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Report

Accident on **4 July 2012**
at **Franqueville Saint-Pierre (76)**
to the **Piper Aircraft PA-34-220T Seneca III**
registered **D-GABE**
operated by **Pixair Survey**

BEA

Bureau d'Enquêtes et d'Analyses
pour la sécurité de l'aviation civile

Ministère de l'Ecologie, du Développement durable et de l'Energie

Safety Investigations

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SPECIAL FOREWORD TO ENGLISH EDITION

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.

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Glossary

USG	US Gallon (≈ 3,785 l)
In.Hg	Mercury inch
DSAC	French Civil Aviation Safety Directorate - West *Direction de la Sécurité de l'Aviation Civile - Ouest*
IFR	Instrument Flight Rules
FL	Flight Level
MAP	Specific activity manual *Manual d'Activités Particulières*

Synopsis

Fuel starvation on final, collision with the ground during a radio relay flight

Aircraft	Piper Aircraft PA-34-220T Seneca III
Date and time	4 July 2012 at 16 h 51[(1)]
Opertor	Pixair Survey aerial work company
Place	Franqueville Saint-Pierre (76)
Type of flight	Aerial work
Persons on board	Pilot
Consequences and damage	Pilot lightly injured, aircraft destroyed

[(1)]Except where otherwise indicated, times in this report are local.

The pilot was undertaking an IFR radio data relay flight in the context of the fourth stage of the cycling Tour de France. After about 6 h 15 min of flight, the mission ended and the pilot flew towards Rouen - Vallée de Seine aerodrome (76). During final to runway 22, the right engine no longer provided any power. The pilot aborted the approach. The left engine also stopped. During the emergency landing, the aeroplane collided with a tree in the garden of a private property located about 600 m from the runway. On the ground, the right tank was found to be empty. The left tank contained about 13 USG.

The pilot, before starting the approach, switched the fuel supply for the left engine to the right tank in order to optimise the balance between the two tanks. The right tank was then supplying both engines. The pilot then forgot that he had made this change. During the final the engines shut down due to this tank being empty. The pilot did not have time to analyse the failure, or to choose an appropriate area for an emergency landing.

The investigation revealed that the operator, which was undertaking a radio relay mission for the first time, had had little time to prepare for this and train the pilot. For this type of mission, the length of the flight was close to the aeroplane's maximum endurance, thus leaving a narrow safety margin. During the accident flight the true average consumption was higher than that planned by the company, which further reduced this margin.

DSAC's monitoring of the company was undertaken in accordance with the regulations in force. Nevertheless the investigation showed that DSAC cannot assess the level of safety of a company's missions through this monitoring.

During the first stage of the race, following his mission with D-GABE, the pilot had landed with 3 USG of usable fuel. This quasi fuel starvation should have alerted the company to the safety level of its operations. The operational context of long flights repeated every day, and for which all the company's resources were mobilised, likely made it impossible for the company to have the distance required to analyse this incident.

In April 2014, European regulation n° 965/2012, which defines the technical requirements and the administrative procedures applicable to aviation operations, was modified. Its scope was extended to specialised commercial operations (aerial work). This regulation in fact contains requirements related to safety management by operators and monitoring of these operators by the oversight authority. The BEA thus decided that it was not necessary to issue a safety recommendation.

1 - FACTUAL INFORMATION

1.1 History of Flight

At around 10 h 15 the pilot took off from Le Touquet – Paris Plage aerodrome (59) for a radio data relay operation between Abbeville (80) and Rouen (76) in the context of the fourth stage of the Tour de France. The objective of the flight was to follow a car in the middle of the caravan that preceded the event and which stretched out over about 20 km.

A short time before the end of the mission, the pilot positioned the left engine fuel selector on the *''CROSS FEED''* position. At around 16 h 30 the mission came to an end. The pilot flew towards Rouen aerodrome. During the final for runway 22, the right engine stopped delivering power. The pilot started a go-around. The left engine also shut down. During the emergency landing, the aeroplane collided with a tree in the garden of a private property located about 600 m from the runway threshold.

1.2 Injuries to Persons

	Injuries		
	Fatal	Serious	Light/None
Pilot	-	-	1
Passengers	-	-	-
Others	-	-	-

1.3 Damage to Aircraft

Aircraft destroyed.

1.4 Other Damage

None.

1.5 Personnel Information

Male, aged 26.

The pilot, holder of a commercial pilot's aeroplane licence CPL (A) issued in September 2011, had been employed by the aerial work company since October 2011.

He had a total of about 580 h flying hours, including 423 on twin-engine aeroplanes, of which about 30 (including the accident flight) on PA-34, all on D-GABE. He made his first flight on PA-34 on 29 June 2012 in dual control for training on the *''turbo/supercharged''* difference, which lasted about 35 min. At the end of the flight he ferried the aeroplane alone to set up the mission. He made data transmission flights for the first three stages of the race on D-GABE. These flights, which occurred from 1st to 3 July 2012, lasted respectively 7 h 30 min, 7 h 05 min and 6 h 05 min.

1.6 Aircraft Information

1.6.1 Airframe

Manufacturer	Piper Aircraft
Type	PA34-220T Seneca III
Serial number	34-8133181
Registration	D-GABE
Entry into service	1981
Airworthiness certificate	Valid until 11 June 2013

1.6.2 Engines

Manufacturer: Teledyne Continental

Type: IO-360-KB

	Engine n° 1	Engine n° 2
Serial number	315191	314186

1.6.3 Fuel circuit

The PA34-220T is equipped with two wing tanks with a total capacity of 128 USG of which 123 USG is usable.

In standard operation, both engines' fuel selectors are in the *''ON''* position, each tank supplying the engine on the same side.

Figure 1 - Fuel selectors on D-GABE

A fuel quantity higher than that consumed by the engines is taken from the tanks. The fuel not consumed by an engine is returned to the wing tank on the same side.

If necessary, the selectors can be placed in the « CROSS FEED » position, which makes it possible to supply an engine with fuel from the opposite-side tank. The selection of the « CROSS FEED » position is only mentioned in the flight manual in case of an engine failure. This selection allows the engine to operate with fuel from both tanks. The logic of the fuel return is not modified in the « CROSS FEED » position.

The aeroplane was equipped with an instant fuel flow indicator with needles and a fuel level indicator for each of the tanks. There was no low fuel level indicator.

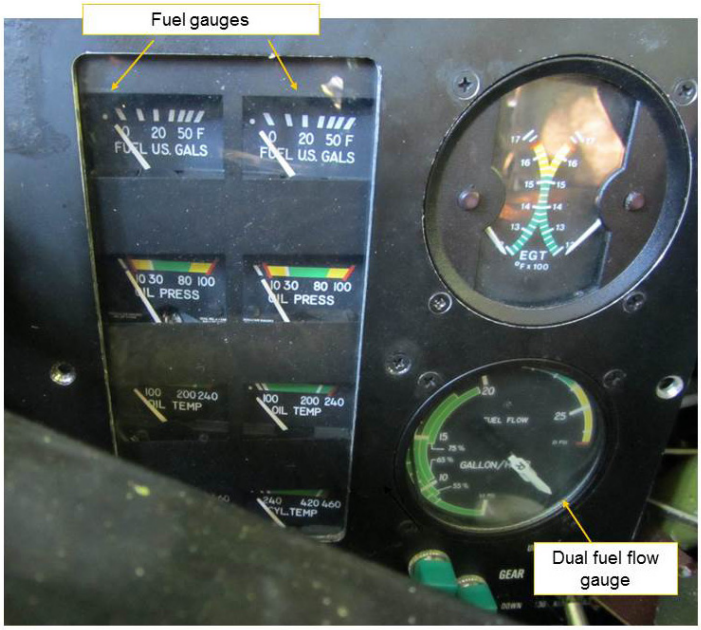

Figure 2 - Photograph of the fuel indicators on D-GABE taken after the accident

1.6.4 Normal and emergency procedures

APPROACH AND LANDING

Gear warning horn .....check
Seat backs .....erect
Belts/harness .....fasten/adjust
Fuel selectors .....ON
Cowl flaps .....as required
Auxiliary fuel pumps .....OFF
Mixture controls .....rich
Prop controls .....FULL FORWARD
Landing gear .....DOWN, 130 KIAS max.
Flaps .....set, 115 KIAS max.
Approach speed .....90 KIAS or above

GO-AROUND

Full takeoff power, both engines. (40 in. Hg. maximum manifold pressure)
Establish positive climb at 85 KIAS.
Gear .....UP
Flaps .....retract slowly
Cowl flaps .....adjust
Trim .....as required

Figure 3 - Flight manual section 4 - normal procedure - approach and go-around

ENGINE INOPERATIVE PROCEDURES

NOTE

The power on the operating engine should be reduced when safe to do so.

DETECTING DEAD ENGINE

Loss of thrust.
Nose of aircraft will yaw in direction of dead engine (with coordinated controls).

ENGINE SECURING PROCEDURE (FEATHERING PROCEDURE)

Minimum control speed.....66 KIAS
One engine inoperative best rate of climb.....92 KIAS
Maintain direction and airspeed above 85 KIAS.
Mixture controls.....forward
Propeller controls.....forward
Throttle controls.....(40 in. Hg. Max.) forward
Flaps.....retract
Gear.....retract
Identify inoperative engine.
Throttle of inop. engine.....retard to verify

FUEL MANAGEMENT DURING ONE ENGINE INOPERATIVE OPERATION

CRUISING

When using fuel from tank on the same side as the operating engine:
Fuel selector operating engine.....ON

Fuel selector inop. engine.....OFF
Aux. fuel pumps.....OFF

When using fuel from tank on the side opposite the operating engine:
Fuel selector operating engine.....CROSSFEED
Fuel selector inop. engine.....OFF
Aux. fuel pumps.....OFF

Use crossfeed in level cruise flight only.

NOTE

Do not crossfeed with full fuel on same side as operating engine since vapor return fuel flow will be lost through the vent system.

Figure 4 - Flight manual section 3 – emergency procedures – engine failure

1.6.5 Performance

The aeroplane was within the weight and balance limits set by the manufacturer.

The flight manual specified that the aeroplane's maximum endurance in fuel-saving mode (45% of the power) was about 7 h 10, with no reserve, for a cruise at FL100 in standard atmosphere, which corresponds to average consumption of about 17.2 USG/h. This estimation takes into account taxiing, the climb and the descent.

The flight manual also specifies that during takeoffs and go-arounds, power must be applied without exceeding 40 in.Hg of inlet pressure admission because of the supercharged engines.

1.7 Meteorological Information

The regular meteorological observation automatic message at Rouen for 17 h 00 mentioned the following information:

- wind: 210° / 10 kt, variable from 180° to 250°;
- visibility: more than 10 km;
- cloud: 1 to 2 octas at a height of 4,500 ft;
- temperature: 25 °C;
- dew point temperature: 14 °C;
- QNH: 1009 hPa.

1.8 Aids to Navigation

The flight took place under instrument flight rules (IFR). The IFR flight plan filed indicated cruise at FL90, as well as diversion aerodromes at Le Havre Octeville (76) and Caen Carpiquet (14). Il It also specified that the airplane's fuel autonomy was 8 hours.

During the approach to runway 22, descending through 6,500 ft, the pilot asked for a visual approach, which he was given. At the time of the accident the pilot was flying without means for navigation.

1.9 Telecommunications

At the time of the accident the pilot was in contact with the tower controller at Rouen - Val de Seine aerodrome.

Communications took place between 16 h 42 and 16 h 50, the signal from the distress beacon was received at 16 h 50 min 54:

16 h 42 min 00	the pilot contacted the Rouen controller
16 h 45 min 41	the pilot said he had the aerodrome in view and asked for a visual approach, which he was given
16 h 48 min 59	the pilot was cleared to land
16 h 50 min 37	the pilot said that he was going around, without giving any reason

1.10 Aerodrome Information

Rouen - Val de Seine aerodrome is open to public air traffic. At the time of the event paved runway 22 (1,700 m x 45 m) was in service.

1.11 Flight Recorders

The aeroplane was not equipped with a recorder. This is not required by the regulations.

1.12 Wreckage and Impact Information

The accident occurred near a dwelling in a landscaped garden with an area of about 1 000 m2. The aeroplane arrived with the wings almost horizontal and a steep descent slope. The left engine struck a rock located in front of the trees. The aeroplane pivoted to the left and came to a stop in the trees. The cockpit passed between the trunks and did not suffer high impact.

Figure 5 – Photo taken in the direction of the impact trajectory

The distortion of the propellers and the marks on the vegetation showed that neither of the engines was delivering power during the impact. Observation of the engines, in particular of the filters and of the pumps, showed an absence of fuel in the engines. The right wing tank contained no fuel but the left wing tank contained about 13 USG.

1.13 Medical and Pathological Information

The pilot was taken into care by a SMUR, then by an emergency hospital service for 24 hours. He had superficial injuries on the left hand and leg as well as some lower back muscular pain related to superficial bruising.

1.14 Fire

There was no fire.

1.15 Survival Aspects

During the collision with the trees, the pilot's immediate surroundings in the cockpit were preserved. The pilot, who was fastened in, was only subject to high deceleration. He was able to evacuate the aeroplane by his own means.

1.16 Tests and Research

Not applicable.

1.17 Information on Organisations and Management

1.17.1 Specific Activities

Chapter 3 of the decree of 24 July 1991 relating to the conditions of use of aircraft in general aviation deals with special activities. These activities are commonly referred to as aerial work.

It states that an operator can only use an aircraft in the context of these activities if it has made available to the personnel concerned a special activities manual (MAP). This manual must include *''the rules and procedures to follow, as well as all the information and instructions necessary so that the various objectives of the operations can be reached in satisfactory conditions of safety''*. It must be *''easily usable and the operator must ensure that it is known and applied by the personnel concerned''*.

This manual is filed by the operator with the competent inter-regional DSAC, the DSAC-Ouest in the case of Pixair, to provide information on the organisation and procedures put in place to ensure that:

- operations have an overall consistency;
- instructions, rules and information given to the personnel make it possible to respect the applicable technical regulation, in particular in terms of safety.

The competent services can impose modifications of the manual if they notice that its content is not in accordance with the technical regulation applicable to the operation and that the operator's personnel do not know the provisions necessary to ensure satisfactory conditions of safety.

The content of the MAP is defined in the appendix to the decree. It is divided into two parts:

- the *''General''* part defines the operator's general policy;
- the *''Utilisation''* part contains the instructions, rules and information specific to the implementation and utilisation of the aircraft.

The decree of 24 July 1991 does not make it mandatory for the competent authority to follow up or inspect the company.

The Pixair MAP was filed with the DSAC-Ouest in 2011. After several exchanges and modifications the MAP was judged to be in compliance. Radio relay activities were included.

1.17.2 TDCom Company

The company offers communication solutions, voice, image and data transmission.

The company developed specifications for putting in place aerial means during the race. The specifications specifically stated the need for three aeroplanes: one for the race, one for the caravan and one in reserve. It also stated that the aeroplanes should:

- be twin-engine;
- be IFR-equipped;
- have a minimum operational endurance of 8 h;
- be able to reach FL 200 easily.

It is also specified that *''A TDCom technician, onboard the race aeroplane, with aeronautical knowledge, is the head of the mission. He/she passes on recommendations and requirements concerning the choice of altitude for aerial work, the positioning of the aeroplanes, the behaviour in flight of the aeroplanes, according to the stages, the safety of the flights and the positioning of vehicles on the ground''*.

TDCom released the specifications on 3 February 2012 and signed a contract with Pixair Survey at the end of April for the positioning of the aerial means. The Pixair Survey technical proposal stated that it was making available aeroplanes for this mission with endurance of 7 h. It was not stated whether this was total or operational endurance.

1.17.3 Pixair Survey Company

Based at Rouen aerodrome, the aerial work company was made up of a president (also chief pilot), of a maintenance manager and five pilots, including one on an unlimited term contract. It had several twin-engine piston aeroplanes (PA-31, PA-34, BN2P) and one twin-engine turbine (BN2T). D-GABE was purchased in Germany and on 14 June 2012 the director of the company flew the aeroplane to Rouen. It was the company's only PA-34.

To perform the radio relay mission, the company chose the PA-31 for the race, the PA-34 for the caravan, with the BN2P in reserve.

Between the 15 and the 24 June 2012 the equipment necessary for the radio relay missions was installed on D-GABE.

Following the accident, the company continued the mission using a BN2P as a replacement for D-GABE.

1.17.4 Pixair Survey Special Activities Manual (MAP)

The following points are extracted from the aerial work company's MAP:

- Work duration[(2)]
  ''The work time to be used is that of a single pilot:
  - *8 h maximum a day (including transit from the base to the place of operations);*
  - *34 h maximum for 7 consecutive days (including transit time);*
  - *a minimum of 24 h rest is mandatory after 7 consecutive days of operation''*.

[(2)]There are no specific provisions relating to flight time limitations in aerial work.

- Aerial operations – general procedures
  ''The pilot, after consultation, prepares his flight dossier[3] which will contain:
  - *the weather forecast on the route and on the workplace;*
  - *the NOTAMS ;*
  - *the outward and inward routes ;*
  - *the fuel plan;*
  - *the weight and balance limits;*
  - *the CRM and safety procedures;*
  - *the necessary flight plans;*
  - *the dossier must be carried in the aeroplane''*.

- Minimum fuel quantity
  The Minimum fuel quantity cannot be lower than the following:
  - *''Fuel quantity for the planned length of the mission (mission + ferry), plus the additional consumption associated with the most recent forecast meteorological conditions, or an additional 10% if the meteorological conditions are not known + 30 minutes route reserve at cruise speed''*.

[3]The company was not able to supply the flight dossier.

1.18 Additional Information

1.18.1 Witness Statements

1.18.1.1 Pilot's statement

The pilot explained that the mission consisted of flying ovals over a car travelling at about 40 km/h, without moving further than 20 km away from the it. For this he had an offset screen displaying the position of the car and the position of the aeroplane. He was not supposed to bank the aeroplane more than 15° so as not to mask the antennae that relayed the data. Due to this limitation, the flight was undertaken without using the autopilot.

The pilot explained that during previous flights on this aeroplane, he had noticed that the left engine consumed about 1 USG/h more than that of the right. A short time before the end of the mission, he positioned the left engine fuel selector in the *''CROSS FEED''* position to supply the left engine with fuel from the right tank and thus balance both tanks before the approach to Rouen. He then forgot that he had activated the transfer. During the final at a height of about 100 ft, the right engine shut down and the aeroplane moved slightly to the right of the extended runway centreline. He applied full power, retracted the gear and a few moments later the left engine also shut down. He then remembered that he had activated the fuel transfer and set the left engine fuel selector to *''ON''*. This action had no effect.

The pilot added that he regularly made fuel checks during the flight based on the indications from the fuel gauges. After having switched the fuel supply from the left engine to the right tank, he did not make a fuel check. The pilot stated that he thought that he had performed the *''Approach and landing''* check-list but that he had certainly forgotten to check the fuel selectors[4]. He stated that he did the check-list from memory since the in-flight use of the aeroplane flight manual is not practical. He added that the mission had taken place without any special difficulties and that forgetting the fuel transfer was likely due to the higher workload during the approach. The pilot added that he was certainly tired at the end of the flight.

[4]In the check- list, it is required to check that both fuel selectors are *''ON''*.

1.18.1.2 Statement by the Pixair Survey Director

The president of the company explained that the request for this radio relay operation was based on two aeroplanes with 6 h endurance to follow the race and the convoy of cars. He proposed to undertake the mission with a PA-31 and a PA-34 and obtained the contract in April 2012. He stated that this was the first mission of this nature for the company. At the time of the accident he was flying the PA-31 for the radio relay of the race itself.

The president of the company explained that he decided to use the newly acquired PA-34, as it was the only aeroplane with a turbo engine. The missions were undertaken with an IFR flight plan at around FL100 when the stages took place on the plain, but for the stages in mountainous regions it was necessary to have an aeroplane capable of climbing much higher, especially when the meteorological conditions deteriorated.

The president of the company stated that he estimated the aeroplane's consumption based on his experience on PA-34 during radio relay operations. For the flights at 40% power the average consumption was about 16.25 USG/h. On this basis, he fixed the maximum duration of operations at 30 flying hours with a margin of about one hour. The first flights performed on D-GABE confirmed this estimation to him. He stated that during flights he adjusted the mixture to EGT[5] peak. He added that he had planned to equip the aeroplane with a digital flow meter with a totalizer, but that he hadn't had the time to have this equipment installed.

[5]EGT : Exhaust Gas Temperature.

The operation's flight time was initially calculated to end during the arrival of the car at the head of the convoy. At the end of the first stage, following a request from the client, it was decided to prolong operations until the last car of the convoy. This increased flight time by about 30 min.

The president of the company stated that he had made two short duration instruction flights on D-GABE with the pilot to train him in the *''turbocompressed / supercharged engine''* difference and to release him onto the aeroplane. Through a lack of time, he didn't present the flight manual to the pilot in detail. He stated that during go-arounds on turbo-engined aeroplanes, there is a risk of choking the engines when the power levers are placed in the full power position quickly. During the two instruction flights, they did not perform any go-around exercises.

1.18.1.3 Statements by TDCom Management

Several members of TDCom management stated that they considered the operational endurance as the flight time between takeoff and the end of the radio relay. They thought that one hour of flight should be maintained for safety at the end of the mission to get to the arrival aerodrome. They stated that they had ensured the radio relay for this race for a number of years. In practice, endurance (flight time) of 7 hours is adequate since the flights rarely exceeded 6 hours. Pixair's offer, proposing aeroplanes with an endurance of 7 hours, was thus compatible with the mission to be performed.

They also stated that the first three stages of the race had gone well and that they had decided to prolong the mission to include the last car. They added that the convoy can stretch out over about twenty kilometres and that the last car can arrive an hour after the first.

The TDCom management met the members of Pixair Survey following the accident to understand the reasons for it and, specifically find out if their radio relay equipment had contributed to the event. They stated that they had no aeronautical competence to evaluate operational choices.

The onboard technician stated that he had undertaken a large number of missions of this nature, in particular on PA-34. He stated that he had not followed any specific aeronautical training. He added that on the day of the accident was on board the PA-31. He asked the pilot of the PA-34 to end the mission and return home at about 16 h 40[6] .

[6]The aeroplane had been flying for about 6 h 25 min.

1.18.2 Rules Relating to Fuel to be Carried on IFR Flights

Paragraph 5.6.3 of the decree of 24 July 1991 relating to the conditions of use of the civil aircraft in general aviation states that the pilot-in-command must ensure before any flight that the quantity of fuel makes it possible for him to perform the planned flight with an acceptable safety margin. It is specified that the minimum quantity of fuel to be carried must not be less than that required to:

- reach the planned destination taking into account the most recent meteorological forecast, the rpm and planned altitude, or if not, the quantities necessary without wind, increased by 10%;
- in addition, in IFR, if one or more diversion aerodromes are included in the flight plan, to be able to reach the furthest away of these aerodromes;
- and continue the flight at economic cruise power in IFR flight for 45 min.

In relation to in-flight fuel management, this decree only states that *''nobody can continue a flight near a landing site if there is not enough fuel left on board to be able to fly for fifteen minutes''*.

1.18.3 Fuel management on Radio Relay Missions

The minimum quantity fuel rules stated in the MAP, with theoretical consumption of 16.25 USG/h used by the company, made it possible to undertake 7 hour missions with a reserve of 30 minutes.

The flight times and the refuelling done during the first three stages[7] showed that the average consumption of the aeroplane was between 15.8 and 17.1 USG/h. The refuelling done at the end of the 7 h 30 min flight during the 1st stage showed that there was less than 3 USG of usable fuel in the tanks.

[7]Of respectively 7 h 30, 7 h 05 and 6 h 05.

During the accident flight, the average consumption was 17.5 USG/h. The endurance was thus about 7 h. The quantities of fuel necessary to divert to Le Havre and Caen[8]in accordance with the filed IFR flight plan, were respectively about 7 and 9 USG (excluding approach procedure). The quantity of fuel for the final reserve of 45 minutes was about 13 USG at economic cruise power.

[8]Diversion aerodromes included in the flight plan.

The rules for carrying fuel for IFR flights thus limited the length of the flight to about 5 h 45 min.

1.18.4 European Regulatory Context for Special Activities

European regulation n° 965/2012 defines the technical requirements and the administrative procedures applicable to air operations. This regulation was modified by European regulation n° 379/2014[9] of the Commission on the 7 April 2014 to specifically enlarge the field of application of Regulation n° 965/2012 to specialised commercial operations.

[9]http://easa.europa.eu/regulations

The phrase *''specialised operations''* includes special activities such as those in agriculture, observation, photography or aerial publicity. Within this, the radio relay mission is considered as a specialised operation. The oversight authority and operators have until 21 April 2017 to conform to these new regulatory provisions.

This regulation[10] specifies that:

[10]Regulation n° 965/2012 ORO. GEN.200.

- *''Before commencing a specialised operation, the operator shall conduct a risk assessment, assessing the complexity of the activity to determine the hazards and associated risks inherent in the operation and establish mitigating measures''*;
- *''Based on the risk assessment, the operator shall establish standard operating procedures (SOP) appropriate to the specialised activity and aircraft used […]''*.

In addition, the operator must establish and maintain a safety management system[11] that includes:

[11]Regulation n° 379/2014 SPO.OP.230.

- identification of dangers for air safety that result from its the activities;
- their evaluation;
- management of associated risks.

DSAC must also put in place an oversight programme[12] of these operators with audits and inspections including ground inspections and random inspections.

[12]Regulation n° 965/2012 ARO. GEN.305

This regulation contains requirements on the carrying of fuel (SPO. OP.130) but also on the management of fuel in flight. Paragraph SPO. OP.190 in fact states that:

''The pilot-in-command shall check at regular intervals that the amount of usable fuel remaining in flight is not less than the fuel required to proceed to a weather-permissible aerodrome or operating site and the planned reserve fuel as required by SPO.OP.130 and SPO.OP.131.''

2 - ANALYSIS

2.1 Scenario

During the first stages of the race, the pilot noticed a slight difference in consumption between the two engines, of the order of 1 USG/h, leading to difference of about 16 kg after 6 hours of flight. In order to optimise the balance of the two tanks before the landing, he applied, at the end of the flight, a fuel supply procedure that is planned for use only in the case of a failure of both engines.

After more than six hours of flight, the radio relay task came to an end and the pilot may have felt a certain relaxation accentuated by the fatigue of the flight. In this context he may have had difficulties in mobilising his resources, so he forgot that he had activated the transfer on the left engine and also forgot to check the fuel selectors during the approach check-list. In addition, at the end of the mission the pilot was likely not aware of the low quantity of fuel remaining, due to an excess of confidence in the precision of the fuel level gauges and of the performance of a 7 h 30 min flight on this aeroplane three days before.

During the final approach, at a height of about 100 ft, the right engine shut down following right wing tank fuel starvation. No longer being on the extended runway centreline, the pilot made a go-around. The left engine, still being connected to the right wing tank, then shut down. The pilot repositioned the left engine fuel selector in its standard *''ON''* position. The left engine did not restart. The right engine could not restart as it was still supplied by the right tank, which was empty.

2.2 Preparation of the Mission

The aerial work company was undertaking a radio relay mission for the first time. The president of the company set the endurance of the aeroplane at 6 h 30 min with a reserve of about one hour. He established this endurance based on his experience on other PA-34s during similar operations. Performing a 7 h 30 flight during the first stage, at the end of which there was less than 3 USG of usable fuel in the tanks, supported this estimation.

The aeroplane flight manual contains no consumption information for the engine power chosen by the company for this type of mission. The company could thus not base itself on the flight manual alone. Furthermore, the company had little time between obtaining the contract, the acquisition of the aeroplane and the start of operations to precisely evaluate the aeroplane's consumption, to perceive the risks inherent in this type operation and to prepare itself.

The radio relay mission was undertaken under instrument flight rules (IFR). The rules on carrying fuel in the company MAP were based on those covering the rules for a flight in VFR. In the context of this special flight, the company did not establish the fuel needs as defined for an IFR flight.

In-flight consumption fluctuates according to meteorological conditions, the precise adjustment of the mixture and how the aeroplane is flown. During the accident flight, the average consumption was more than about 1 USG/h (thus 6 % higher) above that used by the company[13]. The impact of higher consumption on the endurance was thus greater, given that it was a long flight.

[13] The aeroplane's endurance was 30 min less than that planned.

Under these conditions, the fuel reserve was less than one hour of flight. This reserve was further reduced when the company, after the first stage, accepted to lengthen the missions by around thirty minutes, thus meaning that the aeroplane flew more than 6 h 30, the maximum endurance set by the company director.

2.3 Safety Management

Following the flight of 7 h 30 undertaken on D-GABE during the first stage, there was less than 3 USG of usable fuel in the tanks. However, this flight took place in a nominal way. This quasi fuel starvation should have alerted the Pixair Survey company to the safety level under which it was operating. The operational context of long flights repeated every day, where all of the company's resources were mobilised, likely did not allow the company to maintain sufficient distance to analyse this incident.

Setting up risk evaluation, safety management and operational procedures, as required in European Regulation n° 379/2014, is intended to help operators to improve the level of safety of their activities.

2.4 Oversight of the Operator by DSAC

The oversight of the aerial work company, undertaken in accordance with the regulations in force at the time of the accident, was limited to the company registering the MAP. The authority thus does not have adequate and effective means to make it possible not only to evaluate if companies' aerial work missions are undertaken under satisfactory safety conditions, but also to accompany these companies in their reflections on safety.

In the context of European Regulation n° 379/2014, a programme of oversight of operators, including audits and inspections, is going to be put in place by DSAC. It should lead DSAC to put in place more effective oversight of aerial work companies.

3 - CONCLUSION

3.1 Findings

- the pilot undertook an aerial work instrument flight to ensure a radio relay mission for the Tour de France;
- the pilot had the licences and ratings necessary to perform the flight;
- the aeroplane had a valid certificate of airworthiness; it was maintained in accordance with the regulations;
- at the end of the mission, the pilot applied a fuel transfer procedure not covered by normal procedures;
- the pilot forgot that he had applied the fuel transfer procedure and forgot to check the position of the fuel selectors during the « Approach and landing » check-list;
- during the final approach the right engine shut down following the right tank fuel starvation;
- during the go-around the left engine, also supplied by the right tank, shut down;
- the pilot reselected the tanks to a normal configuration;
- the left engine did not restart;
- the accident occurred after about 6 h 40 min of flight;
- there was about 13 USG left in the left tank;
- the right tank was empty at the time of the accident;
- the length of the flight, under an IFR flight plan, was not compatible with the rules relating to carrying fuel;
- the company under-estimated the quantity of fuel necessary to perform the mission.

3.2 Causes of the Accident

The fuel starvation occurred in a context which led the aerial work company to make flights with insufficient fuel reserves. During the accident flight, inadequate fuel management by the pilot at the end of the flight and his forgetting to check the fuel selectors during the *''Approach and landing''* checks led, in this context, to fuel starvation on the right tank, which was supplying both engines during the final. This was probably due to a context in which he was winding down at the end of the mission and the fatigue from more than 27 flying hours over four days.

Given the low height at the time the engines shut down, the pilot could not manage to land in an area suitable for an emergency landing.

The following factors contributed to undertaking a mission close to the aeroplane's maximum endurance:

- the short preparation time that the company had for the mission;
- the failure to take into account sufficiently the risks associated with fuel management for this specific type of mission despite the quasi-fuel starvation that occurred three days before the accident;
- the implicit commercial pressure and the operational context of long flights repeated every day;
- limits on the checks, by the oversight authority, mandated by the decree of 24 July 1991, relating to the conditions of use of aerial work companies' aircraft in general aviation.

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