Accident to the CESSNA U 206 registered **F-BXAM** on 7 June 2022 at Punaauia (French Polynesia)

Time	Around 07:50[1]
Operator	SARL Tahiti parachutisme
Type of flight	Instruction parachute drop flight
Persons on board	Instructor pilot + pilot in instruction
Consequences and damage	Aeroplane substantially damaged
This is a courtesy translation by the BEA of the Final Report on the Safety Investigation. As accurate as the translation may be, the original text in French is the work of reference.	

Engine shutdown during descent after parachute drop, ditching in a lagoon

1 HISTORY OF THE FLIGHT

Note: the following information is based on radio and radar recordings along with statements.

The pilot in parachute-drop training, accompanied by an instructor, took off at 07:16 from runway 04 of Tahiti Faa'a to drop four parachutists in the sector of point SC (point ❶ on the flight path below). It was the first flight of the day.

At 07:18:55, he was cleared by the aerodrome controller to climb to FL 100, to point SC (point ❷).

At 07:22:01, he was transferred to the approach controller who confirmed that he could climb to FL 100 and asked him to call back before the drop (point ❸). At 07:37:59, the pilot in instruction reported that he was at three minutes from the drop (point ❹). The controller told him that there was no restriction and asked him to call back on descending through 5,000 ft. The drop took placed at FL 97 overhead point SC.

At 07:44:51, the pilot in instruction reported that he had started the descent[2] to the controller (point ❺). The approach controller asked him to contact the aerodrome controller. According to the crew's statements, the engine failed when descending through 4,500 ft (point ❻).

[1] Except where otherwise indicated, the times in this report are in local time.

[2] In reality he was descending through 5,000 ft.

At 07:48:08[3], the instructor pilot, after taking the controls and the radio and before contacting the aerodrome controller, reported to the approach controller that he thought he had an engine failure. The approach controller acknowledged the message.

At 07:48:25, the pilot emitted three MAYDAY messages indicating that he had had an engine failure on passing abeam point SB and that he was aiming for the lagoon in front of the Méridien hotel. The approach controller transferred him to the aerodrome controller. On first contact with the controller at 07:48:43, the pilot reported that he was in a MAYDAY situation. The controller replied that he would put the emergency services on alert. The pilot indicated once again that he was aiming for the lagoon, between the Méridien hotel and KP 18[4] (Punaauia beach).

At 07:48:56, the controller asked him to display IDENT on the transponder. The communications then broke up before completely breaking off. At 07:49:05, the tower supervisor activated the DETRESFA emergency phase.

The pilot ditched down at the point which he had indicated. The aeroplane turned over on impact (cf. figure 1). The two occupants, unharmed, evacuated the aeroplane.

At 07:51:06, the pilot contacted the tower supervisor by telephone. He indicated that he had landed on the reef and that no-one was injured. The controller replied that he would contact the emergency services.

[3] i.e. 41 s after the last recorded radar contact.
[4] Kilometre Point 18, ground reference also corresponding to point SC.

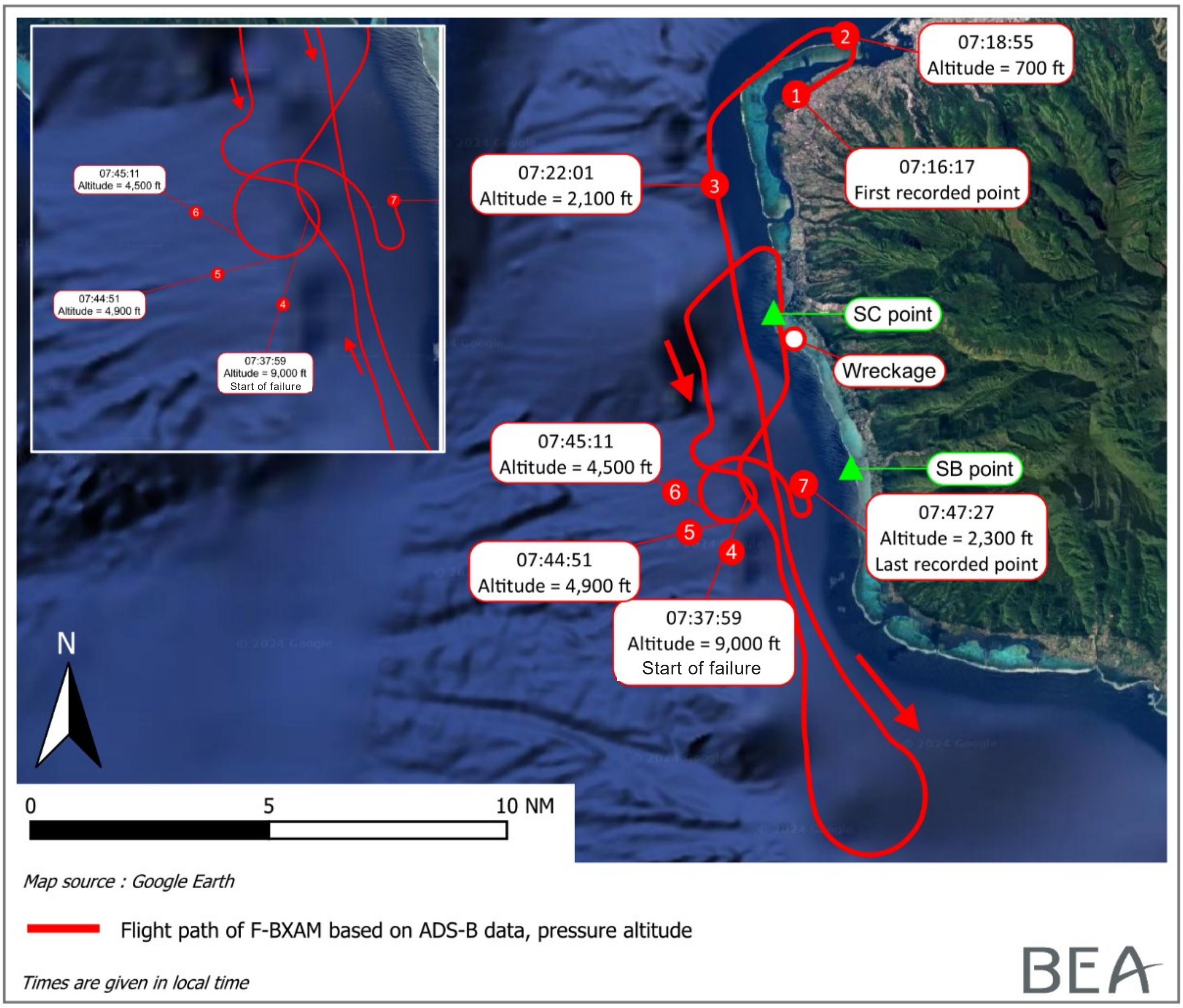

Figure 1: F-BXAM lying on reef
Source: French naval aviation Flotilla 35F

2 ADDITIONAL INFORMATION

2.1 Operation and maintenance of F-BXAM

The aeroplane is owned and operated by SARL TAHITI PARACHUTISME.

The flight was carried out in the scope of a specialised operation complying with the requirements of PART-SPO of Regulation (EU) No 965/2012, known as "AIR-OPS".

The aeroplane's maintenance was organised as follows:
- SEGA AERO was responsible for the CAMO[5];
- C3P was responsible for the maintenance operations.

2.2 Aircraft information

2.2.1 General

The Cessna U206 "Stationair" is a six-seat, single-engine, high wing aeroplane.

The F-BXAM, S/N U20602751, was equipped with a Continental IO-520-F engine providing a maximum power of 300 hp (or 220 kW). This engine S/N 291432R had been installed on the aeroplane in March 2022 after being purchased from RAM Aircraft (USA)[6]. It was delivered with its full TBO after a complete overhaul and had logged an operating time of 149 h 20 min since being installed on F-BXAM.

Figure 2: Cessna U206 registered F-BXAM
Source: Internet

2.2.2 Fuel system particularities

F-BXAM was equipped with two "long-range" fuel tanks for a total capacity of 303 litres including 15 unusable litres. Each fuel tank could hold 151.5 litres including 7.5 unusable litres. The diagram of the aeroplane's fuel system is given in Figure 3 below.

It is specified in the aeroplane Owner's Manual that the engine might shut down due to fuel starvation when the remaining quantity of fuel is equal to or less than one quarter of the tank's capacity[7] and the aeroplane has been flying for a long period in an uncoordinated configuration such as sideslips.

[5] Continuing Airworthiness Management Organisation
[6] https://www.ramaircraft.com
[7] i.e. for this aircraft, 38 l per tank.

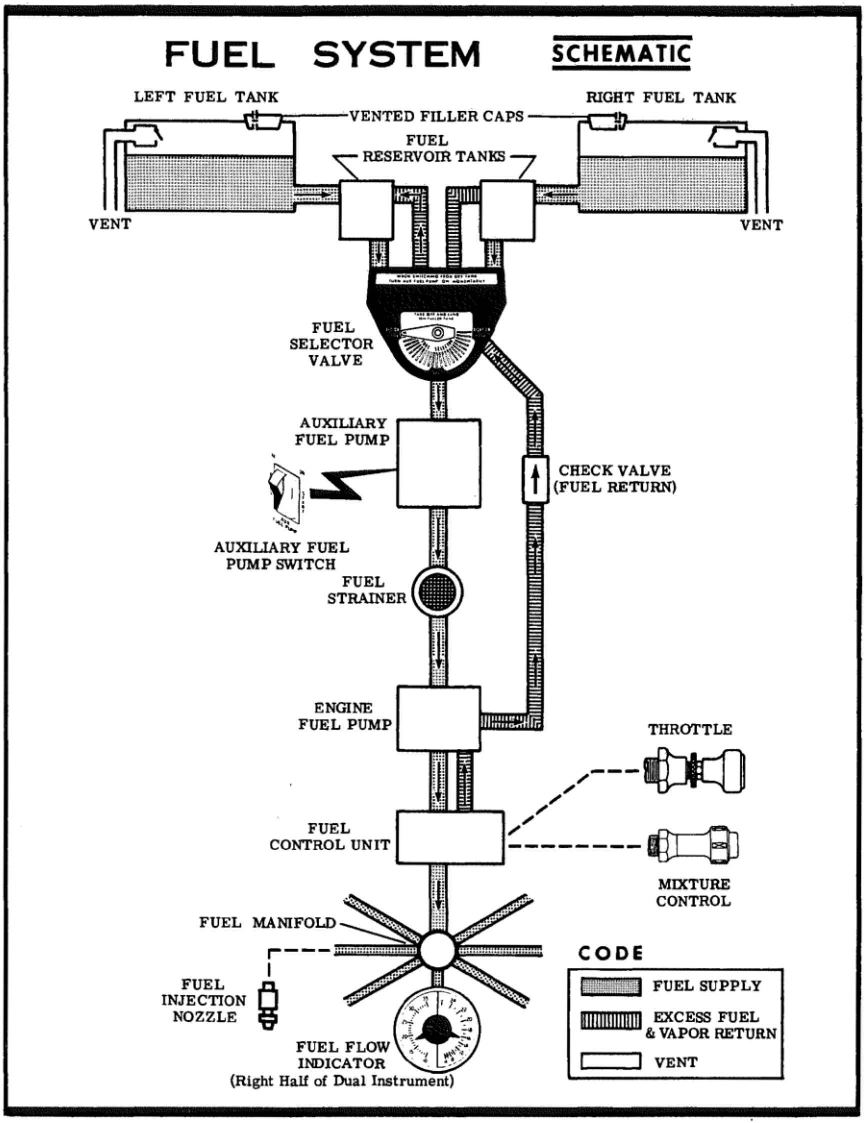

Figure 3: diagram of the aeroplane's fuel system

Source: Owner's Manual CESSNA _ Model U206 _ Section II

2.2.3 Procedure in event of fuel starvation in a fuel tank

The chapter in the Owner's Manual concerning the fuel system specifies:

Excerpt:

"To ensure a prompt engine restart in flight after running a fuel tank dry, immediately switch to the tank containing fuel at the first indication of fuel pressure fluctuation and/or power loss. Then place the right half of the auxiliary fuel pump switch in the ON position momentarily (3 to 5 seconds) with the throttle at least 1/2 open. Excessive use of the ON position at high altitude and full rich mixture can cause flooding of the engine as indicated by a short (1 to 2 seconds) period of power followed by a loss of power. […]

If the propeller should stop (possible at very low airspeeds) before the tank containing fuel is selected, place the auxiliary fuel pump switch in the ON position and advance the throttle promptly *until the fuel flow indicator registers approximately 1/2 way into the green arc for 1 to 2 seconds duration. Then retard the throttle, turn off the auxiliary fuel pump and use the starter to turn the engine over until a start is obtained*."

2.2.4 Refuelling procedures

F-BXAM is refuelled from a stepladder using a 200-litre drum and a pump (always the same one, supplied by C3P). The quantity is measured with a 30 cm long wooden gauge graduated in litres, kept in the aeroplane ("home-made" gauge, specific to Tahiti Parachuting, different from the other gauges used by C3P).

The instructor and the pilot in instruction stated that they thought that it was a good gauge, considered it as more reliable and found that the flat square surface made measuring easier.

The area where the aeroplane was parked while being refuelled was described as flat.

Eighty litres were required for the flight, corresponding to the regulatory 45 min (i.e. 40 l) + 40 l per rotation. During the pre-flight checks of the aeroplane, the pilot in instruction, at the instructor pilot's request, checked the quantity present in the fuel tanks. This was 100 l (60 l in the RH fuel tank, 40 l in the LH fuel tank) which was considered satisfactory by the instructor pilot.

No route factor fuel is included for a drop flight. The fuel tank selection is only changed when on the ground between two drops.

The analogue type gauges do not provide accurate fuel monitoring. The operator had had an EDM 830 (Engine Display Monitoring) installed in order to monitor parameters such as the fuel flow and cylinder temperatures for example. On start-up, a fuel quantity of 100 l was entered in the EDM.

2.3 Instructor pilot experience and statement

The 31-year-old instructor held, at the time of the occurrence a CPL(A) along with the SEP(T), MEP(T), IRSE(A), IRME(A), FI(A), CRI(A) and IRI(A) ratings as well as a B200 TR and a declaration of proficiency for parachute drops.

The day of the accident, he had logged 3,200 flight hours including 1,200 hours as instructor. He had totalled 60 h on the Cessna 206 including 6 h 35 min in the previous 90 days and only this flight of 0 h 35 min in the previous 30 days.

He specified that as FI, he carried out dual flights during the training of new drop pilots, the latter already holding the SEP rating.

Before the flight, the aeroplane was parked as usual, with its nose in the direction of the parking exit. It was not moved for refuelling.

The fuel was measured using the usual wooden gauge. There were 60 l in the RH tank and 40 l in the LH tank. The oil level was correct, between 11 and 12 quarts of US Gallons[8]. Take-off was on the RH tank. The instructor indicated that during the descent, just after the drop, he wanted to turn left towards the sea in order to ask the pilot in instruction to carry out several descending turns with a 45° bank to check that the latter controlled the aircraft in all of its envelope (no spiral dive or loss of control of the speed). He wanted to show him that with this type of descent, it was

[8] 1 US gallon = 3.785 litres

possible, at the same speed, to increase the rate of descent. He indicated to him that this could prove useful if there were clouds or ATC constraints during the descent.

He specified that it was the pilot in instruction who was at the controls except for one turn during which he had shown him how to carry out a symmetric 45° turn in descent. All of the turns were carried out with a maximum bank angle of 45°, with some at 30°.

The instructor pilot added that the constraint for this type of aeroplane was that in descent, it was not possible to totally reduce power in order to avoid thermal shocks. The descent is therefore carried out by managing the indicated airspeed and monitoring the temperature parameters.

He added that during this type of turn, the ball is centred and the speed stabilised. The load factor is kept at a calculated 1.4 g (1/cos(bank)). He does not carry out 60° turns for several reasons:

- if the quantity of fuel is low (i.e. less than 25 l) in the fuel tanks, there is a risk of fuel starvation;
- the risk of entering a spiral dive is too great for a young pilot, for a limited time gain in the descent.

On flying through 4,500 ft, both pilots felt a strong deceleration as if the engine had been shut down or set to full low pitch. The pilot in instruction made several inputs on the power lever, to no effect. The instructor pilot then took the controls and the management of the radio, heading for the Faa'a runway at maximum glide speed. After 30 minutes of flight, the estimated fuel was 70 l (30 l in the RH tank and 40 l in the LH tank).

He indicated that he set the mixture control to full rich and changed the tank selection, checking that the magnetos were on BOTH. He did not perceive any change. He then, in succession, made inputs on the starter, the propeller lever, the power lever and then the mixture control again, setting it to full lean and then full rich. None of these actions had any influence on the behaviour of the engine. The engine still seemed to him, to be operating in idle. He indicated that that was no variation in noise, vibrations or smell. According to the instructor pilot, the indications on the EDM showed a rather erratic fuel flow, starting at around 20 to 22 GPH, and intermittently dropping to 0. The manifold pressure was erratic. The instructor pilot added that the failure was not clear for him.

A suspected engine failure was then reported to the approach unit.

After asking the pilot in instruction for any other idea as to the failure and the latter replying in the negative, he set the mixture control to full lean and the magnetos to OFF.

The instructor pilot indicated that on flying through 500 ft, they were in a high rate of descent of around 1,000 ft/min.

He emitted the MAYDAY messages and selected the code A 7700. They carried out a safety briefing in preparation for the ditching. They ditched with the flaps retracted. The instructor pilot flared slightly. The speed at the time of the impact was around 70 mph. On contact with the water, the impact was substantial and the aeroplane turned over. The fuel selectors were set to OFF after ditching. The pilot specified that on ditching, there were around 40 l in the LH tank and 30 l in the RH tank.

2.4 Pilot in instruction experience and statement

The 25-year-old pilot in instruction held, at the time of the occurrence, a CPL(A) along with the SEP(T), MEP(T) and IRME(A) ratings.

He had logged a total of 228 flight hours, including 1 hour 30 minutes on the Cessna 206. He had not flown any hours in the previous 30 days. In the previous 90 days, he had not flown on the Cessna 206 and had flown 40 minutes on the Cessna 172.

He had carried out the theoretical training for parachute drops and a one hour flight without passengers to familiarize himself with this aeroplane. This was his second flight on this aeroplane. It was planned that he would become a service provider for the company on completion of his drop training.

He indicated that after a series of turns over the sea, when they were descending through 4,500 ft abeam KP 18, there was a large deceleration. He felt that he was being held pushed forward. He tried a first time to restart the engine, without success. The instructor pilot then took the controls, calling this out. On flying through 1,000 ft, the instructor tried again to start the engine, again without success. All the systems were shut down before the impact. It was violent. The aeroplane then turned over.

2.5 Controllers' statements

The approach controller indicated that when the pilot of F-BXAM reported that he suspected an engine failure, he informed the tower supervisor of this so that the latter could activate the emergency services. He then transferred the flight to the tower frequency so that it would be on the same frequency as the emergency services.

The pilot, after ditching, called the tower supervisor by telephone, which reassured the controllers on duty.

The aerodrome controller indicated that he heard the pilot declare a MAYDAY but that most of the transmissions were inaudible. There was no radar detection of the aeroplane but there was a "flight plan track". He asked to pilot to select IDENT on the transponder but this had no effect. He then activated the emergency services.

2.6 Meteorological information

2.6.1 General situation

The Météo-France forecast for 7 June 2022 at 05:00 local time for Tahiti Faa'a was:
- predominantly sunny;
- a few clouds clinging to the high ground in the afternoon;
- minimum and maximum temperatures 21 and 29° Celsius;
- moderate north-easterly wind with gusts along the coast of 50 km/h.

In these conditions, the parachute drop zone was protected by the terrain (windless area); the wind was weak.

2.6.2 Weather report

07:00 Tahiti Faa'a METAR: wind from 110° of 3kt, FEW clouds at 2300 ft, BKN clouds at 7300 ft, temperature 23°C, QNH 1015, NOSIG.

2.7 Examination of wreckage

The wreckage and the propulsion system of F-BXAM were not examined by the BEA's specialised investigators. The information below is based on the observations made by the field investigators[9] present in French Polynesia:

- the engine's crankshaft freely rotated;
- the crankcases were intact;
- all the equipment and hoses were in place on the engine;
- no significant solid contamination was identified in the fuel system.

A failure of an internal component of the engine block was therefore ruled out. In the BEA's experience, when an internal component of the engine block is destroyed, the crankshaft is very often found blocked in rotation or is very difficult to rotate. Furthermore, the destruction of an internal component is very often associated with a perforation of the crankcases or the presence of external evidence.

The following components of the propulsion system were sent to the BEA for further examination. Due to the immersion of the propulsion system during the accident and the long period of time between the raising of the wreckage and the examinations carried out by the BEA in mainland France, the equipment showed significant corrosion damage, making most functional tests impossible.

A detailed examination of the equipment revealed that:

- the two magnetos were not functional due to the consequences of the corrosion; the internal components were complete and in place, and the settings were as expected for the equipment installed;
- the spark plug electrodes showed no significant wear, nor any other singularity;
- there was no contamination in the fuel decanter filter. The filtering element was whole;
- the testing of the fuel pump assembly on a special test bench, at speeds of 600 to 2,600 rpm, revealed that the settings that did not correspond to those specified by the manufacturer;
- the throttle and control assembly was functional;
- the fuel manifold valve assembly was blocked due to its immersion in seawater. The internal components were in place and whole;
- the injector nozzles were contaminated but not blocked;
- the air filter was not clogged.

Several samples of fuel (AVGAS 100LL) were taken from the wreckage. Two of these were analysed. A slight loss of light ends was noted among the characteristics measured. This non-conformity can be explained by the time that elapsed between the date that the sample was taken and the date of the analysis. The other characteristics measured correspond to those expected for the fuel in question.

2.8 Fuel Pump Assembly

The BEA carried out a functional test of this equipment item isolated from the engine and the aeroplane. The recorded values do not, therefore, take into account the associated systems. To carry out these tests, the BEA used the equipment manufacturer's specifications. In the

[9] Persons approved by the Director of the BEA in accordance with Article R1621-7 of the Code of Transport.

experience of the BEA and the ENAC workshop in Castelnaudary, where the tests were carried out, these settings are not normally very different to those expected on this aeroplane, although it is not possible to define the exact consequences on the power provided by the engine.

The tests carried out consisted of:
- driving the pump at a set speed;
- setting the fuel return pressure (return to the tanks) at a defined value;
- measuring the fuel flow provided by the pump.

The results of these tests showed that the fuel flow rates provided by the pump (measured at several rpm) did not correspond to the flow rates specified by the equipment manufacturer. To return to the values specified by the equipment manufacturer, the pump's setting screw had to be turned half a turn.

The engine manufacturer, Continental Aerospace Technologies, told the BEA that before the engine is delivered, the fuel flow provided by the pump is adjusted on the test bench and the fuel return pressure is then checked. In operation, the fuel return pressure must be checked at each 100-hour inspection. However, the flow rate is not checked. The engine manufacturer also indicated that if the fuel flow rate is too low, this could damage the cylinder heads and if it is too high, this could lead to an engine flame-out due to choking. The influence of an incorrect pump setting on the fuel flow depends on the engine speed: it can result in both an excessive fuel flow at some speeds and an insufficient fuel flow at others.

The American company Ram Aircraft, which sold the engine, told the BEA that the final setting of the engine fuel pump is carried out on the aeroplane after the engine has been installed. The procedure for this can be found in the Cessna maintenance manual for this aeroplane and in the maintenance information provided by Continental Aerospace Technologies.

Several documents published by Cessna and Continental Aerospace Technologies specify that the fuel system settings must be adjusted in the following conditions:
- when the engine is installed on the aircraft;
- during the 100 h and annual inspections;
- each time a component of the fuel supply system is replaced or adjusted;
- when there are modifications in the operating environment.

The company in charge of the maintenance of the aeroplane informed the BEA that it had not adjusted the settings at the intervals mentioned above. It explained that it did not have the tools recommended by the manufacturer for this type of operation, including calibrated pressure gauges and several valves[10]. It had tried to acquire this equipment, but it was not available from the supplier, nor from the main aeronautical tool dealers. For information, the ENAC workshop where the BEA carried out the tests during the investigation does not use the tools specified by the manufacturer, but other calibrated pressure gauges meeting the same need.

2.9 Examination of Engine Display Monitoring (EDM)

The ECM 830 is a system equipping light aircraft. It displays the engine parameters and records them in a non-volatile memory. The evolution of the recorded and analysed parameters during the occurrence flight[11] are shown in the figure below:

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[10] SID97-3G, published by the engine manufacturer and revised in 2015, specifies the use of Model 20 ATM-C Porta-Test Unit.

[11] For an unknown reason, the occurrence flight was split into two flights and a few seconds of data was lost between the two flights.

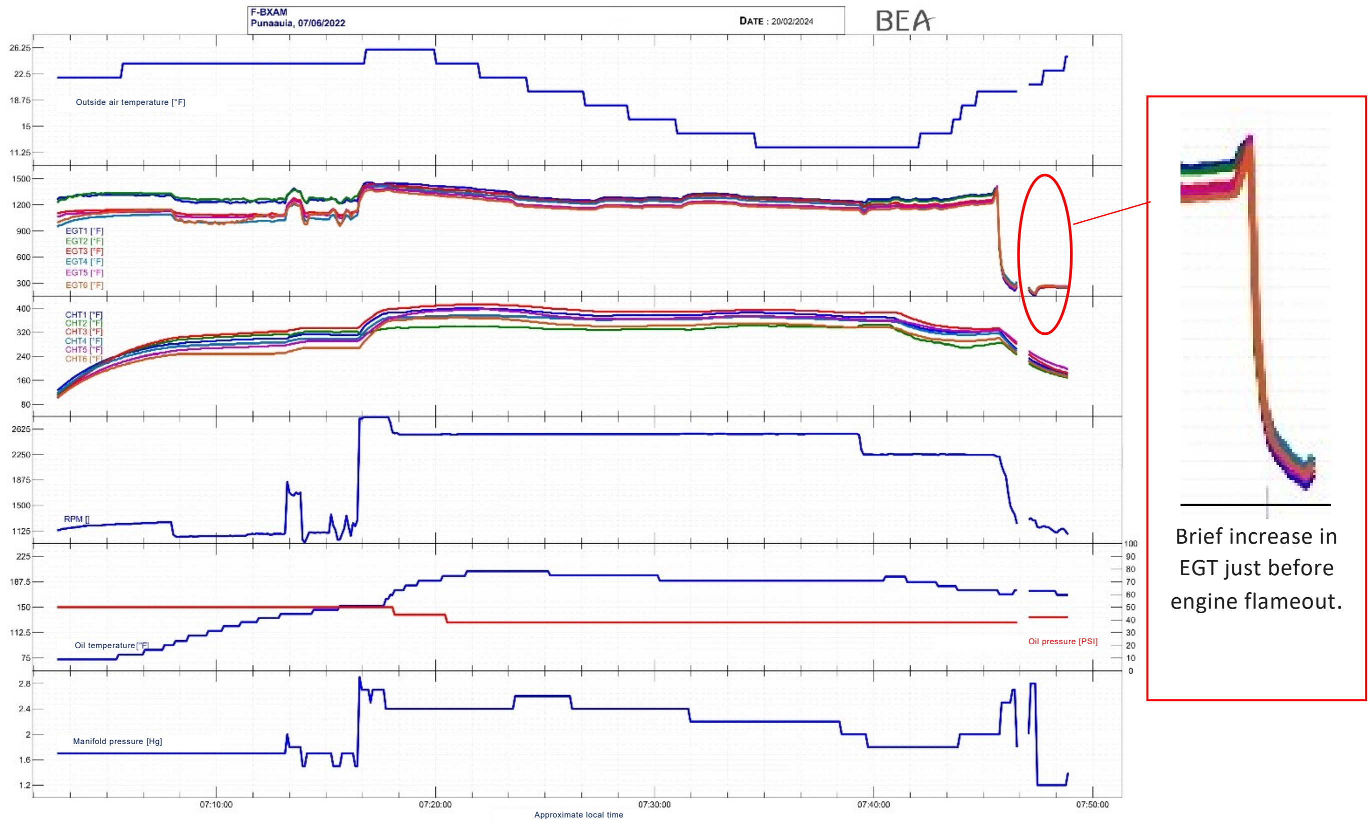

Figure 4: flight parameters (Source: BEA)

The CHT[12], RPM, oil temperature, oil pressure and intake pressure values do not call for comment.

However, just before the engine flameout, a brief increase followed by a sudden drop in the EGT values was noted. This phenomenon is characteristic of a transient lean mixture that occurs when the fuel system is starved of fuel. This information was shared with the engine manufacturer, who indicated that it was in agreement with the BEA.

3 CONCLUSIONS

The conclusions are solely based on the information which came to the knowledge of the BEA during the investigation. They are not intended to apportion blame or liability.

Scenario

The pilot in instruction and his instructor took off from runway 04 of Tahiti Faa'a for a parachute drop flight at FL 100.

After the drop, the instructor pilot decided to fly out over the sea in order to have the pilot in instruction carry out several turns in descent with a 45° bank. During these manoeuvres, the instructor pilot and the pilot in instruction observed a sudden reduction in engine power. Their inputs on the various flight controls had no effect. The instructor pilot then reported to the approach controller that he thought he had an engine failure and was going to try and ditch in the lagoon. The aeroplane ditched and turned over on contact with the surface of the water. The two occupants, unharmed, evacuated the aeroplane.

[12] Cylinder Head Temperature

Contributing factors

During the manoeuvres in descent, it is likely that the engine shut down following fuel starvation of the fuel system. The quantity of fuel in the right tank, 30 l, was less than a quarter of the tank's capacity, and the manoeuvres carried out could have resulted in asymmetric flight. According to the aeroplane Owner's Manual, these conditions are conducive to fuel starvation.

In the emergency situation in which they found themselves, the instructor and the pilot in instruction had difficulty understanding the condition of the engine. The actions taken by the instructor were not those required in the case of fuel starvation in a tank. In particular, he did not activate the auxiliary pump.

In general, restarting a hot engine can be uncertain and the multiplication of certain actions may flood the engine.

It was not possible to determine whether the supposed incorrect setting of the fuel pump was such as to be conducive to the engine shutdown or to compromise its restart.

The BEA investigations are conducted with the sole objective of improving aviation safety and are not intended to apportion blame or liabilities.