ACCIDENT

Aircraft Type and Registration:	Cessna T303, Crusader, D-IAFC
No & Type of Engines:	2 Continental Motors Corporation IO-520-AE piston engines
Year of Manufacture:	1983
Date & Time (UTC):	19 September 2006 at 1228 hrs
Location:	North Sea, approximately 9.5 nm south-east of Aldeburgh, Suffolk
Type of Flight:	Commercial Air Transport (Cargo)
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - 1 (Serious) Passengers - N/A
Nature of Damage:	Destroyed
Commander's Licence:	Commercial Pilot's Licence
Commander's Age:	67 years
Commander's Flying Experience:	24,000 hours (of which 6,000 were on type) Last 90 days - 65 hours Last 28 days - 35 hours
Information Source:	AAIB Field Investigation

Synopsis

Whilst on a cargo flight from Braunschweig, Germany, to Oxford, England, when approximately 30 nm from the English coast, the right engine started to run roughly. On checking the fuel gauges, the pilot observed that they were indicating in the 'red sector'. The right engine subsequently stopped, shortly followed by the left engine. The aircraft then glided from FL100 towards the Suffolk coast and ditched in the sea approximately 9.5 nm southeast of Aldeburgh. The pilot was able to abandon the aircraft, which sank quickly. He was rescued from the sea some 18 minutes later by a Royal Air Force Search and Rescue helicopter and taken to hospital, where he was found to have suffered a fractured a vertebra. The investigation determined that the aircraft had run out of fuel, due to insufficient fuel for the intended journey being on-board the aircraft at the start of the flight.

Background information

Four days prior to the accident the pilot flew D-IAFC from Braunschweig (EDVE), Germany, to Bratislava (LZIB) in the Slovak Republic. The pilot believed he filled the fuel tanks to full before returning to EDVE; this flight took 1 hr 59 mins. The aircraft was then not flown again until the accident flight.

On the morning of the accident, the pilot received a telephone call asking him if he could fly an ad hoc cargo charter flight from EDVE to Oxford (Kidlington) Airport (EGTK), to which he agreed. Because the flight was to be conducted as soon as possible, the pilot called a friend in Hanover, Germany, and asked him to prepare the routing, fuel plan and submit the ATC flight plan[1]. Having done this, his friend faxed the paperwork to the pilot at EDVE.

The pilot calculated that the fuel remaining in the aircraft from the previous flight would be sufficient to complete the flight to EGTK. This was based on his experience from numerous long flights using a 'Digi-Flow' fuel flow meter fitted to the aircraft. He believed that, with full fuel and careful leaning of the fuel/air mixture to the engines during the cruise, the aircraft would have an endurance of 5 hrs 30 mins to fuel exhaustion. Reasoning that he had refuelled the fuel tanks to full at LZIB prior to returning to EDVE, and with a planned flight time of 2 hrs 30 min to EGTK, he estimated that the aircraft had an endurance remaining of 3 hrs 30 mins. Additionally, he could not refuel to full tanks prior to flying to EGTK as he thought that this would have put the aircraft above its Maximum Take Off Weight (MTOW).

The pilot reported that upon checking the fuel gauges prior to departure from EDVE, they were both indicting three-quarters full.

History of the flight

D-IAFC took off from EDVE at 1003 hrs with 262 lb of cargo on-board[2]. The aircraft climbed to FL100 for the cruise, and flew at a TAS of 170 kt; this gave a groundspeed of approximately 160 kt as computed by the aircraft's Global Positioning System (GPS) receiver.

The aircraft's routing took it west through Germany and southern Holland before entering UK airspace. During the flight the pilot did not notice anything untoward and the times overhead en-route waypoints correlated reasonably well with the calculated times. As the weather was good he planned to continue under VFR after the Clacton VOR (CLN), so as to fly around the London Terminal Manoeuvring Area to minimise any potential delays. The flight progressed without incident until shortly after the aircraft crossed the UK FIR boundary at reporting point REFSO, 56 nm to the east of CLN, at 1158 hrs. He was then transferred to London ATC and, upon initial contact, was given clearance to fly direct to CLN.

At 1212 hrs, when 30 nm from the Suffolk coast and still at FL100, the aircraft's right engine began to run roughly. Initially, the pilot thought this might have been caused by water in the fuel so he switched on the fuel booster pump. The engine recovered momentarily and then stopped. On looking at the fuel gauges, he noticed both were indicating in the 'red sector'. As a result, the pilot transmitted a PAN call to ATC, advising them that he was short of fuel and asked them what was the "next airport?" They advised him it was Stansted Airport, 72 nm away. The pilot said he thought he had only five minutes of fuel remaining and declared an emergency. ATC asked the pilot to squawk 7700[3] and advised him that Clacton Airport was 38.6 nm away; he replied that this was too far. ATC informed him that the closest point on the coast was 30 nm distant and gave him a heading to fly. He then said that he was looking for a ship below,

Footnote

[1] Although the pilot had intended the flight-plan to state that the flight would be conducted as a General Aviation IFR flight, it was in fact submitted as a Commercial IFR flight.

[2] See paragraph titled **Aircraft's Weight**.

Footnote

[3] Squawk code 7700 is the MAYDAY transponder code.

that he was descending at approximately 500 ft/min and could only fly for about another 10 nm. ATC advised him that the emergency services had been alerted.

At 1217 hrs, the pilot was informed by ATC that the coast was now 23 nm away and they asked him if the aircraft's engines had stopped. He replied saying that the right engine had stopped and only the left was working. Three minutes later the pilot was transferred to the Distress and Diversion (D&D) radio frequency of 121.5 MHz[4].

On initial contact with D&D, the pilot informed the controller that "both engines are dead now" and that he was planning to ditch in the sea near to one of three ships that he could see. They advised him that a Search and Rescue (SAR) helicopter had been scrambled and, upon enquiring how far away it was, the pilot was informed 15 mins. He replied that he thought he had only three minutes before he would have to ditch.

At 1225:30 hrs, the pilot reported he was at 1,500 ft amsl, to which D&D informed him he was 9 nm from the coast. Shortly thereafter, they informed him radar contact had been lost. He replied that he expected to ditch in about 30 seconds and removed his headset in preparation. No further communications were received from the aircraft. Although the aircraft's Operating Manual contains a section on '*Ditching'*, and the pilot later stated that he carried out the ditching check list from memory.

As the aircraft approached the sea, the pilot positioned it to fly parallel to the heading of a ship he had seen during the descent, planning to ditch near it in order to minimise the time taken to be rescued. At 100 ft amsl, he opened the emergency hatch located in the right door. Just before the aircraft touched down, the pilot flew the aircraft level, until the stall warning sounded. At a speed of about 80 kt, the tail of the aircraft hit the sea, followed by the fuselage. The aircraft survived the impact without breaking up and, when it came to rest, the pilot unstrapped, abandoned the aircraft through the emergency hatch, climbed onto the right wing, took off his shoes and got into the water. Due to the swell of the sea, water entered the aircraft cabin through the open hatch and it sank after approximately three minutes. The accident occurred at 1228 hrs.

The ditching was witnessed by personnel on the ship, who immediately launched a lifeboat. Just before this reached the pilot, the SAR helicopter arrived on the scene and winched him on board. Once in the helicopter, the pilot was found to be suffering from the effects of immersion in cold water. He was flown to a hospital in Ipswich, Suffolk, where he was found to have suffered a fractured vertebra.

Search and Rescue

At 1216 hrs, D&D were informed by London ATC that an aircraft had run out of fuel and was going to ditch in the sea. Control of the SAR operation was subsequently transferred to the Aeronautical Rescue Control Centre (ARCC) at RAF Kinloss, Scotland. As a result, at 1240 hrs, two lifeboats, one from Harwich and one from Aldeburgh, Suffolk, were launched. The SAR helicopter from RAF Wattisham, near Ipswich, was scrambled at 1226 hrs and, by 1245 hrs, had winched the pilot on board. The Harwich lifeboat was then stood down but the Aldeburgh lifeboat continued to the scene to search for wreckage and to check for possible pollution. On arrival on the scene, at 1312 hrs, no evidence of either was found.

Footnote

[4] This was to enable radio contact to be maintained for as long as possible in the descent, as this frequency had a better low level capability than the en-route frequency.

During D-IAFC's gliding descent, the crew of a commercial passenger aircraft inbound to London Heathrow Airport (LHR) from Brussels, was asked by ATC if they could offer assistance in locating the aircraft during the final stages of descent before radar contact was lost; at this point D-IAFC was 15 nm ahead. Having assessed that their aircraft had an excess endurance of approximately 15 mins, the crew were able to help. ATC cleared the aircraft to descend to FL100 and vectored it in the direction of D-IAFC. Once above D-IAFC's position, the crew became visual with the aircraft and watched it ditch approximately one nautical mile ahead of a ship. They then informed ATC that the aircraft was floating and had not broken up, and passed on its position before continuing to LHR.

Another commercial passenger aircraft, also inbound to LHR, had fuel available to remain in the area for two hours and offered further assistance. This aircraft proceeded to the position passed by the previous aircraft and, with ATC clearance, descended to 3,000 ft asml. Once overhead, the crew observed a stationary ship, but no aircraft, and passed the description of the ship to ATC. At this time, the SAR helicopter was approximately 5 nm west of the position. Upon arriving at the scene the helicopter crew became visual with the ship and its lifeboat before locating the pilot in the water. On hearing this over the radio, the passenger aircraft continued to LHR.

Survival aspects

The pilot was fortunate to locate a ship prior to ditching and to have commercial air traffic in the vicinity to expedite his rescue. He was dressed in a long sleeved shirt and trousers. At the time of the accident the sea temperature was 17ºC and, at this temperature, without appropriate survival equipment, he had an expected survival time of just over one hour[5]. He was in the water for 18 minutes.

Footnote

[5] Data from the Royal Air Force.

Weather

An aftercast covering the duration of the flight was obtained from the Met Office. This stated that the wind at FL100, was from 230º at 25 to 30 kt. At the ditching location there was scattered cumulus cloud at 3,000 ft amsl, the surface wind was from 270º at 15 to 20 kt and the visibility was in excess of 10 km. Additionally, the sea swell was 0.5 to 1 m with a period of five seconds. The average track for the flight was 260º. The wind at FL100 would have given a headwind component of approximately 22 kt.

Pilot's comments

The pilot was interviewed by the AAIB in hospital the day after the accident. He was also interviewed by the German Federal Bureau of Aircraft Accidents Investigation - Bundesstelle für Flugunfalluntersuchung (BFU) - after his return to Germany.

He stated that he had planned the flight on the basis of an average fuel consumption rate of 104 litres/hr. He added that there was a 'Digi-Flow' meter fitted to the aircraft but that it had not been serviceable for "some time". Because the manufacturing company had ceased trading it had not been possible to obtain any spare parts. Additionally, he stated that the aircraft's fuel gauges were "pretty inaccurate" and so he usually trusted his own calculations. The aircraft was not fitted with low fuel quantity warning lights.

The pilot also stated that there was no way of directly establishing the contents of the fuel tanks on the ground, due to the dihedral of the wings and the fact that the refuelling caps are located close to the wing tips. Also, there were no dip sticks fitted. The only indication of fuel quantity on board the aircraft were the readings from the fuel gauges located close to the cockpit floor. He added

that he had not checked these during the cruise until the right engine started to run roughly, as they were difficult to see as well as being inaccurate[6].

The aircraft did not carry a liferaft, but two lifejackets were located in the rear of the cabin. The pilot stated he had not worn one as he had not remembered that they were there.

Aircraft fuel system

The Cessna T303 has one fuel tank in each wing, with a total useable fuel capacity of 579 litres (918 lb). There are two fuel gauges, one for each tank, marked left and right, located at the rear of the centre console just above floor level, Figure 1.

The lower sector of the fuel level scale is marked in red, to indicate when only unusable fuel is remaining in each tank; unusable fuel is quoted in the manual as 12 lb.

A separate low fuel level warning system, incorporating two warning lights on the instrument panel, was available as a customer option on the T303, but this was not fitted to D-IAFC. Each light illuminates when the fuel remaining in its respective tank reduces to 38 litres (60 lb) or less.

The aircraft had been modified to incorporate a 'Digi-Flow' digital fuel flow meter, but this had been inoperative for some time.

Figure 1

Footnote

[6] Another operator of this aircraft type has also reported that the fuel gauges are inaccurate.

Company information

The aircraft's operating company had an Air Operator's Certificate (AOC) issued by the German authorities. This gave approval for the company to transport cargo and passengers. The AOC was valid at the time of the accident.

The company's flight planning documentation states that 25 lb of fuel should be allowed for during start-up and taxi, and a fuel flow rate of 174 lb/hr should be used for calculating the trip fuel. This includes the fuel used during climb and descent. Additionally, there are columns to add to the trip fuel for contingences such as diversion to an alternate airfield and 45 mins holding.

Aircraft performance

The flight planned track from EDVE to EGTK was 468 nm and the head wind component was approximately 22 kt. When this data is plotted on the Fuel and Time Required (60% power) graph in the aircraft's Operating Manual, a flight time of approximately 3 hrs 21 minutes and fuel required of approximately 585 lb is predicted. This includes fuel for engine start, taxi, takeoff, normal climb, descent and 45 minute reserve. The time required includes that for normal climb and descent, all of which equates to a fuel consumption rate of 174 lb/hr. The Holding Time table states that 80 lb of fuel is required for 45 minutes holding at 45% power.

Fuel plan

All pre-flight and in-flight paperwork was on-board the aircraft and was not recovered. However, the refuel certificate for D-IAFC was obtained from LZIB, and this showed that 200 litres (317 lb) of fuel was uplifted prior to the aircraft returning to EDVE. Table 1 compares the pilot's assumed fuel load and endurance with the (AAIB) estimated fuel load and endurance, for the accident flight and the two previous flights. The estimated departure fuel figures were derived with reference to the aircraft's

	Depart EDVE	Arrive LZIB	Depart LZIB	Arrive EDVE	Depart EDVE	Arrive EGTK
Pilot's assumed fuel on board (lb)	918 (a)	406	918 (b)	548	548 (d)	113
AAIB estimated fuel on board (lb)	918 (a)	406	723 (c)	353	353 (d)	-107
Pilot's assumed endurance	5 hr 30 min	---	5 hr 30 min	---	3 hr 30 min	1 hr
AAIB estimated endurance	5 hr 8 min	---	4 hr 0 min	---	1 hr 53 min	-37 min
Flight time	2 hr 48 min	---	1 hr 59 min	---	2 h 30 min (e)	---

Table 1

Pilot's assumed and AAIB estimated fuel figures and endurances

Notes:
(a) Aircraft departed EDVE with full tanks
(b) Pilot assumed the tanks were full prior to departing LZIB
(c) Fuel records show only 200 litres (317 lb) uplifted at LZIB, giving 723 lb on departure
(d) Aircraft was not refuelled again prior to departing for EGTK
(e) Flight plan estimated elapsed time

refuelling records. The arrival fuel figures and the endurances were calculated using the fuel consumption figures quoted in the operator's flight planning logs.

The estimated endurance figures are to fuel exhaustion and make no allowance for reserve and alternate fuel.

Aircraft's weight

The MTOW of D-IAFC was 5,150 lb.

When interviewed after the accident, the pilot stated to the AAIB that there was 200 lb (90.9 kg) of cargo on board the aircraft. When interviewed by the BFU, on his return to Germany, he amended this to 540 lb (242.5 kg). He later explained that he had expected a cargo of this weight and, as this would have placed the aircraft close to its MTOW, he decided not to refuel prior to departing for EGTK. Documents recovered from the supplier of the cargo indicate that its total weight was actually 262 lb (119 kg). As this flight was an ad hoc charter flight, the cargo supplier is convinced there was no additional cargo on board. Furthermore, the operating company's insurer has not been notified of any other loss other than the 262 lb of documented cargo.

The following tables compare the aircraft's takeoff weight for its flight from EDVE to EGTK (using the two different cargo weights) with the maximum permitted takeoff weight, with the pilot's assumed fuel on board (Table 2) and the AAIB estimated fuel on board (Table 3). These tables use a basic aircraft weight of 3,654 lb, a pilot weight of 187 lb and the fuel figures from Table 1; all weights are in pounds.

	540 lb cargo	262 lb cargo
Aircraft's weight with pilot	3,841	3,841
Pilot's assumed fuel	573	573
Fuel used during start up/taxi	-25	-25
Pilot's assumed takeoff weight	4,929	4,651
Fuel weight available, but not used, limited by the MTOW	221	499
Additional flight time if fuel weight available had been used, assuming fuel consumption at 174 lb/hr	1 hrs 16 mins	2 hrs 52 mins

Table 2

	540 lb cargo	262 lb cargo
Aircraft's weight with pilot	3,841	3,841
Pilot's assumed fuel	378	378
Fuel used during start up/taxi	-25	-25
Pilot's assumed takeoff weight	4,734	4,456
Fuel weight available, but not used, limited by the MTOW	415	694
Additional flight time if fuel weight available had been used, assuming fuel consumption at 174 lb/hr	2 hrs 23 mins	3 hrs 59 mins

Table 3

Joint Aviation Requirements - Operations (JAR-OPS) 1

'*JAR-OPS 1 Subpart B - General, Appendix 1 to JAR-OPS 1.005(a) paragraph (12) 1.255 Fuel Policy*' states:

> *'(ii) For A to B Flights – An operator shall ensure that the pre-flight calculation of usable fuel required for a flight includes;*
>
> *(A) Taxi fuel - Fuel consumed before take-off, if significant; and*
>
> *(B) Trip fuel (Fuel to reach the destination); and*
>
> *(C) Reserve fuel -*
>
> *(1) Contingency fuel - Fuel that is not less than 5% of the planned trip fuel or, in the event of in-flight re-planning, 5% of the trip fuel for the remainder of the flight; and*
>
> *(2) Final reserve fuel - Fuel to fly for an additional period of 45 minutes (piston engines) or 30 minutes (turbine engines); and*
>
> *(D) Alternate fuel - Fuel to reach the destination alternate via the destination, if a destination alternate is required*
>
> *(E) Extra fuel – Fuel that the commander may require in addition to that required under subparagraphs (A) – (D) above.'*

Joint Aviation Requirement - Flight Crew Licensing (JAR – FCL) 1

'JAR – FCL 1, subpart A – General Requirements', states:

> *'JAR–FCL 1.060 Curtailment of privileges of licence holders aged 60 years or more*
>
> *(See Appendix 1 to JARFCL 1.060)*
>
> *(a) Age 60–64. The holder of a pilot licence who has attained the age of 60 years shall not act as a pilot of an aircraft engaged in commercial air transport [CAT] operations except:*
>
> *(1) as a member of a multi-pilot crew and provided that,*
>
> *(2) such holder is the only pilot in the flight crew who has attained age 60.*
>
> *(b) Age 65. The holder of a pilot licence who has attained the age of 65 years shall not act as a pilot of an aircraft engaged in commercial air transport operations.*
>
> *(c) Any national variant to the requirements in (a) and (b) above are given in Appendix 1 to JAR-FCL 1.060.'*

There are no German national variants to the requirements in (a) and (b) in Appendix 1.

Analysis

Licensing

The pilot was 67 years old at the time of the accident. He held a Commercial Pilot's Licence. This was valid until 18 June 2007, but this only permitted him to fly in Germany, which he also did as a flying instructor. His

licence, however, was not valid for him to fly as a pilot of an aircraft engaged in CAT operations, as he was over 65 years old.

Fuel planning

The fuel flow rate (of 104 litres/hr) that the pilot stated he used in his calculations, equates to 164 lb/hr. With the aircraft's fuel tanks full, this equates to a flying time (to fuel exhaustion) of 5 hrs 26 mins, allowing 25 lb for start up and taxi. This figure is effectively the same as the pilot's assumed full tanks endurance of 5 hr and 30 mins, if slightly optimistic.

Although the pilot believed that he had filled the aircraft's fuel tanks to full at LZIB, it was estimated that they may have been less than full by some 195 lb (123 litres). If this were so, and the tanks had been refuelled to full, the aircraft should have been able to fly for, approximately, an additional one hour seven minutes before running out of fuel. The fuel on board prior to taking off from EDVE, estimated by the AAIB, was 353 lb. This equates to an endurance of two hours. The fuel on-board became exhausted after 1 hr 53 mins and 314 nm, approximately 160 track miles from EGTK. At a ground speed of 160 kt in the cruise, the aircraft was, therefore, approximately one hour short of its destination. Thus, although the aircraft should have been able to reach EGTK, had the fuel tanks been full on departure from LZIB, it would not have had any reserve or fuel to fly to an alternate airfield.

If the aircraft's fuel gauges were accurately indicating three-quarters full prior to takeoff for EGTK, there should have been approximately 688 lb (434 litres) in the fuel tanks. This equates to an endurance of around 3 hr 50 minutes to fuel exhaustion, using the operating company's fuel burn figure of 174 lb/hr, allowing 25 lb for start up and taxi. The flight planned route was 468 nm and, at a ground speed of 160 kt, this should have taken 2 hr 55 minutes. In order to fly to EGTK in the flight planned time of 2 hrs 30 minutes, the aircraft would have had to fly at a groundspeed of 187 kt; this is an unrealistic speed for the aircraft with the headwind at the time, given that average groundspeed of D-IAFC from takeoff to fuel exhaustion was 149 kt. At this average speed, it would have taken 3 hr and 8 mins to fly from EDVE to EGTK, and would have required 545 lb of fuel. The AAIB estimate of fuel on-board at the start of the flight, from Table 1, was 353 lb.

It appears the pilot may have thought the weight of his cargo was 540 lb, not its actual weight of 262 lb. Using the pilot's assumed weight of the cargo and his assumed fuel on-board (573 lb, see Table 2) prior to departure, this would have allowed him to load an additional 221 lb of fuel to take the aircraft up to its MTOW. This would have given the aircraft an additional 1 hr 16 min of flying time to fuel exhaustion. Thus, flying at an average groundspeed for the trip of 149 kt, the aircraft would probably have reached EGTK, but would not have had any alternate or reserve fuel. Using the AAIB estimated fuel quantities from Table 3, and the pilot's assumed weight of the cargo, he should have been able to load an additional 415 lb of fuel without exceeding the aircraft's MTOW. This would have given an additional 2 hrs 23 min flying time to fuel exhaustion. Thus, the aircraft should have been able to reach EGTK with sufficient fuel remaining to reach an alternate airfield, plus reserve fuel.

Survivability

Although the pilot's survival time, at a water temperature of 17ºC, was theoretically predicted to have been about one hour, his useful conscious time would have been significantly less. It was fortunate that the SAR

helicopter and the rescue boat from the nearby ship were on scene so quickly as, after only 18 minutes in the water, he was diagnosed as already suffering from the effects of cold. It was also fortunate that the sea state was slight, given that the pilot was not wearing a life jacket. Had it been greater, his chances of surviving in the open sea long enough to be rescued would have been much reduced. Although the aircraft was not carrying a dingy, had the pilot been able to deploy and board one, his survival time would have been greatly increased. It would, therefore, seem prudent for single and multi-engine aircraft not required to carry a dingy, to do so when transiting large areas of water, and for pilots to be trained in their deployment and operation.

The CAA have published Safety Sense Leaflet 21, titled '*Ditching',* which contains comprehensive information on this subject.

Conclusion

The accident occurred as a result of the aircraft running out of fuel approximately 160 nm short of its destination. Although the wreckage of the aircraft was not recovered, all the evidence suggests that this occurred due to insufficient fuel being on-board the aircraft prior to departure, rather than because of a technical problem. The pilot's lack of awareness of the fuel quantity and the actual weight of the cargo on board D-IAFC prior to takeoff, are considered to have been significant causal factors in the accident. A contributory factor was that the pilot did not monitor the reportedly 'unreliable' fuel gauges, thus missing a chance to notice the aircraft's low fuel state and divert to a suitable airfield before the situation became critical.