



# AIRCRAFT ACCIDENT REPORT

(Cf. the Aircraft Accident Investigation Act, No. 59/1996)

PLEASE NOTE: This report has been translated and published by the Icelandic Ministry of Transport in order to make it accessible to a non-Icelandic audience. While every effort has been made to ensure the accuracy of the translation, it must be pointed out that the original Icelandic version is the basis of reference.

L.Í.O. ehf./Air Charter Iceland  
TF-GTI. Type: Cessna T210L, Centurion II  
In the inlet Skerjafjörður (64°07,482'N 021°57,585'V)  
7 August 2000

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The aim of aircraft accident investigation is to identify factors contributing to aircraft accidents for the sole purpose of preventing aircraft accidents from reoccurring and to encourage increased safety in aviation. The purpose is not to determine fault and/or responsibility. The Report of the Aircraft Accident Investigation Board (AAIB) may not be used as evidence in criminal cases, as investigation of possible punishable offences in connection with aircraft accidents is to be independent of aircraft accident investigation as provided for by the Aircraft Accident Investigation Act, No. 59/1996 (see Articles 1 and 14).

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<b>Aircraft:</b> Cessna T210L, Centurion II	<b>Registration:</b> TF-GTI. Normal class. Passenger Transport
Registered owner: L.Í.O. ehf./Air Charter Iceland	<b>Operator/User:</b> Registered owner
<b>Crew:</b> One	<b>Passengers:</b> Five
<b>Place of accident:</b> In the inlet Skerjafjörður, by Reykjavík airport (64°07,482'N 021°57,585'V)	<b>Date:</b> 7. 7 August 2000, 20:35

**SYNOPSIS** The flight was a taxi flight by L.Í.O. ehf./Air Charter Iceland, carrying five passengers from the Westman Islands airport to Reykjavík airport. The aircraft was ascending and had reached an altitude of approximately 500 feet over Skerjafjörður in a missed approach following a VFR approach to runway 20, when the engine lost power and stopped. The pilot informed the tower immediately and was cleared, "Shortest way and cleared to land!"

An instant later the pilot shouted that plane was in a stall; a large number of eye witnesses saw the aircraft begin a left turn, then roll over to the left and fall in a steep spiral into the ocean some 350 metres from shore.

The aircraft broke apart when it crashed into the ocean and sank to a depth of some six metres with all those on board. Rescuers were quick to arrive on the scene and managed to bring four passengers and the pilot to the surface. Two of the passengers survived the accident, seriously injured, while the pilot and three passengers died.

This report indicates that the Aircraft Accident Investigation Board (AAIB) considers the most probable cause for the engine power loss was fuel starvation and that subsequently the pilot lost control of the aircraft so that it stalled and fell into a steep spiral from which he could not recover.

In the report, the AAIB makes a several safety recommendations.

<b>1.1 History of the flight</b> See p. 2.	<b>1.2 Injuries to persons</b> See p. 3.	<b>1.3 Damage to the aircraft</b> Destroyed
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<b>1.4 Other damage</b> None	<b>1.5 Personnel information</b> See p. 3.	<b>1.7 Weather</b> See p. 4.
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**1.6 The aircraft** Six-seater high wing Cessna T210L, Centurion II, manufactured in September 1973, serial number 21060050, equipped with one Teledyne Continental TSIO-520-H, six cylinder 285 hp piston engine. It was non-pressurised.

The aircraft was registered in Iceland on 14 June 2000 as TF-GTI, owned by L.Í.O. ehf./Air Charter Iceland, of Reykjavík airport and was issued with a Certificate of Airworthiness (CofA) for commercial flights on 15 June 2000, valid until 30 June 2001. On 16 June the aircraft was registered for taxi flight service on the operating licence of *Leiguflug Ísleifs Ottesen hf.* (L.Í.O. ehf./Air Charter Iceland), Reykjavík airport, which used the aircraft in its commercial operations. The aircraft had liability and aircraft hull insurance with Codan. Gl. Kongevej 60, Copenhagen. In the aircraft there were two seats, side by side, in three rows. It was outfitted with dual controls, one in front of each of the front seats.

The last inspection of the airplane was a 50 hours inspection, carried out 1 August 2000. Since that time the aircraft had been flown a total of 11 hrs. 18 min.

<b>1.8 Aids to navigation</b> Not relevant	<b>1.9 Communi-cations</b> See 1.1 History of the flight	<b>1.10 Aerodrome information</b> Runway 14/32 was closed due to earthmoving (repair) operations	<b>1.11 Flight recorders</b> None, nor were they required
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<b>1.12 Wreckage and impact information</b> See p. 5.	<b>1.13 Medical and pathological investigations</b> Forensic chemical tests on the pilot's corpse were negative and the cause of death was a combination of multiple injuries and drowning.
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<b>1.14 Fire</b> Did not occur	<b>1.15 Survival aspects</b> See p. 5.	<b>1.16 Tests and research</b> See p. 6.
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<b>1.17 Organisational and management information</b> See p. 8.	<b>1.18 Additional information</b> See p. 10.	<b>1.19 Useful and effective investigation techniques</b> None
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<b>2. ANALYSIS</b> See p. 21.	<b>3. CONCLUSIONS</b> Probable causal factors are marked with an asterisk * See p. 25.
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<b>4. SAFETY RECOMMENDATIONS</b> See p. 26.	<b>5. APPENDICES</b> 5.1 Diagram of the flight path of TF-GTI 5.2 Weather map 5.3 Photographs 5.4 Performance figures for Cessna T210L 5.5 Diagram of the Cessna T210L fuel system
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# 1. CIRCUMSTANCES

## 1.1 History of the flight

On 7 August 2000, TF-GTI began its flights from Reykjavík, taking off at 7:53 and flying to the Westman Islands. The same pilot flew TF-GTI all day. He made 10 trips with passengers from the Westman Islands to Selfoss airport with the final trip concluding with a landing at the Westman Islands airport at 19:48. After that it was planned to fly the plane to Reykjavík and the pilot made a flight plan in the Westman Islands accordingly. It called for a 30 minute VFR flight from the Westman Islands to Reykjavík, endurance was given as 2:30 min. and aboard the plane were the pilot and five passengers. According to data from the airport tower in the Westman Islands, take-off was at 20:03 and the aircraft flew VFR en route to Reykjavík.

At 20:19:15, when the aircraft TF-GTI was some 24 nautical miles (NM) from Reykjavík and climbing to an altitude of 4000 feet approaching Hellisheiði, the pilot contacted Reykjavík airport approach control and requested IFR clearance direct to radio beacon “GF” (Gróf) in Reykjavík. TF-GTI was cleared to fly IFR at 4000 feet, direct to radio beacon “EL” (Elliðavatn). At 20:20:15 radar contact was confirmed and that the aircraft was four NM west of Selfoss. At 20:20:55 the Reykjavík airport approach control informed the tower that TF-GTI was on IFR clearance, with estimated time of arrival 20:33 and that the aircraft would be number three for approach following ICB-753 (which was a Dornier aircraft of Íslandsflug hf.). At 20:23:50 the pilot of TF-GTI cancelled the IFR. The Reykjavík airport approach control notified the tower of this and also that TF-GTI was abeam Sandskeið.

At 20:24:15 TF-GTI called the tower at Reykjavík airport to report he was 12 NM east of the airport coming in for landing. TF-GTI immediately received instructions from the tower: “Report approaching Laugarnes for runway 20”.

A few seconds later TF-FTS, a Cessna 152 trainer plane flying VFR to Reykjavík, reported that it was over “Tangi”, which is on Kjalarnes and it was told to report over Viðey. The pilot has testified that heavy cloud was visible over Reykjavík and that he had had to fly at an altitude of 900 feet due to clouds.

About a minute later the tower contacted TF-GTI and informed the pilot that visibility appeared rather poor and that another aircraft was approaching from the north. The tower then requested TF-GTI to head for Víflsstaðir and fly in to the west of the airport downwind, which the pilot agreed to do. He asked about the wind and was told it was 120°/5-10 knots.

At 20:26:17 Faxi-153 (which is a Fokker F-50 of Flugfélag Íslands hf.) reported it was passing the radio beacon “Skagi” and was 9.5 NM from the airport on IFR approach; the tower told him he was number one for landing on runway 20.

At 20:27:42 the pilot of TF-GTI reported he was at Víflsstaðir and was then informed that his aircraft was number two for landing after a Fokker (Faxi-153) which was on final approach and that he should report “downwind west of the airport”. About 10 seconds later TF-FTS called and reported over Viðey and was instructed to report at Laugarnes.

Faxi-153 received clearance to land at 20:28:00, the wind was 130°/10 knots and the pilot confirmed receiving this information. At the same time TF-FTS reported over Laugarnes and the tower instructed TF-FTS to hold over Laugarnes and the pilot said he would fly one circle.

At 20:29:00 ICB-753 reported on localiser and on IFR approach to runway 20 at Reykjavík airport.

At the same time, the pilot of TF-FTS was asked whether he saw the Fokker on final. The pilot of TF-FTS did not see the Fokker and then ICB-753 was asked to report five miles out and slow down if he could and ICB-753 confirmed this.

TF-FTS was then told to come in on base leg for runway 20 and at the same time TF-GTI reported over Álftanes. At 20:29:38 TF-FTS reported that he saw a Fokker on final and Faxi-153 received at the same moment repeated clearance to land. TF-FTS was informed at 20:29:53 that he was number two, following the Fokker, and was instructed to come in the shortest way.

At 20:30:00 TF-GTI was informed that he was number three following the Cessna (TF-FTS) on left base leg for runway 20. The pilot of TF-GTI confirmed and asked about TF-FTS, then confirmed at 20:30:12 that he saw the aircraft. Faxi-153 then landed and received at 20:30:44 instructions to expedite to hangar. At 20:31:02 ICB-753 reported five miles out and received the answer that he would be number three following a Cessna 210 (TF-GTI) on right base leg.

At 20:31:10 TF-FTS received clearance for landing and at 20:31:27 the pilot of TF-GTI was asked for his position; he answered that he was then coming over the tanks (of Örfirisey).

The tower confirmed that it saw TF-GTI and at 20:31:39 the tower said: “Seven five three, the traffic is at the tanks now, low on the final”. ICB-753 confirmed at 20:31:41 that he had received this. The tower then asked ICB-753 at 20:31:42 whether he was VFR and received the answer at 20:31:49 that he was IFR. At 20:31:52 the tower instructed TF-GTI: “Tango, India. Break off approach to the east.” GTI responded at 20:31:54 “Breaking off to the east. Tango, India.” At 20:32:07 ICB-753 was notified that it was number one for landing.

According to the report from the pilot of ICB-753 he saw the tanks at Örfirisey at an altitude of about 600 feet and was then slightly north of them.

According to a radar image, ICB-753 was at an altitude of about 600 feet when TF-GTI turned eastward. ICB-753 descended and was at an altitude of about 400 feet when the aircraft was abeam Engey and about 300 feet abeam

Örfirisey, at which time TF-GTI was turning north abeam Engey in its circle. The altitude of TF-GTI did not appear in the radar image.

At 20:32:14 the pilot of TF-GTI was told he could continue and come in on a left turn behind a Dornier which was about to pass over the tanks. At 20:32:20 TF-GTI confirmed that he was making a left turn and would come in following the Dornier (“Taking a left and getting behind him. Tango, India.”) and TF-FTS was instructed to taxi to hangar no. 1 (which is east of runway 20 by the old tower building).

At 20:32:30 ICB-753 was cleared for landing. The aircraft was then on short final and the wind was 130°/08 knots.

At 20:33:49 the TF-GTI reported: “Tango, India, over the lake now”, and received the reply at 20:33:52: “Tango, India, number one” and in direct continuation ICB-753 was told to “turn left off the runway for apron”, which ICB-753 confirmed (“Roger, 753”).

The pilot of ICB-753 said he had landed at a normal spot on the runway and had already reduced the aircraft’s speed abeam hangar no. 1. He made a 90° left turn (east) to taxi off the runway. He then looked out of his left side window and said he saw TF-GTI on a “very short final” and at the same moment the pilot of TF-GTI received instructions to abort the landing and fly a traffic circuit.

At 20:34:10 the tower instructed TF-GTI: “Tango, India, discontinue and fly a traffic circuit.”

Many witnesses saw TF-GTI abort its landing at or below a height of 100 feet near the threshold of runway 20 and initiate a missed approach. The aircraft was seen retracting its landing gear abeam hangar no. 4 (which is between runway 02/20 and the building of Flugfélag Íslands hf.) and turn right near the junction of runways 02/20 and 07/25 and climb to the southwest close to the direction of runway 25.

The aircraft was flying straight, climbing slowly and at an altitude of about 500 feet in the estimation of eye witnesses when the pilot called at 20:34:54: “And Tango, India, request to come in! - I have lost the engine!” The tower answered immediately: “Have you lost the engine?. . . Shortest way in and cleared to land!” At 20:35:04 the pilot shouted: “It is a stall! It is a stall!”

Eye witnesses near the shore who watched the aircraft first noticed it when they heard the abnormal sound of the engine. The aircraft flew almost directly over one of them who described the sound as “coughing” or “hiccoughing” and a number of eye witnesses described the sound as “coughing as if the engine were about to stop”. The sound was also described as a “misfiring sound”.

Many eye witnesses were of the opinion that the aircraft had reached an altitude of about 500 feet and that it was flying almost level or climbing slowly when it turned left. The angle of bank increased and at the same time the aircraft fell in a steep spiral, which ended in the ocean some 350 metres from the shore. The aircraft broke apart and sank to a depth of some six metres with all those on board.

## 1.2 Injuries to persons

One of the passengers died at the site of the accident, but the others, including the pilot, were brought ashore, but showing little sign of life. The pilot and one of the passengers were declared to be deceased shortly after arrival at hospital and one of the passengers died several days later. Two of the passengers survived the accident, but suffered very extensive injuries. One of them died several months later.

Injuries to persons	Crew	Passengers	Others
Fatal*)	1	3	-
Serious	-	2	-
Slight/none	-	-	-

\*) According to the ICAO definition, which is included, for instance, in Council Directive 94/56/EC, fatal injury means “an injury which is sustained by a person in an accident and which results in his/her death within 30 days of the date of the accident”.

## 1.5 Personnel information

The pilot was a 28-year-old male, Icelandic citizen. His first pilot’s licence was a student pilot’s licence, issued by the Icelandic Civil Aviation Administration (ICAA) 24 June 1993 and his private pilot’s licence was issued 25 May 1994. When the accident occurred he possessed a commercial pilot’s licence Class III aircraft, issued 2 January 1996 and valid until 31 January 2001.

Ratings to the pilot’s licence: Single-engine landplane of up to 5700 kg and night flying rating, dated 2 January 1996. Instrument flight rating, dated 4 November 1996 and flight instructor’s rating, dated 21 July 1997. Type ratings: PN-68, dated 1 November 1996, C-310 dated 15 April 1999 and MEP (multiple-engine landplanes with reciprocating engines), dated 19 August 1999.

The pilot began work for L.Í.O. ehf./Air Charter Iceland in 1996 and had continued to work there since that time. According to the pilot’s flight log books and other documents, his total flying time was 1266 hours 43 minutes

when the accident occurred; a total of 181 hours 33 minutes of this time were flown during the past 90 days. His total flying time for the Cessna 210 type was all flown on this aircraft, TF-GTI, a total of 27 hours 06 minutes.

According to the pilot's flight log book, his flying time the last 28 days before the accident totalled 81 hours 39 minutes, of which a total of 12 hours 06 minutes were on the Cessna 210. He had logged a total of 3 hours 30 minutes of flying time in the US on 5-6 December 1998, in a Cessna 206, which is a type similar to a Cessna 210.

His first flight in TF-GTI was, according to the flight log book, 1 hour 24 minutes, made on 20 June 2000 with another pilot from the operator. On 2 July he flew a total of three flights with the same pilot, who signed for the flights as "C-210 Check" in his flight log book. According to the journey log book of TF-GTI, in addition to the two pilots there were passengers aboard on these flights.

Following this the pilot made one solo flight in the plane, for 1 hour 08 minutes, before transporting passengers as a pilot. His total flying time on these flights was a total of 5 hours 46 minutes. These training flights were in accordance with current rules.

The pilot's most recent training in a Flight procedures trainer (AST-300) was on 23 June 1999. The training took a total of 1 hour 54 minutes, according to the pilot's flight log book. According to the flight log book he passed the qualification exam for his licence (multiple-engine planes and instrument flying rating) on a special training flight from Reykjavík on 12 July 2000 in an aircraft of the type Cessna 402. He furthermore passed his most recent medical examination Class I for his flying licence on 16 January 2000.

The investigation revealed that the pilot was one of two pilots on a flight by the aircraft TF-GTI to Grímsey Island, 2 July 2000, where fuel from the wing-tip tanks of the aircraft was used.

## **1.7 Weather**

The following is excerpted from a report provided by the Icelandic Meteorological Office (IMO) at the request of the AAIB for a special examination of weather conditions at the time of the flight of TF-GTI.

### **1.7.1 "Summary of weather map.**

On the weather map at 18:00 on this day a high pressure ridge is visible extending from North Scotland northwest across Iceland. This ridge had moved slightly northeast from its position earlier that day. Over the Greenland Sea there was a very uninfluential 1008 hPa low pressure area. A weather satellite image at 16:30 shows a belt of precipitation stretching from the west coast of Scotland to the southwest coast of Iceland and from there in the direction of the low pressure area. This appears, however, very scattered in the vicinity of Iceland, and precipitation was not substantial, only a slight drizzle or rain in a few places in the southwest of the country. The next map shows that at 21:00 this situation was practically unchanged, the precipitation belt had moved slightly closer to land.

The Iceland map at 18:00 shows that over by far the greatest area of the country the weather was fairly clear and visibility excellent. Low, stratus (fog) clouds with slight drizzle were, however, hovering along the south coast and at some locations around the bay Faxaflói, especially later in the day. The wind was southeasterly on the ground, in most areas from 10 to 15 knots, but southwesterly at an altitude of approx. 5000 feet. This wind kept low stratus clouds along the Reykjanes mountain ridge and Hellisheiði for most of the day and as evening approached and the precipitation belt moved in from the south, the cloudy air also began to reduce visibility in lowland areas south of the mountain ridge, although considerably clearer weather remained further inland.

High altitude observations from Keflavík airport show that the altitude of the freezing point line was approx. 9000 feet. The air was rather humid up to approx. 10,000 feet and weather satellite images at 16:30 and at 18:12 show a cloud mass which probably reached that height. Weather observations, e.g. in Reykjavík, indicate that the lower edge of this mass would have been at a height of close to 3000 feet. The eastern edge of this cloud appears to have followed the Reykjanes mountain ridge and Hellisheiði, as the wind was southwesterly at their elevation. Over the lowlands of south Iceland, however, there were few clouds at this elevation, but some considerably lower stratus clouds, as previously mentioned, especially along the coast and on the eastern slopes of the mountain ridge.

### **1.7.2 VFR weather between the Westman Islands and Reykjavík**

Weather observations from Eyrarbakki can, together with other weather information, provide an idea of the VFR conditions for part of the route between the Westman Islands and Reykjavík. They describe, for instance, cloud conditions at Skálafell on Hellisheiði and at Ingólfssjall.

Having regard to weather maps, images from weather satellites and observations, the conclusion can be drawn that on the route between the Westman Islands and Reykjavík there was fairly calm weather, generally good visibility and the height of the main cloud layer above the ground would have been close to 3000 feet on the western part of the route. On the eastern part of the route there was considerably less high-altitude cloud, but a series of low stratus clouds travelled over the Westman Islands from the southeast, with the result that cloud level now and again dropped to 100-300 feet. In between the sky cleared, however, and visibility was good for most of the time. This cloud series was borne up towards the shore and piled up along the eastern sides of the Reykjanes mountain ridge. Viewed from the east it

would hardly have appeared advisable to fly VFR under the clouds over Hellisheiði. The cloud series, however, did not reach far inland; there the air was drier and VFR conditions as a result better. This conclusion accords with visual observations made by the weather observer in Eyrarbakki; the clouds reached considerably farther down the slopes of Skálafell on Hellisheiði than on the sides of Ingólfssjall. In observations made at 18:00 and later the observer could not see Skálafell, but at 18:00 clouds did not reach as far down as the top of Ingólfssjall.

These low stratus clouds moved only slightly westward over the mountain ridge, and VFR conditions were thus good under the mass of cloud which was mentioned earlier (lower surface close to 3000 feet).

### 1.7.3 Weather in the vicinity of the Reykjavík airport

Airport observations from Reykjavík airport during the latter part of the day and into the evening describe a main cloud mass at an altitude of close to 3000 feet and also mention a bit of lower cloud (FEW, 1/8-2/8) This presumably refers mainly to stratus clouds along the Reykjanes mountain ridge to the south and southeast, as it can be seen from observations at Keflavík airport that there are more such clouds there and the cloud height is slightly less.

There would have been practically no stratus clouds in the near vicinity of Reykjavík airport, since it enjoyed the shelter of the mountains to the southeast. A ceilometer, which is located on a rooftop at the north end of the lake in Reykjavík, recorded no clouds at a height of less than 2800 feet from 17:30 to close to 22:00. An airport observation made at 20:00 does, however, report precipitation in the area and there is a reference to slight drizzle and visibility of 9 km in a record from 21:00.

An image from a weather radar, taken at 20:40, shows a bank of precipitation WNW of Reykjavík and probably some slight precipitation north of Reykjavík in the direction of Akranes, but none the less it is difficult to see that weather in any way made final approach and landing difficult at Reykjavík airport around the time the accident occurred.”

### 1.7.4 Weather observations at Reykjavík airport on 7 August 2000.

19:01.	METAR	10009KT	9999	FEW018	SCT026	BKN034	12/10	Q1014	RERA
19:56	METAR	10010KT	9999	VCSH	FEW016	BKN032	12/09	Q1014	
20:52	METAR	10008KT	9000	DZBR	FEW010	BKN026	OVC031	11/10	Q1013

These weather observations show that at 19:56 the wind was 100°/10 knots, visibility 10 km or more, showers in the vicinity, light cloud at an altitude of 1600 feet, partly cloudy at 3200 feet, temperature 12°C, dew mark 9°C and atmospheric pressure 1014 hPa. At 20:52:00 the wind was 100°/8 knots, visibility 9 km, drizzle and mist, light cloud at an altitude of 1000 feet, partly cloudy at 2600 feet, overcast at 3100 feet, temperature 11°C, dew mark 10°C and atmospheric pressure 1013 hPa.

**1.7.5 Weather information which the pilot of TF-GTI obtained prior to departure** Prior to his flight to Reykjavík, the pilot of TF-GTI obtained a description of the weather from a pilot of L.Í.O. ehf./Air Charter Iceland, who had just arrived in Reykjavík from the Westman Islands. According to information from L.Í.O. ehf./Air Charter Iceland, he was informed that Hellisheiði was considered doubtful as far as VFR flight was concerned, but that the way was okay via Thingvellir and Mosfellsheiði.

On the way to Reykjavík the pilot also made radio contact with another aircraft in the area and obtained the information, according to the testimony of a pilot who heard their conversation, that there were VFR conditions over Hellisheiði.

## 1.12 Wreckage and impact information

Investigators from AAIB arrived at the scene of the accident about 25 minutes after it occurred. Rescue operations were still underway at that time and the last of the persons rescued from the wreck of TF-GTI where it lay on the ocean floor were being brought to land. An AAIB investigator went out in a boat to the diving barge which had by then reached the location of the accident and was above the wreck. There he followed the rescue operation and later directed the retrieval of the wreck from the ocean and its transport to a hangar at Reykjavík airport.

When the aircraft fell into the ocean the tide was beginning to come in and the aircraft was at a depth of some six metres. The left wing of the aircraft had broken and been mostly torn off; it hung from the wreck on the control cables of the aileron. The front end of the wreck was pointed toward the mouth of the inlet and it lay on its left side, with the right wing pointing upwards. The wing tip protruded from the ocean at first and could be easily seen, so that the men from the fire department, who were quick to arrive at the scene, did not need to search for the wreck. Rescue actions thus began without further delay. Divers retrieved four of the passengers and the pilot from the wreck where it lay on the ocean bed, but a passenger in the right front seat was jammed in his seat and could not be released until the wreck had been brought ashore.

The wings had been torn apart, and thus both of the aircraft's main fuel tanks, which are integral tanks, were opened in the accident and seawater had flooded into them. There was little fuel spillage on the ocean surface by the wreck and the divers who worked at rescuing the people were hardly aware of fuel pollution in the water.

Ropes were placed around the wreck and photographs taken of it before it was hoisted from the water. The wreck was then transported on the barge to shore, where a temporary investigation took place, after which it was taken

into the custody of the AAIB.

All the signs indicated that the aircraft had entered the ocean in a steep spiral to the left and that the impact at the ocean surface had been extremely forceful. Both of the left engine mounts had broken, both the main doors and the engine cowlings had been torn off. The fuselage had broken apart just in front of the tail, which hung from the wreck on the control cables of the elevator and rudder. The flaps were retracted and the landing gear had also been retracted. The propeller, which is a constant speed propeller, showed signs that it had had no power when it entered the water. The blades were in fine pitch and two of them, nos. 1 and 2, were bent far backwards. Otherwise the principal parts of the plane and control surfaces were in their places. There was no indication other than that the aircraft had been in one piece when it crashed into the ocean.

### **1.15 Survival aspects**

Four firemen from Reykjavík airport very quickly reached the shore nearest to the accident location. They had brought a boat with them and three of them donned flotation outfits on their way out to Skerjafjörður. They launched the boat and hurried to the location of the accident.

Divers from the [City of Reykjavík] fire station on Skógarhlíð and the Reykjavík police were also very quick to arrive on the scene and began rescue attempts without delay. The operator of a diving barge, who was at his home by the Kópavogur harbour on the peninsula of Kársnes on the opposite side of the inlet Skerjafjörður, was told by his family that a plane had crashed into the ocean. He hurried out to the barge and went straight to the scene of the accident where he was of invaluable assistance to the divers.

When the accident occurred the tide was coming in. Low tide was at 18:18. Since the last spring tide had been on 1 August, the difference between high and low tide in Skerjafjörður was two metres and when the divers came on the scene the right wing of TF-GTI protruded up from the ocean, as the aircraft's wing span was just under 12 metres (11.86 m). As the left wing had been mostly torn off, the aircraft lay at about a 45° to 60° angle on its left side. Since both the main doors had been torn off, the divers had fairly good access to the passenger cabin.

The two divers who were first to reach the wreck saw the two aftermost passengers loose inside the back windows of the aircraft; it later turned out that the inner mounts of their safety belts had been torn from the floor. The divers broke the windows immediately and one of them worked at getting a passenger out through the window while the other diver sought a passenger from one of the seats in the middle row. These two passengers were thus the first to reach the surface, an estimated quarter of an hour after the accident occurred. After that the divers sought [another] two passengers, one from the middle row and the other from the aftermost row of seats and brought them to the surface.

Finally they managed to bring the pilot to the surface by cutting his seat belts. The passenger in the right front seat was jammed in his seat, as the aircraft's instrument panel had been forced right up against him and his legs were caught under it; the divers thus could not loosen him while the wreck was on the ocean bottom. The pilot and all of the passengers had had their safety belts fastened. There were shoulder straps in the front seats and the pilot had his fastened but the passenger in the right seat did not.

From the injuries sustained by the persons, they can be assumed to have all lost consciousness upon the impact of the aircraft striking the ocean. Survival possibilities were thus very limited, and depended first and foremost on how quickly help arrived and how quickly resuscitation attempts could begin.

### **1.16 Tests and research**

#### **1.16.1 Examination of the aircraft wreck, its engine and fuel system**

**1.16.1.1 The wreck of the aircraft** The AAIB examined the wreck, its engine and fuel system. The operator's technical director and inspectors of the ICAA Flight Safety Department were summoned to take part, under the direction of the AAIB, in the investigation as concerned parties, in part to provide information which could be of use to this investigation.

The condition and appearance of the breaks and other damages indicated that the aircraft had been in one piece when it struck the ocean. All the control surfaces were in place and their control cables were unbroken when the wreck was retrieved from the ocean, but the cables holding the left wing and the tail to the fuselage had to be cut to facilitate the transport of the wreck to the hangar.

The position of the trim tabs on the elevator and rudder was not regarded as significant, since these were only tabs connected to control cables and there were no electrically operated actuators according to which the position of the tabs could be measured. The directional gyro of the plane was set at 200° and showed 210°. The engine tach time indicator showed 3508.6 hours.

The handle for the engine cowl flaps in the cockpit was unlocked, but almost in closed position; since the engine cowlings and thus the cowl flaps had been torn off, it was not possible to say for certain as to the position of the cowl flaps when the accident occurred.

The position of the engine controls was not considered significant due to the deformation of the wreck. The throttle was fully forward (full power). The propeller setting was almost fully forward (fine pitch) and the mixture control was fully forward (rich mixture).

The selector switch for the fuel tanks was set on the left main tank. The primer was in and in locked position. No mechanical failure was discovered in this investigation which could explain the engine's loss of power.



The wreck was badly broken up and all the fuel tanks with the exception of the right wing tip tank had been destroyed in the accident.

The right wing tip tank turned out to contain four litres of aviation gasoline and six litres of seawater when the contents of the tank were measured after the wreck was in the hangar.

The baggage compartment of the aircraft was open when rescuers reached the wreck in the ocean and according to their statements it was full of baggage. They could not recall any loose baggage in the passenger cabin. One small bag had come away from the wreck and was floating in the water a short distance from the accident location; rescuers thought it had most likely also been in the baggage compartment. The baggage was thoroughly soaked and the Reykjavik police looked after drying and weighing it; it proved to weigh a total of 53 kg.

The aircraft was equipped for IFR flying and had an autopilot.

**1.16.1.2 The engine, its fuel system and propeller** The engine is of the type Teledyne Continental TSIO-520-H, a six-cylinder, 285 hp gasoline piston engine with supercharger and direct fuel injection, which accords with the Owner's Manual for TF-GTI.

On the data plate, however, it states that it is a 300 hp, of the type TSIO-520-ECH, serial number 165605-8-E. "ECH" indicates that the engine was manufactured as type E but subsequently modified to type H. The H type is 285 hp (see Section 1.18.14).

The engine oil cap was not found and it is presumed to either have fallen off when the aircraft crashed into the ocean or been torn off in hoisting the wreck. There was no oil on the outside of the engine nor in the engine nacelle as tends to occur if the cap is not set in place before flight or falls off in flight. From the photographs which were taken before the wreck was hoisted it can be seen that the cable which was placed around the drive shaft of the propeller lay across the engine and it is probable that it caught under the edge of the cap. The engine was full of seawater and thus assessment of the oil which remained was not considered significant. It can also be assumed that, if the aircraft had lost oil in flight, the pilot would have given notification of such.

The fuel system appears to have been undamaged when the accident occurred and there was fuel in the lines to the distributor (631351-5, serial no. J257808C) which feeds fuel to the induction manifold of the engine's cylinders. There was also fuel in the lines from the distributor to the fuel flow meter.

The distributor was opened up and it was revealed that it was also full of fuel as far as the membrane valve of the distributor, which does not release fuel flow to the induction manifold until the fuel pressure exceeds 2.5-3 psi and vice versa, closes when the pressure falls below this limit. Pipes transporting fuel to the manifold were examined; there was no fuel found in them but a small amount of salt water.

The distributor was tested in the maintenance shop of the Icelandic Coastguard and worked normally, i.e. opened and closed at approximately the pressure prescribed by the manufacturer.

The AAIB sent certain parts of the fuel system for closer research to a specialised maintenance shop, Canadian Aero Accessories Ltd., in Calgary, Canada. The results of this examination were that no malfunction was found in these parts of the fuel system, nor anything else which could have caused engine disturbances or loss of power. The results of this examination were referred to experts of the aircraft manufacturer and engine manufacturer for their opinion and they were in agreement.

A fuel tank (main tank) is located in each wing of the Cessna T210L and are integral wing tanks. From each tank fuel lines lead to small reservoir tanks which are under the floor in front of each of the front seats. These tanks were deformed and both turned out to be ruptured. There is a selector switch for these tanks, with three options, LEFT – OFF – RIGHT, so that it was not possible to use fuel from both main tanks at the same time. The selector switch was found set to the left main tank. The selector switch (C291503-0101, serial no. 1031, C/D 2Q-73, manufactured during the second quarter of 1973, which was also the year of the aircraft's manufacture) was removed from the wreck and all its options functioned normally when tested.

An electric pump (4140-00-15RX, serial no. 102), which is located between the fuel selector and main filter functioned normally when connected to electric current. The switches of this pump were found in OFF position. This pump is used primarily when starting the engine. The pump should not be switched ON if the fuel flow is steady and fuel quantity between 36 to 120 pounds per hr. This pump was installed in the aircraft (i.e. the pump was replaced) in an annual inspection, dated 9 June 2000.

The engine-driven fuel pump (632818-5, serial no. H237846B) functioned when it was rotated, and was sent for examination by the specialised maintenance shop in Canada, where it was confirmed that its condition was good and performance normal. The throttle and control assembly, (632774-1, serial no. J257820A) was also sent to the same maintenance shop for examination and proved to function properly despite some impurities in the strainer which filters the fuel after it leaves the engine-driven pump.

The main fuel filter, which is a strainer and filters the fuel before it goes to the engine-driven pump, was for the most part clean. There was no fuel in the strainer chamber, but the wire of its discharge valve had been stretched to such an extent by the deformation of the aircraft, that it stood open. The check valve (part no. 340000), which is on the line which directs excess fuel from the engine-driven pump and the fuel control unit through the fuel selector to the collector tanks, was tested and functioned properly.

The air intake system and exhaust system were severely damaged, but there were no signs of their malfunction before the aircraft crashed into the ocean.

Both magnetos functioned and produced a spark when tested (Slick 6310, serial nos. left 96062523 and right 96062523). All spark plugs were clean and in good condition (Champion RHB-32E (1K98)).

The engine turned normally and all its drives, such as the drive for the fuel pump, magnetos and generator, functioned properly. Compression in the engine cylinders was measured and was considered normal in four of them (nos. 1 to 4: 40/80) considering the condition of the engine after the accident. The two front cylinders (nos. 5 and 6) which had been damaged, had practically no compression and leaked at the piston rings.

When this measurement was taken there was little oil in the engine, and leaking at the piston rings was not unlikely. According to the engine documents, its compression was most recently evaluated in an annual inspection in June 2000, but a recording of compression measurements for this engine has not been produced. One of the damaged cylinders was removed and the internal condition of it and the piston examined. There were no signs of internal malfunctions.

The propeller (McCauley, D3A32C88MR, serial no. 730423) is a three-blade constant speed propeller. Its condition indicated that it had had no power when it entered the ocean, as two of the blades, nos. 1 and 2, were bent far backwards. Examination revealed that the propeller was at fine pitch, into which it goes automatically when its oil pressure falls. The pitch setting of the propeller blades was tested and measured at the propeller shop of Flugfélag Íslands hf. The pitch of propeller blade no. 3, which was only slightly bent, could be measured and turned out to be 11.2°, but should be 14.0° according to the aircraft type certificate. Coarse pitch was measured as 33.6° for the same propeller blade, but should be 33.0° according to the type certificate.

In accordance with above, nothing was found which indicated that there had been anything wrong with the engine or its machinery before it crashed into the ocean. Further investigation of it was not deemed likely to provide significant results due to the damage it had suffered on impact and with the rapid cooling upon entering the ocean.

## **1. 17 Organisational and management information**

### **1.17.1 Passenger transport in TF-GTI and entries to the journey log book**

The Regulation on air transport No. 641/1991, as subsequently amended, cf. Point 3 of Article 2.1.a) and Article 11.5, requires that a journey log book be kept and information entered as the journeys are made.

A journey log book was kept for TF-GTI. It was not aboard the plane, but entries were made in it and it was kept in the operations office of the operator at the Reykjavík airport. Each page contained spaces for 16 flights. These pages included columns for entering the fuel on board following each flight and the position of the engine time-in-service gauge, but there were no entries in these columns. Each page had a column for Technical Remarks, but no provision was made for attestation by the pilot or his signature, which is necessary and obligatory to have recorded after each flight, cf. Article 11.5.1 of the Regulation on air transport, No. 641/1991, as subsequently amended.

According to Point 10.3.1 in the operator's operating manual, fuel and oil records must be kept for each flight, cf. this same Regulation, and must be preserved for at least three months. There was no such record in the documents submitted by the operator. The pilot thus had no available comparison of the fuel consumption and flying time nor an overview of the fuel quantity in the tanks.

The latest entry in the journey log book was 6 August 2000. The last flight made that evening to the Westman Islands was missing as well as the 22 flights made by TF-GTI on 7 August 2000.

From 19 June 2000 until 6 August 2000 there were entries for 70 flights in the journey log book, of which three flights were training flights, two flights were without passengers, three flights were made with one passenger, eight flights with two passengers, seven flights with three passengers, 24 flights with four passengers and 23 flights with five passengers.

According to the documents available it can be presumed that on those 76 flights where the aircraft TF-GTI transported passengers since it was taken into commercial service (including 7 August) it carried four or five passengers on 58 flights. It was not possible to see from the aircraft's documents the quantity of fuel aboard at the beginning of a flight or its distribution in the plane's four tanks.

There were no entries for the 21 flights made 7 August 2000 before the plane set out on its last flight to Reykjavík from the Westman Islands. Information on the aircraft's take-offs and landings that day was available from the control towers in Reykjavík and the Westman Islands and from the airport supervisor at the Selfoss airport. The total flying time that day was, according to this information, 422 minutes or 7 hours 02 minutes.

TF-GTI's first take-off on 7 August was from Reykjavík at 07:53 and the last was at 20:03 from the Westman Islands. There is no indication that there were passengers on board to the Westman Islands, but as many as 5 passengers were carried on each trip from there to the Selfoss airport.

L.Í.O ehf./Air Charter Iceland has submitted a list with the first names of 300 passengers, who were transported from the Westman Islands on 7 August 2000. In 37 cases the last name is also mentioned, but no other information on the passengers existed. In this group the ages of two girls, 3 and 6 years of age, were mentioned. The gender breakdown was 186 males and 114 females. The list did not specify when each passenger left the Westman Islands, with what plane he or she travelled, or to where.

In addition to the pilot who died in the accident three other pilots of the operator had flown the aircraft from the time it was taken into service in June 2000. From the documents available it can only be concluded that all of them had followed similar working procedures, i.e. they appear not to have left any documents which could be used to verify whether the loading of the aircraft had been within authorised limits. The pilots of TF-GTI were aware that they were to calculate the proper take-off and landing weight and calculate the location of the plane's centre of gravity before each flight. When questioned they claimed that they had made such calculations but, due to a lack of forms, these were not preserved. They were also aware of the difficulties involved in using all of the aircraft's seats and that the location

of the centre of gravity would be close to the aft limits when adult passengers sat in the rear seats and when there was baggage in the baggage compartment behind them.

It was revealed that they were not aware that the modifications which had been made to the aircraft had a conditional effect on its maximum permitted take-off weight (cf. Section 1.18.11).

They were not aware that Airworthiness Directives (ADs) had been issued concerning the aircraft's fuel gauges and on procedures for refuelling. In daily operations they were accustomed to having a small step-ladder aboard in order to be able to access the refuelling intakes of the tanks and measure the fuel in them with a dip stick which was kept in a seat pocket in the plane. When the accident occurred there was no such step-ladder aboard TF-GTI, but there were such step-ladders in Selfoss and on the airport apron in the Westman Islands, on the far side of the location where the plane was parked between flights.

### 1.17.2 Flying and duty time limitations

Joint Aviation Requirements-Operations, JAR-OPS 1, have not yet come into effect in Iceland except for operators of aircraft with a maximum gross weight of over 10 tonnes and/or intended for the transport of 20 passengers or more. Among the exceptions to this, however, is Subpart Q of Section 1 of these rules, entitled "Flight and Duty Time Limitations and Rest Requirements". This Section is an Appendix to the Regulation on transport flight No. 250/1996, as subsequently amended, and provides instructions on flight and duty time limitations. These rules came into effect 1 April 1998.

The rules state, for instance, that a flight operator shall specify an arrival time on the job which is realistic in consideration of the time needed in preparation for the proposed flight. This shall, however, be no later than 60 minutes before the commencement of the intended flight time unless aviation authorities have otherwise agreed. There are also provisions to the effect that, if a flying shift is divided into two shifts, and if between them there is a clearly demarcated pause, which flight personnel have been notified of beforehand, then the operator may lengthen the proposed permitted flying shift, as laid down in Tables No. 2 and 3 in JAR-OPS 1.1085.

The following rules apply to flying shifts and flying time for flights by a single pilot and carried out completely in accordance with visual flight rules (VFR) (JAR-OPS 1.1085):

1. Total flight time should not exceed 100 hours for each continuous 28-day period (Section a, Point ii).
2. Total shift time should not exceed 55 hours for each continuous 7-day period (Section b, Point iii).
3. Maximum length of a flight shift when working time commences during the period from 07:00 to 11:59 is 10 hrs. (JAR-OPS 1.1085, Section c, Table 3 and Point 6).

The Operating Manual of L.Í.O. ehf./Air Charter Iceland did not include current Regulation provisions on flight and duty time limitations or schedules for rest time for flight personnel, as it should have.

According to the pilot's flight log book and other documents the pilot's flying time during the last 90 days prior to the accident, including 7 August, totalled 181 hours 33 minutes, of which 27 hours 06 minutes were flying TF-GTI. During the last 30 days prior to the accident the pilot's flying time totalled 97 hours 54 minutes, of which 17 hours 12 minutes were flying TF-GTI. During this period he was off duty for a total of 6 whole days. He was off duty from late Saturday, 5 August, until he began his flying shift on the morning of 7 August.

TF-GTI took off from Reykjavík at 07:53 so that the pilot's flying shift may be regarded as having commenced at around seven o'clock. According to the current rules he should thus have concluded his shift no later than 17:00. At 17:00 the pilot landed in the Westman Islands after his 15<sup>th</sup> flight that day. He was flying his seventh flight after that, and his 22<sup>nd</sup> flight that day, when the accident occurred in Reykjavík at 20:35. At that time his flying shift had lasted over 13 hours.

### 1.17.3 ICAA surveillance

Article 1 of Regulation No. 441/1997, on the Icelandic Civil Aviation Administration, its organisation and tasks, says of its role:

"The Icelandic Civil Aviation Administration (ICAA) shall supervise that Acts, Regulations and instruction on aviation activities are enforced, placing special emphasis on flight safety."

The Flight Safety Division of the ICAA (Icel. *Flugöryggissvið Flugmálastjórnar*, formerly *Loffferðaeftirlit*), is to supervise, for instance, the maintenance and registration of aircraft and issuing of certificates, as well as flying operations.

Due to circumstances and experience, the ICAA had taken considerable precautions in the Westman Islands on the weekend in question, and had sent several of its staff there to provide assistance and security supervision at the airport.

**1.17.3.1 Maintenance** A written contract existed between L.Í.O. ehf./Air Charter Iceland and the aircraft maintenance and repair firm Flugvélaverkstæði G. V. Sigurgeirssonar ehf., dated 28 December 1994, whereby the latter agrees to carry out the maintenance and technical direction of aircraft registered under the operating licence of the former.

The contract does not define who is responsible for individual aspects of technical direction and maintenance, such as procurement of spare parts, implementation and interpretation of ADs and planning of maintenance. Nor is this in fact required, since L.Í.O. ehf./Air Charter Iceland carries on flying operations as provided for in the Regulation on air transport, No. 641/1991, as subsequently amended, where it states in Article 3.3.4 that the operator's technical director is responsible for these aspects.

Iceland is a member of the European Joint Aviation Authority (JAA). With the advent of the Joint Aviation

Requirements (JAR) of JAA states, the working methods of the ICAA have changed. It is a requirement of the rules JAR-145 for maintenance companies and JAR-OPS for operators, that these undertakings set up quality systems and appoint quality managers. The quality system and quality manager must be approved by the ICAA. In addition, the undertakings must submit a quality manual, containing written working procedures for their activities, for the approval of the ICAA. With the advent of quality systems in commercial aviation undertakings, part of the surveillance role has been transferred to the undertakings themselves. The quality manager is responsible for preparing an evaluation plan which includes all the requirements of the Regulation under which the undertaking operates and for seeing to it that internal evaluations are carried out in accordance with the plan.

Surveillance by the ICAA involves primarily audits to confirm the efficacy of the quality system. ICAA prepares and follows an evaluation plan for each individual undertaking, which includes all the provisions of Regulations under which the undertaking operates. The execution of the ICAA audits, and of the internal audits by undertakings themselves, the treatment of and dealing with irregularities, must be in accordance with generally recognised quality management methods.

The firm G.V. Sigurgeirsson ehf. operates in accordance with JAR-145 and has ICAA approval No. ICAA 005. The undertaking has a quality manager and an approved quality manual. According to information from the company manager, one internal audit was carried out by the company in 1999 and two in 2000. Several irregularities were recorded and dealt with in accordance with approved working procedures for such.

According to ICAA data, two audits of the firm G.V. Sigurgeirsson ehf. were carried out in 1999 and three in 2000. One of the audits in 2000 was carried out by a JAA assessment committee, concurrent to its audit of the ICAA. These audits registered an average of five irregularities, which were all handled in accordance with recognised working procedures. One of the irregularities which the ICAA raised objection to in its audit of 25 November 1999 was due to an AD concerning aviation operations and not maintenance which had been signed as "carried out" when in fact no indication of such work existed. The undertaking's technical director dealt with this irregularity by confirming the implementation by an inspection after the objection was received.

**1.17.3.2 Aviation operations** The requirements of JAA states concerning aviation operations, JAR-OPS 1, which are in effect in Iceland, include only operators of aircraft with a maximum gross weight of over 10 tonnes and/or intended to carry 20 or more passengers, as previously indicated. In the case of aircraft with a maximum gross weight less than 10 tonnes and/or intended to carry 19 or fewer passengers, the entry into force [of the requirements] was postponed indefinitely by an advertisement of the Minister of Transport of 9 March 1998. Thus, as far as the aviation operations of L.Í.O. ehf./Air Charter Iceland are concerned, the provisions of Regulation No. 641/1991 on air transport still apply. As a result the undertaking does not need to have a quality system or an appointed quality manager.

Surveillance of aviation operations of such operators by the ICAA is to be carried out by formal inspection of their operations and, in addition, through formal surveillance flights, where an inspector of the ICAA supervises the preparation and execution of a flight by the undertaking. According to information from the ICAA there were no plans made for evaluation and/or inspection of the services of operators for 1999 and 2000.

The ICAA has informed the AAIB that a formal evaluation of the operations of L.Í.O. ehf./Air Charter Iceland was last carried out in January 1998. Since that time surveillance of operations has taken place, in particular, in the form of conversations and exchange of letters, often in connection with a review of proposals by the operator for a new flight operations manual, which is intended to fulfil the requirements of JAR-OPS 1, and furthermore in the form of review of a course (JAR-FCL) for Class ratings for the company's aircraft.

The AAIB soon concluded that, whatever the causes of the accident might prove to be, investigation of the accident had revealed certain aspects of aviation operations to which an immediate response was required. The Flight Safety Department of the ICAA was informed of this by telephone 11 August 2000. This was subsequently followed up with a meeting called by the AAIB with aviation authorities. At this meeting, held at the office of the AAIB on 17 August, the AAIB presented its comments concerning the operation of TF-GTI. At this meeting the ICAA presented a copy of a letter, dated 14 August 2000, which was addressed and sent to the operations directors of all small aviation companies.

The letter stated that, in view of circumstances and experience, the ICAA Flight Safety Department wished to reaffirm and draw to the attention of those concerned, that they must follow very precisely that pre-flight inspections be made with utmost exactitude in compliance with aircraft manuals and that it be attested to with a signature that this had been done, that weight and balance computations be made for each flight and registers of the loading and distribution of weight preserved, and furthermore that detailed and accurate passenger lists be compiled and preserved at the point of departure.

## **1.18 Additional information**

### **1.18.1 Aircraft flight manual and instructions**

The aircraft TF-GTI, which was formerly registered as N131DC, had been modified by the installation of new wing tips with auxiliary fuel tanks on 28 December 1996, in accordance with STC SA4300WE, cf. Section 1.18.11 below, thus increasing its range.

According to information from the manufacturer, the modification in question had the effect of lengthening the plane's wing span by some 66 cm, which resulted in increasing the moment from the lengthened wing tips. Due to the modification, information had to be placed on the instrument panel on a reduction in maximum speed ( $V_{NE}$ ) when

flying at an altitude of over 18,000 feet, on maximum fuel quantity in the wing tip tanks, together with procedures for their use and instruction on how the maximum gross weight depended upon the quantity of fuel and its distribution in the tanks. It must be pointed out that this aircraft was non-pressurised.

The maximum gross weight of the aircraft is 3800 lbs; as a result of the modification this weight could only be used if there were at least 7 US gallons (26.5 litres) of fuel in each of the two wing tip tanks and the main tanks were at least 2/3 full, i.e. contained at least 60 US gallons (227 litres). If both of these conditions were not fulfilled then the maximum gross weight of the aircraft was limited to 3530 lbs.

The aircraft flight manual (Owner's Manual) for an unmodified Cessna T210L, Centurion II, was found in the wreck. The manual assumes that the aircraft has a 285 horsepower engine. There were no additions concerning the operation of the wing tip tanks, in accordance with STC SA4300WE, in the manual but according to the aircraft's documents they had been added to it and according to the testimony of pilots who had flown TF-GTI they were on a separate page which was stapled to the manual. This page had come loose, they said, and was kept in the same pocket of the aircraft as the flight manual. This page was not found in the wreck. The original of the additions was in the aircraft's maintenance documents. In addition, these modifications required that new information on limits to the aircraft's maximum permissible weight and altered speed limits be placed on instruction placards in the cockpit. Upon inspection this information was not found on board the wreck.

Information on permitted payload had been placed on the aircraft's instrument panel as if it were an unmodified plane after it had been weighed in Iceland on 16 July 1999.

### 1.18.2. Airworthiness Directive (AD) concerning the fuel system

The most recent AD issued for this type of aircraft by the US Federal Aviation Administration (FAA), the country where the aircraft was manufactured, which applied to TF-GTI was AD 94-12-8. According to the aircraft's maintenance documents and upon inspection it was revealed that not all of the instructions of this Directive had been implemented as the airworthiness regulations prescribe.

The Directive was comprised of four Points, A, B, C and D. Of these, Points A, C and D applied to TF-GTI. According to Point A, a description was to be inserted in the flight manual or the aircraft documents on what procedures were to be used when filling the main tanks with more than 75 US gallons (284 litres) of fuel. In such case, it was necessary to make sure that the aircraft was not leaning to one side, that its nose was lifted by 4.5° and, in addition, that the caps of the main fuel tanks were fastened properly.

Point C was divided into two Points, C<sub>1</sub> and C<sub>2</sub>. Point C<sub>1</sub> prescribed testing the fuel gauges for the fuel tanks to confirm that they indicated correctly when the tanks were empty.

If Point C<sub>1</sub> was not carried out, then Point C<sub>2</sub> should be carried out, which provided for marking the gauges with a red line at the reading they gave when the tanks were empty and then placing the following marking to one side of the instrument panel:

**“FUEL GAUGES NOT CALIBRATED, BASE ALL FUEL CALCULATIONS ON VISUAL INSPECTION, TIME AND CONSUMPTION FIGURES. WITH FULL TANKS, MAXIMUM ENDURANCE IS 4 HOURS FOR FLIGHT PLANNING.”**

Neither these markings nor the placard were in place in the aircraft, but despite this part of the label was glued into a storage compartment on the right side of the instrument panel which read:

**FUEL GAUGES NOT CALIBRATED, BASE ALL FUEL CALCULATION ON VISUAL INSPECTION TIME AND CONSUMPTION**

No indications of other markings were found in/on the wreck.

Point D was also divided into two parts. Either a new type of refuelling neck, together with cap, was to be installed on the fuel tanks, Point D<sub>1</sub>, or else a warning alongside the original refuelling neck, Point D<sub>2</sub>. There were no indications that this part of the AD had been implemented. The placard was not on the wreck. It was supposed to be as follows:

**“TO ASSURE FULL CAPACITY WHILE FILLING, FILL SLOWLY DURING LAST 5 GALLONS. RECHECK FOR FULL AFTER 2 MINUTES”.**

The aircraft's maintenance documents only confirmed that Point C<sub>1</sub> had been carried out by JAS Inc. on 15 June 1999, but since the mechanic's signature was lacking it was not possible to confirm that this had been done.

The technical director said he had received no complaints concerning the gauges and had thus not tested them especially. The director of L.Í.O. ehf./Air Charter Iceland has confirmed that the gauges functioned but that they did not show “full tanks” when the tanks were full. The report mentions that pilots of TF-GTI regarded the fuel gauges to be so unreliable that they said they would never trust them.

The ADs were to be implemented no later than 22 July 1995.

### 1.18.3. Aircraft log books, etc.

Since the aircraft's original log books and part of its maintenance documents were not available, the owner was responsible for having a recognised party prepare new log books. The new log books should have indicated that these were new books, since the original log books were missing or had been lost.

According to generally approved methods in the aviation industry (AC-43-9C, Maintenance Records), these should, furthermore, have indicated that it had been confirmed by inspection that all major repairs and modifications to the aircraft had been executed in accordance with approved methods. In addition, the log books should have confirmed that all ADs issued for this aircraft and its components had been implemented; in such cases where their implementation could not be established by a simple inspection, the ADs should have been implemented specifically and attested to in the log books.

There was no indication in the log books that these were new log books, nor was there confirmation or mention that the aircraft had been inspected specifically in view of the fact that the original log books were missing. There was nothing in the log books on confirmation of the implementation of Airworthiness Directives.

The first entry in the aircraft's log book was where JAS Inc., 6805 Boeing Drive, El Paso, Texas, FAA approval number JULR259K, issued a maintenance certificate following an annual inspection on 15 February 1999. In the engine log book there was a maintenance certificate for overhaul of the engine pasted at the front of the book, which was followed by a sign-out from JAS Inc. after a 100-hour inspection. The propeller log book contained a maintenance certificate on overhaul by Precision Propeller Service Inc.

The aircraft documents included a list of ADs, prepared and signed by JAS Inc. There were signatures attesting to only part of the Directives which applied to this aircraft and its components. With regard to AD 94-12-8, cf. Section 1.18.2, it said that Point C<sub>1</sub> had been implemented.

The maintenance documents which accompanied the aircraft include a declaration, dated 15 February 1996, from its former owner, Wayne T. Castelberry (sic), witnessed by Mrs L. Gonzales, Justice of the Peace (Notary Public) in Belize, on 29 February 1996. According to this declaration W.T. Castleberry (sic) was the owner of N131DC, a Cessna T210L, serial number 21060050, until 16 September 1994. On that day the tach time meter had shown 3390.0 hours, which was in accordance with the total time recorded in the aircraft's log book. Furthermore, that the log book recorded no history of damages.

The declaration covered neither the engine nor the propeller; there is nothing in the log books on the installation of the engine or the propeller.

The present registered owner of the aircraft has stated that as far as he knew the aircraft had not been flown at all from 14 September 1994 until he acquired it and said he was certain that the aircraft had been transported by truck between states in the US. This accords with the confirmed tach time of the aircraft above and the flying time which was reported when the aircraft was registered in Iceland, cf. Section 1.18.4. No documents on this transport have been submitted and there is no mention in the log books of possible disassembling or reassembling of the aircraft before or after transport.

The aircraft N131DC was owned by Sunland Air Inc. in Maryland, USA, when a maintenance certificate was issued following an annual inspection and the aircraft certified for return to service by JAS Inc. which recorded the total flying time of the aircraft as 3390.0 hours in its log book on 15 June 1999 following the annual inspection.

In a conversation which the AAIB had with the representative of JAS, who certified the aircraft for return to service on their behalf, the latter said, for instance, that he had carefully gone over the installation of the engine and wings and had found nothing of concern. Following this inspection the aircraft had been given two trial flights and everything had proved normal and in good working condition.

According to the engine log book, it was overhauled by Gold Star Aviation Accessories Inc., 3597 Northwest 154<sup>th</sup> Street, Miami, Florida 33054. The date of overhaul is 15 December 1996 and when the new log book was issued the engine tach time was recorded as 0 hours since overhaul (TT 0 since O-haul). There was no mention as to what the total time in service for the engine was then, from what aircraft it had come, when it had been installed in the aircraft N131DC, or by what means it had been prepared for storage in accordance with FAA AC 20-62D, Eligibility, Quality and Identification of Aeronautical Replacement Parts.

According to the requirements of JAA (JAR 145.55 Maintenance Records) recording only the time in service since last overhaul is approved when new log books are being prepared instead of older ones which are missing.

According to the log book, the propeller (McCauley, D3A32C88MR, serial number 730423), was overhauled on 6 December 1994 by Precision Propeller Service Inc., Tuscaloosa, Alabama. It was inspected after storage (Long Term Storage Inspection) by JAS Inc. Propeller Dept. on 24 May 1999. It is not indicated, however, in the log book when it was installed in the aircraft or who did this. According to the maintenance certificate its total time in service was unknown, but the time since overhaul was 0.

The most recent inspection of TF-GTI was a 50-hour inspection, dated 1 August 2000. At this time the total flying time of the aircraft was recorded as 3486 hours and the time in service of the engine and propeller since last overhaul recorded as a total of 96 hours. When the accident occurred the aircraft had been flown a total of 11 hours 18 minutes since this latest inspection. According to the log books and the registers concerned, the flying time of the aircraft then totalled 3497 hours 18 minutes and the time in service of the engine and propeller totalled 107 hours 18 minutes from last overhaul.

#### **1.18.4 Former registration and initial registration in Iceland**

According to data from the FAA the aircraft was issued with its registration certificate in the US as N131DC on 17 June 1999, with Sunland Air Inc. as the registered owner. The aircraft was then flown to Iceland on 2 July 1999.

The registered owner requested that it be deregistered on 23 March 2000, the aircraft was deregistered in the US on 29 March 2000 and this deregistration notified to the ICAA.

The ICAA documents on TF-GTI included a bill of sale/purchase contract, dated 19 April 2000, from Sunland Air Inc. to L.Í.O. ehf./Air Charter Iceland, Reykjavík airport.

The aircraft maintenance and repair firm G.V. Sigurgeirsson ehf. carried out annual inspection of the aircraft TF-GTI on 9 June 2000. On the basis of this inspection, application was made for a commercial airworthiness certificate. The application states that the aircraft is equipped with instruments for VFR flying and limited night VFR. The documents were not well prepared and the application was poorly filled out.

This application was signed and attested by an ICAA inspector on 15 June 2000 and an aircraft airworthiness certificate, No. 808, was issued, valid until 30 June 2001.

The ICAA re-issued on 16 June 2000 a supplement (Carrying out Aviation Operations – Sheet 1) to the aviation operating licence of *Leiguflyg Ísleifs Ottesen hf.* Reykjavík airport, where the aircraft TF-GTI was registered for taxi flight service.

An inspection, which is commonly referred to as “Conformity Inspection” of aircraft, to confirm that they conform to commercial airworthiness requirements as provided for in JAA requirements, is to be carried out before they are issued with a maintenance certificate according to the rules of JAR-145. This applies to aircraft which come from another regulatory environment or which have been maintained according to other requirements, e.g. aircraft which are brought into the JAA region or aircraft which have been maintained in accordance with rules on private aircraft.

This provision applied to TF-GTI when it was registered in Iceland, since it had previously been maintained in accordance with requirements for private aircraft and in addition had been registered in the US.

ICAA accepts an annual inspection by an approved party as sufficient in such cases, but JAA considers an annual inspection to be a minimum, provided all necessary documents on the maintenance of the aircraft are available.

In view of the above it can be concluded that inspection of the aircraft should have been more thorough than an annual inspection, since all documents on maintenance were not available and re-issuing of the flight log books had not been carried out in accordance with generally approved procedures in the aviation industry, cf. Section 1.18.3.

In the work order for the annual inspection of 9 June 2000 it was indicated that a compression test of the cylinders had been carried out, but there were no markings on the engine or records in the aircraft’s documents of the results of this test.

#### **1.18.5 Aircraft fuel**

The aircraft TF-GTI had four fuel tanks. There were two main tanks, holding a total of 90 US gallons, or 340 litres, of which 337 were usable. Special work procedures used to fill the main tanks are described in the ADs, so that it is certain that they contain 340 litres. Care must be taken to ensure the aircraft is standing properly and the last 20 litres or so must be pumped slowly into each tank, the contents examined again after two minutes, and then topped up. The investigation revealed that the pilots were not aware of this refuelling method.

Fuel tank selection was made with a switch which had three settings, LEFT – OFF – RIGHT, so that in flight fuel was used from either the left or right main tank, but it was not possible to use fuel from both tanks simultaneously.

In addition, the aircraft had wing tip tanks which held a total of 33 US gallons, or 125 litres, of which 32.5 US gallons or 123 litres were usable fuel. Use of the wing tip tanks was, however, conditional in that fuel could only be pumped from them into the main tanks while cruising, and then only into that tank which was not in use.

As was mentioned previously, at least 7 US gallons (26.5 litres) had to be in each of the wing tip tanks and the main tanks had to be at least 2/3 full, i.e. holding 60 US gallons (227 litres) or more, for the maximum gross weight of 3800 lbs. to be valid for the aircraft. Otherwise the conditional maximum weight of 3530 had to apply. Not all of the pilots of TF-GTI whom the AAIB contacted appear to have been aware of this.

According to information from the refuelling services (*Eldsneytisafgreiðslan*) at Reykjavík airport, as far as its personnel knew only one of them had pumped fuel into the wing tip tanks of TF-GTI and had done so only once, approx. 20 litres into each tank, as far as he recalled. They did not recall the pilots themselves having pumped fuel into the wing tip tanks from tank trucks.

The refuelling necks themselves are so constructed that half-cylinders extend downwards from the opening, the lower end of which is 5.4 cm below the edge of the collars to which the caps are attached. In everyday speech of pilots and refuelling personnel this lower cylinder edge was called a “hak” (notch). Refuelling was often based on filling both tanks to this notch. When this was done exactly there were 65 US gallons (246 litres or 390 lbs.) of fuel on board.

According to information from the operator, aircraft operations were based on estimated consumption by the engine of 60 litres per hour.

According to fuel receipts and the testimony of refuelling service personnel, the main tanks of the aircraft were last filled on 6 August at 18:15. The employee of the refuelling service *Eldsneytisafgreiðslan hf.* at Reykjavík airport who filled the tanks was asked whether he had taken special care to pump the last 20 litres or so slowly into each of the main tanks and then to examine them again two minutes later, as is said to be necessary by the AD, which are supposed to be in the Aircraft Manual, in order to ensure that they are filled. He said that he had not been aware of this point and thus had not taken special care to do so. This may have caused some uncertainty as to the quantity in the main tanks after refuelling and thus of the quantity of fuel on board on the aircraft’s last flight, but if the tanks had been carefully filled at 18:15 on 6 August there would have been 340 litres in the main tanks, 337 of them usable.

Following this refuelling a flight was made to the Westman Islands and back on the evening of 6 August. Take-

off from Reykjavík was at 18:24, landing in the Westman Islands at 18:57, take-off there at 22:55 and landing in Reykjavík 23:25, a total of 63 minutes of flying time. When the pilot made his flight plan for this flight from Reykjavík airport, he estimated the endurance of the aircraft at 5 hours 00 minutes (67 litres/hr.). He has confirmed that the main tanks were full. He said he had not used fuel from the wing tip tanks on that flight and in fact had never done so on the flights he had flown in TF-GTI.

Fuel was not added to the aircraft's tanks before its next flight, which was flown on the morning of the next day, 7 August, from Reykjavík to the Westman Islands, and took 28 minutes. Prior to that flight the pilot indicated an endurance of 4 hours 30 minutes. It is impossible to maintain whether or not he over-estimated the amount of fuel in the aircraft's tanks, but the endurance he gave was in accordance with the fuel consumption which the AAIB deems that he assumed in his flights all that day, or 60 litres/hr.

The pilot then began flying between the Westman Islands and the Selfoss airport. He gave endurance as 4 hours 00 minutes when he made his first flight plan from the Westman Islands. After that he did not give any endurance until he made his last flight plan to Reykjavík that evening.

He flew first 7 legs between the Westman Islands and Selfoss. Following this the aircraft had flown a total of 221 minutes since its refuelling in Reykjavík the previous evening.

After one take-off in the Westman Islands the pilot did not manage to retract the aircraft's landing gear. He flew to Selfoss airport and then back with the landing gear down. There an aircraft mechanic from the operator's technical director, who was at the airport in the Westman Islands all that day, fixed slight damage to the torque link in the landing gear. There is no record of this in the aircraft's maintenance documents, but the mechanic in question thought that he had fixed this around 11:00. According to documents the aircraft landed at 10:36 in the Westman Islands following its second trip to Selfoss airport and then returned to Selfoss at 12:30.

At 13:45, 120 litres were added to the main tanks of the aircraft when it was at Selfoss airport from a tank truck from Refuelling services at Reykjavík airport, which was there for at least the latter part of that day.

The employee delivering the fuel there said he had not seen the pilot measure the quantity of fuel with a dip stick, but he did see the pilot, standing on the supervisor's step-ladder stretch up to stick his finger into one of the tanks after 60 litres had been pumped into it. The employee thought that the fuel level in that tank at the time had been approx. four to five cm below the notch.

After this refuelling 8 legs were flown on the same route, totalling 142 minutes.

At 17:40 another 120 litres were added to the main tanks of the aircraft at Selfoss airport. Finally, 5 legs were flown on this same route, and [the aircraft] landed in Westman Islands at 19:48. The final journey was made to Reykjavík and these legs following the last refuelling until the accident occurred totalled 122 minutes of flying. Fuel was not added to the aircraft's tanks that day in the Westman Islands. According to information from the person in charge of a fuel pump, which is at Selfoss airport and under the supervision of the Selfoss Flying Club, the pilot of TF-GTI did not purchase fuel there that day.

The aircraft was thus flown a total of 485 minutes or 8 hours and 5 minutes after its tanks were filled on 6 August at 18:15. If they had contained 337 litres of usable fuel after that refuelling, and with the addition of the 240 litres which were pumped into the main tanks at Selfoss airport that day, there were a total of 577 litres of fuel in the main tanks to be burned in these flights which took a total of 8 hours 05 minutes. This does not include the time used for taxiing before and after flights and in warm-ups.

None of the employees at the Westman Islands airport that day, interviewed by the AAIB after the accident, recalled having seen the pilot of TF-GTI measure the fuel of the aircraft there.

The flying of TF-GTI that day differed from those flights which the aircraft had flown up until that time, in that 20 of the 22 flights were very short, i.e. many take-offs were executed that day.

The AAIB sent information on the aircraft's flights between Selfoss and the Westman Islands to a specialist of the manufacturer and requested that he estimate the average consumption of the engine during these flights. In his response average consumption for them was considered to be 19 US gallons (72 litres) /hr. and the manufacturer considered it normal for these engines to burn between 17 to 21 US gallons (64 to 79 litres) /hr.

These figures include consumption due to take-off and climbing, which play a large part in making fuel consumption as high as it actually was on these short flights.

To gain an idea of the engine power which the pilot of TF-GTI used on his flights on 7 August, the AAIB calculated the average speed of the aircraft while cruising on its flights between the Westman Islands and Selfoss that day. The result of these calculations was that, if the aircraft flew at 1000 feet and consideration was had for the time and distance involved in take-offs and climbing, the average cruising speed of the plane was then 157 mph. According to the aircraft's flight manual this cruising speed is achieved at 56% engine power, 24 inch manifold pressure and 2300 RPM.

The AAIB calculated the probable fuel consumption of the aircraft on flights made by TF-GTI after the main tanks of the aircraft were filled on the evening of 6 August 2000. Performance figures from the flight manual were used, which take into consideration fuel consumption in taxiing and warm-ups. They assume 56% engine power and a flying height of 1000 feet on flights between the Westman Islands and Selfoss. The results of these calculations are given in Table 1.18.5.1.



### 1.18.5.1 Table of flights by TF-GTI

The following table shows calculations of probable fuel consumption of TF-GTI after the main fuel tanks of the aircraft were filled on the evening of 6 August 2000.

Flight	From	Take-off	Flying time			Fuel consumption			Fuel on board		Refuelling
			Climb (min.)	Cruising (min.)	Total (min.)	Climb (litres)	Cruising (litres)	Total (litres)	Before (litres)	After (litres)	
6 August-00											
Main tanks filled in Reykjavík at 18:15											
1	RK	18:24	02:36	30:24	33	10.4	22.1	32.5	337	305	
2	VM	22:55	02:36	27:24	30	10.4	22.9	33.3	305	271	
7 August-00											
3	RK	07:53	02:36	25:24	28	10.4	19.8	30.2	271	241	
4	VM	08:35	02:04	17:56	20	9.5	14.0	23.5	241	218	
5	SF	09:01	01:44	13:16	15	9.0	10.3	19.3	218	198	
6	VM	09:31	02:04	18:56	21	9.5	14.7	24.2	198	174	
7	SF	10:16	01:44	18:16	20	9.0	14.2	23.2	174	151	
8	VM	12:30	02:04	17:56	20	9.5	14.0	23.5	151	127	
9	SF	12:55	01:44	13:16	15	9.0	10.3	19.3	127	108	
10	VM	13:23	02:04	16:56	19	9.5	12.3	21.8	108	86	
					hours:	03:41	Fuel added to main tanks in Selfoss at 13:45				120
11	SF	13:55	01:44	14:16	16	9.0	11.1	20.1	206	186	
12	VM	14:20	02:04	17:56	20	9.5	14.0	23.5	186	163	
13	SF	14:45	01:44	14:16	16	9.0	11.1	20.1	163	142	
14	VM	15:20	02:04	18:56	21	9.5	14.8	24.3	142	118	
15	SF	15:46	01:44	15:16	17	9.0	11.9	20.9	118	97	
16	VM	16:18	02:04	14:56	17	9.5	11.6	21.1	97	76	
17	SF	16:44	01:44	14:16	16	9.0	11.1	20.1	76	56	
18	VM	17:18	02:04	16:56	19	9.5	13.2	22.7	56	34	
					hours:	02:22	Fuel added to main tanks in Selfoss at 17:40				120
19	SF	17:43	01:44	16:16	18	9.0	12.7	21.7	154	132	
20	VM	18:13	02:04	17:56	20	9.5	14.0	23.5	132	109	
21	SF	18:40	01:44	13:16	15	9.0	10.3	19.3	109	89	
22	VM	19:07	02:04	15:56	18	9.5	12.4	21.9	89	67	
23	SF	19:29	01:44	17:16	19	9.0	13.4	22.4	67	45	
24	VM	20:03	02:36	29:24	32	10.4	22.9	33.3	45	12	
					klst.:	02:02					
<b>Total:</b>			<b>hours: 08:05:00</b>			<b>litres: 565.2</b>					

NB.

Time and consumption in take-off are included in figures for climbing.

- Extra fuel from the auxiliary tanks is not assumed to have been used.

When these calculations are examined it can be seen that the engine's average fuel consumption on flights between Reykjavík and the Westman Islands was 63 litres per hour. On the other hand, its consumption on flights between the Westman Islands and Selfoss was 72 litres per hour on average. This is in accordance with the conclusions of an expert from the engine manufacturer who estimated fuel consumption on shorter flights, i.e. between the Westman Islands and Selfoss, to be an average of 72 litres, that is if take-offs and climbs are included. If the engine's fuel consumption during take-off and climbing is compared with consumption while cruising, the outcome is that on an 18-minute flight the engine consumes 9 litres during take-off and climbing which takes 1:44 minutes and 12.7 litres during just over 16 minutes of cruising.

At the same time as it sought the opinion of the engine manufacturer's experts on fuel consumption, the AAIB also asked the manufacturer's experts to calculate its consumption based on the aircraft's flights from the time its main tanks were filled on the evening of 6 August. The results of these calculations were in accordance with AAIB's calculations.

### 1.18.6. Flight preparations, weight and balance

The investigation of the accident revealed no data which indicate that the pilot of TF-GTI made weight and balance computations before taking off from the Westman Islands airport as the operator's operating manual provide for doing and is in accordance with current regulations. It did not prove possible to obtain a load sheet and balance

computations for any flight made by the aircraft from the time it was taken into service on 16 June 2000.

JAR-OPS 1, Subpart J, which came into force in Iceland on 11 November 1997, on mass and balance, includes a table on mass values for passengers in aircraft with one to five passenger seats. In Subpart J the standard mass value for crew is 85 kg including hand baggage.

This table is in the Operator's Manual of L.Í.O. ehf./Air Charter Iceland (Chapter Six, Section 6.1.4). There it states that in calculating the take-off weight and load of aircraft the following average weights shall be used as a basis for aircraft having 1-5 passenger seats. Men – 104 kg, women – 86 kg, children – 35 kg. The values in the table include hand baggage, but if this is calculated separately then 6 kg may be deducted from the mass values for men and women.

The pilot did not leave any passenger list behind in the Westman Islands and there was no indication that one had been compiled before the flight.

As was pointed out in the report, the maximum permitted gross weight of the aircraft depended upon the quantity of fuel and its distribution between the aircraft's tanks. If the user of the aircraft intends to utilise its maximum gross weight, 3800 lbs., then its main tanks must contain at least 60 US gallons (227 litres) of fuel, i.e. the tanks have to be at least 2/3 full, as they hold a maximum of 90 US gallons (341 litres), and at least 7 US gallons (26.5 litres) must be in each of the two wing tip tanks. This means that the aircraft and its load other than fuel may not exceed 3356 lbs. if the maximum gross weight of 3800 lbs. is used. If both of these conditions were not fulfilled then the maximum gross weight of the aircraft was 3530 lbs.

In his flight plan from the Westman Islands the pilot assumed he had an endurance of 2 hours 30 minutes. According to information from the aircraft operator he would have assumed that this included approx. 150 litres, i.e. almost 40 US gallons.

According to the aircraft type certificate the maximum aft limits for the centre of gravity with maximum gross weight (with the wheels down) are 53.0 inches and the fore limits 42.5 inches behind the datum point. When the landing gear is retracted the aircraft's centre of gravity changes and its moment increases by 3207 lb-inches. When the plane crashed there were, in addition to the pilot, four men, one woman and some 53 kg of baggage aboard.

The aircraft repair and maintenance shop G.V. Sigurgeirsson ehf. carried out the last weighing of the aircraft on 16 July 1999 and placed a placard on the aircraft's instrument panel showing the empty weight of the aircraft as 2421 pounds. Furthermore, information on the permitted payload of 1379 lbs. was placed on the instrument panel of the aircraft. There was no further information to the effect that this figure was substantially conditioned by the addition of the wing tip tanks. In the report of the technical director on the weighing there was an inaccuracy in the calculation of the moment arm of the aircraft's centre of gravity. The aircraft was weighed with 540 lbs. (90 US gallons) of fuel in the wings, i.e. with full main tanks and empty wing tip tanks. In refuelling, according to the technical director, care was not taken to fill the main tanks in accordance with the provisions of AD 94-12-8 cf. Section 1.18.2, so that there might be some inaccuracy in the weighing. In his calculations the technical director used the figure 23.0 for the moment arm of the fuel instead of 43.0, which is the correct figure according to the aircraft flight manual.

The calculated arm of the centre of gravity for empty weight was thus 44.13 inches instead of 39.67 inches. Even though the calculation was incorrect it erred in the right direction with regard to its effect on flight safety.

If the pilot had made weight and balance computations before the flight to Reykjavík, according to the information available, i.e. the quantity of fuel he assumed to be in the aircraft's tanks and the weights of the passengers, which the operator's manual expected him to use, along with the inaccuracy which appeared in the calculations of the technical director, it would have become clear that the aircraft was exceeding maximum take-off weight and that its centre of gravity was behind the permitted limits.

The calculations would then have appeared as shown here:

### TF-GTI

Weight and balance in accordance with the information available to the pilot

<b>Component</b>	<b>Weight (lbs.)</b>	<b>Moment arm (ins.)</b>	<b>Moment (lb.-in.)</b>
Aircraft	2421	44.13	106838.7
Pilot (85 kg)	187	37.00	6919.0
Passenger (98 kg)	216	37.00	7992.0
Two passengers (2 x 98 kg)	432	71.00	30672.0
Passenger (98 kg)	216	101.00	21816.0
Passenger (80kg)	176	101.00	17776.0
Baggage (53 kg)	117	138.00	16146.0
Fuel in the wing tips (8 ltr.)	13	49.50	644.0
Fuel in the main tanks (150 ltr.)	238	43.00	10234.0
<b>Total:</b>	<b>4016 lbs.</b>	<b>54.54 inches</b>	<b>219037.7</b>

Weight and balance affect the stability and control of an aircraft. The provisions of the operator's operating manual concerning the weight of passengers were identical to JAR-OPS 1, Subpart J, cf. above. The operating manual assumed only that the previously mentioned standardised figures would be used. On the other hand it is permitted, in accordance with Subpart J of JAR-OPS 1, to estimate the weight of passengers in aircraft having fewer than six

passenger seats. It is possible that the pilot had checked the weight of the passengers or assessed it, and these weights are thus used in the calculations here below.

If the weight of the passengers is assessed according to size and body build, the standard weights, cf. the above, could be reduced, i.e. the weight of the men in the front and middle seats to 90 kg each, the weight of the man in the back seat to 80 kg and the weight of the woman to 60 kg.

In the original testimony of the pilots they said they had had verbal instructions to have a few litres in the wing tip tanks. In later conversations they said, however, that they had had 7 US gallons in them.

The left wing tip tank had been ruptured in the accident, but about four litres (1 US gallon) of fuel were found along with sea water in the right wing tip tank. The right wing tip pointed upwards all the time after the plane sank, and also when it was hoisted up and transported to shore. Sea water probably entered the wing tip tank through the fuel line to the tank which had come apart. Since fuel is lighter than seawater it is unlikely that this could have leaked out. It is probable that a similar amount of fuel would have been in both wing tip tanks, but there is no certainty as to what this quantity was; hereafter it will be assumed to be this quantity, i.e. 4 litres.

Taking the above-mentioned assessments into consideration with regard to the weight of the passengers and the estimated fuel, the aircraft's weight and balance computations would have been something like this when it lost its engine power:

<u>Component</u> <u>ins.)</u>	<u>Weight (lbs.)</u>	<u>Moment arm (ins.)</u>	<u>Moment (lb.-</u>
Aircraft	2421.0	39.67	96041.1
Pilot (85 kg)	187.0	37	6919.0
Passenger (90 kg)	198.0	37	7326.0
Passenger (90 kg)	198.0	71	14058.0
Passenger (90 kg)	198.0	71	14058.0
Passenger (80 kg)	176.0	101	17776.0
Passenger (60 kg)	132.0	101	13332.0
Baggage (53 kg)	117.0	138	16146.0
-----			
Total excluding fuel:	3627.0	51,185	185656.1
Fuel in the wing tips (8 ltr.)	13.0	49.5	643.5
Fuel (12 litres)	19.0	43.0	808.4
Retracted landing gear			3207.0
-----			
<b>Total:</b>	<b>3659.0 lbs.</b>	<b>52.0 inches</b>	<b>190315.0</b>

According to the above the aircraft was then heavier than the 3520 pounds which was the permitted maximum gross weight under these conditions. Its centre of gravity was within the aft limit, which is 53.0 inches. If there was more fuel in the wing tip tanks than is assumed here, the aircraft would have been that much heavier.

### 1.18.7 Right of way in approach

In section 1.1 above and according to radar data (Accompanying Document 5.1) it was indicated that TF-GTI was, at 20:31:27, on VFR flight and nearing its final approach to runway 20 from the west. At the same time ICB-753, which was a Dornier aircraft of Íslandsflug hf. was in IFR conditions nearing Örfirisey on a final approach to the same runway. Under such conditions the air traffic controller evaluates how the traffic can proceed with greatest safety and least delay and arranges the aircraft for approach and landing accordingly.

Since it was indicated that ICB-753 was still flying IFR, the air traffic controller in the tower at Reykjavík airport decided in accordance with the above to have TF-GTI, which was VFR and starting or about to start its final approach, turn aside and fly a traffic circuit and come in for landing after ICB-753. He thus gave the pilot of TF-GTI instructions to discontinue approach and break off to the east, which the pilot confirmed and flew eastward.

At 20:32:14 the pilot of TF-GTI was told he could continue and come in on a left turn behind ICB-753, which was passing over the tanks on Örfirisey. The pilot of TF-GTI confirmed at 20:32:20 that he was making a left turn and would come behind ICB-753.

The radar recording of the approach radar of Reykjavík airport was examined. Height figures on the radar show intervals of a hundred feet.

ICB-753 approached the localiser for runway 20 and descended. The aircraft was, according to the radar image, flying at an altitude of 600 feet when TF-GTI turned to the east; it then descended and was flying at an altitude of 400 feet when it reached Engey and 300 feet at Örfirisey, at which time TF-GTI was turning north at Engey in its holding circle. The altitude of TF-GTI did not appear on the radar image. The air traffic controller in the tower has access to a radar image of the air traffic.

Since the pilot of TF-GTI had received instructions to come in after ICB-753, then he was supposed to maintain an adequate and safe distance behind ICB-753 right up until landing. The circle which TF-GTI flew and its flight to the final approach was made in such manner that when TF-GTI was coming in to land at the end of the runway, ICB-753 was taxiing to the left (east) off the runway across from hangar no. 8 (which is connected to hangar no. 1), in front

of the control tower.

In the estimation of the air traffic controller in the tower ICB-753 was still on the runway and he thus could not, according to his working procedures, give another aircraft clearance to land there. He thus gave the pilot of TF-GTI instructions at 20:34:10 to break off and fly a traffic circuit. The pilot of TF-GTI had given no indication of any cause for concern on his part.

#### **1.18.8 Vapour lock**

A vapour lock can interrupt or stop the flow of fuel to the engine of aircraft. The flight manual for a Cessna T210L says there is a possibility of a vapour lock forming when the engine is restarted after a short stop in high air temperatures.

This occurs because steam bubbles or gas bubbles form in the aircraft's fuel lines, as the fuel heats up in the fuel tanks, fuel lines and fuel pump behind the engine in the engine nacelle.

According to information from the aircraft manufacturer, Cessna Aircraft Co., vapour lock was a known problem of Cessna 210 aircraft which were manufactured from 1976 to 1979 with 300 horsepower engines. It was generally felt that with the advent of this more powerful engine more vapour formation took place in the holding tanks in the floor of the aircraft. In 1981 the manufacturer issued a Service Bulletin, SE81-33, which provided for modification of the aircrafts' fuel system. The modification was comprised of an auxiliary line connecting the holding tanks and the main tanks to release vapour from the collector tanks to the main tanks. In accordance with the service bulletin, this modification had not been made to TF-GTI, as this aircraft had a 285 horsepower engine.

According to information from the manufacturer there are no known instances of a vapour lock forming in the fuel systems of aircraft with 285 horsepower engines as TF-GTI had, but there are several known instances of such formation in fuel systems of aircraft with 300 horsepower engines.

The aircraft manufacturer, Cessna Aircraft Co., issued a service bulletin (SE79-25) with a description of a vapour lock and how the pilot should respond to this. A supplement with this information was in the flight manual of TF-GTI as the service bulletin provides for. Furthermore, an extract of the information was to be placed on the instrument panel. This extract was found in the wreck.

The supplement describes what the response of the pilot should be "in the very unlikely event of power interruption due to fuel vapour accumulation".

A suggestion to reduce the possibility of a vapour lock is to ensure adequate cooling of the engine, for instance, by using the cowl flaps, which are manually controlled vents which open the flow of air out of the engine nacelle and thus increase the flow of air around the engine. According to the flight manual for Cessna T210L, for instance, the cowl flaps should be open on take-off, in an aborted approach and while climbing at full power.

As was indicated in Section 1.16.1.1 the handle for the cowl flaps was unlocked, but close to being in closed position, but since the engine cowling with the cowl flaps was broken and torn off the aircraft the position of the handle was not a certain indication of the position of the cowl flaps when the accident occurred.

#### **1.18.9 Similar occurrences**

In the aircraft accident database of the National Transportation Safety Board (NTSB) in the US, 42 incidents were recorded where the engine of a Cessna 210 had stopped in flight because the fuel in the aircraft's tanks was exhausted or fuel could not be obtained from a tank in flight [one tank emptied and another not connected] (starvation). The database recorded 4 instances where the cause of engine failure was said to be uncertain, but the possibility of a vapour lock having occurred was mentioned.

In at least one instance there was no certain explanation for the engine failure, and the main tanks contained 9.5 US gallons (36 litres) of fuel after an emergency landing. NTSB mentions in this connection that in the Cessna Pilot Safety Supplement it mentions that when 11 US gallons (41.6 litres) or less are in the main tank, uncoordinated flight, such as skidding or slipping, can cause fuel to drain away from the tank outflow and cause fuel starvation to the engine.

Chapter 2, page 2, of the flight manual of the Cessna T210L states the following where it discusses the fuel system.

#### **NOTE**

Unusable fuel is at a minimum due to the design of the fuel system. However when the fuel bays are 1/4 full or less, prolonged uncoordinated flight, such as slips or skids can uncover the bay outlets, causing fuel starvation and engine stoppage. Therefore, with low fuel reserves, do not allow the aircraft to remain in uncoordinated flight for periods in excess of one minute.

#### **1.18.10 From the Aeronautical Information Publication (AIP)**

The RAC Chapter of the Aeronautical Information Publication (AIP), p. 4.16, Section 5.3, includes the procedure for departure of a single engine aircraft in VFR flight from runway 20 at Reykjavík airport. It states, for instance:

"Following take-off a 40° right turn shall be made when altitude and speed permit (not, however, before

abeam of hangar 3) to reduce noise pollution on Kársnes. This direction shall be maintained until 1000 feet or until Kársnes has been passed.”

**1.18.11 From the Supplement to the flight manual for TF-GTI concerning STC SA4300WE**

The boldface text is from AAIB.

## Flint Aero

FAA Approved Airplane Flight Manual Supplement

to

Cessna Flight Manuals for Models 210G, T210G, 210H,  
T210H, 210J, T210J, 210K, T210K, 210L, **T210L**,  
210M, T210M, P210N, 210N, T210N.

The information in this document is FAA approved material which, together with the basic AFM is applicable and **must be carried in the basic manual** when the airplane is modified by the installation of auxiliary wing tip tanks and fuel system in accordance with STC SA4300WE.

The information in this document supersedes the basic manual only where covered in the items contained herein. For limitations, procedures and performance not contained in this supplement, consult the manual proper.

### Limitations and conditions

**Placards:**

The following placards are required in locations noted:

**On instrument panel in clear view of the pilot.**

„Total aux. fuel 33 U.S gals. (32.5 useable). Transfer aux. fuel only in level flight when main tank is half empty and when main tank is not supplying engine. Aux. fuel switch must be off during take-off , landing, filling and when empty.”

**Adjacent to the airspeed indicator** (Models T210G, T210H, T210J, T210K, **T210L**, T210M, P210N and T210N only):

„Reduce  $V_{NE}$  5 MPH per 1,000 feet above 18,000 feet.”

**In full view of the pilot:**

- (a) For Models 210G, T210G, 210H, T210H, 210J and T210J:

„Design weights 3400 lbs. max provided each wing tip contains 7 gals. or more fuel. 3240 lbs max. with no fuel in wing tips.”

- (b) for Models 210K, T210K, 210L, **T210L**, 210M, T210M, and 210N:

**„Design weights 3800 lbs. max. provided each wing tip contains 7 gals. or more fuel and main tanks are 2/3 full or more. 3530 lbs max with no fuel in wing tips.”**

- (c) For Models P210N and T210N:

Wing Tip Aux. Tank Weight Limits

<u>Aux. Fuel Tank</u>	<u>Max. T.O. Weight</u>	<u>Max Ldg. Weight</u>
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Either is less than 7 gals.	3730 lbs	3530 lbs
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<u>Both are 7 gals.</u>	<u>4000 lbs</u>	<u>3800 lbs</u>
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Procedures:

No Change

Performance:

Noted in Placards.

FAA Approved: James M Bugbee (Sign.)

Chief, Flight test Section, AWE-216

Federal Aviation Administration, Jan 16, 1984

#### **1.18.12. Safety recommendations which the AAIB made following an accident in 1998**

On 13 September 1998, an accident occurred in taxi flight service of a comparable aviation operation (cf. M-07798/AIG-28). Following the investigation of this accident the AAIB issued a report dated 11 March 1999. In it a number of points were revealed which pointed towards similar irregularities in flight operations as well as surveillance thereof as were revealed in this investigation. The AAIB made safety recommendations in its report on the accident, which included having the ICAA give the operations of the operators concerned sufficient supervision to ensure that the rules applicable to flight operations were adhered to.

#### **1.18.13 Data Plate of TF-GTI**

Examination of the wreck of the aircraft revealed that its data plate, which is supposed to be securely fastened to aircraft, was located inside the left door jamb of TF-GTI and had been affixed with glue. The plate had rivets which were also glued and not riveted as might have been expected.

The AAIB examined the wreck of the plane especially in this regard and, furthermore, because the former log books of the aircraft were missing, in order to see whether another aircraft could be involved than was indicated by the data plate.

The manufacturer was requested to provide serial numbers for the principal parts of the aircraft, but he gave the information that at the time the aircraft was built, serial numbers were not placed on all parts as manufacturers of aircraft do today.

The examination revealed nothing to indicate otherwise than that the aircraft involved was the right one, i.e. that the data plate applied to this aircraft.

#### **1.18.14 Engine of TF-GTI**

An investigation of the engine data revealed that its origins were unknown, i.e. the log book on its origin, use and total time in service was not available. The engine had been overhauled in 1996 in a workshop in the US which was not approved (FAA certificated FAR part 145 repair station) to issue a certificate of airworthiness (Airworthiness Approval Tag, FAA Form 8130-3). Since the engine was in a private plane in the US there was no need for such a certificate.

On the other hand, regulations JAR 145 50 require that maintenance certificates be available for aircraft and their components which are in commercial use in countries where the JAA requirements apply, such as Iceland.

The AAIB requested an explanation of this provision from JAA and also sent a query to the ICAA requesting an explanation as to why this requirement had not been fulfilled when the certificate of airworthiness for commercial operation was issued for TF-GTI in Iceland.

The reply from JAA stated that such a certificate was not necessary if the aircraft had fulfilled airworthiness requirements in its previous regulatory environment. Here [in Iceland] a maintenance certificate had been issued by a JAR-145 approved repair station for the aircraft as a whole, including its components, such as the engine.

As has previously been mentioned, the origin of the engine is unknown. According to the engine data plate, it had been modified from Type E to Type H (ECH). When the manufacturer, Teledyne Continental, was asked its opinion of this, [a spokesman] informed the AAIB that it was almost impossible to carry out such a modification, since these two types were very different ("There is almost no commonality in the major engine components"). On the other hand, he confirmed that the engine in question was of Type H and thereby the correct engine type for the aircraft according to the flight manual.

The engine maintenance documents show that it is the same engine as was overhauled by Gold Star Aviation Accessories on 15 December 1996 and the same which was in the aircraft TF-GTI when it came to Iceland.

As previously mentioned, the investigation by the AAIB and its experts did not reveal any cause for concern as to the engine machinery before it ended in the ocean.

## 2. ANALYSIS

The aircraft had valid registration and airworthiness certificates issued by the ICAA. Its maintenance was looked after by an approved party (JAR-145) and inspections of the aircraft, its engine and propeller had been carried out at the proper time following its registration in Iceland.

The aircraft TF-GTI had been modified by the installation of new wing tips with fuel tanks, in accordance with STC SA4300WE. As a result of this the maximum gross weight, 3800 lbs., now was conditional. To be able to utilise this gross weight at least 26.5 litres (7 US gallons) of fuel had to be in each of the wing tip tanks and the main tanks had to be at least 2/3 full, i.e. to contain at least 227 litres (60 US gallons). Otherwise the maximum take-off weight of the aircraft was limited to 3530 lbs.

According to information from the manufacturer, the modification in question had the effect of lengthening the plane's wing span by 66 cm, which resulted in increasing the moment from the lengthened wing tips. As a result of this information had to be placed on the instrument panel and a supplement added to the Owner's Manual concerning the reduced maximum speed ( $V_{NE}$ ) if flying at an altitude of more than 18,000 feet and instructions as to how the maximum gross weight was subject to the quantity of fuel and its distribution in the tanks. According to the testimony of pilots of TF-GTI, they were not all aware of just how conditional use of the maximum gross weight of 3800 lbs. was.

The aircraft flight manual (Owner's Manual) for an unaltered Cessna T210L, Centurion II, was found in the wreck of TF-GTI. No supplements for operating the wing tip tanks in accordance with STC SA4300WE were in the Owner's Manual but in the aircraft's maintenance documents it is confirmed that these supplements had been added to it and according to the words of the pilots of TF-GTI they were on a separate page which was stapled into the manual. This page had come loose, they said, and was kept in the same pocket in the plane as the Owner's Manual was stored in, but it was not found in the wreck. The original of the supplements was in the aircraft's documents.

The list of airworthiness directives (ADs) was incomplete. It was based on the list which JAS Inc. issued. There was, for instance, a signature attesting that Point C<sub>1</sub> of AD 94-12-8 had been implemented, whereas in fact Points A, C<sub>1</sub> or C<sub>2</sub> and D<sub>1</sub> or D<sub>2</sub> should have been implemented, cf. Section 1.18.2.

That part of the ADs which had not been carried out provides for the addition of a description of procedures for filling the main fuel tanks to the Owner's Manual. This concerned making sure that the aircraft stood with wings level and with the nose slanting 4.5° upwards. This addition was not found in the Owner's Manual. Instructions should also have been placed by the re-fuelling necks on pumping the final 20 litres slowly into each tank, waiting for two minutes and then topping them up. These instructions were not found on the aircraft.

It was indicated in the aircraft maintenance documents that the fuel quantity gauges had been tested. According to the testimony of the pilots the gauges were so inaccurate that they said they did not rely on them.

Pilots are generally aware that the fuel gauges of smaller aircraft such as this one are inaccurate and provide more of an indication rather than reliable information on the quantity of fuel in the tanks. This makes it all the more important for secure flight operation that the pilot himself check the tanks, using available aids such as a dip stick to measure the fuel in them. Before landing, for example, the fuel tank containing more fuel should be selected, which can be difficult if the gauges are hardly reliable.

A journey log book for the aircraft was not kept on board the aircraft but entries were made and the log kept in the operator's office. There was no place in it for attestation by the captain to the condition of the aircraft, which is necessary after each flight. The journey log book had columns for entering the fuel on board following each flight and the reading of the tach meter, but there were no entries in these columns.

It is mandatory in commercial operations to keep fuel and oil records, so that the pilot can always have ready access to fuel consumption per flight hour as well as to how much fuel is currently on board. These records were not kept.

The pilot thus did not have available detailed information as to the actual consumption of the aircraft per flying hour.

The aircraft's older log books were not available and new log books had been issued. The renewal of the log books was not done in accordance with approved aviation practices. Furthermore, a list of ADs was incomplete.

In the aircraft's log book it was attested that on 9 June 2000 an annual inspection had been carried out by the G.V. Sigurgeirsson ehf. aircraft maintenance and repair firm. There is no indication that this was a special conformity inspection and the list of ADs compiled was based on the incomplete list which accompanied the aircraft from the US. The aircraft's total time in service was then recorded as 3431 hours. In the log book of the engine and propeller the total time in service for each was recorded as 41 hours since overhaul. The total time in service for the engine and propeller from manufacture was unknown. On the basis of the annual inspection, application was made for a commercial airworthiness certificate (CofA). The application stated that the aircraft was equipped with instruments for VFR flying and limited night VFR. Even though all the documents which are formally required for issuing a CofA were made available, there was reason to raise objections, for instance, due to their unsatisfactory preparation.

In consideration of the fact that the aircraft came from another regulatory environment, i.e. from the US (FAR) to a European (JAR) environment, and also with regard to the absence of older log books and maintenance documentation when commercial registration was effected, the AAIB is of the opinion that the ICAA might have sought further information concerning the renewal of the aircraft's maintenance records and concerning the inspection which was the basis for acceptance of the aircraft into the JAR environment. The inspection which was carried out, i.e. an annual inspection, is considered a minimum inspection by the JAA.

As indicated in this report, the aircraft TF-GTI was registered on the operating licence of *Leiguflug Ísleifs*



*Ottesen hf.* on 16 June 2000 and used for taxi flight services until it crashed on 7 August 2000. The investigation revealed that there were irregularities on certain points of the aircraft's operation right from the first day of operation.

There were no forms available from the operator for compiling weight and balance records for TF-GTI. It did not prove possible to obtain a load sheet and balance computations for those flights made by the aircraft from the time it was taken into service on 16 June 2000. In addition, no passenger list was produced and no passenger lists had been compiled for the flights made in this aircraft on 7 August 2000.

Pilots of TF-GTI have claimed that they calculated take-off weight together with the location of the centre of gravity for each flight, but due to a shortage of forms these calculations were not preserved. They were also aware of the difficulties involved in using all of the aircraft's seats and that the location of the centre of gravity would be close to the aft limits when adult passengers sat in the rear seats and when there was baggage in the baggage compartment behind them. As previously indicated, they were not aware that the modifications which had been made to the aircraft affected its maximum permitted gross weight.

The AAIB is of the opinion that when the accident occurred the aircraft was heavier than its permitted maximum weight of 3530 lbs. since the conditions for minimum fuel in the main and wing tip tanks were not fulfilled. However, the aircraft probably weighed less than 3800 lbs. The centre of gravity was somewhat aft but nevertheless within permitted limits.

All flights by TF-GTI on 7 August 2000 were, up until the last flight, flown VFR and the flight from the Westman Islands to Reykjavík was intended to be VFR, as single engine aircraft may not be flown IFR commercially. The aircraft TF-GTI was equipped with instruments for IFR but was only registered for VFR and limited night VFR.

The pilot had a valid commercial pilot's licence with IFR rating. Prior to the flight to Reykjavík he obtained a weather description from another pilot of L.Í.O. ehf./Air Charter Iceland, who had just arrived in Reykjavík from the Westman Islands and was informed that VFR flight over Hellsisheiði was regarded as questionable, but that the route over Thingvellir and Mosfellsheiði was clear. On the way to Reykjavík the pilot also made radio contact with another aircraft in the area and obtained the information, according to the testimony of a pilot who heard their exchange, that VFR conditions were acceptable over Hellsisheiði.

The report from the Icelandic Meteorological Office states that, having regard to weather maps, satellite images and weather observations taken at the time, the conclusion can be drawn that on the route of TF-GTI between the Westman Islands and Reykjavík there was calm weather and generally good visibility; the height of the main cloud layers above ground had been close to 3000 feet on the western part of the route. On the eastern part of the route there was considerably less high cloud, but a series of low stratus clouds travelled over the Westman Islands from the southeast, with the result that cloud level now and again dropped to 100-300 feet. In between the sky cleared, however, and visibility was good for most of the time. This cloud bank was borne up towards the shore and piled up along the eastern sides of the Reykjanes mountain ridge. Viewed from the east, in the estimation of a meteorologist at the Icelandic Meteorological Office, it would hardly have been regarded advisable to fly VFR under the clouds over Hellsisheiði.

When the aircraft approached the Reykjanes mountain ridge, the pilot probably thought it not advisable to attempt VFR flight over Hellsisheiði. He contacted approach control at Reykjavík airport at 20:19:15 and requested IFR clearance to Reykjavík and was cleared at 4000 feet. At 20:23:50 he concluded his IFR, at which time he was, according to a radar image, near Sandskeið. After that he continued VFR flight right up until the time of the accident.

The investigation revealed that when the accident occurred the pilot of TF-GTI had put in a long day of work, i.e. he had been on continuous flight duty for more than 13 hours. According to current rules the maximum length of flight duty is 10 hours, for a single pilot on flights flying only VFR. That the alertness and speed of reaction of the pilot may have been reduced due to fatigue when the accident occurred cannot be excluded.

As indicated above, the aircraft was equipped with dual controls, so that active controls were in front of both its front seats. Some states have, for security reasons, set certain rules on limited use of seats where there are active controls. This investigation gave no indication that the pilot had been disturbed by the passenger in the front seat.

Following the accident a routine investigation was carried out on the wreck. There was no indication found of any malfunction of the aircraft as far as load bearing strength or mechanical equipment is concerned which cannot be attributed to the impact at the ocean surface. Nor was there anything found in the examination of the engine which indicated a malfunction in it or its systems which could have caused the engine disturbances and subsequent loss of power.

Investigation of the fuel system of the engine revealed that the fuel lines from the engine-driven fuel pump to the fuel distributor and the line from there to the fuel flow meter were full of fuel. On the other hand there was no fuel in any of the six fuel lines from the distributor to the cylinders. This indicates that the distributor membrane valve had closed, which happens when the flow of fuel ceases and pressure in the system in front of the distributor drops to below 2.5-3.0 psi.

According to information from the engine manufacturer's expert, the lines to the cylinders empty very quickly after the flow of fuel stops, due to heat radiation and heat flow from the cylinders and cowlings.

All indications are that the above-mentioned fuel lines from the distributor to the cylinders would not have been empty if there had been a malfunction in the ignition system or other engine systems, such as the cylinders, valves, camshaft, crankshaft, cylinder rods or bearings, and the engine had continued to rotate and in so doing drive the fuel pump. If a malfunction had, on the other hand, resulted in the complete stoppage of the engine (i.e. it had stopped rotating) then the six lines would have emptied. No sign of such malfunctions were found.

When examined, the engine rotated easily, i.e. the crankshaft together with the camshaft and all drives.

The only malfunction which could have caused the complete loss of engine power, despite sufficient fuel being at the intake of the engine-driven fuel pump, which proved to be in order and the lines from the distributor to the cylinders were empty, would be if the transmission from the camshaft to the engine-driven fuel pump had been disrupted and the pump thus ceased to rotate. The transmission was examined and the backlash between the gears proved to be normal as did its rotation.

In the opinion of the AAIB a malfunction in the engine or its systems was not the reason for the engine disturbances.

As previously indicated, no fuel record was kept for the aircraft from the time it was taken into service and no information on the re-fuelling and endurance before and after flight was on board the aircraft. There are strong indications that, prior to the flight from the Westman Islands to Reykjavík, the pilot had estimated the quantity of fuel in the aircraft's tanks and not confirmed this by examination or measurement, for instance, with a dip stick.

As early as in the preparation of the flight from Reykjavík on the morning of 7 August, a difference was revealed in the evaluation of pilots of the aircraft's fuel consumption. The pilot who flew the plane on the preceding flight, i.e. from Reykjavík to the Westman Islands and back the evening before, after the main tanks had been filled, had estimated prior to his flight 5.00 hrs of endurance (67 litres/hr.) but his flight took 63 minutes. Before the flight from Reykjavík to the Westman Islands on the morning of 7 August, the pilot who now was to fly the aircraft estimated 4 hours 30 minutes endurance, but no fuel had been added to the aircraft's tanks between these journeys. His estimate was in accordance with the fuel consumption which the AAIB deems he had estimated in his flights all that day, or 60 litres/hr.

The AAIB considers it reasonable to assume no less than 56% engine power during the flights of the aircraft that day, i.e. a consumption of 63 litres (16.6 US gallons) per hour on longer flights, such as between Reykjavík and the Westman Islands, but 72 litres (19 US gallons) on shorter flights, i.e. between the Westman Islands and Selfoss. This is in accordance with the opinion of experts from the manufacturers of the aircraft and engine.

The investigation revealed that the refuelling personnel were not aware of the warnings in the ADs, which prescribed pumping the last 20 litres or so of fuel slowly, then waiting two minutes and topping them up. It was also necessary to make sure that the aircraft was standing properly at the time (cf. Section 1.18.2). This could, in the opinion of the AAIB, cause some uncertainty as to the quantity of fuel in TF-GTI's tanks during the aircraft's last flight.

The Owner's Manual assumes that when approaching to land, the tank which has more fuel is to be selected. It also assumes that such a selection is made before each take-off. The report gives reasons for assuming that probably approximately 154 litres of fuel had been in the aircraft's main tanks after 120 litres were pumped into them at Selfoss airport at 17:40 on 7 August. Following the refuelling, three flights were flown to the Westman Islands and two to Selfoss before the last flight to Reykjavík commenced.

The investigation indicates that before the last flight from the Westman Islands, there was considerably less fuel in TF-GTI's tanks than would correspond to the 2 hours 30 minutes endurance which the pilot then estimated. According to AAIB calculations, there were then approximately 45 litres remaining in the main tanks when the flight commenced to Reykjavík, a flight which took 32 minutes.

The uncertainty factor is the fuel in the wing tip tanks. They were not generally used, but the pilots had a few litres in them as a rule. According to AAIB calculations of the probable engine fuel consumption (cf. Section 1.18.5.1) from the time the main tanks of the aircraft were filled on the evening of 6 August, the pilot could have had some 12 litres of fuel remaining in the main tanks when the engine lost power.

If the main tanks had not been filled on the evening of 6 August in accordance with the special working procedures which applied to them, the fuel would have been less.

Electric fuel pumps are used to send fuel from the wing tip tanks to the main tanks and in the wreck the selector switch for the left one was ON. Fuel must not be pumped from a wing tip tank into a main tank except during level flight and not into a tank which is in use or during take-off or landing. Although it is possible that a passenger or rescuer may have bumped against this switch, which is a rocker switch, located on the upper right side of the aircraft's instrument panel, it is nonetheless impossible to exclude the possibility that the pilot may have tried to obtain some fuel from a wing tip tank.

When TF-GTI approached the Reykjavík airport traffic circle from Sandskeið runway 20 was in use. Runway 14/32 was closed due to earthmoving (repair) operations. The pilot was first instructed to come in north of the airport over Laugarnes for approach to runway 20, but when a Cessna 152, which was VFR along the coast en route to land, called over Kjalarnes, TF-GTI was directed to fly south of the airport and in on a right base leg for runway 20.

A short time later the pilot was notified that he was number two following a Fokker 50 which was making an IFR approach from the north from Skagi to runway 20. The pilot of a Dornier aircraft, flight number ICB-753, which was also making an IFR approach from Skagi to runway 20, later confirmed to the tower that he was IFR.

At this moment four aircraft were planning to land at Reykjavík airport at almost the same time. In the estimation of the air traffic controller in the control tower, traffic would proceed most smoothly by allowing ICB-753 to continue IFR flight and have TF-GTI, which was VFR and on or nearing its final approach, fly a circle left and come in for a landing after ICB-753. He thus instructed TF-GTI to break off to the left which the pilot did.

When the pilot of TF-GTI had received instructions to come in after ICB-753, then he was supposed to maintain an adequate and safe distance behind ICB-753 right up until landing. According to the radar plotting TF-GTI flew a rather tight circle over the harbour to the south of Engey and came in on final for runway 20 following ICB-753. The reason why the circle was as tight as it was is not completely clear, but it later turned out that there was a bank of

precipitation farther north over the bay.

When TF-GTI reported over the lake in Reykjavík at 20:33:49, ICB-753 was on the runway. The pilot of TF-GTI was then instructed: "Tango, India, number one". According to the report of the air traffic controller in the tower, ICB-753 was still on the runway abeam the tower when TF-GTI was about to pass the threshold of the runway. When ICB-753 was about to taxi off the runway abeam the tower, TF-GTI was on a very short final and at 20:34:10 the tower thus instructed TF-GTI to abort and fly a traffic circuit, as in his evaluation the margin for landing was not safe. At that time TF-GTI was, in the estimation of the air traffic controller, at an altitude of 70 to 100 feet near the threshold of the runway.

The pilot of ICB-753 says he had already slowed the aircraft after landing abeam with hangar no. 8 (which is connected to hangar no. 1) and then turned 90° left to taxi off the runway, when he looked out his left side window and saw TF-GTI on a very short final and at the same moment the tower instructed the pilot to abort and fly a traffic circuit.

The pilot of TF-GTI began a missed approach and turned right at or before the intersection of runway 02/20 and 07/25 and climbed on a heading close to the direction of runway 25. He thus quickly turned off the heading of runway 20 in his missed approach, whereas the AIP instructs pilots that on departure from runway 20 they are to turn 40° to the right after take-off when altitude and speed permit, but not before abeam of hangar no. 3, and to maintain that course until reaching 1000 feet or after passing Kársnes.

When both the tight circle over the outer harbour and the fact of how soon the pilot turned in his missed approach are considered, it cannot be excluded that the pilot had begun to have doubts about the quantity of fuel aboard and thus intended to come in as soon as possible for a landing at the airport. He never, however, gave indication of such nor requested priority.

At 20:34:54 the pilot called and said he had "lost the engine".

The AAIB is of the opinion that the investigation of the fuel system of the engine itself indicates that the loss of power was caused by a shortage of fuel to the engine (starvation).

When considering the final chain of events it is clear that they involved engine disturbances and then loss of power, when the aircraft was leaving the airport boundary flying at an altitude of about 500 feet, in the estimation of eye witnesses.

It cannot be excluded that in the right turn of the missed approach uncoordinated flight may have slid the little fuel that remained from the out port of the selected tank and this caused fuel starvation to the engine, as can occur if it contains 42 litres (11 US gallons) or less according to the Owner's Manual.

According to information from the engine manufacturer and the NTSB database, there are no known occurrences of vapour lock forming in the fuel systems of aircraft of this type with a 285 hp engine of the type which was in TF-GTI. On the other hand, some examples are known of vapour lock forming in the fuel systems of aircraft of this type with 300 hp engines.

The loss of engine power under the circumstances which existed here should not necessarily mean that the pilot should lose control of the aircraft. If he tried to restart the engine this would have taken some time, and to do so while maintaining control of the aircraft demanded concentration and effective actions.

According to the description by eye witnesses, the aircraft was on almost level flight heading away from the airport when the engine lost power. It appears clear that the pilot did not turn the nose of the aircraft immediately downward in order to maintain or acquire airspeed for an emergency landing after the engine lost power. Under such conditions flying speed drops rapidly, especially as the propeller goes into fine pitch and the drag increases.

It is not clear whether the pilot intended to attempt to return for a landing on runway 02, but given the aircraft's altitude and distance from the airport there was scarcely any other option but to maintain air speed in a glide to a controlled emergency landing on the ocean.

The aircraft turned left, the angle of bank increased, the aircraft stalled and fell in a steep spiral.

The AAIB refers to the safety recommendations which it directed to the ICAA following an aircraft accident of another taxi flight operator on 13 September 1998 (cf. M-07798/AIG-28). It is of the opinion that the objective of these recommendations has not been achieved in the manner intended, having regard to what has come to light concerning surveillance of operations of the aircraft TF-GTI.

In its reply to these recommendations the ICAA confirmed that the rules of JAR-OPS 1, which currently apply for larger operators will in a short time also apply to smaller operators. It is the opinion of the AAIB that the entry into force of these rules will address most of those aspects which were found unsatisfactory during the investigation of this case.

### **3. CONCLUSIONS Probable causal factors are marked with an asterisk \***

- 3.1 The aircraft TF-GTI had valid registration and airworthiness certificates for commercial air transport operations, issued by the ICAA.
- 3.2 The pilot had valid qualifications as a commercial pilot, with IFR rating and the required ratings to make this flight.
- 3.3 The operator, L.Í.O. ehf./Air Charter Iceland, had a valid operating licence for taxi flight service. The aircraft TF-GTI was registered on the operator's licence on 16 June 2000.
- 3.4 The flight was a VFR taxi flight in the aircraft TF-GTI carrying one pilot and five passengers from the Westman Islands to Reykjavík.
- 3.5 The flight in the control zone of Reykjavík airport and the approach to the airport was VFR flight in accordance with VFR.
- 3.6 The aircraft TF-GTI had been modified by the installation of new wing tips with fuel tanks, in accordance with STC SA4300WE. Such a modification required the installation of new information on conditional maximum gross weight of the aircraft and altered speed limits, both in the Owner's Manual and on instruction placards in the cockpit. The instruction placards were not in accordance with the instructions of the wing tip manufacturer.
- 3.7 Airworthiness Directive AD 94-12-8, which was issued by the aircraft's country of manufacture and applied to its fuel gauges and its refuelling, had according to the aircraft documents been only partially implemented. A description of the procedures for refuelling was not found in the Owner's Manual and there were no markings by the refuelling necks.
- 3.8 It was not possible to see in documents from the operator in what manner provisions concerning load or balance had been complied with in the everyday operations of the aircraft from the time it was taken into commercial air transport operation.
- 3.9 The pilot of TF-GTI does not appear to have made a load sheet and balance computations prior to take off from the Westman Islands airport. Such a load sheet and computations, made in accordance with the operator's operating manual, would have shown him that the aircraft was overloaded before take-off. There was no copy found at the departure location nor was it found in the wreck.
- 3.10 A passenger list was not made prior to take-off from the Westman Islands as provided for in the provisions of the Aviation Act.
- 3.11 \* Fuel and oil records had not been kept as provided for by regulations since the aircraft was taken into service by the operator. The pilot thus did not have available detailed information as to the actual fuel consumption of the aircraft per hour of flying time.
- 3.12 \* The pilot does not appear to have ascertained what the quantity of fuel was in the aircraft's tanks prior to departure from the Westman Islands.
- 3.13 \* The pilot appears to have underestimated the fuel consumption of the aircraft and overestimated the quantity of fuel in its tanks prior to departure from the Westman Islands, in which case the aircraft had considerably less endurance than he assumed.
- 3.14 No mechanical malfunctions were found in the investigation of the accident which could explain the engine's loss of power.
- 3.15 \* The engine disturbances and loss of power were most likely due to engine fuel starvation, because the selected fuel tank had been emptied.
- 3.16 During the approach to Reykjavík airport, extra strain was placed on the pilot due to other air traffic, including Do-228 with the call sign ICB-753, which was on an IFR approach from Skagi to runway 20; four aircraft estimated landing at almost the same time.
- 3.17 In the estimation of the air traffic controller in the control tower, traffic would proceed most smoothly by allowing ICB-753 to continue IFR flight and have TF-GTI, which was on VFR, and on or nearing its final

approach, fly a circle left and come in for a landing after ICB-753. He thus instructed TF-GTI to break off to the left which the pilot did.

- 3.18 For reasons which are not clear, the pilot of TF-GTI flew such a sharp circle that when the aircraft was approximately over the threshold of the runway, ICB-753 was still on the runway but about to taxi off it abeam hangar no. 8. The air traffic controller deemed that the margin of TF-GTI for landing was not safe and thus instructed the pilot to abort and fly a traffic circuit.
- 3.19 The pilot did not execute the missed approach in accordance with the rules of the AIP, but instead quickly turned aside from the runway heading and climbed, close to the heading of runway 25 towards the inlet Skerjafjörður.
- 3.20 The tight circle which the pilot flew to land after ICB-753, as well as his untimely turn after receiving instructions to abort his landing could be an indication that he had doubts about the quantity of fuel on board. The pilot never, however, gave an indication that he needed priority to land.
- 3.21 The pilot of TF-GTI was ascending, had retracted the landing gear and flaps and the aircraft had reached an altitude of 500 feet over Skerjafjörður after his missed approach when the engine lost power. The aircraft was in level flight and turned to the left. The pilot shouted that the aircraft was stalling and numerous eye witnesses saw it roll to the left and fall in a steep spiral into the ocean some 350 metres from shore. The aircraft broke apart and sank to a depth of about six metres with all occupants on board.
- 3.22 The aircraft was heavily loaded at low air speed after a missed approach when the engine lost power. If the pilot tried to restart the engine this would have taken some time, and to do so while maintaining control of the aircraft demanded concentration and effective actions. Since this was his 22<sup>nd</sup> flight that day and his flying shift had become 13 hours long, this may have reduced his concentration and accuracy in controlling the aircraft and contributed to him losing control of it.
- 3.23 When the engine disturbances began and the engine lost power, the pilot continued level flight over Skerjafjörður. At its altitude and given position relative to the airport then, there was no other possibility than to maintain sufficient airspeed in gliding to a controlled emergency landing on the ocean surface.
- 3.23 \* It appears clear that the pilot did not turn the nose of the aircraft immediately downward in order to maintain or acquire airspeed for an emergency landing in the ocean after the engine lost power.

## **4. SAFETY RECOMMENDATIONS**

### **The AAIB recommends to the Minister of Transport:**

- 4.1 that he re-evaluate the decision indicated in Advertisement No. 171, of 9 March 1998, concerning indefinite postponement of the entry into force of rules based on JAR-OPS 1 concerning the commercial operations of smaller aircraft.

### **The AAIB recommends to the ICAA:**

- 4.2 that working procedures of the Flight Safety Department of the ICAA, concerning registration of used aircraft for commercial operations be reviewed. Either the importer should be required to obtain a CofA for Export from the CAA of the exporting state, or the ICAA should itself perform an inspection of the aircraft which fulfils the requirements for issuing such a certificate;
- 4.3 that it establish a quality system for the operations of the ICAA Flight Safety Department;
- 4.4 that the operations section of the Flight Safety Department draw up a plan for formal evaluations of operators. These evaluations should be made in accordance with recognised quality management methods;
- 4.5 that it place special emphasis on having aircraft maintenance parties keep accurate records of the maintenance carried out including, for instance, recording the results of all test measurements made;
- 4.6 that it see to it that operators, who have not already done so, adopt provisions in their operations manuals concerning the access of passengers in front seats with active steering controls when there is only one pilot in an aircraft;
- 4.7 that it strengthen its surveillance of flights in connection with the extensive passenger transport occurring in connection with annual festivities in the Westman Islands on the August long weekend.

Reykjavík, 23 March 2001

**Aircraft Accident Investigation Board**