support diameters were in good condition, without existing signs of bearing movement or rotation. The oil galleys and passages in the crankcase halves were intact clear and unrestricted.
- The components and galleys of the remaining systems, including the oil and fuel systems, were also in good condition.

The no. 4 cylinder connecting rod and piston were subjected to a metallurgical study, which showed that the material possessed the strength requirements specified and that the fractures present had resulted from an overload.

The cause of the lack of engine lubrication could not be determined.

## 1.6. Additional information

The pilot of the aircraft, who used it on a regular basis, reported that ever since the engine replacement, the aircraft had operated with engine oil temperature readings above the normal operating range.

According to the pilot, several repairs and adjustments were made, but the high oil temperature problems persisted.

After the repair (the turbocharger was replaced, the silent blocks were properly fit and the radiator was repaired), during which the nos. 4 and 5 cylinders were replaced, the high temperature indications disappeared and the aircraft's operations continued normally.

## 2. ANALYSIS AND CONCLUSIONS

### 2.1. Analysis of engine failure

The inspections of the engine revealed that the no. 4 connecting rod had fractured where it attached to the crankshaft. There were impact marks from the connecting rod on the crankshaft, camshaft, the other cylinders and on the walls of the crankcase.

The fracture process probably started in the connecting rod, which would have been followed by the break of the no. 4 cylinder piston, which allowed the connecting rod and the pin to move inside the crankcase, hitting various engine components and the crankcase, until they exited via the hole that was made in the crankcase.

The condition of the crankshaft main bearings, and in particular of the connecting rod bearings, showed warping and even a lack of material, indicative of having withstood temperatures that were high enough to cause local melting of the metal. This points to a lack of lubrication in that area.

Since the engine had sufficient oil, as verified when it was drained during the inspection performed at the accident site, the lack of lubrication could have been due to insufficient pressure, which made it impossible for the oil to reach the affected areas, or to the oil attaining temperatures in excess of normal operating values.

The inspection conducted at the manufacturer's facilities showed that the oil was reaching the rocker arms in all of the cylinders until the engine stopped, meaning that there was probably not a lack of oil pressure.

It was also discovered that the left-side engine baffers were not properly adjusted, since the zinc primer had not worn like on the right side, which resulted in air leaks that gave rise to improper cooling of the cylinders, especially those on the left side.

Lastly, the no. 4 cylinder is in the center left part of the engine (between the 2 and 6 cylinders), where the temperature should be higher than at the ends. According to the lubrication system diagram, the oil first flows through the right side of the crankcase. It is when it flows through the left side that it lubricates the crankshaft, and therefore the crankshaft main bearings and the connecting rods.

As a result of the above, it seems likely that the oil flowed through the lubricating system at a higher than normal temperature, and that this contributed to the inadequate cooling of the engine's cylinders.

## 2.2. Cause

The accident occurred as a consequence of an in-flight engine failure which forced the pilot to conduct an emergency landing.

The engine failed due to the fracture of the no. 4 connecting rod cap as the result of inadequate lubrication of the connecting rod bearings, which caused it to overheat, eventually prompting the connecting rod to fail.