REPORT

Of an Ad Hoc Investigation Committee appointed in November 2002 to investigate an aircraft accident in the inlet of Skerjafjördur on 7 August 2000

Cf. the Act No. 59/1996 on the investigation of aircraft accidents
and regulation No. 852/1996.

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REYKJAVÍK 2003-05

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The objective of aircraft accident investigation is to analyse the causal factors of aircraft accidents with the sole purpose of preventing recurrence of aircraft accidents and to work for increased air safety. The purpose is not to apportion guilt and/or responsibility. An Aircraft Accident Investigation Board report shall not be used as evidence in public proceedings, as an investigation of alleged punishable acts in connection with aircraft accidents is independent of aircraft accident investigation, according to the Act on Aircraft Accident Investigation No. 59/1996.

1.0 Preface

On 7 August 2000 the aircraft TF-GTI crashed in the inlet Skerjafördur killing the pilot and 5 passengers. The AAIB issued a final report on 23 March 2001. The fathers of two passengers that died got two British aircraft accident investigators, B. M. E. Forward and A. F. Taylor, to provide comments on the execution of the investigation and AAIB's final report, which is further described at the beginning of Chapter 14 hereinafter. Their report is dated 16 September 2002. The AAIB received the report for review and had numerous observations. For that reason the AAIB suggested in a letter dated 3 October 2002 to the Minister of Transport "that he, as far as law permits, set up an independent committee of honourable persons, Icelandic and foreign, specialised in aviation and aircraft accident investigation, to provide as soon as possible a neutral evaluation of the conclusions of AAIB's report on the TF-GTI accident on 7 August 2000 and provide, as required by circumstance, other possible explanations for the accident as well as additional safety recommendations.". The AAIB also requested that it be excused from continued management of the case.

For that reason the Minister of Communications appointed an Ad Hoc Investigation Committee in November 2002 to investigate the aforementioned accident. The following were appointed to the Committee:

Sigurdur Líndal, Professor Emeritus, Chairman
Kjartan Nørddahl, Captain and lawyer
Birger Andreas Bull, Consultant, Norway
Søren Flensted, Inspector, Denmark
Ronald L Schleede, Consultant, USA

The Committee was to adhere to the Act No. 59/1996 on the investigation of aircraft accidents and regulation No. 852/1996.

Otherwise the Committee had a free rein in its task which it defined; to review and appraise the following reports:

1. Draft report on the aircraft accident on 29 December 2000, with the comments of the Flight Safety Division of the Icelandic Civil Aviation Administration.
2. Final draft – Aircraft accident report. Dated 12 March 2000.
3. AAIB's final report titled "Aircraft Accident Report" and dated 23 March 2001.
4. A report by B.M.E. Forward and A.F. Taylor dated 16 September 2002. The title is "A Review of the report and circumstances relating to the fatal accident to Cessna 210 TF-GTI on 7 August 2000".
5. "Answers [from the AAIB] to commentary with regard to a report by two former aircraft accident investigators from Britain, Mr Bernie Forward and Mr Frank Taylor, dated 16 September 2002." The answers dated 2 October 2002.
6. "Analysis Report to Minister of Transport from the Director General of Civil Aviation on the report of Bernie Forward and Frank Taylor on account of the aircraft accident in Skerjafjördur 7 August 2000." The report is dated 4 October 2002.
7. Other items of interest in light of the above-mentioned information.

A short account of the members of the committee is in order:

Mr Líndal, born 1931, Professor Emeritus, lawyer and historian, private pilot license 1967. Professor of law 1972-2001. Has been fellow judge in a few cases concerned with aircraft accidents and flight incidents.

Mr Norddahl, born 1940, pilot and lawyer. Has worked as a pilot, later as captain and has operated a legal office since 1988. Executive manager of the *Icelandic Air Line Pilots' Association* since 2003.

Mr Bull, born 1955, civil engineer and pilot. Has worked in the Norwegian Navy, been a captain and flight instructor; Inspector of Flight Operations / Head of Licensing Department / Senior Adviser at the Norwegian Civil Aviation Authority and, since August 2003, he is an Inspector of Accidents in the Accident Investigation Board in Norway.

Mr Flensted, born 1951, aeronautical engineer and pilot. Has worked far and wide as a technical consultant and technical manager, and since 1990 Chief Inspector at the Civil Aviation Administration in Denmark and has also worked for the Joint Aviation Authorities.

Mr Schleede, born 1943, scientist and pilot has 35 years experience in aviation safety. Was in the US Air Force 1965-72 where he worked as a test pilot and flight instructor. Worked for the US National Transportation Safety Board (NTSB) for 28 years (1972-2000) as an air safety investigator and manager. After retiring from the NTSB in 2000, he has been a consultant in the field of international flight safety working for numerous clients, including ICAO, governments and airlines all over the world. Has been chairman of many international committees and workgroups on flight safety, i.a. on the preparation of an agreement on flight safety between Russia and the USA that the Prime Minister of Russia and the respective US Secretary signed in 1998.

The Committee consulted Hallgrímur Jónsson, chief pilot of Icelandair and Gunnar Valgeirsson, aircraft maintenance technician. The Committee also turned to the Icelandic Flight Academy for assessment of a calculation of how much fuel had been used in the aircraft's flight from the time fuel was put in its main tanks at 18.15 on 6 August 2000 until the accident. That report was prepared by the Chief Flight Instructor Reynir Einarsson, the instructors Eyjólfur Gunnbjörnsson and Gudmundur H. Sveinbjörnsson; and a copy of their report accompanies this report. Furthermore, Tern Systems, Inc, which is owned by the University of Iceland and the Civil Aviation Administration (CAA), allowed the Committee to use civil engineer Matthías Sveinbjörnsson's report initiated by the CAA, entitled "Statistical analysis of the estimated fuel level of TF-GTI on the 7th August 2000", where the methods of probability theory are used to estimate the amount of fuel in the aircraft's tanks at the time of the accident. This report is also attached.

The Committee convened on 13-14 June 2003 with meetings from 9.00-18.00 both days. Mr Schleede came a day earlier -Thursday 12 June - and Mr Líndal, Mr Norddal and Mr Valgeirsson had informal meetings with him that day.

On Friday 13 June, a meeting was held from 9.00-18.00 where the reports were reviewed, discussing mostly the engine, including possible seizure and possible fuel starvation. Mr M. Sveinbjörnsson appeared before the Committee and explained his previously mentioned report. Next Thorsteinn Thorsteinsson, who was the Investigator-in-Charge of the accident from 7 August 2000 until 15 December 2000, appeared before the Committee and answered questions on specific points in AAIB's final report and the flight instructors Mr Einarsson, Mr

Gunnbjörnsson and Mr G.H. Sveinbjörnsson presented their report. Finally, Thormódur Thormódsson, the present Chief Inspector of Accidents appeared and answered questions, as he had assisted in completing the AAIB's final report on the aircraft accident of 7 August 2000.

On Saturday 14 June the meeting began at 9.00. Mr Gunnbjörnsson and Mr Sveinbjörnsson presented and explained their calculations. At 10.00 a visit was made to the storage area where the wreck was kept and it inspected, with the propeller receiving special attention. In the afternoon the Committee listened to recordings of communications between the air traffic controller and the pilot that took place just before the accident and until the aircraft stalled, with the assistance of an interpreter for the foreign members of the Committee. Mr Flensted was not present as he used that time to study the aircraft's log books. Then the oil filter was taken apart, see further description in Section 7.5.3 of the report. During that time Mr B.A. Bull, Mr H. Jónsson and Mr G.H. Sveinbjörnsson studied the flight route from Vestmannaeyjar to Reykjavík. Subsequently, at about 15.30, all members of the Committee reunited and discussed what remained of the reports presented, the relation of the AAIB and the CAA, balance calculations, load sheets, inspections and checks. The meeting ended shortly after 18.00.

Later that summer the chairman received written reports from the foreign members of the Committee, which are referred to in this report. The Chairman then compiled the report last summer and autumn in cooperation with Mr Norddahl. Mr Valgeirsson and Mr Jónsson were his advisors. A draft of the report was then sent to the foreign members of the committee and they have sent comments as needed.

On December 30 2004 a draft final report was delivered to the AAIB and the CAA, and the same day it was sent to the G.V. Sigurreirsson Aircaft Maintenance and Repair firm and Skúli Jón Sigurdarson who took over the accident investigation on 15 December 2000 and completed it. The following day – 31 December – it was delivered at the house of Friðrik Ottesen, Ísleifur Ottesen's son, at Vídihvammur 5, Kópavogur, as Ísleifur is in the USA.

Deadline was set for 20 January when comments were received from the AAIB and Skúli Jón Sigurdarson. The CAA got an extension until 26 January when it sent in its comments. No comments came from the G.V. Sigurreirsson Aircaft Maintenance and Repair firm nor from L.Í.O. ehf./Air Charter Iceland. The committee has reviewed all comments and revised the draft report as required.

The Committee had access to facilities at the Reykjavík Air-Ground Rescue Organization at Flugvallarvegur in Reykjavík. The AAIB gave the Committee access to all documents on the accident of 7 August 2000 and provided information on whatever was requested. The Ministry of Communications has assisted the Committee in many ways concerning management, among which were the visits of the foreign members of the Committee.

Vilhelm Steinsen, certified translator of Reykjavik Translations plc. translated this report. The report contains numerous references to sources translated by others. Among those translators are Hilmar F. Foss who translated the Draft AAIB report from Icelandic to English and has authorised reference to his translation, the translator of AAIB's final report permitted reference as well as minor adjustments in wording for sake of coordination, Vilhelm Steinsen translated ICAA's Answers to the report of Forward and Taylor dated 2 October 2002, the Director General of Civil Aviation translated the CAA's Analysis Report on Forward and

Taylor's review dated 4 October 2002; Skúli J. Sigurdarson permitted reference to his translation of the law on aircraft accident investigation; references to the fuel calculation report (Annex I) of Reynir Einarsson, Eyjólfur Gunnbjörnsson and Gudmundur H. Sveinbjörnsson are direct as they wrote the report in English; and then Matthías Sveinbjörnsson translated his statistical fuel level analysis report (Tern Systems Inc., Annex II).

Thorkell Ágústsson and Thormódur Thormódsson, members of AAIB, translated AAIB's comments on the report of the Ad Hoc Investigation Committee, dated 19 January 2005 (Annex III). Björn Björnsson translated ICAA's Analysis Paper - Comments on the final draft report of the Special Investigative Committee[1] and its two Appendices B and C[2] dated 25, 24, and 31 January 2005 respectively (Annex IV). Vilhelm Steinsen translated the Responses of the Ad Hoc Investigation Committee (Annex V).

The report follows hereafter.

July 2005

Sigurdur Líndal
Chairman

Birger Andreas Bull[3]

Søren Flensted

Kjartan Norddahl

Ronald L. Schleede

[1] Comment from Ad Hoc Investigation Committee translator: A variation of the Icelandic name of the Ad Hoc Investigation Committee.

[2] Appendix A was not translated as it covers only those provisions of the Icelandic Aviation Act No. 60/1998 that concern aircraft registration and issue of airworthiness certificates.

[3] Birger Andreas Bull has mainly contributed in the Ad Hoc Investigating Committee regarding fuel calculations and investigation of possible fuel starvation. He finished his report 10. August 2003.

2.0 Does Iceland meet the demands of the International Civil Aviation Organization?

2.1 Introduction

On 20 April 1947, Iceland formally became a member of the International Civil Aviation Organization, see advertisement No. 45, 2 April 1947, by ratifying the agreement on international aviation, drawn up in Chicago on 7 December 1944. Article 26 of the agreement concerns investigations of aircraft accidents and states that they shall be carried out according to case procedures recommended by ICAO. The organization has published annexes on this matter, of which Annex 13 deserves special mention, as well as various standards, recommended practices and guidance material.

2.2 Are ICAO standards minimum standards?

2.2.1 From the Forward and Taylor report

In the beginning of their report F and T state:

> It has been stated that Iceland meets the requirements of ICAO with respect to aircraft accident investigations (apart from the IAAIB not having its own facilities for the storage and study of aircraft wreckage). However the lay, or non-aviation, person may not appreciate that ICAO standards are minimum standards as agreed by the 188 states, many of which are undeveloped without the financial resources to fully support aviation. Thus most developed countries seek to establish and maintain very much higher standards in all of their aviation activities and we would expect that Iceland would wish to be considered to be in this category rather than be measured against the lowest.

2.2.2. Objections of the Icelandic Civil Aviation Administration

The ICAA disputes the above assertion and considers that F and T inaccurately represent the implications of ICAO standards and directives which are not compromises on flight safety issues. Furthermore, the observations of the ICAA include the following, cf. Analysis Report, dated 4 October 2002, Introduction:

> The concern in the area of aviation safety is primarily that many states do not satisfy the requirements that are contained in these standards. For this reason an extensive safety audit programme was initiated by ICAO four years ago in order to bring forward the status of aviation safety in the world in the area of key standards. Practically all the ICAO states have now been audited. No state has avoided criticism including the most highly regarded aviation states of the world. As could be expected the Western European states fared well in these audits. Iceland is in the group of the highest ranking states in this category as is clearly reflected by audit data provided by ICAO.
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> Although the organization of accident investigation was not included in the aforementioned audit a special investigation was undertaken by ICAO (at the request of the Minister of Transport). This revealed that the organization of these activities is in good order inter alia because of the establishment of the Icelandic Aircraft Accident Investigation Board (AAIB) as an autonomous body. Despite a small population and limited resources the AAIB has been able to tackle its tasks in a very satisfactory manner with the assistance of sister organizations in neighbouring countries when needed, e.g. for specialized investigation of aircraft parts or for the full investigation of accidents.

2.2.3 ICAO's review of legislation, procedures and facilities for aircraft accident investigation in Iceland

2.2.3.1 Flight safety issues in Iceland in general

This special inspection referred to is a review by ICAO of Icelandic flight safety issues that took place from 28 August to 5 September 2000. A letter from the President of the Council to the Minister of Transport dated 20 June 2001 refers to this review and says among other things:

> You may wish to note that the safety oversight performance of Iceland compares favourably to that of a group of eight selected States comprising the Nordic States and Western European/North Atlantic States. In turn, the safety oversight performance of this group compares favourably with that of thirty-three States in the European and North Atlantic Regions of ICAO and, even more so, with 120 states globally.

Because of the accident in Skerjafjördur on 7 August 2000, the Minister of Transport, in letters dated 18 April and 10 May 2001, asked the ICAO to review and appraise legislation, investigative processes and facilities for aircraft accident investigation, and also judge how the investigation of the aircraft accident of 7 August 2000 had been conducted. Two representatives of the organization[1] visited Iceland from 15 -19 May 2001. Their report *"Review of Legislation, Procedures and Facilities for Aircraft Accident Investigation in Iceland"* was enclosed with the aforementioned letter dated 20 June 2001.

The main conclusion of the 20 June letter was as follows:

> Concerning the accident on 7 August 2000, you may wish to note that all relevant aspects of the accident flight had been considered in the investigation by the AAIB. Appropriate safety recommendations have been made with the aim of preventing future accidents and promoting aviation safety; therefore, the purpose of an accident investigation has been met, and no further aircraft accident investigation action appears necessary with respect to this tragic accident.

The letter concludes with the following:

> Based on ICAO's safety oversight audit and its assessment of the accident investigation capability of the AAIB, it is considered that the civil aviation system in Iceland is being operated in accordance with ICAO requirements and compares favourably with regional and global norms.

The introduction of the aforementioned report is as follows:[2]

The review team was of the opinion that legislation and rules, the investigative process and policy covered all aspects of aircraft accident investigation and were adequate. The employees were considered well qualified and adequately trained to investigate aircraft accidents and aircraft incidents according to the standards set in Annex 13 to the Convention of ICAO[3] which contain instructions on aircraft accident investigation. Investigators also had access to checklists and other material in a draft Handbook. Adequate funds and facilities were provided. The reviewers considered that the AAIB should be independent in everything concerning technical accident investigation activities and in particular with respect to results and formulation of safety recommendations. Generally speaking, the AAIB should remain fully accountable to the Ministry of Transport and Communications for its policies and activities.

About the AAIB final report, it was the opinion of the reviewers that it was essential to make sure that the purpose of aircraft accident investigation was according to Annex 13 to the Convention of ICAO and the Aircraft Accident Investigation Act No. 59/1996 to prevent flight accidents and promote safety in aviation. The reviewers noted that safety

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[1] One of these was the head of the ICAO section in charge of aircraft accident investigations and their prevention.

[2] Cf. Executive Summary, page ii.

[3] Annex 13 – Aircraft Accident and Incident Investigation, to the Convention of the International Civil Aviation, ICAO.

recommendations in the final report considered the concerns about increased aviation safety expressed by the representatives of the relatives of those who died in the accident. As appropriate safety recommendations have been presented and the purpose of the investigation thereby achieved, it appeared to the reviewers that further investigation of the accident was not necessary.

Chapters 1-5 following the summary cover administration of aircraft accident investigations in Iceland in further detail. There is no reason to discuss here the first three Chapters of the report. They describe the investigative process, the legislation, especially Annex 13 and the Act No. 59/1996 on aircraft accident investigation and the position of the AAIB. These items do not need further treatment here, but the latter part of the report requires further explanation.

2.2.3.2 Concerning the AAIB

Reviewers considered the AAIB suitably staffed for investigating aircraft accidents in order to fulfil the provisions of Annex 13 and personnel was therefore not a problem, personnel tending to remain with Board for long periods of service. However, the reviewers pointed out that aircraft accident investigators had to perform administrative duties because the AAIB did not employ support staff for such work (cf. Section 4.4; hereinafter references will only be to report Section numbers).

According to documents provided to the reviewers, the accident investigators were in every aspect well equipped for reaching the accident site. The reviewers considered telecommunications in order (4.5).

As previously stated, the reviewers considered the personnel well qualified and adequately trained to supervise investigation of aircraft accidents and incidents according to Annex 13. The personnel had attended reputable courses in accident investigation abroad and attended meetings and seminars held by European Civil Aviation Conference (ECAC), ICAO and the International Society of Air Safety Investigators (4.6).

The reviewers considered the AAIB to have adequate facilities, but drew attention to the fact that it did not have any fixed space such as a hangar for storage and investigation of wreckage. They had been informed that the AAIB rented space in hangars for such use when needed. However, the reviewers considered that it might be difficult to store wreckages securely in a limited space in a hangar that was otherwise in normal use and to which people not connected to aircraft investigation had access for purposes unrelated to such activities.

Furthermore, the reviewers considered the equipment that investigators used in the field and equipment to protect investigators against biological hazards exceeded what was required in manuals ("... exceeded the list of suggested items contained in the appendices to Chapter 2 and Chapter 5 of the Manual of Aircraft Accident and Incident Investigation (Doc 9756), Part I – Organization and Planning, First Edition 2000"). In addition to photographic equipment indicated in the ICAO manual, a Kodak DC 290 200M digital camera was available. On the other hand, no hard hats were available. Reviewers considered that equipment for field inspection was adequate (4.7).

2.2.3.3 Aircraft accident in Skerjafjördur 7 August 2007

Reviewers stated that they assessed the final report with the assistance of an interpreter and discussed investigative processes and methods used in the inspection with the AAIB. They agreed that all aspects relevant to the flight before the accident had been examined in the inspection (5.5.1).

Reviewers noted that much of the evidence and documents about the accident were in Icelandic which they were unable to assess, and that it had been outside their mandate to scrutinise evidence and re-evaluate conclusions drawn therefrom (5.1.2).

About the release of the engine early in the investigation process while the final report was being prepared, the reviewers stated that the engine had been thoroughly examined in the investigation and no mechanical discrepancies were found suggesting operating trouble. The fuel system had been removed from the engine and sent to a workshop abroad. Reviewers were also told that the owner had requested to have the engine released. This is very common in aircraft accident investigations. There is no doubt that the AAIB was authorised to determine whether the engine could be released. That is common in aircraft accident investigations. If compared to how aircraft accident investigations in other countries are conducted, it is by no means unusual that an engine is released in circumstances such as these (5.1.3).

The reviewers did not consider 7½ months from the accident until a final report was produced an unusually long time. It accorded very well to the time for a similar investigation in other countries (5.1.4).

Upon the Minister of Transport's request the reviewers met with representatives of the families of those who did not survive. With the meeting the families' representatives wanted to draw the reviewers' attention to their concerns. They pointed to numerous points, mainly in the following areas: Registration of the aircraft in Iceland, the issue of an airworthiness certificate, release of the engine early in the investigative process, air traffic service when the accident took place, previous incidents where the pilot was involved, the operator's flight operations and maintenance services, as well as changes that were made to a draft compared to the final report (5.2.1).

Finally, the reviewers treated the subject of safety recommendations. They considered it outside their mandate to review evidence or documents of the accident. They pointed out, however, that many of AAIB's safety recommendations addressed what representatives of the families of those who did not survive considered not to be in order (5.3).

By taking into account the purpose of aircraft accident investigations according to Annex 13 to the articles of association of ICAO and the Act on Aircraft Accident Investigation No. 59/1996 to prevent accidents and work towards safety in aviation, it was the reviewers' opinion that this purpose had been achieved by the investigation into the accident when a Cessna 210 went down. Reviewers point specifically to the fact that safety recommendations in the AAIB's final report address the flight safety concerns expressed by the representatives of the families of those who did not survive (5.3.2).

As adequate recommendations for increased safety had been proposed, the reviewers considered that further investigation of the aircraft accident was unnecessary (5.3.3).

2.2.4 Forward and Taylor's assessment of the quality of AAIB's investigation and final report

In Chapter 1 of their report F and T assess the quality of AAIB's report and investigation:

> The Report complied with the format recommended by Annex 13 to the Chicago Convention. However, much of the analysis was based on assumptions rather than hard evidence. In particular, the conclusion that the aircraft had run out of fuel in the tank in use was based on suspect fuel quantity calculations and selective assumptions regarding the position of the fuel system controls. It was stated that the position of the cowl flaps could not be determined because their control lever may have been displaced due to impact forces, yet the position of the fuel selector control was accepted without question and in the absence of any confirmatory evidence. The investigation appears to have come to the conclusion at an early state that the primary cause of the accident was fuel starvation for whatever reason and thus only evidence that supported this conclusion was given weight in the subsequent analysis. This contention is supported by the superficial examination of the engine following the accident. There was no in depth inspection of the rotating components of the engine and no attempt to assess the state of the engine by reference to oil sample analysis which, had it been done, would probably have either confirmed or eliminated the possibility of engine seizure.
>
> Similarly, the Report seeks to explain the pilot's actions in making a *'tight'* circle late on the approach and his *'untimely'* turn after the go around on the basis that he thought that he was short of fuel. There is no evidence to support this contention. The term 'tight' when applied to a turn normally implies a small radius or steeply banked. Study of the radar data shows that this particular turn took about 1 minute 50 seconds to complete. This is only marginally less than the time taken to complete a similar turn under Instrument Flying procedures or when in cloud. In no way could this turn be said to be tight. When challenged in April 2002, the IAAIB sought to justify the term 'tight' by saying that what the Report intended to convey, was that the turn was 'tight' in the sense that the pilot positioned his aircraft too close to the Dornier at the completion of the turn. However, as stated in Para 7, the separation achieved was adequate had the Dornier cleared the runway in a reasonable time. Moreover, the evidence of the RTF tapes indicates that, despite his overlong duty period, the pilot's voice was calm and showed no distress when he was told to delay his approach at a late stage. Regarding the pilot's 'untimely' turn, this could not have been untimely since there was no published procedure for a VFR go-around at Reykjavik and the pilot's action in turning at a safe height was perfectly reasonable and totally legal. However, the Report seeks to bolster its fuel starvation theory on the basis of this action.

The main points in F and T's treatment above seem to be as follows:

1. Much of the analysis in AAIB's final report was based on assumptions rather real evidence. This assertion will be addressed later where F and T's report will be discussed in general, cf. Chapter 12 hereinafter.
2. Fuel calculations are questionable. They will be covered in more detail in Chapter 8 hereinafter.
3. Selected assumptions concerning position of fuel system controls, among other things that cowl flap positions could not be established. This will be covered in more detail in Section 7.3.4 hereinafter.
4. Inspection of the engine was superficial, such that a possible seizure was not considered as it should have been. This will be covered in more detail in Chapter 7.0.
5. AAIB's criticism of the go-around does not hold up to scrutiny and the way it was carried out is no proof of lack of fuel.
6. Radar data show that the go-around turn took 1 minute and 50 seconds and cannot therefore be considered tight.
7. There was sufficient separation from the Dornier aircraft on the runway.
8. The pilot's voice in the tape recordings showed no sign of distress.
9. There was no published VFR go-around procedure for Reykjavik.

Issues raised in points 5-9 will be covered in a specific chapter (Chapter 9 on the go-around).

3.0 Connection between the AAIB and the CAA

3.1 Introduction

F and T feel there is reason for concern about the connection between the AAIB and the CAA, pointing to two specific items in the AAIB draft report of 29 December 2000[1] which they consider to have been altered in the AAIB final report due to pressure from the CAA. One item concerns the airworthiness of the aircraft TF-GTI, and the other the working hours of the pilot.

3.2 On the airworthiness of the aircraft TF-GTI

3.2.1 What F and T say about the airworthiness of TF-GTI

The first item appears in the following commentary in Chapter 2 of their report:

> Comments by the ICAA on a draft report dated 29 December 2000 submitted to them by the IAAIB, raise the following points:
>
> A draft conclusion stated: *'The aircraft was not airworthy in accordance with the applicable rules'*. [cf. section 3.7].
>
> It is quite clear that the IAAIB felt at this stage of the investigation that there was sufficient evidence to support such a conclusion and subsequent investigations would support this. However, the ICAA's response to the entire list of draft conclusions was: *'Based on the comments and indications which the ICAA has advanced above it is clear that the following conclusions cannot be accepted as presented. The ICAA considers it unavoidable that these be revised having regard for the Administration[']s indications'*.
>
> Subsequent drafts, including the published report, make no reference to the fact that the aircraft was not airworthy although there is ample evidence to suggest that it was not.

F and T refer to comments by the CAA in the AAIB draft report of 29 December 2000 (p. 30), written in italics in the quoted text. It is a general comment that applies to all the numbered sections, from Section 3.1 to 3.21, in the summarised conclusions of Chapter 3 in the AAIB draft report. In other words, it covers all comments and suggestions that the CAA presented to the AAIB and that are printed at their respective places in the draft report. The main emphasis of F and T is, however, that while the aircraft was not considered airworthy in the draft report, it was considered airworthy in the final report. In their opinion this change is due to pressure from the CAA, and they support this opinion specifically with the draft report text indicated above, stating that the aircraft had not been airworthy according to applicable rules, and with the above-mentioned CAA comment in which the CAA calls a review of the conclusions in Chapter 3 of the draft report inevitable, taking the CAA's points into account. However, F and T do not specify clearly what the sufficient evidence is indicating the aircraft was not airworthy.

3.2.2 On the issue of an airworthiness certificate for the aircraft TF-GTI, in AAIB's draft report of 29 December 2000

The cause of F and T's criticism seems to be the following commentary in Chapter 1.16.2.4 of the AAIB's draft report from 29 December 2000:

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[1] Reference is made to Draft Aircraft Accident Report from the AAIB, dated 29 December 2000. Flight Safety Division of CAA comments, 5 February 2001.

In the data of the TF-GTI with the ICAA there was the Deed of Conveyance/Bill of Sale dated 19 April 2000, from Sunland Air, Inc., to L.I.O. ehf./Air Charter Iceland at Reykjavík Airport, being signed by Ísleifur Ottesen for both parties. There is no mention of a sales price, but reference is made to another Purchase Agreement which would contain a more detailed specification of the aircraft. This Purchase Agreement was not among the documentation with the ICAA.

In the TF-GTI documentation at ICAA there were three applications concerning this aircraft,

a) concerning initial registration dated 8 June 2000,
b) concerning the issue of a certificate of airworthiness dated 8 June 2000,
c) concerning renewal of C of A dated 9 June 2000.

According to the application for an initial registration there was to be attached the latest certificates of registration and airworthiness for the aircraft. These were not among the data which were in the custody of ICAA, but were found on board the wreck of the TF-GTI.

In the application for the issue of a C of A information was filled in by the Technical Manager of L.I.O. ehf./Air Charter Iceland and registration for commercial flights was being applied for. Questions concerning a foreign C of A or export C of A were left unanswered, but such certificates have then probably expired as the aircraft had been struck off the registry in the United States on 29 March 2000.

In the application:

a) the year of manufacture was said to be 1974, but it was actually 1973,
b) the total operation of the aircraft was said to be 3,431 hrs.,
c) the operation of the engine (Serial No. 165605-8-E) as of manufacture [2] was said to be 41 hours,
d) the operation of the propeller (Serial No. 730423) as of manufacture said to be 41 hours.

No adequate data justifying these figures in clauses c) and d) concerning operational time as of manufacture are at hand.

The application for the issue of a certificate of airworthiness was confirmed by the current registered owner on 8 June 2000 and thereupon endorsed by an ICAA supervisor on 15 June 2000 recommending the issue of C of A No. 808 for the TF-GTI. A certificate (with classification, normal/general/passengers) was thereupon issued with term of validity until 30 June 2001.

In the application for renewal of a C of A (for aircraft of less than 5,700 kilogrammes) which was filled in by the operator's Technical Manager the Serial No. of the propeller was now recorded as "16605.8", operation since manufacture was still recorded as 41 hours, Serial No. of propeller had been changed to "41" and the time of operation as of manufacture/overhaul was left blank. The application was not accompanied by the aircraft's maintenance record or a list of airworthiness directives. According to the application form it is not necessary to submit this documentation when there is a case of JAR145 maintenance, but the Technical Manager of L.I.O. ehf./Air Charter Iceland operates a workshop approved under JAR145.

3.2.3 ICAA comments on the above-mentioned text from the AAIB draft report

The CAA made the following comments on this text, inserted in AAIB draft report, Section 1.16.2.4:

The ICAA considers the Chapter hereinbefore to give on important aspects an incorrect picture of the registration procedure and the issue of CoAs in this Country. This is perhaps because the ICAA's included a document stating that this was a case of a renewal of TF-GTI's CoA. No renewal of a CoA in this country was on the agenda nor could this occur as will be referred to hereinafter.

It is right immediately at the outset to arouse attention to the fact that there is a difference between, on the one hand, to register an aircraft and, on the other hand, to issue a CoA for it, cf. separate Sections of the Aviation Act No. 60/1998.

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[2] Here and in the rest of the text where the word "manufacture" is used it appears to refer to an overhaul.

As F and T take the issue of an airworthiness certificate as an example of inappropriate connections between the AAIB and the CAA, only that aspect will be treated here, and the registration will be covered specifically later in Section 4.0. The comments of the CAA on Section 1.16.2.4 of the AAIB draft report and which are inserted into that chapter explain previous registration certificates, an initial registration in Iceland and the issue of a commercial airworthiness certificate. For instance, the following is stated:

> As it pertains to the issue of CoA there were available all data relating to clauses a) and e) in Art. 20 of the Aviation Act No. 60/1998. As it pertains to clauses a), b) and d) these conditions are met by means of a type certificate. As it pertains to clause c) relating to maintenance there were at hand data to the effect that the aircraft obtained maintenance and administration thereof with a JAR-145 approved maintenance station as is required in transport flights. As it pertains to clause e) on insurances confirmation of insurances was at hand.
>
> The ICAA does not require that a CoA for an aircraft which is issued by FAA be submitted upon the issue of an initial CoA in this Country, i.a. as such certificates do not stipulate a period of validity, but are deemed to remain valid while maintenance records confirm that the aircraft has been maintained in accordance with US rules (FAR).
>
> This fact not withstanding the ICAA looked up the US CoA under reference for the aircraft in the FAA database when it was registered.
>
> According to the ICAA's application form for the issue of a CoA it is not requested that the previous CoA (the foreign one) be delivered upon the first issue of a CoA in this Country.
>
> However when there is a case of the *renewal* of a CoA the certificate, i.e. the Icelandic CoA intended for renewal, must naturally be available. New forms were recently taken into use, including the application form under reference. The check-list which maintenance parties use when they undertake annual inspections on account of *renewal* of a CoA is on the reverse page of the application form for *renewal* of a CoA. The same check-list is used upon the first issue of the CoA, cf. clause c) Art. 20 of the Aviation Act mentioned hereinbefore. This check-list is only to be found on the reverse page of the form for renewal, although it be also used upon the initial issue of a CoA. The reason for ICAA's inspector signing the "Renewal Form" is to the effect that he thereby confirmed that the check-list formed part of the application to which was fixed, but that which had been entered on the front page of the application was not concerned with the matter.
>
> In addition to the data which has been mentioned hereinbefore, there were submitted all log books (for the aircraft, engine and propeller) and including data pertaining to operating time. This was also accompanied by a newly revised list of the airworthiness directives pertaining to the aircraft and a weighing form which was prepared shortly after the aircraft arrived in this Country in 1999 with the signature of a JAR-145 maintenance party.
>
> The ICAA has never had the technical facility, e.g. maintenance station, nor sufficient personnel having specialized knowledge to scrutinize as to whether a specific activity or repair job has been discharged in the required manner. This technical sector is directed to approved maintenance stations and the ICAA relies on the conclusions thereof. The ICAA thereupon investigates at regular intervals as to whether modes of work and maintenance control of such parties meets the requirements to which such activities are subjected.
>
> It will be clear from the foregoing that all stipulated data and information were at hand to register the aircraft and grant it a CoA.
>
> As it pertains to the comments that the serial number of the airworthiness (sic!) propeller[3] had changed to 41 in the renewal form it is obvious that this refers to the operating time of the propeller and

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[3] Translator's comment: The term "airworthiness propeller" is a translation of what appears to be an error in the source text. The Ad Hoc Investigation Committee assumes that the intended meaning was propeller.

> furthermore only the check-list on the reverse page as well as the receipt on the front page actually constituted part of the application for a CoA.

In continuation of this comment the AAIB draft report says, cf. section 1.16.2.4:

> It is clearly mentioned in the application that the aircraft be fitted with equipment for VFR flights and limited VFR night flights, but not IFR flights. This application was endorsed by ICAA's supervisor on 15 June 2000 and it was confirmed that the C of A for aircraft No. 808 had been renewed until 30 June 2001.

On this, the ICAA makes the following observation in the draft report:

> IFR transport flight with a single-engine aircraft is not permitted. There may, on the other hand be complete IFR equipment on board which are conceivably used e.g. on private flight or in case of emergency. The aircraft will have been fitted with such equipment, but that is no concern of public transport flight and there is therefore no reason to make a mention thereof in the application.

3.2.4 Main provisions of the Aviation Act, No. 60/1998, regarding the issue of an airworthiness certificate

The main provision on airworthiness is in Art. 20 of the Aviation Act and reads as follows:

> An aircraft used for aviation according to this Act shall be airworthy.
>
> An aircraft is airworthy only if it meets the following conditions:

a. it is designed according to appropriate standards and is certified as such,
b. it is manufactured by a recognized manufacturer; however, special rules may apply to homebuilt aircraft, cf. Art. 12,
c. its maintenance and regular inspection are in accordance with rules and instructions set by civil aviation authorities regarding the administration of maintenance and use of recognized maintenance stations and regarding overhaul, repairs, modifications and the installation of equipment.
d. it meets demands set by the authorities on pollution prevention, i.a. due to noise and exhaust,
e. the aircraft, its crew and passengers are insured in an adequate manner as stipulated in this Act.

3.2.5 Summary of CAA comments in the draft report of 29 December 2000

The above-mentioned comments of the CAA can be summarized as follows:

1. There was no intention of renewing the airworthiness certificate.
2. A distinction must be drawn between a) aircraft registration, cf. Chapter III of the Aviation Act, No. 60/1998, and b) the issue of an airworthiness certificate, cf. Chapter IV of the Act.
3. Registration took place according to set rules and based on the required documents. The aircraft was deregistered in the USA. Registration will be treated separately in Section 4, later in this report.
4. The issue of an airworthiness certificate was consistent with the provisions of Art. 20 of the Aviation Act, No. 60/1998, where conditions for airworthiness are listed as Items a-e. These were met in accordance with legal provisions, as stated below:
    a. The aircraft was designed according to appropriate standards and had a certificate thereof, i.e. a type certificate, cf. Item a, Art. 20.
    b. The aircraft was manufactured by a recognized manufacturer according to the type certificate, cf. Item b, Art. 20.
    c. The aircraft was maintained and the maintenance was administered by a workshop certified according to JAR-145, as stipulated in Item c, Art. 20.

  d. The aircraft met the requirements of authorities concerning pollution prevention, including those of noise and exhaust, according to the type certificate, cf. Item d, Art. 20.
  e. The aircraft, its crew and passengers were insured in an adequate manner, according to confirmation by an insurance company, cf. Item e, Art. 20.

5. The CAA does not require that FAA airworthiness certificates be presented upon the issue of an Icelandic airworthiness certificate. An airworthiness certificate is considered valid as long as maintenance books confirm maintenance.
6. Upon the first issue of a certificate of airworthiness in Iceland, no submission of an earlier certificate of airworthiness (the foreign one) is required. Notwithstanding this fact, the CAA looked up the US airworthiness certificate for the aircraft in the FAA database when the aircraft was registered.
7. Upon renewal, the Icelandic airworthiness certificate that is to be renewed must be available.
8. All log books for the aircraft, engine and propeller were presented, including acceptable data for the time of service.
9. Technical aspects are directed to recognized maintenance stations, as the CAA has neither the technical facilities nor specialised staff to scrutinise whether a particular repair job has been performed in an acceptable manner. The CAA does, however, inspect maintenance stations regularly.

Pursuant to this, the conclusion of the CAA comments is that all stipulated data and information were available for registering the aircraft and granting it a certificate of airworthiness.

3.2.6 On the issue of an airworthiness certificate for the aircraft TF-GTI in the AAIB final report.

Section 1.18.4. of the AAIB final report treats the subject of the aircraft's registration in the USA and its flight to Iceland. This section also explains the issue of a commercial airworthiness certificate in Iceland; and this section replaces Section 1.16.2.4 in the draft report of 29 December 2000, which has been quoted above, cf. 3.2.2. Then the section of the AAIB final report says:

> 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.[4]
>
> 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.

[4] Mr Ísleifur Ottesen was President of both companies according to the IAAIB Draft Report which is quoted thus above.

> The ICAA re-issued on 16 June 2000 a supplement (Carrying out Aviation Operations - Sheet 1) to the aviation operating license of *Leiguflug 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.

The AAIB final report emphasises this in Chapter 2 Analysis[5] where it says:

> 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.

According to what is stated above, the AAIB points out the following regarding registration and the issue of an airworthiness certificate:

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[5] Translator's comment: In the translation of the draft final report the heading of Chapter 2 is "Sector Analysis", whereas in the translated final report it is Analysis.

1. Not all data on maintenance was available, for instance older log books and other maintenance data for commercial aviation registration.
2. Log books were not renewed and re-issued according to generally approved procedures in aviation.
3. The list of airworthiness directives was inadequate, as it was based on an inadequate list that had accompanied the aircraft from the USA.
4. Annual inspection took place on 9 June 2000, but the log book has no record of any special conformity inspection.
5. The documents were improperly prepared and therefore inadequate.
6. Markings on the engine were lacking, as was a record in the documentation of cylinder compression tests.

For the above-mentioned reasons, the AAIB concluded that the CAA should have requested further information on the renewal of those aircraft maintenance documents which were concerned with the inspection that was the basis for accepting the aircraft, as it was coming from the regulatory environment of the United States (FAR) into the European (JAR). The inspection by the aircraft maintenance and repair firm G.V. Sigurgeirsson ehf. might well have been more thorough than an annual inspection; also, the inadequate completion of application documents should have been objected to and further information on the renewal of maintenance documents insisted on.

Upon comparing the text of Chapter 1.18.4 in the AAIB final report cited above with the CAA comments on Chapter 1.16.2.4 of the AAIB draft report cited above in Chapter 3.2.3, cf. the summary in Chapter 3.2.5, it is clear that the AAIB by no means took into account every comment by the CAA. This comparison does not support the ideas of F and T regarding inappropriate influence of the CAA on the AAIB's work, about which they have expressed concern, indicating especially CAA's comments on Chapter 1.16.2.4 in the AAIB draft report as examples of such influence.

The CAA comments (cf. the Analysis Report to the Minister of Transport from the Director General of the ICAA dated October 4 2002) on Chapter 6 in the report by F and T, where the history of the engine is treated, to be dealt with in Chapter 5 below, say that further to discussions of the engine when the AAIB report was presented, the CAA changed its registration process to the effect that there is now little danger of an aircraft or engine with false or forged documents being registered in Iceland. The comments then say, cf. Chapter 6:

> In the F&T report the authors correctly express doubt (p. 15) that a certificate of airworthiness had been issued if the above information on the origin of the engine had been known when the aircraft was put up for registration. On the other hand they acknowledge that this is easy to say after the fact or in their own words: "This may be easy to say with hindsight ..."

Registration and airworthiness directives will be treated in Section 4.0 below.

3.3 Working hours of the pilot in aircraft TF-GTI

3.3.1 From the Forward and Taylor report

The latter point which F and T take as an example of an inappropriate relationship between the AAIB and the CAA, is the treatment of the pilot's working hours, with their report stating as follows, cf. Chapter 2:

A further conclusion states that the pilot had completed a 13 hour duty at the time of the accident, whereas at the time of the accident 10 hours was the maximum allowed under Icelandic regulations. The ICAA sought to dismiss this conclusion by stating: *'These 13 hours are not far from being the maximum time which were permissible if a flight shift had been extended due to unforeseeable conditions in the flight work proper after commencement of flight shift and unforeseen circumstances following upon take-off on a final flight[.]'*

This statement is very hard to understand and if it were not from an official organ of government, it could be interpreted as flippant. It is a fact that the pilot had had a very long day involving many sectors and the fact that, had circumstances been different, it is possible that he might have been operating within permissible limits is irrelevant.

In the draft of 29 December 2000 the conclusion relating to flight time excedence quite rightly appears as a separate item as befits its relevance to the accident. However, in the Final Report, it is relegated to an after thought in the conclusion relating to the weight of the aircraft at the time of the engine failure.

3.3.2 From the draft report and final report of the AAIB

The draft report of 29 December 2000 says the following towards the end of Chapter 1.17.2:

> ... he had time off as of the latter part of Saturday 5 August until he commenced flight shift in the morning of 7 August. Take-off of the TF-GTI from Reykjavik occurred at 0753 hrs., so that the pilot's flight shift may be considered to have commenced about seven o'clock. According to current rules he should therefore have finished the shift no later than about 1700 hrs.
>
> At 1700 hrs. the pilot landed at Westman Islands following upon his 15th flight on that day and according to the rules he should then have been relieved. He was on his seventh flight after this and his 22nd flight on this day was on at the time the accident occurred in Reykjavik at 2035 hrs. Then the flight shift had exceeded 13 hours.
>
> These 13 hours are not far from being the maximum time which were permissible if a flight shift had been extended due to unforeseeable conditions in the flight work proper after commencement of flight shift and unforeseen circumstances following upon take-off on a final flight [...].

Chapter 1.17.2 of the final report by AAIB says:

> He [the pilot] was off duty from late Saturday, 5 August, until he began his flying duty on the morning of 7 August.
>
> TF-GTI took off from Reykjavik at 07:53 so that the pilot's flying duty may be regarded as having commenced at around seven o'clock. According to the current rules he should thus have concluded his duty no later than about 17:00. At 17:00 the pilot landed in the Westman Islands after his 15th flight on that day [and according to the rules he should then have been relieved off duty]. He was flying his seventh flight after that, and his 22nd flight that day, when the accident occurred in Reykjavik at 20:35. At that time his flying duty had lasted over 13 hours.

In the final report the words in the square brackets from the draft report have been deleted; however, that seems to have no significant effect.

Chapter 2, "Sector Analysis" of AAIB's draft report (page 64) says the following:

> Upon the investigation it was revealed that at the time the accident occurred the pilot of TF-GTI had had a long working day or been on flight duty continuously for over 13 hours. According to current

> rules the maximum flight shift is 10 hours based on a single pilot flying where VFR flight only is flown. [See indication 1.17.2, but that hardly changes the conclusion immediately below.][6].
>
> It is not possible to exclude the prospect that the vigilance and reaction of the pilot had been abridged due to fatigue.

Chapter 2, Analysis in the AAIB final report, says:

> 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.

In an observation on what is quoted here from the draft report, Chapter 2, p. 64, the CAA refers to its commentary towards the end of Chapter 1.17.2, which F and T quote in italics in their report, see above, saying that under unforeseeable conditions the maximum of 10 hours for flight duty may be disregarded; nevertheless, this hardly changes the AAIB conclusion on it being impossible to exclude that the alertness and reaction speed of the pilot may have been reduced due to fatigue. If the above-mentioned texts of the draft report and the final report are compared, it can be seen that nothing in the final report has been materially changed from what was in the draft report.

The results of the AAIB draft report say, cf. Item 3.16:

> Take-off from Reykjavik was at 0753 hrs. on 7 August. The pilot was on his 22 flight on this day when the accident occurred at Reykjavik at 2035 hrs. and at that time his flight shift had exceeded 13 hours. The current flight operations manual of L.I.O. ehf./Air Charter Iceland does not include the currently applicable provisions of Regulations on flight and working hours' limitations or schedules of the rest-hours of air crew. The maximum length of flight shift (one pilot on flight which is in all respects undertaken in accordance with visual flight rules) when working hours commence during the period 0700 - 1159, is 10 hours. (JAR-OPS 1.1085 (Art. c, table 3) and clause (6). It is not possible to exclude the prospect that a long working day under difficult circumstances has contributed to the pilot's losing control of the aircraft after the engine lost power.

Section 3.21*[7] states the following:

> The aircraft was doing little speed on go-around, overloaded and with centre of gravity at the aftmost limits when the engine stopped. It is probable that the pilot has tried to re-start the engine, but that required many strokes of work. This may have reduced his concentration and accuracy and caused him to lose control of the aircraft.

The conclusions of the final report state the following, in Section 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 22nd flight that day and his flying duty had become 13 hours long, this may have reduced his concentration and accuracy in controlling the aircraft and contributed to him losing control of the aircraft.

<u>3.3.3 No significant difference between the AAIB draft report and final report</u>

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[6] Ad Hoc Investigation Committee comment: The bracketed phrase is CAA's comment on the AAIB draft report of 29 December 2000.

[7] Probable cause factors are marked with an asterisk *.

In Section 3.3.1 on the pilot's working hours, F and T are quoted as saying that the CAA, by referring to unforeseen circumstances that had in fact not existed, made little of the pilot's having exceeded the 10-hour maximum flight duty on 7 August 2000. They take this as an example of an inappropriate relationship between the CAA and AAIB, in that the AAIB did not operate as independently as necessary. The excessive time of the pilot's flight duty is not assessed as a separate item in relation to the accident, as is done in the draft report, but as an afterthought, within the conclusion on the aircraft's weight when the engine stopped.

It is not quite clear what F and T mean by this comment. Section 3.16 in the conclusions of the AAIB draft report says it cannot be excluded that a long day's work under difficult circumstances contributed to the pilot losing control of the aircraft after the engine lost power, and Section 3.21 of the draft report points out that the aircraft was moving at slow speed, that it was heavily and incorrectly loaded, and that the pilot had tried to restart the engine, which required several movements, reducing his concentration and accuracy and causing him to lose control of the aircraft. In the conclusions of the final report, Section 3.22, the above-mentioned texts are summarised and placed in direct association with the accident. The result is the same: that his flight duty had reached 13 hours and that this may have reduced his concentration and accuracy and contributed to his losing control of the aircraft. There is no indication in the text of the final report that anything of relevance has been altered from what was stated in the draft report.

A reminder is in order concerning the CAA comment in "Sector Analysis", Chapter 2 of the AAIB draft report, where the CAA claims that its commentary on authorisations to deviate from 10-hour flight duty in unforeseen circumstances does not alter the aforementioned conclusions of the AAIB that a long working day may possibly have reduced the concentration and accuracy of the pilot and thereby agrees with the AAIB conclusion.

There is nothing in the AAIB coverage of the pilot's working hours to suggest inappropriate influence from the CAA on the work of the AAIB.

3.4 The AAIB's status pursuant to the Aircraft Accident Investigation Act, No. 59/1996

There are provisions on the AAIB in the Aircraft Accident Investigation Act, No. 59/1996, which applied until they were replaced by the Act No. 35/2004.

It says in Art. 6:

> The Aircraft Accident Investigation Board is totally independent of government authorities and other investigation authorities, prosecuting authorities and courts. The Board will decide when there is reason for an investigation of an aircraft accident.
>
> The Board can request from the Civil Aviation Administration an admission to whatever documents and evidence that are necessary for an investigation.
>
> The Civil Aviation Administration, the criminal police and the police are obliged to render all necessary assistance to the Board with an investigation.

Art. 4 says as follows:

> A special competence of Board members and the employees of the Aircraft Accident Investigation Board, is dealt with in Chapter II of the Administrative Procedures Act No. 37/1993.

It is clear that the aforementioned legal provisions are meant to ensure the independence of the AAIB. There is no administrative connection between the AAIB and the CAA; due to the nature of circumstances, nevertheless, communications between them must be considerable. The new Act on aircraft accident investigation No. 35/2004 served to strengthen AAIB's position even further, nevertheless, the accident and the investigation took place while the Act No. 59/1996 applied, which is the basis of this report.

Thus it is a matter of debate whether the AAIB is under some indirect or informal pressure, such that it may be doubted whether it is in fact independent in its work. Anyone suggesting this must point out some example thereof to support such doubts. It is the Ad Hoc Investigation Committee's opinion that the above-mentioned two examples mentioned by F and T do not do so.

3.5 Right to objection

Notwithstanding this, those who are defending their honour and interests may always be expected to try to influence the work of individuals and institutions set to inspect them and are liable to criticise them due to their position and work. This applies to the AAIB as well as others with such a function. In fact this is provided for by law, and the right to object should be pointed out as a principle of administrative law, cf. Art. 13 of the Administrative Procedures Act, No. 37/1993, which reads as follows:

> A party to a case shall be given the opportunity to express his views on the subject-matter of the case before a public authority reaches a decision thereon, unless his reasoned position on the matter already appears in the documentation on the case, or it is clearly unnecessary for him to do so.

The Aircraft Accident Investigation Act, No. 59/1996, re-emphasises this principle in Art. 15:

> Parties to an aircraft accident, the owner or operator of the aircraft, as well as the Civil Aviation Administration shall in a manner the Aircraft Accident Investigation Board decides in each case and within given time limits, be given the opportunity to express themselves about the Board's final draft to the report, before the final report is published, cf. Para. 14, provided the pertaining documents do not include the opinion of those parties and their arguments for this opinion or this is obviously not necessary.

F and T hint that this was not ensured and say the following at the beginning of Chapter 2 in their report:

> During the review of the investigation, the apparent relationship between the IAAIB and the ICAA gave rise to some concerns. It is normal, and indeed good practice, to submit the draft report for comment to those parties whose reputation may be adversely affected by the findings of the report so that they may comment on the report before it is published. This procedure was followed in the case of the ICAA but does not appear to have been followed in the case of all other parties. Although others interested may have been given the opportunity to comment, there does not appear to be any record of their having been extended this courtesy. In the case of this investigation, it would have been proper for the estate of the deceased pilot, the Operator of the aircraft, the maintenance organisation and possibly ATC to have been given the opportunity to comment, in addition to the ICAA.

F and T say here that it "seems" the AAIB sent its draft report only to the CAA and not to any others. The AAIB states, however, in its comment on this commentary that the draft final report was sent to all parties to the case as stipulated by law. The draft was sent to the operator and the maintenance company in addition to the CAA. Everyone made comments, which were considered when preparing the final report. The CAA confirms this in general terms.

The Ad Hoc Investigation Committee has inspected the manner in which the AAIB final report was made. A draft report, dated 21 December 2000, was brought up for review at an AAIB meeting on 28 December of the same year. The final draft of the AAIB report was approved, and it was also agreed to send it to the parties concerned and call for their comments, for which they were given until 20 January 2001.

The draft report, dated 29 December 2000, was then sent out with a letter of the same date to the CAA, LÍO ehf./Air Charter Iceland, and the aircraft maintenance and repair firm G.V. Sigurgeirsson ehf. The CAA sent detailed comments dated 5 February 2001. LÍO ehf./Air Charter Iceland sent comments dated 4 February 2001, and the aircraft maintenance and repair firm G.V. Sigurgeirsson sent comments dated 3 February 2001.

Upon receiving these comments, the Board drafted a new report, dated 12 March, and sent it to the same parties. They were given until 16 March 2001 to comment. An answer came from the CAA in a letter, dated 16 March, where it claimed to have various reservations and comments on the final draft of the report, although due to the short time limit the CAA would present its comments in another setting if needed.

However, the following comments were made in the letter:

> However, the CAA would like to ask why the cause[8] of the accident is no longer considered as the pilot not having checked whether there was enough fuel in the aircraft before leaving Vestmannaeyjar. It is also considered appropriate to point out that the final draft states that pilots were aware that fuel gauges could not be trusted and that there was a placard in the aircraft stating that the gauges were not calibrated and should not be trusted. Uncalibrated gauges can therefore not be considered a likely cause of the accident..

The following item is added to the Conclusions, Chapter 3, of the AAIB final report , Item No. 3.12*, which is considered a probable cause factor:

> 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.

This was not stated in the final draft of 12 March 2000, which means that the CAA comments were taken into consideration.

The AAIB conclusions do not refer to uncalibrated fuel gauges as a cause of the accident in the final draft nor the final report, except if considered indirectly in Item 3.13 of the final report which states the same as Item 3.12 in the final draft, namely:

> 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.

This is considered one of probable cause factors.

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[8] Ad Hoc Investigation Committee: It is questionable to talk about a "cause" of an aircraft accident, it being more appropriate to talk of causal factors as such accidents are usually preceded by a sequence of events.

Furthermore, comments were received from Birgir Björgvinsson, director of operations at LÍO ehf./Air Charter Iceland, and from company president Ísleifur Ottesen, both dated 16 March 2001. Two members of the Ad Hoc Investigation Committee, Kjartan Norddahl and Sigurdur Líndal, have reviewed these comments and in their opinion they received due consideration in the final report. Finally, comments came from the aircraft maintenance and repair firm G.V. Sigurgeirsson ehf., dated 14 March 2001; however, these comments do not seem to have called for changes in the final report.

The CAA then sent comments, as it had indicated in the aforementioned letter of 16 March, in an analytical report dated 29 March 2001. This gives an account of CAA operations, describes CAA dealings with the aircraft TF-GTI, its flight from Vestmannaeyjar to Reykjavík on 7 August 2000, and specifically the flight to Reykjavík Airport. Finally, the AAIB's suggestions to the CAA are treated and measures for improvement are described. The CAA does not make specific comments on the final draft or on the AAIB final report, which had actually been published by then, except on Section 4.4 of Chapter 4 with the safety recommendations, cf. Section 16.1 of this report, as CAA quality systems were undergoing systematic improvements.

The doubts of F and T are therefore uncalled for. It is, nevertheless, a matter of dispute who is to be allowed to comment. The word "Parties" at the beginning of Art. 13 does not stipulate this clearly, although F and T feel it would have been right to give the pilot's estate and air traffic control the opportunity to comment. As the pilot was deceased, nothing indicates that the spokesmen for his estate, his heirs or other family members could have provided any explanations that would have been relevant.

The standards, recommended practices, and guidance materials of the ICAO do not provide for the estates of pilots to be sent drafts of confidential aircraft-accident reports. However, this is done in some countries, such as the UK, Canada and Australia, though not in the USA and a number of other countries. A neutral investigative institution, independent of aviation regulatory/safety inspection authorities, is considered adequate to ensure the interest of all parties, including the relatives of those who did not survive.

If the relatives of those who have not survived have access to a draft report, there is a risk of the investigation being forced into unnecessary legal complications that have no relation to flight safety. Furthermore, the relatives cannot be expected to have knowledge useful for the investigation or to make professional comments for a final report. They would have to rely on an advocate who would assist attorneys in looking after their interests, not in working towards flight safety. In this respect, the AAIB abided by Icelandic law in every way.

Even though it was proper, according to F and T, to invite the CAA to comment, they seem to feel that this went too far and that the CAA was given an opportunity to exercise undue pressure on the AAIB. Their commentary in Chapter 2 is as follows:

> While it is quite proper for the IAAIB to invite comments from the ICAA, they must be constantly vigilant to prevent undue pressure being applied during the compilation of their reports. The tone of the ICAA's comments could best be described as 'forceful' and, from the above, it would appear that they succeeded in convincing the IAAIB that changes were required in those conclusions that related to the regulation where the ICAA was most vulnerable to criticism.
>
> It is acknowledged that Iceland has complied with the requirements of Annex 13 and the European Directive as regards the separation of regulatory and investigative functions in relation to the investigation of aircraft accidents. It is also understood that the pool of suitably qualified personnel

> available to fill all the necessary posts is limited because of Iceland's small population. However, it would be beneficial to the future of totally independent accident investigation in Iceland if further separation could be achieved between the IAAIB and the ICAA in the area of accident investigation.

All this is rather unclear. Of course one may agree with F and T that it would be beneficial to aircraft accident investigations to separate the AAIB and the CAA as distinctly as possible. However, they do not suggest any measure further to what is provided for by law. They mention a "forceful" tone in the CAA commentary and that it had succeeded in "convincing the IAAIB that changes were required in those conclusions that related to the regulation where the ICAA was most vulnerable to criticism". The examples of the aircraft's airworthiness and the pilot's working hours seem to be meant to help prove where the CAA was most vulnerable and to serve as an indication of the AAIB having given in to the CAA's non-factual pressure, but it has been demonstrated above that that conclusion cannot be reached from those examples. They show the opposite.

Another matter, however, is that the wording of the law could possibly be sharpened, even though that would probably not change much, while a better solution would be to set rules for Board members and employees concerning their communications with those who operate aircraft as well as authorities in the field. It could also be considered whether it would be right to place the CAA and the AAIB under separate ministries, which has in fact been discussed.

Finally, mention should be made of the safety recommendation that the AAIB directed at the CAA after the taxi flight accident of another operator on 13 September 1998. In its final report, the AAIB felt the intended goal of those recommendations had not been reached with reference to what was revealed concerning the inspection of TF-GTI operations.

The CAA's response to the recommendations confirms that the rules of JAR-OPS 1, which apply now to larger operators, will soon also apply to smaller operators. The AAIB believes that when these rules take effect they will apply to most of the points that were wanting and were revealed in this investigation. (AAIB final report, Chapter 2, Analysis).

3.6 Conclusion on whether the CAA had inappropriate influence on AAIB's final report

As mentioned several times in this Chapter, F and T suggest that the AAIB was under undue pressure from the CAA while preparing the final report. It is actually undisputed that the AAIB's treatment of the CAA's working methods and practices stirred up its employees. This is therefore a sign of the AAIB's independence. Even though the AAIB took some of the CAA comments into consideration and made changes accordingly, there are no signs of this having been done due to pressure from the CAA. The AAIB simply agreed that the comments gave reason for changes.[9] It is worth noting that the AAIB recommended reforming CAA work processes and working methods, cf. Chapter 4 of the AAIB final report, Safety recommendations, Sections 4.2-4.7, which will be prensetned in the final Section of this report (16.1).

The then Chief Inspector of Accidents, Skúli Jón Sigurdarson, and the then Deputy Chief Inspector of Accidents, Thorsteinn Thorsteinsson, were at that time the only permanent AAIB

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[9] One member of the committee, Birger Andreas Bull, points out that he feels that the wording of AAIB's final report is much milder than the draft report. In Norway important changes are rarely made from the text of the AAIB draft report to its final report. If this happens the AAIB sends out a new draft before the final report is completed.

employees. Their working methods included having one of them in charge of investigating each incident that came up.

The Deputy Chief Inspector of Accidents was in charge of inspecting the TF-GTI accident from 7 August 2000 to 15 December 2000, when he went abroad and stayed until 30 June 2001. The Chief Inspector of Accidents then took over the investigation and finished it. The Deputy Chief Inspector of Accidents attended three AAIB meetings of March 2001 when the Board was completing its report after all commentary had been received. It is clear from the case documents and interviews with the Deputy Chief Inspector of Accidents, that he did not agree with all the changes that had been made to the report. It is not uncommon for there to be a difference of opinion regarding how reports are to be changed on account of the comments made, as these are frequently subject to an evaluation of how matters of opinion should be settled.

The Ad Hoc Investigation Committee has reviewed the draft report along with the CAA's comments and compared them to the final report. The committee's opinion is that changes to the draft report due to the CAA comments were in many sections entirely logical and worked for the better in the final report. In a few instances some text in the draft report was not included in the final report. There are no clear signs that arguments were lacking for any of these changes. For example, some of the omitted text contained accusations. It is specifically worth mentioning that the original draft directly stated that the aircraft was not airworthy when the accident took place. Such a deduction is an accusation, which is not the purpose of aircraft accident investigations. It is the job of the CAA to determine whether an aircraft was airworthy. It is therefore fully justifiable to omit this text, while the facts concerning airworthiness remain in the report. In this instance the AAIB pointed to faults regarding safety of airworthiness and recommended reforms for these faults. The same may be said for the pilot's working hours, which F and T refer to as an indication of inappropriate pressure by the CAA.

It is clear that the CAA felt threatened and the AAIB chose to omit accusations from the report, without retracting conclusions that were supported by facts along with their analysis. Even though there were omissions in a few places and wording was rendered milder, the report was objective and covered every point of importance.

It must also be noted, irrespective of the CAA commentary and changes entering the final report, that the AAIB reached conclusions in various sections and made safety recommendations that entailed criticism of the CAA's performance.

4.0 On the registration and issue of airworthiness certificate for the aircraft TF-GTI

4.1 Introduction

The issue of an airworthiness certificate for the aircraft has already been treated along with the connection between the AAIB and the CAA. It included CAA's comments on what AAIB's draft report said about the aircraft's airworthiness certificate and finally the text of AAIB's final report, cf. Section 1.18.4, was taken up. The conclusion is that in spite of suggestions of that nature there has been no indication of inappropriate CAA influence on AAIB's work or other kind of undue connection between the institutions. In this respect it was unavoidable to consider the issue of an airworthiness certificate and actually registration as well. Before leaving this item, the aircraft registration and issue of airworthiness certificate calls for an independent consideration even though it entails some repetition of what has already been said. The registration will be considered first and then the issue of an airworthiness certificate.

4.2 On registration and issue of an airworthiness certificate

4.2.1 Main provisions of the Aviation Act No. 60/1998

The main provisions of the Aviation Act No. 60/1998 regarding aircraft registration are as follows:

From Art. 10:

> An aircraft owned by Icelandic citizens with legal domicile in Iceland or Icelandic legal persons with residence in Iceland may be registered in Iceland. [...].

From Art. 11:

> An aircraft that is registered abroad cannot be registered in Iceland until it has been deregistered from a foreign registry. [...]

From Art. 12:

> An aircraft shall not be registered unless it has a type certificate issued by or validated by the CAA or another kind of certificate that the CAA considers adequate. [...]

From Art. 13:

> An aircraft shall be registered according to a written application from its owner. An application shall include reports necessary for registration and papers identifying the applicant as the aircraft owner, when it was built and by whom and that the conditions of Art. 10 to 12 are met. [...]

4.2.2 On the aircraft's registration

The aircraft's registration was not much treated in CAA's comments to AAIB's draft report, cf. Section 1.16.2.4. It only said that registration had taken place according to the applicable rules, on the basis of required documents and that CAA had made sure that the aircraft had been deregistered in the USA, ownership was according to legal requirements and the aircraft had a type certificate that the CAA considered valid. All these documents had been available upon registration. Documents on deregistration in the USA were presented, indicating the aircraft type. The CAA considered an FAA type certificate valid without limitations.

In the final report the aircraft's registration seems to be mentioned only in Section 1.18.4 and Chapter 2, Analysis, and that text is presented in Section 3.2.6 above. Information on registration can be summarized as follows:

1. The aircraft received a registration certificate in the USA on 17 June 1999 with the identification N131DC.
2. The registered owner, Sunland Air Inc., deregistered the aircraft in the USA on 29 March 2000, cf. Art. 11 of the Aviation Act No. 60/1998.
3. A deed of conveyance/bill of sale dated 19 April 2000, from Sunland Air Inc. to L.I.O. ehf/Air Charter Iceland is in the CAA documents, cf. Art. 13 of the Aviation Act. (For the abovementioned Items 1-3, see final report, Section 1.18.4).
4. The aircraft was registered on the air operator certificate of "Leiguflug Ísleifs Ottesen hf." on 16 June 2000 and used for air taxi flights until it crashed on 7 August 2000. The investigation revealed flaws in specific points in the aircraft's operation from day one, (cf. Chapter 2 of the final report).

The AAIB concluded that the aircraft had a valid registration certificate issued by the CAA, cf. Chapter 3 of the final report, "Conclusions", Section 3.1. There seems to be nothing further said on registration. Attention is drawn to the draft report mentioning a type certificate but not the final report. It shall be available according to Art. 12 of the Aviation Act as specified above. The CAA's review of F and T's report of 4 October 2002 says that the engine was a subject of much discussion following AAIB's issue of its report on 23 March 2001 and for that reason the CAA changed its working methods for registering aircraft in circumstances like those of TF-GTI. For that reason it is now unlikely that an aircraft or an engine with incorrect or falsified documentation can be registered in Iceland, cf. further Section 5.3.4.

<u>4.2.3. On the issue of an airworthiness certificate</u>

As has been accounted for above, the conclusion of the AAIB draft report from 29 December 2000 is that the aircraft was not airworthy. The CAA was of another opinion and referred to Art. 20 of the Aviation Act as argument, as previously stated.

At this point, for the sake of emphasis, Section 1.18.4 of the AAIB final report will be considered further, in relation to the issue of an airworthiness certificate for the aircraft TF-GTI, cf. Section 3.2.6 above:

1. An airworthiness certificate for commercial aviation was issued on 15 June 2000 based on an annual inspection at the aircraft maintenance and repair firm G.V. Sigurgeirsson ehf. on 9 June 2000.
2. On 16 June 2000 the CAA reissued an additional sheet to the operating certificate of Ísleifur Ottesen hf. where the aircraft was registered for taxi flights.
3. In order to confirm that an aircraft meets conditions of airworthiness for commercial aviation a specific "Conformity Inspection" must be conducted before a maintenance certificate is issued, cf. JAR-145.
4. This applied to the aircraft TF-GTI which came from a different regulatory environment. It had been registered in the USA and had been maintained according

to other requirements, or more precisely, according to requirements for the maintenance of private aircraft.

5. The CAA considers an annual inspection adequate in cases such as this. JAA considers such an inspection a minimum, given that all documents on the aircraft's maintenance are available.
6. The AAIB considered that the aircraft's inspection should have been more thorough than an annual inspection. Not all documents on maintenance were available and the log books were not issued according to generally approved aviation rules, cf. Section 1.18.3 in the final report.
7. The working papers of an annual inspection on 9 June 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.

What has been detailed here is from the AAIB final report, Section 1.18.4. Then the following is added for emphasis in Chapter 2 of the final report, Analysis.

1. The aircraft's older log books were not available and new log books had been issued. The log books had not been renewed according to approved aviation practices, a list of ADs was incomplete.
2. It was attested in the aircraft's log book on 9 June 2000 that an annual inspection had been carried out by the G.V. Sigurgeirsson ehf. aircraft maintenance and repair firm, but not a specific Conformity Inspection.
3. The list of airworthiness directives was based on an inadequate list that came with the aircraft from the USA.
4. The total time in service for the engine and propeller from manufacture was unknown.
5. A commercial airworthiness certificate was applied for on the basis of the annual inspection. The application states that the aircraft is fitted with equipment for VFR flying and limited night VFR.
6. Even though all the documents which are formally required for issuing a certificate of airworthiness were available, there was reason to raise objections, i.a. due to their unsatisfactory preparation.

The aircraft came from another regulatory environment, or more specifically from the USA (FAR) into the European (JAR) environment and older log books and maintenance documents were not available upon registration for commercial aviation. The AAIB considered that the CAA might have asked again for information on the renewal of the aircraft's maintenance documents and on the inspection that was the basis on which the aircraft was accepted into the JAR environment. The inspection which was carried out, i.e. an annual inspection, is considered a minimum inspection by the JAA (see the AAIB's final report, Chapter 2, pp. 21-22).

The AAIB's conclusion is thus that the aircraft had valid registration and airworthiness certificates issued by the CAA. The aircraft's maintenance was in the hands of a recognised party (JAR-145) and engine and propeller had been inspected at the right time after it was registered in Iceland, cf. Chapter 2 of the final report, Analysis p. 21.

In a report to the police dated 22 October 2001, Pétur K. Maack, Director of Flight Safety Division, points out that the same person is the technical manager for the operator and the responsible manager of a maintenance station that is recognised according to JAR 145. A certifying staff member of a recognised maintenance station is to sign a maintenance log book, but not an operator's technical manager.

The maintenance station that carried out the annual inspection was obliged to check that all placards according to a type certificate and additions if any were in place before issuing a maintenance certificate for the annual inspection. A maintenance schedule for the aircraft includes that an annual inspection involves checking all placards whether they belong to an original type certificate or a supplement to it (STC). The JAR-145, cf. notice No. 477/1994, states in Art. JAR 145.50 that certifying staff members with the relevant authorisations issue a certificate of release to service when they have checked that all maintenance of an aircraft as well as all of its components have been correctly performed at the maintenance station. According to the CAA the maintenance station seems to have violated this rule as it was not demonstrated with full certainty that the placards were in place. The conclusion in Pétur K. Maack's report is that the aircraft would not have received an airworthiness certificate if it had been known that it had been wrongly attested that the placards were in place.

In its review of F and T's report of 4 October 2000 the CAA seconds the statement that it is doubtful that an airworthiness certificate would have been issued, had it been known that the engine data plate was not an original. It would temporarily have prevented the aircraft from receiving an airworthiness certificate, cf. Section 5.3.4.

As the aircraft came from a US regulatory environment into a European one, the AAIB considered with reference to how the documents were presented, that it would have been justifiable for the CAA to request further documents before the aircraft TF-GTI was registered and before an airworthiness certificate was issued, and consequently working methods have been changed in this respect. The Ad Hoc Investigation Committee of this report supports this and in fact emphasises it by saying that the aircraft should neither have been registered nor an airworthiness certificate issued given the state of the application. Sections 5.4.3 and 5.5 hereinafter also treat of registration and issue of an airworthiness certificate.

No stand is taken hereby whether the aircraft was in fact airworthy. Furthermore, there is nothing to suggest that these flaws had any part in the accident of 7 August 2000.

5.0 Engine history

5.1 Earlier inspections – AAIB's final report

5.1.1 Short description of the engine

The engine history is accounted for in the AAIB final report from 23 March 2001, Sections 1.16.1.2, 1.18.14 and 1.18.3 and F and T treat of the engine history rather extensively in Chapter 6 of their report.

At the beginning of Section 1.16.1.2 the engine is described as follows:

> 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 type TSIO-520-ECH, serial number 165605-8-E. "ECH" indicates that it is produced as an E type but subsequently modified to type H. The H type is 285 hp (see section 1.18.14).

5.1.2 On the origin of the engine

Now let us turn to what the AAIB final report says in Section 1.18.14., on the engine's origin:

> 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 IAAIB 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.
> [see Section 5.4.4 below].
>
> 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 his opinion of this, [a spokesman] informed the AAIB [in a letter dated 28 February 2001 that will be treated of later] that it was almost impossible to carry out such 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.

5.1.3 Engine overhauled on 15 Desember 1996

Then in Section 1.18.3 of AAIB's final report there is a further account of the Gold Star Aviation Accessories' overhaul of the engine, where it says among other things:

> According to the engine log book, it was overhauled by Gold Star Aviation Accessories, Inc., [...]. 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 of 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 to replace older ones which are missing.

5.2 Log books and documents

5.2.1 Original documents were missing

The AAIB final report, Section 1.18.3, says that neither the original log books nor a part of the maintenance documents were available, and that the owner was responsible for having a recognised party prepare new log books and these should indicate that they were new. It should also have been indicated that it had been confirmed with an inspection that all major repairs and alterations of the aircraft had taken place according to accepted methods. The books should have contained a confirmation of all airworthiness directives issued for the aircraft and its components having been implemented, otherwise all airworthiness directives should have been implemented separately and confirmed in the books.

It says then in Section 1.18.3:

> 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.

5.2.2 About log books and later documents

The AAIB says this in its final report about log books and later documents (cf. Section 1.18.3):

> The first entry in the aircraft's log book was where JAS Inc., [...] 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.[1] 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_1 had been implemented.

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[1] It was supposedly dated 20 February 1996, cf. Søren Flensted's report.

> The maintenance documents which accompanied the aircraft include a declaration, dated 15 February 1996, from its former owner [...with a confirmation of the Notary Public 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 representatives 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.

Then there is an account of the overhaul of Gold Star Aviation Accessories on 15 December 1996 which is described above. It then says in AAIB's final report:

> According to the log book, the propeller (Mc Cauley, 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.

5.3 The report of Forward and Taylor

<u>5.3.1 Special arguments for inspecting the engine</u>

Chapter 6 of F and T's report treats of the engine's history as follows:

> Although at the end of paragraph 1.18.14 it is stated that '*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.*' (an investigation that as explained in paragraph [4] we believe to have been less than complete), nevertheless the AAIB noted and reported upon the fact that this was an unusual engine of unknown origin.
>
> As we understand that the engine is no longer available for examination it will probably never be known whether or not there was other internal damage to the engine and thus whether the engine's

origins and history might have been more central to the investigation, however the AAIB appears to have taken this possibility into account when making Safety Recommendation 4.2 "*that working procedures of the Flight Safety department of the ICAA, concerning registration of used aircraft for commercial operations be reviewed*", a recommendation that we soundly endorse.

The ICAA in April 2002, in answer to our question concerning the history of the engine, stated that: *'On the application for Certificate of Airworthiness for the aircraft the engine is specified as TSIO 520 ECH. Verification of engine type and serial number is part of our pre-certification inspection of the aircraft and its records. According to the Type Certificate for Cessna T210L (TC 3A21) the "H" engine is applicable for the aircraft. ICAA had no reason to inspect further and was not aware of any unapproved or 'impossible' conversion of the engine."*

Whatever a literal interpretation of the law may be we find it difficult to reconcile the statement that there was '*no reason to inspect further*' with the lack of a log book showing total time in service, the data plate showing it to be an 'ECH' rather than an 'H', a Serial Number (165605-8-E) indicating that it was an 'E' and with a horse power shown for an 'E' rather than for an 'H'.

It would appear that an 'H' engine sandcast crankcase, of unknown origin, had been fitted with the data plate from an 'E' engine Permold crankcase with the letters 'CH' added to denote that the engine had been converted from an 'E' to an 'H'.

While the "H" crankcase may be of unknown origin the "E" crankcase from which the data plate was taken was engine Serial Number 165605-8-E. Our researches into this suggest (correspondence with Teledyne Continental) that this '*engine was shipped brand new from the factory on 21st June 1968 to Cessna Aircraft and then registered by the owner, new, in Iceland* .... It would have been installed then in a Cessna 402." Furthermore at some later date (they do not have a Start Date) '*LIO were the registered owners* (of *165605-8-E) ... on our computer records in the Warranty Section'*.

5.3.2 On the operation of L.Í O. ehf./Air Charter Iceland and the CAA's surveillance

In continuation of this F and T discuss the operation of LÍO ehf./Air Charter Iceland and CAA's surveillance. Their words are as follows:

We believe that the above raises many questions relevant to LIO's operations and to the ICAA's oversight of these operations, in addition to the matter of the certification of this particular aircraft and engine combination, questions that the authors are unable to pursue.

The origin of the 'H' crankcase remains a total mystery and we cannot suggest a technically or legally acceptable reason for removing its data plate and replacing it with one from a different type, indeed we believe this action to be illegal in many countries and would be surprised if it were not so in Iceland.

Had the origin of the 'H' crankcase been looked for and/or details of this 'conversion' considered when the aircraft was offered for certification, then we believe that no Certificate of Airworthiness would have been granted and the whole chain of events would have been stopped at source. This may be easy to say with hindsight but nevertheless points to a need for the ICAA to learn from this experience and for the ICAA to put into place much more thorough inspections of all such aircraft, of their associated paperwork and of the aircraft's operators.

Another possibility that has, we understand, been suggested is that, despite the report stating that an expert had said that it was an 'H', it was in fact an 'E' with the sump and some accessories from an 'H', together with appropriately modified engine mountings. We do not accept this, a Teledyne Continental employee with experience of these engines and of accident and incident investigation has studied photographs taken shortly after the aircraft was recovered from the sea and has confirmed the engine to be an 'H'."

When considering the difficulties involved in altering an E-type to an H-type which is discussed further in Section 5.4.5 below, one must agree with F and T in not accepting this opinion, since the alterations described in the last paragraph may be considered practically impossible.

5.3.3 AAIB's reply

The AAIB makes a short comment saying that this is a repetition of what is stated in the AAIB report on the accident. The AAIB issued a safety recommendation regarding this factor.

5.3.4 The comments of the CAA

The CAA has the following to say about the engine history, cf. Chapter 6 of the Analysis Report of the CAA Director General dated 4 October 2002:

> In the examination by the AIB (sic) it was discovered that the engine data plate was not the correct one as it indicated that an engine of the E-type had been converted to an H-type. The data plate may have been from another engine than the one which was installed in the aircraft when it arrived from the United States as detailed in the AIB report. F&T consider themselves to have discovered that an engine with this data plate, which was manufactured in 1968, was installed in a new Cessna 402 which was subsequently registered new in Iceland.[2] A survey made by the ICAA revealed that a Cessna 402 was not registered in Iceland until 1979, i.e. 11 years later. Something is awry in this account which was supposedly obtained (by F&T) from the engine manufacturer. No information is available on the importation (to Iceland) of an engine with this data plate at a later date.
>
> In any event there is no disagreement that the engine in question was of the H-type, i.e. of the type fitting an aircraft of the Cessna T210 type and its accompanying manuals. This engine was verifiably overhauled by an accredited party in the United States to comply with manufacturer's overhaul limits. Consequently there is nothing that indicates that the engine was not airworthy when the aircraft was registered in Iceland. On the other hand it emerged after a thorough examination by the AIB and after consultation with experts from the manufacturer, that the engine data plate, which was in place at the time of overhaul, was not the original one. If this had been apparent at the time of registration it would have temporarily prevented the issuance of a certificate of airworthiness which requires that all formalities be satisfied. It is not unusual that a new data plate must be obtained from the manufacturer of an engine or an aircraft when a plate of this type has been lost. The manufacturer of the engine in question has published special procedures for obtaining data plates for this type of engine. With a new data plate this obstacle to the issuance of a certificate of airworthiness would have been removed. The ICAA has had an experience of this nature where the data plate of an aircraft was found to be missing upon first registration (in Iceland).
>
> An extensive discussion on the aircraft's engine took place when the report of the AIB was submitted in March of 2001. Subsequently the ICAA modified its procedure for the registration of aircraft in this class. Consequently the risk of an aircraft or an engine with incorrect or falsified documentation being registered in Iceland is small at this time. On the other hand this procedure may call for extensive research work by the ICAA in collaboration with parties abroad. In the F&T report the authors correctly express doubt (p. 15) that a certificate of airworthiness had been issued if the above information on the origin of the engine had been known when the aircraft was put up for registration. On the other hand, they acknowledge that this is easy to say after the fact or in their own words: "This may be easy to say with hindsight ..."

The CAA then continues in the Chapter titled Conclusions of the F&T Report.

> The statement that the certificate of airworthiness should not have been issued was strongly embraced by the ICAA in light of the facts that had emerged in the detailed investigation by the AAIB in the wake of the accident. However all necessary documentation was in place when the certificate was issued. ICAA could only have refused to issue this certificate by reasonably drawing these data into question at the time of application. Such reasoned opinion was not on hand at that time. In chapter 6 the authors acknowledge that in retrospect it is easy to say that the certificate should not have been issued.

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[2] This appears not to be an exactly correct quote from F and T. As clarified above a reference is made to the manufacturer that an engine was sent new from the factory and later registered quite new in Iceland. The reference is to an engine, not an aircraft. The CAA probably assumes that the aircraft came with an engine, however, that does not have to be the case. The F and T text is in fact not very clear as will be discussed later on.

Furthermore it is clear that if the issuance of the certificate had been turned down this would have delayed such issuance until a new data plate had been obtained from the engine manufacturer.

5.4 A summary of aircraft and engine history

5.4.1 On the origin of the engine

The AAIB final report says in Section 1.18.14 that the origin of the engine is unclear and that documents are missing, cf. Section 1.18.3. F and T draw attention to the E-crankcase, from which the data plate was removed, having the engine serial number 165605-8-E. With reference to correspondence with Teledyne Continental, there is a chance of the engine having been sent new from the factory on 21 June 1968 and the owner registering it as brand new in Iceland. It would then have been installed in a Cessna 402. At some later point L.Í.O. ehf./Air Charter Iceland became registered owner of an engine with the serial number 165605-8-E in the computer records in the Warranty Section of Teledyne Continental, but the start date is missing. The CAA Director points out, however, that no aircraft of the type Cessna 402 was registered in Iceland until 1979, so that there is some discrepancy in the account the report authors, F and T, got from the engine manufacturer. In the application of Ísleifur Ottesen for an initial registration of the aircraft dated 8 June 2000 the aircraft's serial number stated is T21060050 and year of production 1974.

Here F and T present vague hypotheses that are hardly appropriate in an investigative report. It is completely unclear from where they got the information upon which they base their hypothesis. The history of the aircraft, engine and propeller is unclear up to 1994, when it begins to clear up.

With a statement dated 15 February 1996, signed by the appropriate authority - notary public - on 29 of the same month, a man of the name W. T. Castleberry confirmed having been owner of the aircraft N131DC, Cessna T210L, serial number 21060050, until 16 September 1994. Its time in service meter then showed 3390.0 hours. This accorded with total time registered in the aircraft's log book. The log book had no history of damages. The statement made, however, no mention of an engine or a propeller. Nothing is registered in the log books about an engine or a propeller. There is, however, a notification in a log book about a propeller inspection on 6 December 1994 at the firm Precision Propeller Service.

This maintenance station was not accredited to issue an airworthiness certificate, nor was such a certificate considered necessary as the engine was in a private aircraft, but JAR-rules 145.50 require a maintenance certificate. The JAA's reply to an inquiry on how to understand the abovementioned rules stated that such a certificate - airworthiness certificate - was not necessary if the aircraft had fulfilled airworthiness requirements in its previous regulatory environment. Here in Iceland a maintenance station recognised according to JAR 145 had issued a maintenance certificate for the aircraft as a whole, including its components such as the engine. This means then, that the maintenance certificate was considered sufficient for a private aircraft to meet requirements in Iceland concerning airworthiness.

5.4.2 Issue of log books 1999

It is clear from the AAIB final report that new log books have been issued for the year 1999 as follows:

Aircraft log book.
Engine log book
Propeller log book

5.4.2.1 Aircraft log book

JAS Inc. issued a maintenance certificate for the aircraft after annual inspection on 15 February 1999. This was the first entry in the aircraft's log book and then JAS Inc. certified the aircraft for return into service. On 15 June 1999 the aircraft's total flying time after annual inspection was registered 3390.0 hours in the log book, cf. Section 1.18.3.

5.4.2.2 Engine log book

A maintenance certificate for the engine's overhaul after the abovementioned annual inspection by JAS Inc. on 15 February 1999 was taped to the front of the book, and was followed by a JAS Inc. certification after a 100 hour inspection, cf. certificate by Thorleifur Júlíusson on behalf of JAS Inc. where a 100 hour inspection of the engine is accounted for and stated that the engine was certified to service again.

Section 1.18.3 of the AAIB final report says that according to the engine log book it was overhauled on 15 December 1996 at the maintenance station Gold Star Aviation Accessories and put in the aircraft N131DC. According to the maintenance station certificate dated 15 December 1996 this refers to an engine of the type TSIO 520-ECH with the serial number 165605-8-E. At the issue of the new log book for the engine in 1999 the time in service was registered 0 from overhaul. In other respects information is lacking, among other things about the engine total time in service, but according to JAA requirements it is accepted to register only time in service from last overhaul when new log books are being prepared. It is not stated in the log books that they were new and they lacked information on inspections and confirmation of airworthiness directives. According to maintenance documents this engine was in the aircraft when it arrived in Iceland as will be accounted for below.

5.4.2.3 Propeller log book

The propeller log book contained a maintenance certificate on overhaul by Precision Propeller Service Inc. on 6 December 1994. On 24 May 1999 JAS, Inc. Propeller Dept. inspected the propeller after a long-time storage. The log book does not indicate when the propeller was put on the aircraft nor by whom. According to the maintenance certificate its total time in service was unknown, but the time since overhaul was 0.

5.4.3 Transport of the aircraft to Iceland and registration

Ísleifur Ottesen who bought the aircraft on 19 April 2000 on behalf of L.Í.O. ehf./Air Charter Iceland claimed not to know of the aircraft having been flown from 15 September 1994 until it became his property. This is confirmed in the abovementioned maintenance certificate of the aircraft N131DC, which was then owned by Sunland Air Inc. (its president was Ísleifur Ottesen) and which JAS, Inc. issued 15 June 1999 after an annual inspection, in addition to which the aircraft was certified for return to service. As stated above, Thorleifur Júlíusson signed the certificate on behalf of JAS, Inc. The same day JAS registered the aircraft's total flying time in its log book as 3390.0 hours. This accords with the declaration of 15 February 1996 which was cited above. The AAIB's final report states that the Board spoke to a JAS representative who certified the aircraft for service, this being Thorleifur Júlíusson, who claimed to have carefully checked how the engine and wings were attached and found nothing wrong in addition to which the aircraft went on two test flights and everything proved in order, cf. Section 1.18.3.

According to data from the FAA the aircraft was issued with a registration certificate in the USA as N131DC on 17 June 1999. Sunland Air, Inc. was registered owner. The aircraft was then flown to Iceland on 2 July 1999. The aircraft was deregistered in the USA on 29 March 2000 and the CAA informed thereof. L.Í.O. ehf./Air Charter Iceland then bought the aircraft from Sunland Air Inc. with a purchase agreement dated 19 April 2000. The aircraft had an annual inspection on 9 June 2000[3] at the firm of G.V. Sigurgeirsson and on that basis an airworthiness certificate for commercial aviation was applied for. After that the aircraft was registered in Iceland on 14 June 2000 as TF-GTI. It received an airworthiness certificate on 15 June 2000 which was valid until 30 June 2001.

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 had also been registered in the United States.

The CAA accepts an annual inspection by an approved party as sufficient in such cases, which supposedly refers to the maintenance station JAS, Inc. and probably also to the aircraft maintenance and repair firm G. V. Sigurgeirsson ehf., but the JAA considers an annual inspection to be a minimum, provided all necessary documents on the aircraft's maintenance are available.

In view of the above it may 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. See AAIB final report, Section 1.18.4 for the above.

The aircraft's last inspection, a 50 hour inspection, and certification thereon is dated 1 August 2000. At this time the total flying time of the aircraft was recorded as 3486 hours and the total time in service of the engine and propeller since last overhaul was recorded 96 hours (3390+96=3486). When the accident took place the aircraft had been flown a total of 11 hours

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[3] Ad Hoc Investigation Committee comment: According to the case documents it appeared to the Ad Hoc Investigation Committee that it was not quite certain whether this inspection on 9 June 2000 had been an annual inspection, i.e. a 200 hours inspection (see also Section 4.2.3). Upon closer inspection it was discovered that an annual inspection took place but forms were incorrectly filled out. The committee feels that requirements on how reports, certificates and other documents are prepared must be strengthened. Reference is made to recommendation in Item 1, Paragraph 3, Section 16.2.

and 18 minutes according to log books. The flight time was then 3497:18 hours (3486+11:18=3497:18). The time in service of engine and propeller was then 107:18 hours (96+11:18=107:18) from the last overhaul, cf. AAIB's final report, Section 1.18.3.

As previously stated F and T criticise the issue of a certificate as there was no log book to demonstrate the total time in service, the data plate said ECH rather than H, the serial number 165605-8-E, suggested an E type engine with indicated horsepower for an E type rather than an H type. The AAIB criticises this also in some respect and the CAA has changed its work procedures for registering such aircraft, cf. Section 5.3.4. See also Section 4.2.2.

5.4.4 What type was the aircraft's engine?

Before going any further, let us recall which type of engine was in the aircraft as described in the AAIB final report, Section 1.16.1.1. The engine was a Teledyne Continental TSIO-520-H, six cylinder, 285 horse power. The engine data plate says, however, that it is a 300 hp type TSIO-520-ECH, serial number 165605-8-E, which indicates that it is produced as an E type but changed to an H type.

The engine was according to this an H-type which is a right type for a Cessna T210L aircraft according to aircraft manual. The manufacturer, Teledyne Continental Motors, confirms this according to the AAIB final report Section 1.18.14 and the end of Chapter 6 of F and T's report. The CAA then reiterates this in its report where comments are made on Chapter 6 of F and T's report. It is not stated directly in the overhaul certificate of Gold Star Aviation Accessories from 15 December 1996, whether the engine is an E-type or an H-type, but the certificate indicates that the engine is an H-type, among other things because the crankshaft (cf. P/N 649134) and sump used did not fit other than H-types.

In a police report dated 17 May 2001 the director of operations of L.Í.O. ehf./Air Charter Iceland stated his doubts concerning the AAIB final report conclusion regarding the engine type of the aircraft TF-GTI. It was his opinion that the aircraft had contained an E-type engine, 300 hp, but not a 275[4] hp H-type, as stated in the AAIB report. He supports this with the JAS, Inc. certificate from 15 June 1999 where the inspected engine is indicated as a TSIO-520-ECH. A certificate from Gold Star Aviation Accessories, dated 15 December 1996, says:

> 12/15/96 – Overhauled Continental Engine, Model TSIO-520-ECH, S/N 165605-8-E in accordance with Continental Overhaul Manual for TSIO-520 Series Aircraft Engines, Form X-30042A, dated August 1982.

On this occasion Skúli Jón Sigurdarson wrote on behalf of the AAIB a letter to the Investigations department of the Police of the City of Reykjavik dated 21 May where it says among other things:

> The engine manufacturer, Teledyne Continental, numbers the cylinders of its aircraft engines starting from the back. Thus cylinder No. 1 is the one furthest back to the right, No. 2 the one furthest back to the left, No. 3 the one furthest back but one on the right, No. 4 the one furthest back but one on the left, cylinder No. 5 is the front one on the right side and cylinder No. 6 is the front one on the left side.
>
> Enclosed (see enclosure 1) is a picture of the engine in TF-GTI showing the filler neck for the engine's lubricating oil. This is situated on top of the engine block between the front cylinder and the one behind it on the engine's left side (between cylinders 4 and 6). In a sketch of the engine types TSIO-520 from Teledyne Continental (enclosures 1a and 1b), it can be seen that the picture fits the type TSIO-520 H

[4] Ad Hoc Investigation Committee comment: This is probably a misspelling of 285 hp.

(Sandcast) (enclosure 1b), but not TSIO-520 type E (Permold) (enclosure 1a), as the neck is different and situated one cylinder further back.

The oil cooler of the TF-GTI engine is in front of cylinder No. 5 (enclosures 1, 2, 3 and 4) which confirms further still that this is a type H, as the oil cooler of the "Sandcast" type is in front of cylinder No. 5 (enclosure 6) which is the front cylinder on the engine's right side, but on the "Permold" type the oil cooler is behind cylinder No. 2, which is the one furthest back on the engine's left side.

The difference between types "E" and "H" is that they have different crankcases, the "E" type is a Permold and the "H" type is a Sandcast.

In maintenance documents on the overhaul that was made by Goldstar Aviation Accessories, 3597 Northwest 154th Street, Miami, Florida 33054, on December 15 1996 it is confirmed that the crankshaft (Crankshaft Serial nr. 165605-8-E) that was put in the engine, is a crankshaft for type H TSIO-520 and does not fit in type E (enclosures 7a, 7b, 7c, cf. column C/S Assembly) (C/S=Crankshaft).

Enclosures No. 8a and 8b show that the sump of the H type (enclosure 8a) is different from the sump of the E type (enclosure 8b).

The photograph shows the aircraft's engine The oil cooler is on the left side in the photograph in front of cylinder No. 5 which confirms that the engine is a type H

The AAIB and Teledyne Continental claim that this is the same engine as the one that was overhauled at Gold Star Aviation Accessories. The aircraft's flight time according to the log book on 16 September 1994 and the JAS, Inc. maintenance certificate of 15 June 1999 which both show 3390.0 hours supports that conclusion. Furthermore, it is worth mentioning that none of those who have inspected the engine seem to have made any objections, which they must have done if it had been an E-type and not a correct type for a Cessna T210L. The next Section will treat of whether an E-type was changed to an H-type.

5.4.5 Was the engine type changed?

5.4.5.1 Difficult to change an E-engine to an H-engine

According to the engine data plate, it has been modified from type "E" to type "H" (ECH). This is confirmed in the overhaul report of Gold Star Aviation Accessories of 15 December 1996. It says in the CAA Analysis Report dated 4 October 2002, in the comments on Chapter 6 of F and T's report, that during the AAIB investigation it appeared that the data plate showed that E had been changed to H. AAIB's final report states that the manufacturer, Teledyne Continental, was asked about this and he informed that this was practically impossible, as the types were so different, cf. the AAIB final report, Section 1.18.4.

Eric Parlow, engineer at Teledyne Continental, with a long experience of producing aircraft engines confirms this in a letter dated 26 February 2001 where he answers the questions of Thormódur Thormódsson, Investigator of Aircraft Accidents, (the current Chief Investigator of Aircraft Accidents) i.a. on the engine.

Parlow claims to have investigated the engine's serial number (ESN) on the data plate. The plate was for a TSIO-520-E2 released to Cessna on 21 June 1968.

> The markings added to the data plate are typical of an engine conversion. "E"=the original model, "C"=converted, "H"=the new model. We have discuss[ed] that it would be VERY difficult to convert an "E" to a "H" engine. The "E" model is a Permold crankcase, the "H" is Sandcast. They are not interchangeable.
>
> You can identify a Permold by the gear driven alternator in front of cylinder 5 on the front right of the engine. Permolds also have the oil cooler behind cylinder 2 on the back left side.
>
> Sandcast engines have the oil cooler in front of cylinder 5[5] and the belt driven alternator. This will take more investigation. Can you please send photos of the entire engine?

5.4.5.2 What does the abbreviation ECH mean ?

In a letter dated 28 February Eric Parlow answered a few questions from Thormódur Thormódsson, including what the abbreviation ECH means. Parlow's answer was as follows: "E" would be the original engine model, "C" typically stands for converted, "H" would be the model the engine was converted to. Conversion from a Permold "E" to a Sandcast "H" is virtually impossible. There is almost no commonality in the major engine components.

5.4.5.3 The engine manufacturer says the change not permitted, but possible

Eric Parlow answered a few questions from Thormódur Thormódsson in a letter dated 1 March 2001:

> Q- Can a E engine be converted to an H engine by de-rating it and changing the data plate?
>
> A: A- No, not by derating and changing the data plate. Major alteration are also required (see below).
>
> Refer to US FAR Part 43 for Alterations and US FAR Part 45 for Identification.

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[5] For further explanation the oil cooler is at the back of the engine, even though Parlow's letter does not say so.

> Specifically to US FAR 43.3 (a); reference Appendix A (a), (2), (i) for conversion of an aircraft engine from one model to another.
>
> Also refer to TCM Service Bulletin M75-6 rev. 1 "CONVERSION OF ENGINES FROM ONE MODEL TO ANOTHER". The "E" and "H" engine are not in the same family of engines. The "E" is in the "Permold" family and the "H" is in the Sandcast family. Therefore TCM would deem it NOT permissible.
>
> [...].
>
> Question Q- If not than what would be involved in this conversion?
>
> A: A- The following major components would require conversion:
>
> Crankcase
> Crankshaft
> Camshaft
> Oil Cooler
> Alternator
> Starter Adapter
> Induction System
> Oil Pan
> Engine Mounts
> Turbocharger
> Fuel System
> Oil Pump
>
> Not a complete list

This means then that it is possible to change an engine by replacing the main components indicated here, but the manufacturer says that it is not permitted.

5.4.5.4 What specified changes can be done according to the manufacturer?

In spite of the statement quoted from Eric Parlow's letter, dated 1 March 2001, cf. the chapter above, a Service Bulletin M 75 6, REV 1 from the manufacturer, TCM (Teledyne Continental Motors), presents further specified changes that the manufacturer permits:

It says:

> Although we have never recommended conversion of engines from one model to another, we have had over the years many inquiries on whether or not it is permissible to convert from one model to another. As a result, in order to maintain a good relationship with owners who desire to convert their engines, we have issued previous bulletins granting that certain conversions can be accomplished; such as:
>
> 1. Within a basic engine family, it is permissible to convert from one dash number (or letter) to another as long as it is accomplished with parts currently approved for the model to which the engine is being converted.
> 2. In the case of the "E" series engines, any conversion of an E-185 to an E-225 will require a new serial number, which can only be issued by Teledyne Continental Motors. For information og how to procure a new nameplate, see our bulletin M75-5.
> 3. On other models, impression stamp the letter "C" after the existing model letter (or number) and then impression stamp the new designation letter per the following example:
>   IO-470-U to IO-170-V = IO-470-UCV.
> 4. Do not alter serial numbers or suffixes.

> It should be pointed out that obviously TCM cannot accept the same degree of responsibility on engines which are altered or converted by persons over which it has no control, as it does engines which are built and shipped as complete units for installation in specific aircraft.
>
> For this reason, TCM feels that any owner or service facility involved in any conversion, should fully understand that when such conversion are completed, TCM's warranty policy does not apply in any manner, including new parts which may be installed.

5.4.5.5 The position of the US Federal Aviation Administration

A notice from the CAA of 25 November 2002 says:

> A thorough query by the ICAA has recently shown that it is not only possible to convert an E type to an H type, but such a conversion is authorized according to an information circular from the engine's manufacturer. The US Federal Aviation Administration has also confirmed this to the ICAA. The manufacturer's information circular states that when an engine is converted a new data plate should not be installed but the existing one changed. It is specifically stated in the information circular that the engine's serial number may not be changed. Nothing indicates therefore that the data plate was incorrect and that it did not state clearly which and what type of engine was in the aircraft.

This appears to refer to the aforementioned TCM Service Bulletin M75-5. It is of interest that it is not about changing an E-type to an H-type, but about changes within the E-type.

The confirmation of the US FAA came as a continuation of a letter from Sigurjón Sigurjónsson of the CAA, dated 23 October 2002, wherein he asked about a Continental TSIO-520 engine that had been placed in a Cessna T210 aircraft.

The letter is as follows:

> I refer to our telecom today regarding an engine Continental TSIO-520 installed on a Cessna T 210 that was involved in a fatal accident in August 2000.
>
> According to its data plate this engine, TSO-520-ECH, SN: 165605-8-E was converted from -E engine to ?H engine. As this conversion requires, among other things, replacement of the crankcase and the crankshaft it have been questioned if a modification in this nature could be legal. However TCM Service Bulletin M75-6 R1 states, "within a basic engine family, it is permissible to convert from one dash number or letter to another as long as it is accomplished with parts currently approved for the model to which the engine is being converted". Respecting the TCM SB as FAA Approved data we find this conversion, providing it being appropriately carried out, perfectly legal. Could you please express your opinion on this and confirm if our interpretation is correct.

Jerry Robinette confirmed on behalf of the US FAA that the interpretation above was correct. The main part of the letter reads as follows:

> Your interpretation is correct. Within an engine family, conversions such as this are routinely approved via FAA Form 337. The TCM SB is considered FAA approved data. In this particular case, it would appear that the person would have been money ahead to just sell the –E engine and buy a –H but our concern is safety of the type design not economics. [...].

5.5 Conclusion of the Ad Hoc Investigation Committee

The conclusion here is that various aspects of the engine's origins are unclear and a considerable part of its past up to 1994 is unknown. The propeller was overhauled on 6

December 1994, the engine was overhauled on 15 December 1996 and first log book entry was on 15 February 1999 after an annual inspection by JAS Inc. which is an accredited maintenance station and then a certificate of maintenance overhaul and 100 hour engine inspection was issued. JAS, Inc. inspected the propeller on 24 May 1999. The aircraft was then flown to Iceland on 2 July 1999. L.Í.O. ehf./Air Charter Iceland bought the aircraft on 19 April 2000 and an annual inspection took place on 9 June 2000 at the aircraft maintenance and repair firm G. V. Sigurgeirsson ehf. The aircraft was registered on 14 June the same year and was given an airworthiness certificate on 15 June valid until 30 June 2001. The last inspection was a 50 hour inspection on 1 August, cf. Section 5.1-5.3 above.

The data plate information has caused some uncertainty regarding the engine type, but the conclusion is that the engine was an H-type, cf. Section 5.4.4. However, it remains unanswered whether an E-type was changed to an H-type.

The data plate indicates that an engine was changed from an E-type to an H-type, but the engine manufacturer, Teledyne Continental Motors considered such a change very difficult, practically impossible, but the manufacturer's responses are indecisive in this respect. In the abovementioned letter, dated 1 March, the manufacturer says that it is not permitted to change an E-engine to an H-engine, but the same letter indicates that it is possible by changing important components which are listed in the letter even though that list is not exhaustive, cf. Sections 5.4.5.3 and 5.4.5.4. It may be understood from the manufacturer's service bulletin, TCM SB M 75-6, REV 1, referred to in the letter, that he permits only certain changes within an E-type (E-185 to E-225), which means that the manufacturer does not permit changing an E-engine to an H-engine even though it is possible to do so by changing most of its components. Thereby the manufacturer avoids responsibility as stated in the service bulletin TCM SB M 75-6 REV 1.

The conclusion of what has been accounted for here is that it is unlikely that an engine was modified because of how extensive the changes would have had to be. On the other hand it seems that the data plate was not an original one and provided inaccurate information, whatever the reason.

With reference to what has been accounted for, the Ad Hoc Investigation Committee agrees with the AAIB and F and T, that the CAA should have called for further documents and required a more thorough inspection of the aircraft than the one undertaken, before a used aircraft with an unclear past such as TF-GTI was registered and received an airworthiness certificate, even though a recognised repair station in the USA, Gold Star Aviation Accessories, had overhauled the engine on 15 December 1996, see Section 5.4.2.2, cf. also Sections 4.2.3 and 5.4.3.

However, there is nothing in the aircraft's past or regarding its registration and issuance of airworthiness certificate that suggests in any way that these issues had any part in the accident on 7 August 2000.

5.6 Overview.

1. The engine's origin was unknown.
2. Original log books and a part of maintenance documents were missing.
3. F and T were of the opinion that the engine's history and its path in the past should have been an encouragement to the AAIB to inspect the engine.

4. The engine's history until 1994 is unknown.
5. Engine overhauled on 15 Desember 1996.
6. Log books issued on 15 February 1999 with a maintenance certificate after an annual aircraft and engine inspection. Propeller inspected on 24 May 1999.
7. Aircraft registered in the USA on 17 June 1999.
8. The aircraft flown to Iceland on 2 July 1999.
9. L.Í.O. ehf./Air Charter Iceland buys the aircraft on 19 April 2000.
10. An annual inspection takes place on 9 June 2000.
11. The aircraft registered in Iceland on 14 June 2000 and receives an airworthiness certificate on 15 June.
12. The aircraft had an H-type engine.
13. It is difficult to change an E-engine to an H-engine.
14. The engine manufacturer, Teledyne Continental Motors, does not permit a change from an E-type to an H-type, but considers them executable.
15. The manufacturer permits limited changes within the E-type, and declines liability for anything else.
16. The US Federal Aviation Administration considers it within the limits of the law to change an E-engine to an H-engine, but that it is not financially practical.
17. Inadequate documents, an engine with unclear origins and a debatable history should have been reasons enough for the CAA to call for further documents and have the aircraft inspected before it was registered and given an airworthiness certificate. The CAA has already changed its work procedures regarding registration and issue of airworthiness certificates for used aircraft, so that it should not happen again that aircraft with an unclear history are registered or receive airworthiness certificates on the basis of incomplete documents.
18. Nothing suggests that the engine history as indicated above had any part in the accident of 7 August 2000.

6.0 Delivery of the engine

6.1 Treatment of the engine after the accident 7 August 2000

On 9 August 2000, or two days after the accident, a message was received from Tormod Egner at the insurance company Codan which had insured the aircraft, where he asked Thorsteinn Thorsteinsson, the Investigator-In-Charge of the accident, that the engine be preserved in oil in order to attempt to protect it from rust. According to a hand-written undated memo in the custody of the AAIB, the engine was kept outside the G. V. Sigurgeirsson aircraft maintenance and repair firm during the entire autumn and until January 2001. On 22 August 2000 a public investigation of the operations of L.Í.O. ehf./Air Charter Iceland was requested, cf. an undated memo in the custody of the AAIB which refers to information from Óskar Th. Sigurdsson police officer and a letter from the Reykjavik Police Commissioner, dated 19 September 2000 and a letter from 21 September 2001. There is no further mention of the engine until in a memo by Skúli Jón Sigurdarson, at that time the acting Investigator-In-Charge of the aircraft accident of 7 August 2000, concerning 19 and 20 of January, which was written from memory on 22 January 2001 and on which the following will be based in addition to letters between parties and other data which are specifically referred to.

6.2 Conflict about the engine

<u>6.2.1 Ísleifur Ottesen claims to own the engine</u>

According to the aforementioned memo of Skúli Jón Sigurdarson, Ísleifur Ottesen called Skúli Jón Sigurdarson on Friday 19 January 2001 around 16.40 and requested the original documents with the TF-GTI engine and all its parts which the AAIB had removed from it, as he said he was now the owner of the engine. Skúli Jón Sigurdarson replied that he could not have the original documents as the investigation report was not completed, but that he could have copies of them after the week-end. The AAIB would not release components such as the fuel system which it had removed and sent for further investigation. Ísleifur Ottesen was not content with this answer and told Skúli Jón Sigurdarson that he intended to send the engine abroad the next Monday, which was 22 January. Skúli Jón Sigurdarson said that the AAIB would not authorise this. Around 17.00 Skúli Jón Sigurdarson called Óskar Th. Sigurdsson and told him about this. Óskar Th. Sigurdsson said that this was not good and that he would discuss this with the police attorney.

The police had the original documents "(TF-GTI maintenance documents and AAIB copies)". Skúli Jón Sigurdarsson told Óskar Sigurdsson that the Investigator-In-Charge of the accident , Thorsteinn Thorsteinsson, had released the engine to its owner, the insurance company, in the autumn of 2000 and that it had since then been immersed in an oil container outside the hangar of G.V. Sigurgeirsson's firm. Óskar Th. Sigurdsson would furthermore inquire whether the police wanted the engine. The police consultant, captain Kristján Árnason, called Steinar Steinarsson, who is member of the AAIB that evening and said he wanted to examine whether there had been lubricating oil on the engine. Steinar Steinarsson had confirmed that there had not been any lubricating oil on the outside of the engine, the oilcap had been missing and there had been a mixture of seawater and oil in the engine. In addition, the engine had for some time been immersed in a container with kerosine and was therefore full of kerosine.

When asked, Thorsteinn Thorsteinsson said that he had released the engine and had, according to the request of the insurance company, owner of the engine, put it in an oil container. The engine was now in the custody of Sigurgeirsson on behalf of the owner. Investigation of the engine was finished and it was not concerned with it any more.

6.2.2 Ísleifur Ottesen takes the engine in his own custody under AAIB prohibition

The next day, 20 January, it is registered that Óskar Th. Sigurdsson called Skúli Jón Sigurdarson and said that Egill Stephensen considered it inappropriate that the engine be removed, but that Ottesen could come up with protests which would be difficult to oppose. Óskar Th. Sigurdsson is quoted to have said that "the attorney of the police was considerably surprised by the fact that the engine had not been in the custody of the AAIB", but that he did not think that the police would take it, that the AAIB would try as it could to take it into its custody. It was best for everyone that the AAIB kept it and it was decided that Skúli Jón Sigurdarsson would go and take the engine and move it to hangar 3. Then Skúli Jón Sigurdarson called Steinar Steinarsson and presented the matter to him, at which time Kristján Árnason had spoken again to Steinar Steinarsson. Shortly after this Skúli Jón Sigurdarsson called for a delivery van, but it took about 20 minutes to obtain a large vehicle with a fork lift. Then Skúli Jón Sigurdarson contacted G.V. Sigurgeirsson and announced that he was coming in about 25-30 minutes and was going to take the container into the AAIB's custody. At about 12.00 or shortly after, Skúli Jón Sigurdarson came with a large delivery van to the sea hangar of Sigurgeirsson where they met. Sigurgeirsson told Skúli Jón Sigurdarson that Ottesen had just left with the engine. Skúli Jón Sigurdarson then asked Sigurgeirsson how this could be after their conversation and the latter replied that Ottesen had been outside and that he had not known that Ottesen had left until he went outside. However, Sigurgeirsson did not answer when asked why he had not mentioned this in the conversation that had just taken place. Then Skúli Jón Sigurdarson called Steinarsson and they discussed the incident and Steinar Steinarsson's conversation with Kristján Árnason. Steinarsson then proposed that they have the engine fetched.

6.2.3 The AAIB demands that the engine be released

Sigurdarson called Ottesen who said that he had taken the engine. He said that it had been in his custody since the autumn. In consultation with Thorsteinn Thorsteinsson he had bought a pallet fish container and oil and preserved the engine. He had now taken it and was keeping it and refused to release it. Skúli Jón Sigurdarson demanded that the AAIB receive the engine immediately. Ottesen is then quoted having said: "We are now in the written stage, if you want the engine, you will have to ask for it with arguments." After this Skúli Jón Sigurdarson spoke to Óskar Th. Sigurdsson, but he said that the police was not ready to take the engine and wanted the AAIB to try its utmost. Skúli Jón Sigurdarson then spoke to Kristján Gudjónsson, the AAIB's attorney, and presented the matter to him. He then spoke to Steinar Steinarsson and then Skúli Jón Sigurdarson and Kristján Gudjónsson spoke together again.

In accordance with the conversation, Skúli Jón Sigurdarson wrote a letter to Ottesen dated 20 January 2001. He then called on Ottesen at his home, Skerplugata 4, who promised to be at home and Skúli Jón Sigurdarson drove with the letter to his home. Ottesen answered the door along with an elderly man and received the letter.

The letter is as follows:

> Reference is made to our conversation this morning regarding the engine of the aircraft TF-GTI.
>
> The Aircraft Accident Investigation Board herewith instructs, cf. Art 12 of the Aircraft Accident Investigation Act 59/1996, that you ensure that the TF-GTI engine which is now in your custody be preserved and neither sent out of the country nor taken apart without prior authorisation from the Aircraft Accident Investigation Board.

6.2.4 Further on the preservation of the wreck and the engine

By letter dated 1 February 2001 Thorsteinn Thorsteinsson sent the Reykjavík Police Investigations Department an AAIB memorandum on its investigation of the engine of the aircraft TF-GTI because of an inquiry from the Reykjavík Police Commissioner. The memo is essentially identical to Section 1.16.1.2 of the AAIB's final report, although it states in addition:

> *With regard to what has been said here and the testimonies of those who saw the aircraft when it was in the go-around, heard the engine running trouble and the loss of power and then saw the aircraft dive into the ocean, it was not considered necessary to investigate the engine further as engine malfunctions alone do not cause aircrafts to crash. The continuation of the investigation thus focused on determining whether it was possible that the fuel had been exhausted and to search for the reasons for this or a likely reason for the pilot to lose control of the aircraft after the engine lost power, as the aim of the investigation was to propose amendments as required.*

For due reasons Fridrik Thór Gudmundsson, father of one passenger who died in the accident of 7 August 2000, requested by e-mail dated 20 February 2001 that the TF-GTI wreck be kept in a secure manner, but in the daily newspaper *Dagur* of 17 February, the chairman of the AAIB is quoted to have said that he could not answer as to how long the wreck would be kept. The reason for the letter was that it was likely that the AAIB report would be publicly discussed and that an investigation of independent foreign experts of the AAIB investigation would be called for.

The AAIB replied to the letter on 22 February 2001 and disclosed that on 15 February 2001 the AAIB had moved the wreck of the TF-GTI aircraft from a locked hangar of the Soil Conservation of Iceland at Reykjavík airport and placed it in a container owned by the AAIB. The locked container was kept in the Public Roads Administration yard at Stórhöfdi in Reykjavík under surveillance, as work on the aircraft of the Soil Conservation of Iceland would soon commence in the hangar.

In addition, the letter of 22 February referred to telephone conversations Skúli Jón Sigurdarson had with Fridrik Thór Gudmundsson in the morning and around noon of 20 January 2001, on the custody and preservation of the TF-GTI engine and a copy of the AAIB letter to Ísleifur Ottesen was included, written at noon that day and which Skúli Jón Sigurdarson delivered at his home at Skerplugata 4 and gave to him at around 13.00 that same day. The text of the letter is shown hereinabove.

6.2.5 The engine sent to the United States

Following this Skúli Jón Sigurdarson sent Óskar Th. Sigurdsson an e-mail dated 23 February 2001 and said i.a.:

> Following the AAIB's letter to you yesterday, I would like to inform you that Thormódur Thormódsson spoke with Ísleifur Ottesen on the telephone yesterday evening.
> On this occasion Ottesen told Thormódur Thormódsson that he had sent the TF-GTI engine to the United States in spite of our letter to him on 20 January last.
> That matter seems therefore to have moved to another stage.

6.3 Correspondence on the investigation of the engine and its release

6.3.1 AAIB asks for a report on the treatment and release of the engine

On 26 February 2001 Skúli Jón Sigurdarson wrote a letter to Thorsteinn Thorsteinsson, who was abroad at the time, in which he says that he cannot find anything in the aircraft documents on the release of the engine and its preservation "and that we have let it go." The investigation board asks Thorsteinn Thorsteinsson[1] as manager of the investigation for a short report on the points hereafter:

> How was the treatment of the engine conducted?
> How was it released?
> To whom?
> Why? - good arguments thereon.

In a letter to the AAIB dated 27 February 2001 Thorsteinn Thorsteinsson states that the engine was removed from the wreck and examined first at the wreck's side but it was then moved to the G. V. Sigurgeirsson aircraft maintenance and repair firm for further examination as there were no facilities for this in the hangar of the Soil Conservation of Iceland. At the firm G.V. Sigurgeirsson and his staff partly opened the engine and did this under the supervision and control of two men from the AAIB and two inspectors from the Flight Safety Department.[2]

When this examination was finished, the AAIB members, G.V. Sigurgeirsson and the Flight Safety Department agreed that there was no need at that time to examine the engine further, as no obvious malfunctions had been found.

The insurance company Codan, which had said that it owned the engine after the accident, sent messages on many occasions to the chairman of the AAIB saying that the engine would be preserved in a satisfactory manner, such as in kerosene. Sigurgeirsson had been asked to ensure that the engine and everything that had been removed from it and not delivered to the AAIB would be put into a container with oil. Sigurgeirsson did this and then told the AAIB that the container was securely kept outside his hangar. Neither Sigurgeirsson nor the insurance company had, to Thorsteinn Thorsteinsson's knowledge, requested that the engine be formally released or sent away for further examination or repair.

In his letter Thorsteinn Thorsteinsson points out that the AAIB never had any facility to preserve aircraft wrecks or engines. Aircraft wrecks and engines have always been preserved as long as was considered necessary, either at the owners', the insurance companies, repair

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[1] He had then been Investigator-in-Charge of the accident and also in charge of investigating the engine. (Comment from Skúli Jón Sigurdarson, dated 19 January 2005).

[2] At the workshop Sigurgeirsson partly opened the engine and did this under the supervision and control of the Investigator-In-Charge of the accident and another Board member/Investigator from the AAIB. Also present were two inspectors from the CAA Flight Safety Department that the AAIB had requested would be present at the inspection, cf. Section 7.1.1. (Comment from Skúli Jón Sigurdarson dated 19 January 2005.)

stations, the Civil Aviation Organization, the Soil Conservation of Iceland or the Icelandic Coast Guard. The AAIB had requested at the Ministry of transport and telecommunications that the Board be provided with a facility to examine and preserve aircraft wrecks, but these requests have not been acted upon.

6.3.2 Necessary to explain the storage of the engine and its release

In a letter dated 27 February 2001 Skúli Jón Sigurdarson deduced from Thorsteinsson's above-mentioned letter that Ísleifur Ottesen had taken the engine without authorisation. He then continued.

> The time will come when we must explain why the engine was not (or the container in which it was) put in the same storage as the aircraft wreck and the propeller, i.e. the locked hangar 3 - of the Soil Conservation of Iceland, where we had this in our custody. We had hangar 3 for the wreck and it would have been easy to put the container inside there. There was in fact no lack of storage for what we wanted to take into our custody. We cannot maintain that with any right or fairness. In this case we had a storage facility.

It then says in Skúli Jón Sigurdarson's letter:

> When we have decided to take wrecks and such into our custody, we have always been able to obtain space from a third party and stored in their hangars or sheds, e.g. the CAA [Civil Aviation Authority] or the Soil Conservation of Iceland. This case looked as if there would be legal prosecution, cf. the case you remember with the wreck of the TF-LKH helicopter in Hvalfjördur, when the wreck was lost.
>
> This is the case now and the time will come when we will have to provide further explanations thereon:
>
> The engine was in our custody while the investigation was being carried out.
> The investigation of the engine clearly suggested that nothing was wrong with its mechanical function and that further investigation of the engine would not come to that conclusion. It was therefore placed in an oil container outside the hangar of the G.V.S. ehf. aircraft workshop.
>
> Who did that and with whose authorisation?
> (Is there anything in writing thereon?)
>
> The insurance company representative contacted me several times.
> I always referred his errands to you as the Investigator-in-Charge and did not speak to him about this.
> You dealt with the issues he raised.
> I repeatedly mentioned the engine to you - where it was and you even thought that the insurance company had taken it.
>
> It must be clear in whose custody the engine was after it was put into the container.
>
> Were any instructions given by us on its custody or preservation - oral or in writing?
> If it was not in our custody after this, in whose custody was it then? And was anyone at any time given authorisation to take the engine into their custody - orally or in writing?
> Either the AAIB released the engine or it did not.
>
> As I told you on the phone when I attempted to take the engine on 20 January, I was going to take the container and put it in hangar 3, but Ottesen was just ahead of me and took the engine and refused to give it to me. He said that he owned it.
>
> I likewise told you that morning, when I called police officer Óskar Sigurdsson and told him about this, that he had said that the police was very surprised that the engine had not been in our custody
>
> WAS IT IN THE AAIB's CUSTODY OR NOT from the point the investigation was finished until 20 January 2001?

> There may come a point in time when LÍO will be charged for not having obeyed AAIB's instructions on 20 January which I wrote to him and delivered to him around noon the same day.
>
> In that case it is just as good to have all things clear.

The letter ends by Skúli Jón Sigurdarson urging Thorsteinn Thorsteinsson to write a report on the matter which could be available and used for their defence.

In a reply dated 27 February 2001 Thorsteinn Thorsteinsson expressed the opinion that it is far-fetched to maintain that objects are in AAIB's custody which are kept by a third party, such as the Soil Conservation of Iceland hangar where a multitude of people has access, among those Sigurgeirsson. For his part Thorsteinsson said that he never took the wreck in his own custody or in the name of the AAIB, as he would then be responsible for its security and prevention of theft from it, corrosion and whatever the owner could claim compensation for. Wrecks have usually been in the custody of the owner or those in charge of its maintenance with the obvious condition that the AAIB have continued access to them if further investigation is necessary. It went against the fire protection rules to put the pallet fish container full of kerosene in the hangar of the Soil Conservation of Iceland and made the parties concerned responsible. In fact the engine never was in the custody of the AAIB. It was part of the wreck for two days at the most in the hangar of the Soil Conservation of Iceland. As soon as it had been removed from the wreck and the preliminary investigation finished, it was moved to the G.V.S. workshop and was there in his custody as this was the only recognised workshop available to remove components from the engine and examine it before corrosion would start to cause problems.

At this point there was no data indicating that anything criminal had taken place, as it was not the AAIB's responsibility to be concerned with that. The police could easily have taken the engine into its custody at any time when the public investigation was over.

The only thing of importance to the investigation regarding the engine and the wreck after the AAIB investigation of both items was finished, was whether attestation and documents on their airworthiness - the engine's and the aircraft's - were available. All the documents the owner was willing to release have since then been in the custody of AAIB, apart from the time they were with the police.

Thorsteinsson says that the police examined the wreck in the hangar of the Soil Conservation of Iceland, actually not in his presence, and that he was not aware that they wanted to examine the wreck or the engine more closely than the AAIB had done.

Two men had come to Iceland from the insurance company Codan and had looked at the wreck with Ísleifur Ottesen and inspected how the engine had been disposed of. They made no comments. This could have been interpreted as if the owner's authorisation had been given on the preservation of the wreck and the engine, as a matter of fact there is a written request by e-mail from Codan to Skúli Jón Sigurdarson on the preservation of the engine.

Finally, Thorsteinsson disclosed that Björn Björnsson from the Flight Safety Department, who took part in the investigation of the engine, had told the AAIB that he had mentioned the Codan insurance company's interest in preserving the engine to a colleague in Denmark. The colleague had asked for information on the engine, as he intended to make sure that it would never be put in another aircraft because of the shock it had been subject to.

6.3.3 AAIB demands access to the engine for further investigation

In a letter dated 2 March 2001 to L.Í.O. ehf./Air Charter Iceland, the AAIB referred to a letter of 20 January of the same year from the AAIB which the chief inspector of aircraft accidents delivered to Ísleifur Ottesen at his home at 13.30 that same day. The letter then says:

> In light of new information received by the AAIB, it now demands for the sake of the investigation that the AAIB inspectors be allowed access to the engine at 13.00 on Saturday 3 March, in order to investigate it further.
>
> Kindly reply today, Friday 2 March, and indicate where the engine is and that you guarantee that the AAIB will have access to it.

6.3.4 The engine on its way to the United States

According to a hand-written memo dated 2 March, Ísleifur Ottesen called Thormódur Thormódsson at 16.00 that day and confirmed that the engine was with a transport company which was flying it to El Paso in the United States. The engine should arrive at its destination on 5 March. Ottesen said that he would formally reply to AAIB´s letter "today" or next Monday - 5 March - after he had spoken to his attorney.

Ísleifur Ottesen replied to the abovementioned letter in a letter dated 2 March 2001. It says thus:

> The decision to send the engine abroad for further examination was taken on the grounds of the draft report of the AAIB where nothing indicated engine malfunction in the aircraft TF-GTI. It was believed that investigation of the engine was complete and since the AAIB's investigation was over it was preserved by the undersigned in a container filled with oil in order to avoid further corrosion. The undersigned then had the engine in his custody and considered that the Board had relinquished it when the investigation was over, cf. Art. 12, Para. 1 of Act No.59/1996.
>
> On 18 January it was requested of the AAIB (SJS) that engine components and log book be released to the undersigned as it had been decided to send it abroad. The AAIB has not yet acted on this request.
>
> It cannot be seen that components that have been practically uncared for for 6 months could be regarded as parts of any investigation, nor that the AAIB could after all this time call again for components that have previously been released to their owner after the Board's investigation.
>
> We at L.Í.O. ehf./Air Charter Iceland, however, want to work for an investigation that is as accurate as possible and it is our will that the Board have as ready an access as possible to all data that may be in our custody and could be related to the investigation.
>
> The transport company gave the undersigned the answer today that the engine had been delivered in El Paso on Monday 5 March 2001. Nothing has been done to it but it is expected that it will be further examined preferably no later than 8 March. If the AAIB wishes to investigate the engine further it will be at the Board's or its representatives' disposal for further examination 5-8 March in El Paso.
>
> [...]
>
> Respectfully,
> Ísleifur Ottesen.

6.3.5 AAIB refers further action to the police

On 5 March 2001 the AAIB wrote a letter to the Investigations Department of the Reykjavík Police on the TF-GTI engine. Reference was made to the AAIB letter of 22 February to the

Reykjavík Police, an e-mail of 23 February and previous conversations on the engine. It then said:

> As the police is aware of, the AAIB released the engine to Tormod Egner, representative of the engine's owner, the insurance company Codan in Copenhagen, after it had completed its investigation of the engine. This applies to the engine itself, without its components and systems which the AAIB took and sent for further investigation.
>
> This was before it became clear that there would be a public investigation.
>
> Later when it became known that a police expert expressed a wish to examine the engine, cf. also that of your attorney, the AAIB tried to stop the engine from being sent abroad.
>
> The AAIB has now received a written confirmation of the engine's present owner, Ísleifur Ottesen, Skerplugata 4, that the engine has been moved to the United States in spite of requests to the contrary.

Thereafter reference is made to the last paragraph of the aforementioned letter of Ísleifur Ottesen where it says among other things that the engine will be at disposal for further examination in El Paso on 5-8 March.

Finally, the AAIB letter says:

> Because the Aircraft Accident Investigation Board has completed its investigation of the engine and because its attempts to keep it in the country proved unsuccessful, the Board will not take further action.
>
> The AAIB considers that further mesures and investigation of the case are in police hands.

The letter of 22 February 2001 which is referred to, is essentially identical to the AAIB letter to Fridrik Thór Gudmundsson, of the same date, quoted hereinbefore, describing the aircraft's transport from the Soil Conservation of Iceland's locked hangar to an AAIB container, and the AAIB letter dated 20 January 2001 on the custody and storage of the aircraft engine. The e-mail of 23 February which figures hereinbefore, tells of Ísleifur Ottesen having sent the engine to the United States.

On 4 March 2001, the day before the aforementioned letter was written to the police, Skúli Jón Sigurdarson sent an e-mail to the Civil Aviation Administration in which he requests reports by two experts of the Aviation Safety Department of the Civil Aviation Administration, Björn Björnsson and Sigurjón Sigurjónsson, who had taken part in or been present at the investigation of the TF-GTI engine. It would be best for him and the AAIB that the opinion of the experts, that nothing had be found the matter with the engine which could not be attributed to damages due to its falling into the sea, be presented as clearly as possible. It is then added that Thorsteinn Thorsteinsson unfortunately never bothered to obtain the confirmation of the specialists present.

6.4 Cautioned against using the engine

<u>6.4.1 The insurer attempts to sell the engine</u>

In a letter from Finn Rasmussen from the Nordic Aviation Claims to Thormódur Thormódsson dated 6 March 2001, the letter writer says that he has looked into the case of the TF-GTI engine. He says that a few days after the accident he asked Sigurgeirsson to put the engine in oil in order to protect it from rust after it had been in the sea. Sigurgeirsson did this and moved the engine to his premises. Sigurgeirsson had understood from Thorsteinn

Thorsteinsson that the engine had been released, as the AAIB had already removed the fuel system which their attention was focused on.

Rasmussen said that he had last been in Iceland in September 2000 and spoken with Thorsteinsson about the engine. He had told him [Thorsteinsson] that the insurer was trying to sell the engine. Sigurgeirsson had said that as soon as the investigation of the fuel system was finished its components would be returned to the NAC (Nordic Aviation Claims) so that the entire engine could be sold. Furthermore, Rasmussen said that he had obtained a copy of the engine log book.

Finally, the letter said that Sigurgeirsson had requested instructions on the disposal of the engine in the beginning of the year and that they had sold the engine to Ottesen in the state it was in.

6.4.2 Information sent on the engine

By letter dated 7 March 2001 Sigurjón Sigurjónsson at the CAA Aviation Safety Department replied to the message of Jim Cahill at the US FAA. There Sigurjónsson described the engine and the accident. He said that he had heard that the insurance company had sold the engine and that it had been transported to El Paso; but he did not know exactly where the engine was. It had been kept at the repair station Jules Aircraft Services, so that there could be a connection there. He did not know why the engine was moved to El Paso, but he was concerned if the engine would be put in another aircraft; it had suffered a heavy impact and sunk into a salty sea.

Thormódur Thormódsson sent a letter to David Muzzio at the NTSB dated 8 March 2001. He referred to telephone conversations earlier that day and said that he would send him information on the engine in question. The manufacturer was Teledyne Continental and on the data plate this information on the engine was to be found: P/N TSIO 520 ECH; Serial Number: 165605-8-E.

According to the manufacturer, Teledyne Continental Motors, ECH in a P/N means that the engine was originally an E engine but was changed to H. Furthermore the manufacturer informed the AAIB that the change of an Permold E engine into a Sandcast H engine was in fact impossible because the main components of the two engines had almost nothing in common.

For this reason it is almost certain that at some time in the past the data plate of an E engine had been put on the engine in question here, which is an H type.

The engine was overhauled in December 1996 at the repair station Gold Star Aviation Accessories, 3397 Northwest 154th Street, Miami by Fred H. Tolbert A&P 421767 and Fred E. Tolbert A&P 262737322.

The AAIB is of the opinion that this latter "change" was done at the same time the engine was overhauled or before that.

The engine being presently in El Paso, probably at JAS, Inc. (Federal Aviation Administration accreditation No. JULR 259 K) 6805 Boeing Drive, El Paso, TX. Tel: 915 772 2900.

The owner being Ísleifur Ottesen and his phone number 915 252 8484.

The AAIB has finished its investigation of the engine but in the light of this new information it would like to be sure that this engine will not be installed in any aircraft unless it is rebuilt and the manufacturer or a station it recognises issue a new data plate for such a use.

Finally, the AAIB asks of Muzzio that he give an account in writing on how the NTSB treat engine components that have been fully investigated after an accident when they have come to the conclusion that these did not have any part in the accident. It was inquired whether there was a special process if the conclusion was that the components had been "faulty".

David Muzzio replied in a letter dated 20 March and said that the main rule was to deliver single components to the owner, usually an insurance company, when the investigation was over. If a component was a causal factor in an accident or the accident could in some way be traced to it, the component was kept for some months, only to ensure adequate proof and in order to avoid that another kind of investigation become necessary. But when a case was considered fully solved the component was released.

If, on the other hand, an investigation reveals that a component is "faulty" the Federal Aviation Authority is informed in order that it may take the appropriate measures. If a "faulty" component caused an accident or it could in some respect be traced to it, an attempt is made to find out where it is manufactured and how it came in the accident aircraft. An attempt is also made to gather evidence on who knew about the component before the accident and how many faulty components were put into the aircraft. There is special emphasis on this if the aircraft was used in commercial aviation.

The aforementioned examples are of how accident data is treated when nothing suggested that a charge would be brought for a criminal act. If it was considered possible that a prosecuting authority would start procedures or that a charge would be pressed for a criminal act of intent, nothing would be released without consultation with the prosecuting authority. In addition, the evidence would be kept more securely in the case of a possible charge. The letter then made reference to laws and regulations on these issues in force in the United States, which there is no reason to describe here.

6.5 Repercussions of the engine release

6.5.1 AAIB charged for violation of Art. 162 of the Penal Code No. 19/1940

Fridrik Thór Gudmundsson brought charges against the Aircraft Accident Investigation Board on 26 March 2001 for alleged obstruction of justice by having "only four days after the aircraft accident in Skerjafjördur 7 August 2000 released the engine of aircraft TF-GTI which the Board was investigating" (cf. a letter from the Reykjavik Police Commissioner and a letter of the Director of Public Prosecutions 7 June 2001). The charges referred to Art. 162 of the Penal Code No. 19/1940, which is as follows:

> He who wrongly uses evidence or comes forth with wrong evidence in the intent to influence the results of a court case, shall be subject to imprisonment for up to 2 years. In case of extenuating circumstances and if the violation does not call for a stronger punishment a fine may be applied or imprisonment for up to 1 year.

> He who destroys evidence, hides it away or makes it unusable in full or in part, in order to diminish or forfeit the right of others, shall be subject to imprisonment for up to 2 years.
>
> If a person has committed the deed, mentioned in Para. 1 or 2, on data that could have become points of his guilt in a public proceeding, then the deed is not punishable.

6.5.2 The Commissioner of Police considers no grounds for prosecution - the Director of Public Prosecutions confirms this conclusion

In a letter from the Reykjavík Commissioner of Police dated 3 May 2001 it then said:

> The investigation of this case is finished and the investigation evidence has been reviewed with consideration to Art. 112 of the Code of Public Procedure No. 19/1991. The conclusion of the investigation is that nothing which has come forth indicates that the Aircraft Accident Investigation Board has, with the intention to diminish or forfeit the right of others, destroyed evidence, hidden it away or made unusable in full or in part. Therefore, it cannot be accepted that the subjective conditions of Art. 162, Para. 2 of the Penal Code are fulfilled.

With reference to Art. 112 of the Code of Public Procedure No. 19/1991, this factor of the case was therefore dismissed. This conclusion was confirmed by letter of the Director of Public Prosecutions dated 7 June 2001.

The provision of Art. 112 of the Code No. 19/1991 reads thus:

> When the prosecutor has received the case documents and verified whether the investigation is finished he considers whether a person shall be prosecuted or not. If he deems that what has been put forth is not sufficient or likely to prove guilt, he takes no further action, otherwise he presents the case before a court according to Art. 116.

6.5.3 Forward and Taylor on the release of the engine and AAIB's replies

On the engine release F and T say this in Chapter 4 of their report:

> d. After a very short time, the engine was removed from the IAAIB's custody but they state that they would have had access to it had that been required. It would appear that at no time was the engine re-examined following the initial brief inspection. This adds weight to the supposition that the investigators had concluded at an early stage that a fuel problem was the reason for the accident.

In its answers on 2 October 2002 the AAIB says this, cf. Chapter 4:

> The relatives brought charges against the AAIB for alleged obstruction of justice. The reference is to the Board's treatment of the aircraft's engine. The result of the police investigation was that nothing has been found that indicates that the AAIB has, in order to diminish or forfeit the right of others, destroyed any evidence, hidden it away or made it unusable in full or partly. That result was brought before the Director of Public Prosecutions who reached the same conclusion as the police.
>
> Furthermore, a specialist in aircraft accident investigation for the International Civil Aviation Organization (ICAO) came to the conclusion that AAIB's investigation of the aircraft engine and its release had been according to generally accepted procedures.
>
> It is clear that the Board's decision to release the engine was at that time not out of the ordinary as the possibility of an engine malfunction had been ruled out. In light of the aftermaths the AAIB has changed its procedure regarding the treatment and preservation of field evidence.

F and T do not maintain that the release of the engine was illegal, but they interpret it as arguments for their opinion that the AAIB had early come to the untimely conclusion that fuel problems caused the engine to stop.

6.6 Conclusion of the Ad Hoc Investigation Committee.

The engine was released 4 days after the accident. From the available data it seems possible to come to the conclusion that the engine was left at the G.V. Sigurgeirsson ehf. aircraft maintenance and repair firm, put into a pallet fish container with kerosene upon the insurer's initiative, with the support of Ísleifur Ottesen. It was then kept outside the workshop, cf. Sections 6.1, 6.2.3, 6.3.1, and 6.4.1. The engine remained there until Ottesen took it in his custody, cf. Section 6.2.2. Nothing is known for certain as to when Ottesen bought the engine from the insurance company. From the letter of Thorsteinn Thorsteinsson, cf. Sections 6.3.1-6.3.2 hereinbefore it can be gathered that the custody and preservation of components for investigation was somewhat loosely managed and that there were no rules on the release of components.

As stated above, the AAIB has maintained that releasing the engine was according to accepted procedures when it was estimated that the investigation was finished, cf. Art. 12, Para. 1 of Act No. 59/1996 on the Aircraft Accident Investigation Board where it says:

> The Aircraft Accident Investigation Board decides when an aircraft or its parts beeing investigated are released.

Experts from ICAO who reviewed the aviation safety issues in Iceland from 28 August to 5 September 2000, cf. Section 2.2.3 hereinabove, made no comments on how the engine had been released in the circumstances at the time and they explain this further in the Section mentioned above. This is in accordance with ICAO procedures.

Then the conclusion of both the police and the Director of Public Prosecution is that the release of the engine did not corrupt any data in a manner pertaining to Art. 162 of the Penal Code and was thus not a ground for prosecution.

The Ad Hoc Investigation Committee has endeavoured to investigate the matter and has no reason to believe that any evidence has been corrupted in a criminal manner although the engine was released. It also confirms the opinion of the ICAO experts that no other rules have been broken. The AAIB has pointed out in its answer to F and T's report that, in light of the aftermath of the release of the engine, it has changed the procedures for treatment and preservation of field evidence.

The Ad Hoc Investigation Committee confirms this and believes that in light of the aftermath it would have been better to keep the engine longer. In the future it believes that field evidence must be securely preserved at least until the final report has been made and in fact for a longer time, but it cannot be more precise on this point. Furthermore, it is necessary that the AAIB be provided sufficient funding to acquire facilities to preserve aircraft wrecks, components from them and other field evidence until the investigation is finished. Such facilities would also permit the AAIB to examine wreckage in its own facility. Furthermore, the AAIB should, to the extent possible, establish policies and procedures by which specialized JAA-approved workshops are used that have the necessary appliances and other equipment to functionally test components such as e.g. engines. The committee is also of the opinion that the AAIB register components and that proof be guaranteed of to whom they are released and when, e.g. by letter or receipts.

The National Transportation Safety Board (NTSB) in the USA has a specific form that is used by the Investigato- in-Charge (IIC) to release wreckage to the owner or owner's representative. The form is also used to identify components that are not released initially, but held for further testing. When a part is released, or when parts are retained for further testing, the IIC and the recipient of released components or wreckage must sign the form. The signed form then becomes a part of the record of the investigation. It should be considered by the AAIB to use such a form to make release of wreckage and components more formal.

On the other hand, it is somewhat surprising that the police did not take the engine into its possession when it was asked to investigate an alleged criminal behaviour, cf. Chapter 10 of the Code of Public Procedure No. 19/1991. Here the coordination between the activities of the AAIB and the police seems to have been lacking, although the aims of investigation are different. The sole aim of aircraft accident investigation is, according to Act No. 59/1996, to prevent repeated accidents and enhance flight security, but investigation according to the Code of Public Procedure No. 19/1991 is an independent investigation of aircraft accidents according to Act No. 59/1996, see Art. 1, 6 and 14 of the latter Act.

6.7 Overview of the course of events

Finally, here is an overview of the course of events:

1. The accident occurred 7 August 2000 and 4 days later the engine was placed in a pallet container filled with kerosene and stored at G.V. Sigurgeirsson's firm.
2. Thorsteinn Thorsteinsson, Investigator-in-Charge of the accident investigation, released the engine on 11 August 2000 at the request of the insurance company Codan, as in his opinion the investigation was finished.
3. On 22 August 2000 a public investigation of the operations of L.Í.O. ehf./Air Charter Iceland was demanded.
4. On 19 January 2001 Ísleifur Ottesen demanded the original documents of the engine and all components that had been removed from it, as he owned the engine and intended to send it to the United States. It is not known on what day Ottesen acquired the engine.
5. On 20 January 2001 conversations are quoted in which the police considers inappropriate that the engine leave the country; the police was surprised to learn that the engine had not been in the AAIB's custody. It is decided that Skúli Jón Sigurdarsson take the engine in the custody of the AAIB.
6. The same day Skúli Jón Sigurdarson intends to fetch the engine from the G.V.S. workshop. A little earlier Ottesen had taken it in his own custody. Steinar Steinarsson, member of the AAIB, proposes that the engine be fetched.
7. Ottesen reiterates that he has had the engine in his custody since autumn 2000 and refuses to release it. Skúli Jón Sigurdarson demands that the engine be handed over immediately.
8. In a letter dated 20 January 2001 Sigurgeirsson demands that Ottesen see to it that the engine be preserved and neither sent out of the country nor taken apart without prior authorisation from the AAIB. He delivers the letter to Ottesen himself.
9. In an explanatory report with a letter to the Commissioner of Police dated 1 February 2001 Thorsteinn Thorsteinsson describes the investigation of the engine and the conclusion that no further investigation was considered necessary. The explanatory report is essentially identical to Section 1.16.1.2. of the AAIB final report.

10. In a letter dated 20 February 2001 Fridrik Thór Gudmundsson asks that the wreck be preserved in as secure manner.
11. The AAIB replies and describes the preservation of the wreck in a letter dated 22 February 2001.
12. An e-mail from the AAIB to the police dated 23 February 2001 says that Ottesen has moved the engine to the United States.
13. Correspondence between Skúli Jón Sigurðarson and Thorsteinn Thorsteinsson from 26-27 February on the treatment and release of the engine. Skúli Jón Sigurdarson concludes from Thorsteinsson's letter of 26 February 2001 that Ottesen has taken the engine without authorisation. He considers that lack of storage room did not hinder the AAIB from taking the engine into its custody.
14. In a letter dated 27 February 2001 Thorsteinn Thorsteinsson draws attention to the fact that no data was available on criminal behaviour when the engine was released after examination.
15. By letter dated 2 March 2001 to L.Í.O. ehf./Air Charter Iceland, the AAIB demands access to the engine at 13.00 the next day for investigation due to new information.
16. Ísleifur Ottesen replies by letter on 2 March 2001 that the engine is on its way to the United States and will arrive at destination on 5 March and that it may be examined in El Paso between 5-8 March.
17. On 5 March the AAIB describes how the engine was released to the insurer at the end of the investigation, when nothing had yet been said about a public investigation. The AAIB tried to hinder the engine being transported abroad, but failed. The AAIB has completed its investigation of the engine, its attempts to keep it in the country proved unsuccessful, and the Board will not take further action. The case is now in the hands of the police.
18. By e-mail to the Civil Aviation Organization on 5 March 2001 Skúli Jón Sigurdarson the Investigator-in-Charge asked for a report by two experts of the Aviation Safety Department. He criticises that Thorsteinn Thorsteinsson did not obtain the confirmation of the specialists present at the investigation of the TF-GTI engine. The CAA specialists were asked to present as clearly as possible, the opinion that nothing was found wrong with the engine, which could not be attributed to damage from it falling in the sea.
19. Finn Rasmussen at the Codan insurance company describes the measures regarding the engine and the insurer's attempts to sell it in a letter to Thormódur Thormódsson dated 6 March 2001.
20. By letters on 7 and 8 March 2001 Sigurjón Sigurdsson and Thormódur Thormódsson warn against installing the engine in an aircraft.
21. Thormódsson receives information by letter from David Muzzio at the NTSB dated 20 March 2001 on how data is preserved in the United States.
22. The AAIB is charged on 26 March 2001 for criminal obstruction of justice according to Art. 162 of the Penal Code by releasing the engine early in the investigation process.
23. The police says there are no grounds for prosecution. The Director of Public Prosecutions confirms this conclusion, cf. letter of 3 May and 7 June 2001.
24. F and T consider that the release of the engine without further investigation confirms their opinion that the AAIB had early in the investigation process come to the conclusion that fuel starvation caused the accident and had not considered other possible causes.
25. The AAIB has in the light of the aftermath of the release of the engine changed the procedures for treatment and preservation of field evidence.

7.0 On engine seizure

7.1 Investigation of wreck, engine and fuel system

F and T emphasise that it was not adequately checked whether TF-GTI's engine may possibly have stopped due to seizure and that this needs to be considered specifically. The CAA agrees in the final chapter of its Analysis Report of 4 October 2002 that a hypothesis of a seizure should be investigated as thoroughly as possible even though it is a very improbable one.

7.1.1 AAIB's final report

The AAIB final report of 23 March 2001 treats, among other things, of whether it is possible that the engine seized, cf. Section 1.16.1.1.

It begins with:

> 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 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).
>
> [...]
>
> No mechanical failure was discovered in this investigation which could explain the engine's loss of power.

7.1.2 AAIB conclusions – Nothing suggested malfunction

The last two paragraphs of Section 1.16.1.2 say the following on the engine's loss of power:

> The propeller (McCauley, D3A32C88MR, serial number 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 the 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.

7.2 The report of Forward and Taylor

At the beginning of Chapter 4 of their report, Forward and Taylor draw attention to the following points regarding a possible engine seizure.

7.2.1 Inspection of the oil filter

F and T draw attention to the fact that the AAIB final report does not mention an inspection of the oil filter and they say:

> a. There is no mention in the report of the oil filter having been examined. [Chapter 4].

As covered below, F and T mention that the AAIB later said that the oil in the filter had been checked visually and magnetically and proved satisfactory. On the basis of this superficial examination the AAIB came to the conclusion that the condition of the oil did not call for further analysis.

The AAIB's answer to this, from 2 October 2002, says that the oil filter was "removed and inspected".

The comments in CAA's Analysis Report from 4 October 2002 on Chapter 4 of F and T's report say: "The oil filter was also taken apart, there was no metal grit in it."

The AAIB final report of 23 March 2001 does not mention this.

The AAIB's answer, from 2 October 2002, says only that the oil filter was removed and inspected. There is no reason to doubt this. However, it is exaggerated in the CAA's report of 4 October 2002, that the oil filter was taken apart and inspected. This was not done, as will be discussed further in Section 7.5.3 below. It may therefore be said that it would have been better to inspect the oil filter more properly.

7.2.2 Oil analysis

F and T criticise that the oil was not analysed and say this, cf. Chapter 4:

> b. There is no record of any analysis of any oil that may have remained in the engine. The IAAIB subsequently stated that the oil in the filter was examined both visually and magnetically and found to be satisfactory. On the basis of this superficial examination, the IAAIB concluded that *'The condition of the oil did not call for further analysis'* [italics by F and T]. A basic principle of good accident investigation is that oil samples are taken and subjected to full analysis as a matter of routine.

The condition of the oil is mentioned again in Item l of F and T's report, where it says:

> l. It is a basic procedure in any accident investigation concerning an engine failure that the condition of the oil in the engine at the time of failure is determined. This is done by examination of the oil filter and by analysis of any oil remaining in the engine. No attempt appears to have been made to investigate either of these areas, possibly because the investigator had already decided that the most probable cause of the accident was fuel starvation.

The AAIB final report of 23 March 2001 does not mention this. The AAIB answer of 2 October 2002 says, however, cf. Chapter 4:

> The report authors [F and T] question the conclusion of the engine investigation because the possibility of engine seizure is ruled out [Section 4]. Nothing appeared during the engine investigation that could indicate a piston or engine seizure due to lack of lubrication and during the investigation the oil was inspected upon emptying the sump and the oil filter was removed and inspected. The AAIB admits that it is criticisable that no sample was taken at that occasion.

The CAA's Analysis Report of 4 October 2002 about this point says regarding the criticism that oil was not examined with due diligence:

> [...T]he authors [F and T] provide some arguments supporting the view that the engine suffered seizure for instance due to oil depletion. It is specifically pointed out that the engine and the oil contained in it had not been examined with appropriate diligence. However the AAIB investigation revealed that the engine turned normally after the accident as well as the entire drive train. The compression on all cylinders was checked and one of them was removed to inspect its interior condition. The oil filter was also taken apart showing no sign of metal contamination.

The CAA Analysis Report does not address inspection of the oil directly. However, the CAA considers it of great importance that a hypothesis of the engine having seized, even though very unlikely, be investigated as thoroughly as possible.

The AAIB conclusion is that it would have been right to take a sample of the oil and inspect it specifically as F and T point out. The arguments for such sampling and investigation are that thereby it might have been possible to *avoid completely* that the oil had begun to lose its lubricating properties and degrade. It must also be considered that such an inspection is limited in that seawater had mixed in with the oil, as was in fact indicated in the AAIB final report, as well as dirt such as mud from the bottom of the sea. It may also be considered likely that there was some slick of oil and petrol on the sea, as there is considerable traffic of pleasure boats in the inlet Skerjafjördur. Such an investigation would, in spite of this, have been a certain contribution to determine a possible seizure.

<u>7.2.3 How much oil had been put in the engine?</u>

Further to F and T's criticism that the condition of the oil had not been duly examined, it had also not been attempted to determine how much oil the engine used and whether at some point the engine oil had been replenished. Their report says the following on this (chapter 4):

> 1. [...] Not only was there no serious attempt to establish the quality of any remaining oil in the engine, there appears to have been no effort to establish the quantity of oil in the engine at the time of the accident. While much was made of the fuel uplift and usage on the day of the accident, there is no mention of any attempt to establish how much oil was used by the engine or whether or not the engine oil was replenished at any time. Given the nature and number of the flights, oil consumption would have been high, and when the fact that the history of the engine was somewhat in doubt is taken into consideration, oil consumption may well have been a factor in the accident.

Neither the AAIB nor the CAA comment specifically on this.

As has been previously stated the aircraft underwent an annual inspection at the G.V.Sigurgeirsson's aircraft maintenance and repair firm on 9 June 2000, but the last inspection, a 50 hour inspection, took place on 1 August that same year. An AAIB letter to the police, dated 21 May 2001, says this:

> As regards invoice No. 0010384 (enclosure 9) for purchase of lubricating oil for TF-GTI, the undersigned [Skúli Jón Sigurdarson] spoke to Eiríkur at the Reykjavik Fuel Services at Reykjavik

> Airport. He was not in possession of the original invoice but confirmed that this concerned the delivery of 12 one litre cans of 15W50 lubricating oil for aircraft engines. The undersigned showed Mr Gudjon V. Sigurgeirsson the invoice copy and he said they (G.V.Sigurgeirsson aircraft maintenance and repair firm ehf.) had bought 1 case which contained 12 cans. The H engine takes 10 litres and the rest, two one litre cans had been put into the aircraft for later use as required. Most often they buy one case when oil exchange takes place.

A photocopy of an invoice dated 9 June 2000 (but the writing is unclear) confirms this. There are no documents available of other oil replenishments before the accident. It must, however, be born in mind that pilots flying small aircraft have the habit of checking oil quantity before the first flight of the day, as the aircraft has been stationary during the night and the oil has settled giving a reliable knowledge of the oil quantity. It may be expected that the pilot of TF-GTI did this in the morning of 7 August 2000 before he began flying.

7.2.4 What became of the oil?

The AAIB final report, Section 1.16.1.2 gives an account of the oil in the engine as follows:

> 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.

It then says:

> When this measurement was taken there was little oil in the engine, and leaking at the piston rings was not unlikely.

F and T bring this up in their report in the following text, cf. chapter 4:

> m. In Para 1.16.1.2, the Report states that the oil cap was missing from the engine and was probably disturbed during impact or during the recovery operation. This conclusion is supported by the absence of oil on the engine or cowlings as would have been the case if the cap had come of in flight. However, although there were some reports of fuel in the water at the scene of the crash, there is no mention of any oil which, given the calm condition of the sea, would have persisted far longer than fuel at the scene. Given that the engine was substantially upright on the seabed, removal of the oil cap would have released the majority of, if not all, the oil into the sea. Yet there are no reports of any oil. The Report states that *'the engine was full of seawater'* and implies that there was insufficient oil remaining in the engine on which to perform meaningful analysis. As the engine was not stripped, there is no evidence relating to its internal state except for the condition of one of the front cylinders, which, together with the other front cylinder, was low on compression. So if the oil was not in the engine or on the cowlings or in the sea or on the surface of the sea; where was it? One possible conclusion is that there was little or no oil in the engine at the time of the accident.

In its answers of 2 October 2002 the AAIB says this, cf. chapter 4:

> The report authors [F and T] claim that AAIB's report indicates that no lubricating oil was found in the engine or engine cowling in the sea or on its surface and it is therefore assumed that the oil was nowhere.
>
> The AAIB considers this a misrepresentation as the report states that there was a small quantity of lubricating oil in the aircraft engine. It is also wrong to claim that there was no oil on the sea surface,

> the truth being that there was oil on the surface at the wreck but it was not clear whether it came from a barge or the wreck itself.

The CAA's Analysis Report does not mention this factor specifically.

It should be kept in mind in this context that not a lot of oil is required in order for the engine to turn normally.

7.2.5 Was there oil in the engine – What was its condition?

It is clear from the above that F and T do not agree with the AAIB on how much oil was in the aircraft's engine. Below is a summary of what F and T say about what happened to the oil:

1. Oil filter was not examined.
2. Oil was not analysed.
3. According to the AAIB's original report the oil cap was off so that oil should have poured into the sea. There are no reports of oil on the sea.
4. Oil should, however, have floated on the calm sea much longer than the fuel.
5. The AAIB says in the original report that the engine was full of seawater and draws the conclusion that there was too little oil left in the engine for a significant analysis.
6. The engine was not taken apart and there is no proof of its internal status, except for one front cylinder, which along with the other front cylinder had been low on compression.
7. Finally the question is asked: If the oil was not in the engine or on the cowlings or in the sea or on the surface of the sea, where was it?
8. A possible conclusion is: That there was little or no oil in the engine when the accident occurred.

According to police reports taken on 15, 21, and 22 of January 2002 two divers, those who were first on the scene, remembered a slick on the sea and both said that it was a fuel slick. On the other hand, their testimonies do not indicate whether there were oil slicks on the sea. The other two who came half an hour or three quarters of an hour later hardly noticed any slick on the sea or not at all.

The AAIB final report says in Section 1.12 about an oil slick on the sea:

> The wings had been torn apart, and thus both the aircrafts main fuel tanks, which are integral tanks, opened up 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.

It does not mention oil slicks specifically here.

The final report seems not to mention any oil slick on the sea at the wreck, nor a fuel slick, so that F and T are right in their comment. However, it is a different matter what conclusions may be drawn therefrom. F and T seem not have looked thoroughly at the possible oil quantity in the sea, which will be treated further in Section 7.5.2.

A summary of what the final report and AAIB comments say is as follows:

1. Oil filter was examined.

2. It would have been right to analyse the oil.
3. Ten litres of oil were put in the engine on 9 June 2000 and two litres went with the aircraft for later use.
4. The engine oil cap was not found and it was presumed to either have fallen off when the aircraft crashed into the ocean or been torn off in hoisting the wreck.
5. "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."
6. "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."
7. "The engine was full of seawater and thus assessment of the oil which remained was not considered significant."
8. It can also be assumed that, if the aircraft had lost oil in flight, the pilot would have given notification thereof.
9. When measurement was taken [of the engine cylinder compression] there was little oil in the engine, and leaking at the piston rings was not unlikely.
10. There was little fuel spillage on the sea at the wreck.
11. In its answer of 2 October the AAIB objects that its final reports indicates that there was no lubricating oil in the engine, on cowlings, in the sea or on its surface. The AAIB says this is a misinterpretation, it was stated that there was little lubricating oil in the aircraft's engine and no oil spillage was found on the sea's surface; there was an oil spillage at the wreck, but it was not clear from where it came, from the barge or the wreck itself.

7.3 On the mechanism and movable parts of the engine

For an engine to seize there must be oil depletion and the treatment above has brought no undisputable conclusion on whether there was oil shortage in the engine. It will now be examined whether the internal status of the engine bore signs of seizure.

7.3.1 The engine turned normally

In its final report, Section 1.16.1.2, the AAIB states among other things the following about the engine:

> 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, so that a leak 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 [but the rings were a little rusty due to lack of lubrication].

The sentence in the brackets is from an AAIB memo due to an inquiry from the Reykjavik Commissioner of Police regarding investigation of the engine of TF-GTI, dated 1 February 2001.[1]

F and T make the following observation thereon, cf. Chapter 4:

> c. One relevant paragraph in the draft report is the 11th of 1.16.1.2: *'The engine rotated normally and there was no internal damage thereof.'*. Later in the same paragraph it is stated that *'One of the cylinders was removed and its inner condition and that of the piston were studied.'* [italics by F and T].
>
> In the final report, the 14th paragraph of 1.16.1.2 says only: *'The engine turned normally ...'* with no mention of internal damage. The following paragraph states: "*One of the damaged cylinders was removed and the internal condition of it and its piston examined.*" [italics by F and T].
>
> It would appear from comparing the part of the draft report with the equivalent part of the final report that at some early stage in the investigation it was assumed or became accepted that all cylinders had been examined and found to be undamaged and that only later, by which time the fuel shortage hypothesis had been accepted as the only likely cause, was it realised that in fact only one of the six cylinders had been examined internally.
>
> This kind of assumption is all too easy to make (author Frank Taylor make a similar mistake during the 'Ustica' investigation) and the report's authors are to be commended for having noticed the error prior to publication of the final report. We believe that such an error may have closed the investigators' eyes to other possible causes of engine failure.
>
> It thus appears that early in the investigation it was not felt necessary to investigate the internal condition further because the engine was free to rotate at this stage. The IAAIB were asked to confirm what examination of the engine had taken place subsequent to the accident. No new information was forthcoming and it remains clear that the examination was at best superficial. There is clearly no good record of the work carried out since the IAAIB states *'I cannot confirm that the rear four cylinders and the rear of the crankshaft were not inspected*[2]*'*
>
> [...]
>
> n. It is stated that the fact that the engine was free to rotate after the accident was indicative of the fact that the rotating components were in good condition. However, an engine that has suffered a full or partial seizure due to overheating caused by a lack of lubrication, will rotate on cooling and its internal condition cannot be determined without a strip examination to assess the condition of the internal components. Examination of the oil filter and analysis of any oil trapped in the engine would have possibly generated evidence relating to the state of the engine at the time of the accident. Because the front cylinders of an air-cooled engine are subjected to more cooling than the rear cylinders, it cannot be assumed that the rear cylinders are in the same conditions as the front cylinders. As the rear cylinders were not examined, it cannot be stated with any certainty that they had not been subjected to overheating leading to a full or partial seizure of the engine.

7.3.2 On the conclusions of Forward and Taylor

It is difficult to see how F and T conclude from comparison of the words to which they refer "that at some early stage in the investigation it was assumed or became accepted that all cylinders had been examined and found to be undamaged". The draft report states first that the engine had turned normally and then the following is reported: "[...] and there was no

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[1] In the AAIB draft report from 29 December 2000 the sentence was worded this way: "[...] but the rings had immediately started to rust due to lack of lubrication."

[2] The reference is to the AAIB but the comment is in the first person. It would have been preferable to refer exactly to the source here. The comment is neither in the final report nor AAIB's answer. It seems to be taken from some oral information without any further indication.

internal damage thereof." Then the draft report talks of "one of the cylinders" and refers to it like this: "One of the damaged cylinders was removed and the internal condition of it and its piston examined."

For comparison F and T refer to the final report on the engine having turned normally without internal damages being mentioned. In the following paragraph they then say: "One of the damaged cylinders was removed and the internal condition of it and the piston examined."[3] It appears that F and T conclude from the words in the draft report: "*there was no internal damage thereof [the engine]*", that they suggest that all the cylinders were inspected. This having then been omitted in the final report because at some earlier stage in the investigation it was assumed or became accepted that all the cylinders had been examined and found to be undamaged and that only later, by which time the fuel shortage hypothesis had been "accepted" as the only likely cause, was it realised that in fact only one of the six cylinders had been examined internally.

This train of thought is not easily understood, or at least a far fetched conclusion from the words that "no internal damages thereof [the engine]" mean that all cylinders had been inspected, especially when keeping in mind the continuation where only one of the two cylinders is spoken of, and they use the words "it seems [...]". The result is then that what is presented here is a very far fetched hypothesis.

7.3.3 It would have been desirable to examine all the cylinders

There would have been serious damage inside the engine if it had continued to run after the oil was depleted. The best way to *exclude* completely a possible seizure would of course have been to dismantle the engine and inspect the pistons, cylinders and crankshaft as well as the bearings. It would have been desirable for the AAIB to have facilities to inspect it in this way.

7.3.4 On cowl flaps and engine-driven fuel pump

The AAIB final report refers to cowl flaps in Section 1.16.1.1. It says:

> 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 AAIB final report says this about the engine-driven fuel pump, cf. Chapter 2, Analysis, p. 23.

> The only malfunction which could have caused the complete loss of engine power, in 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.

F and T treat of these issues in the following words, cf. Chapter 4:

> e. The control in the cockpit for the setting of the engine cowl flaps was found to be unlocked, but almost in the closed position. The actual position of the cowl flaps was not determined due to their

[3] Ad Hoc Investigation Committee comment: This would be a reference to one of the damaged cylinders, as the engine had 6 cylinders.

> separation, together with the cowlings, during the impact sequence. Subsequent examination of the wreckage at the request of the authors failed to identify any marks that could have helped to resolve the problem. (However, this was nearly two years after the event)
>
> [...]
>
> k. Given the nature of the impact with the water that TI experienced, it should have been possible for a competent investigator to determine the position of the cowl flaps from witness marks on the cowl flaps and surrounding structure. This does not appear to have been done so it must remain a possibility that the flaps were closed.

It is of interest here that F and T had, according to information from the AAIB, an opportunity to examine the wreck but did not. They should then, according to the comments above about a "competent investigator", have been able to determine the position of the cowl flaps and drawn a conclusion therefrom.

<u>7.3.5 Was it a seizure that caused the fuel pump to stop turning and thereby causing the engine to lose power?</u>

F and T make the following observation thereon in Chapter 4:

> n. In Para 2 of the Report, it states: *"The **only** (authors' emphasis) malfunction which could have caused the complete loss of engine power, despite sufficient fuel being present 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.]* Seizure of the engine would also cause the engine driven fuel pump to stop rotating.

It is of interest here that F and T omit the text within the brackets, which rules out the hypothesis suggested, that the engine-driven fuel pump had stopped turning and the engine therefore stopped.

F and T then continue like this:

> When this evidence is considered with the fact that the cowl flaps may well have been closed as indicated by the position of the operating lever in the cockpit and the total lack of information relating to the state of the engine oil at the time of the accident, the possibility of an engine seizure due to a lack of oil must be considered as a possible cause of the engine failure.

The AAIB final report says this about the engine-driven fuel pump, cf. Section 1.16.1.2:

> 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.

<u>7.3.6 Did a vapour lock stop the engine</u>

F and T criticise the AAIB for having carefully examined whether a vapour lock could have caused the engine to stop even though the manufacturers said that there are no known instances of vapour locks in 285 hp engines. Nevertheless, a vapour lock relates to cowl flaps position and it is therefore right to treat the subject briefly, as it is not clear why F and T place such emphasis on the cowl flaps position if it does not affect the formation of a vapour lock and stopping of the engine.

Cowl flaps are manual lids that open for airflow from the nacelle and increase airflow across the engine. They can thereby provide suitable cooling of the engine. According to the Cessna T210L manual they are i.a. to be open in takeoff, in go-around flight and when climbing with full power. As stated in Sections 7.1.1 and 7.3.4 above it was not possible to determine the position of the cowl flaps when the accident took place.

A vapour lock can interrupt or stop the flow of fuel to an aircraft engine. A vapour lock is formed at a restart when an engine has stopped for a short while in high air temperature. A vapour lock is formed when steam bubbles or gas bubbles form in fuel tanks, fuel lines and fuel pumps behind the engine in the nacelle. One way of preventing the formation of a vapour lock is to ensure suitable cooling of the engine.

There are no known instances of a vapour lock forming in fuel tanks of aircraft with a 285 hp engine, which is the same as the one in TF-GTI. A vapour lock is, however, a known problem in aircraft of the type Cessna 210 that were produced in 1976-79 and had a 300 hp engine. With this more powerful engine there was more vapour formation in the holding tanks below the floor. In 1981 a change of the aircraft fuel system was ordered, so that an additional line was connected between the holding tanks under the aircraft floor and the main tanks in order to release vapour from the holding tanks to the main tanks and thus prevent vapour locks. The aircraft TF-GTI had not been changed as it was not required since its engine was 285 hp. (AAIB final report, Section 1.18.8 and Chapter 2, Analysis, pp. 22, 23, 24).

The conclusion is that there is not a danger of a vapour lock in aircraft of this type. The time needed for engine components to overheat in order for a vapour lock to form was insufficient with reference to the events previous to the accident. In addition to this the pilot only had to start an emergency fuel pump in order to prevent a possible vapour lock.

7.3.7 On the movable parts and mechanism of TF-GTI's engine

AAIB conclusion:

1. The engine turned normally, cylinder compression was normal, no compression in the two front cylinders that were damaged.
2. There was little lubricating oil in the engine when compression was measured so that leaking at the piston rings was not unlikely.
3. The internal condition of one of the damaged cylinders was examined. No sign of internal malfunction.
4. It is not possible to say for certain about the position of the cowl flaps. Their position did not matter as there was no risk of a vapour lock in engines of aircrafts of the same type as TF-GTI.
5. The transmission of the engine-driven fuel pump turned normally so that it had no part in the engine stopping.

The conclusion of F and T was like this:

1. Inspection of the engine was superficial. Only one cylinder was inspected.
2. Even though an engine can be turned that does not disprove a seizure.
3. A seized or stuck engine can turn upon cooling.
4. Front cylinders are cooled sooner than rear cylinders. They may have overheated and seized even though front cylinders seemed in order.
5. The cowl flaps may have been closed and thereby caused overheating and later seizure.
6. Maybe the engine-driven fuel pump stopped turning due to seizure which then caused the engine to stop.
7. Did the position of the cowl flaps cause a vapour lock?

7.4 Opinion of the engine buyers of its condition

7.4.1 The CAA statement

A US company in maintenance and rebuilding of aircraft engines, Western Skyways, bought the engine after the investigation was completed and the CAA statement from 25 October 2002 reads as follows:

> It has been asserted in the media that a company in the US, Western Skyways, which bought the engine after AAIB's inspection of it was completed, said that the engine had suffered a seizure. In a letter to ICAA, Mr Perry Nicholson, spokesman for Western Skyways says, however, that no sign of internal malfunction in the engine was found when it was taken apart. The engine crankshaft did not rotate when the company received it as its steel parts had been rusty and the crankshaft corroded. This must be considered normal as the engine had been in seawater. Mr Nicholson says that the crankshaft was thrown away because it was too corroded. On the other hand a large part of the engine has undergone overhaul and is now a part of other engines that are operated today.

7.4.2 The buyers' comments on the engine

The main points of Perry Nicholson's letter, dated 24 October 2002, referred to in the statement above are:

> In response to everybody's questions on engine TSIO-520-EcH S/N 165605-8-E, this engine was picked up in El Paso, Texas on 3/22/2002.
>
> When I arrived in El Paso I called Isleifur Ottesen and was met at the airport and went to a T Hangar and loaded engine in my truck.
>
> The engine would not turn when received. During disassembly it was noted that the internal steel parts were rusted. The crankshaft was rejected due to excessive pitting. There was no evidence of internal failure.
>
> The case[4] was sent out for repair and was used on an engine that was overhauled in our shop on 9/20/2001.
>
> The parts that were rejected were sold for scrap. The reworkable parts were consumed in other engines. The only items in an engine that we normally keep track of would be more expensive items such as the case and the crankshaft.
>
> There are no parts available for inspection.

[4] Ad Hoc Investigation Committee comment: What is called "case" here supposedly refers to what is called "crankcase" elsewhere in the report.

For further information about the engine a reference may be made to the following correspondence.

After Western Skyways had bought the engine they wrote a letter dated 3 May 2001, gave an account of their operations and business with Ísleifur Ottesen. Its content was as follows:

> Re Isleifur Ottesen
>
> [...] This letter is being written concerning the importation of Mr. Ottesen's TSIO-520-VB Continental engine
>
> Western Skyways, Inc. has been rebuilding Continental and Lycoming engines for over 30 years. We have imported engines into South Africa, the U.K., Germany, Canada, and the Pacific Islands. We have full FAA approval to rebuild any Continental or Lycoming engine.
>
> Western Skyways, Inc. is the leading piston aircraft engine rebuild shop in the U.S. Our reputation and quality are unsurpassed by any other rebuild shop.
>
> We are very pleased with doing business with Mr. Ottesen and hope our reputation can be carried forth into the Icelandic aviation industry.
>
> Trent Stubbs, sales representative

7.4.3 No internal damage in the engine

On hand about the engine condition is a letter from Western Skyways to Ísleifur Ottesen dated 24 May 2001 regarding the engine TSIO-520-EcH, SN: 165005-8-E.

> External damage: Intake system
> Oil pan and pickup tube
> Mount legs
>
> Internal damage: Crankshaft rejected for excessive pitting on mains
> Crankcase servicable
>
> No internal damage from crash.
> Fuel system checked good on flow bench.
> Nothing found to indicate internal failure in flight.
>
> Trent Stubbs, sales representative

7.4.4 The engine was stuck

In a letter dated 16 October 2002 to Hilmar F. Foss, who has assisted Fridrik Thor Gudmundsson and Jón Ólafur Skarphédinsson in litigation due to the aircraft accident, Perry Nicholson, spokesman for Western Skyways, answers Hilmar F. Foss' question regarding the engine and where he says the following:

> In response to your question on engine TSIO-520-EcH S/N 165005-8-E.
>
> This engine was picked up in El Paso on 3/22/2001.
>
> The engine was received with

2ea magnetos P/N 6310 S/N 96062523 & 96062525
1 ea prop gov P/N C290D4T2 S/N 791091
1 ea starter P/N MHJ4003 S/N 10L000051
1 ea turbocharger P/N 406610-9005 S/N unreadable
6 ea chrome cylinders
4 ea fuel nozzles and no fuel lines
1 ea part number 639171 oil cooler
No fuel pump, flow divider or throttle and control
Crankcase match number 9A871S
Crankshaft serial number unknown.

The engine was seized and would not turn.

This engine was purchased and parted out. There was no disassembly report made.

Sincerly
Perry Nicholson
Western Skyways, Inc.

From this letter the conclusion seems to have been drawn that the engine suffered a seizure, cf. the news of the Icelandic National Broadcasting Service on 22 October 2002, where Thorleifur Júliusson protests that new information indicate that the engine had suffered a seizure and a reference is made to the written confirmation of Perry Nicholson. The reference is probably to the phrase in the said letter "The engine was seized and would not turn".

7.4.5 Rust damage and pitting in the engine

In sound recorded interviews by the US attorneys Wayne Ferrell and Charles Peckman, who are in charge of the case of the families of those who died except for the pilot, with Perry Nicholson at Western Skyways on 22 October 2001, Nicholson says among other things that he did not know that the engine had been in an accident and that he would then have treated it differently. He mentioned that the engine was stuck when he received it, the engine had been taken apart and the crankshaft thrown away due to pitting or rust damage, as it had been in seawater. He claimed to have heard that the engine had been placed in oil after it was saved from the sea, but that did not change anything. Steel parts continue to rust in spite of that. He reiterated this later in the interview and added that engine components that are immerged in seawater begin to rust immediately upon coming into contact with air. The only way to avoid rust is to take the engine apart and clean all of its components. Some parts of the engine could be used, others were thrown away, e.g. the crankshaft. When asked whether the crankshaft had been stuck before it began to rust, Nicholson answered that he had not seen any internal damage, he had in fact not been looking for them, but he and the employees had not noticed anything like that. Nicholson claimed to have been searching for engines that he could pick up or were for sale and had got in touch with Ísleifur Ottesen and bought the engine from him. He had received the engine in a hanger marked T.

7.4.6 Overview of the buyers' opinion of the engine

1. The work station Western Skyways bought the engine from the aircraft TF-GTI on 22 March 2001.
2. The engine would not turn when received due to rust damage.
3. A sales representative described Western Skyways as a leading rebuild shop of piston engines for aircraft.

4. The sales representative of Western Skyways stated in a letter of 24 May that there were no internal damages in the engine.
5. Western Skyways spokesman Perry Nicholson describes in a letter of 16 October 2002 the parts that came with the engine when it was purchased and says that the engine was stuck and could not be turned.
6. This was interpreted as a buyer's testimony of the engine having suffered seizure.
7. In a telephone conversation with attorneys Nicholson reiterated that the engine had been stuck when bought, but said that the crankshaft had been thrown away due to rust and pitting.
8. Nicholson did not know when he bought the engine that it had been from an aircraft that had crashed. If he had known that he would have gone about differently.
9. Keeping an engine in oil changes nothing about rust formation. If it has been submerged in seawater it begins to rust the moment it comes into contact with air.
10. When asked, Nicholson repeated that there had been no internal damage in the engine.

7.5 Conclusion on seizure

Following is a summary of the main conclusions of the Ad Hoc Investigation Committee on whether the engine suffered a seizure.

<u>7.5.1 Events leading up to a seizure</u>

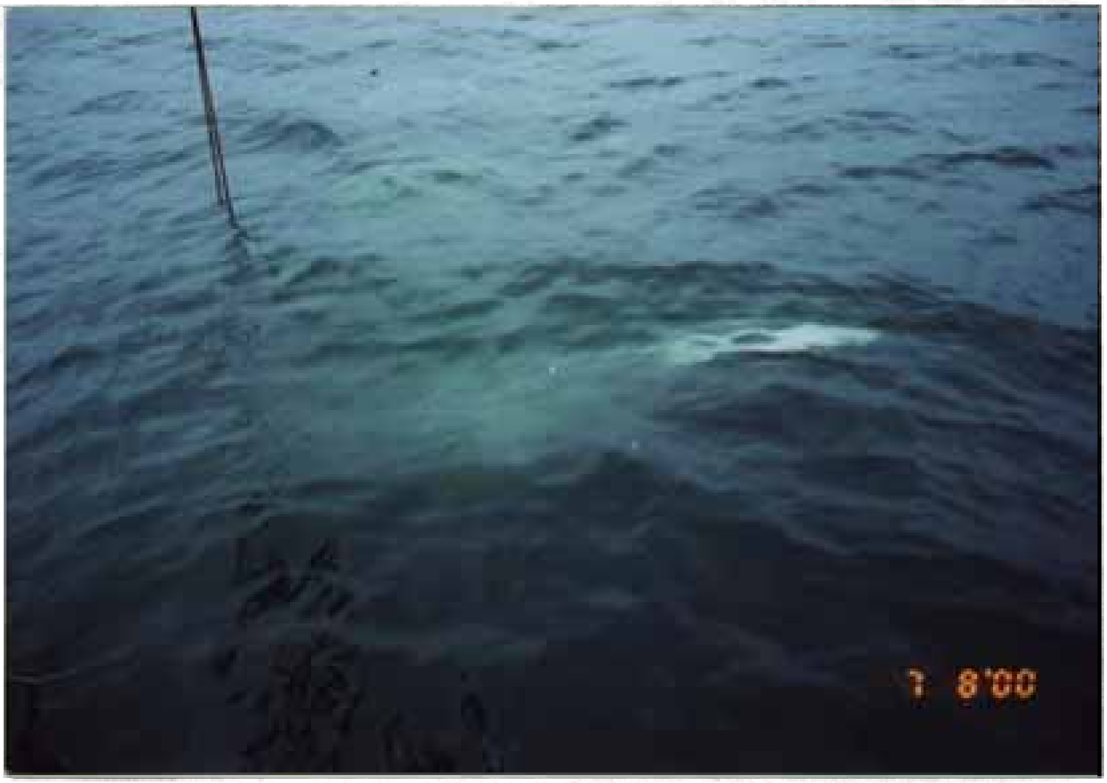
If an engine suffers seizure it does not happen suddenly and unexpectedly. Oil pressure falls or becomes unstable - oil heats. There are gauges in the cockpit where the pilot can monitor oil pressure and oil temperature. The next thing that happens when oil depletion start to have effect and pressure falls is that the propeller blade control becomes unstable because it is governed by the oil pressure. Then the engine starts running with interruptions. These indications are so obvious that they should not have escaped the attention of the pilot. He should therefore have been aware that something serious was wrong. He did not report any such thing as he must have done if the engine was about to suffer a seizure.

<u>7.5.2 No sign of oil depletion</u>

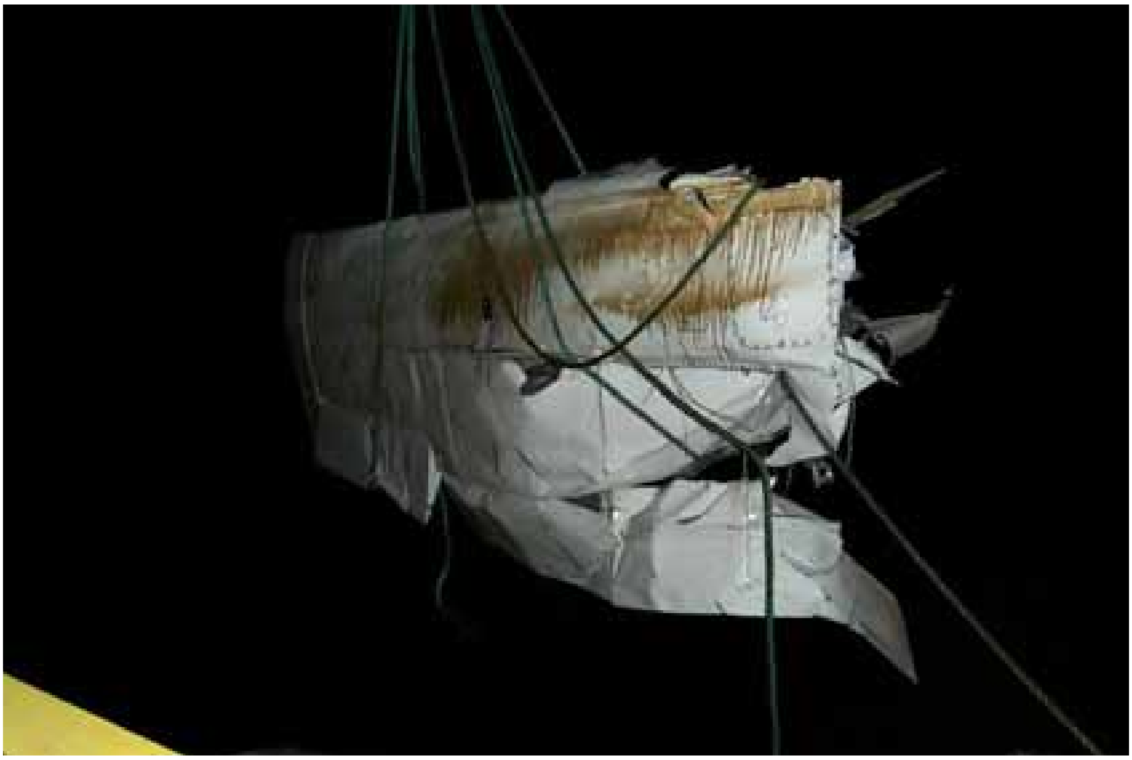
Furthermore, it has been disputed whether there was enough oil in the engine when the engine crashed. An overview of the main disputed items in that respect is in Section 7.2.5.

The Ad Hoc Investigation Committee examined the aircraft wreck in the morning of Saturday 14 August 2003. What was discovered among other things was that the nacelle was clean, such that there were no signs of oil having leaked into it while the aircraft was flying. There were no such indications on the aircraft's wings.

Then there is a difference of opinion between F and T on the one hand and the AAIB on the other hand on how much oil was in the engine. F and T think that there were indications of little or no oil having been in the engine but the AAIB considers that even though there was little oil in the engine when it was examined, it was mixed with seawater. The main arguments of F and T are that there was no oil slick on the sea, which is supported by the testimony of divers that came to the scene shortly after the accident. When considering the testimony of the divers it may be assumed that they were thinking only of saving lives and they may therefore not have paid attention to patches of oil or oil slicks even if it floated on the sea.



The picture shows clearly that oil came up along the wires that were used to lift the wreck from the sea and a slick has formed.



This picture shows considerable oil on the aircraft's wing which is being lifted up. It shows beyond doubt that there was no oil on the wing while it was flying, but that it came onto the wing as it was lifted from the sea. These two pictures do not indicate any oil depletion in the engine.

The pictures of when the wreck was salvaged that have been presented to the Ad Hoc Investigation Committee and are shown here, indicate clearly that oil came up with the wires used to lift the wreck from the sea. The slick was directly over the wreck. Even though it cannot be confirmed whether the oil was from the aircraft's engine or from a barge used for hoisting the wreck to the surface it must be considered very likely that it came from the engine, as it is unlikely that such a quantity leaks from a barge or ship while in use and men are working.

The oil filter was taken apart as further described in the next chapter and after that inspection the conclusion of the Ad Hoc Investigation Committee is that there was enough oil in the aircraft's engine when it crashed so that lack of oil was not instrumental in causing the accident.

7.5.3. Internal damage not to be seen

As has been detailed in a special chapter above, the engine was released shortly after it was inspected. It was then sold, taken apart, some parts used in other engines, others thrown away.

The AAIB says in its report that the engine turned normally when it was examined shortly after the aircraft was recovered from the sea. According to F and T that does not determine whether the engine suffered a seizure because it is just as likely that its movable parts became unstuck in the cold sea.

It is the opinion of the Ad Hoc Investigation committee that it is very difficult to turn an engine that has seized due to oil depletion, even after it has cooled down, due to internal damage to pistons, cylinders and bearings.

The AAIB final report makes no mention of the oil filter having been examined. It is, however, stated in the AAIB answer from 2 October 2002 and the CAA Analysis Report of 4 October 2002 says that the oil filter was taken apart, cf. Section 7.2.1.

The AAIB has an oil filter from the aircraft's engine. This is a "Spin on filter" of the type CH 48109. The oil filter was opened in the afternoon of Saturday 14 June 2003. Present from the Ad Hoc Investigation committee were Ronald Schleede, Søren Flensted, Kjartan Norddal and Sigurdur Líndal. Birger Andreas Bull was not present as he went with Hallgrímur Jónsson and Gudmundur H. Sveinbjörnsson to check out the flight route between Reykjavík and Vestmannaeyjar. To assist there were also Thorkell Ágústsson and Thormódur Thormódsson from the AAIB and Gunnar Valgeirsson aircraft maintenance engineer, and those three opened the oil filter. All those present agreed that the oil looked as good as new and there was no trace of anything suggesting a seizure. If the engine had seized, there would have been metal flakes from the aircraft engine moving parts, such as the crankshaft, bearings, or pistons/cylinders, in the oil.

In spite of this, the committee members consider that it would have been proper for the AAIB to open the filter during the original investigation, even though other information and other data did not indicate seizure.

For further confirmation thereof are these pictures of a piston from one of the cylinders that were opened when the engine was investigated. They show no damages, on the contrary - the cylinder is smooth and shining.

These two pictures show no damages in the engine's pistons which would have had to be if it had seized.

<u>7.5.4 The buyers saw no indication of seizure</u>

As described in Section 7.4.1 and 7.4.2 the workshop Western Skyways bought the engine on 22 March 2001. The buyers took all of the engine apart and found nothing indicating seizure or other internal damage, cf. fax on 24 May 2001 and October 2002. It was pointed out there, as previously stated, that it was not possible to turn the engine when it was received, but the reason was rusty steel parts inside it.

<u>7.5.5 Seizure very unlikely</u>

According to what has been said it is the opinion of the Ad Hoc Investigation Committee that it is indeed very unlikely for the engine to have seized.

F and T criticise the AAIB for not having examined the engine as they should have and determined better whether the engine had seized. They do, however, not mention that an engine does not seize suddenly and unexpectedly. If that happens the pilot notices it and must obtain authorisation for an emergency landing. The pilot did not do that and it is therefore normal for the AAIB to consider seizure improbable from the beginning which was confirmed at the original inspection of the aircraft. The AAIB cannot therefore be blamed for not having investigated the possibility of seizure better than it actually did and directed the investigation to other possible causes of the accident.

Nevertheless, in view of possible repercussions such as have been in this case, and in order for the investigation to be as perfect as possible, especially in case of fatal accidents it would have been desirable to take all of the engine apart, a procedure that could be used as a general rule. The AAIB would thereby have been protected against all possible later criticism and would have had answers to everything that could have been doubted about the investigation.

8.0 On fuel starvation

8.1 Fuel quantity and fuel consumption

8.1.1 Fuel tanks

The AAIB final report, Section 1.18.5, treats of possible fuel exhaustion. It starts with an account of the aircraft having had 4 fuel tanks. There were two main tanks who took 340 litres together, of which 337 were usable. In addition the aircraft had wingtip tanks with a capacity of 125 litres, of which 123 litres were usable.

There had to be at least 26.5 litres in each wingtip tank and main tanks 2/3 filled, or more precisely, they had to contain at least 227 litres in order to use the maximum weight of 3,800 pounds. Otherwise authorised maximum weight was 3,530 pounds.

According to the final report the AAIB spoke to pilots that had flown the aircraft TF-GTI and it seems that not all of them knew how the maximum weight, 3,800 pounds, was conditioned.

8.1.2 Refuelling openings

The refuelling openings of the main tanks are described in the AAIB report as having half-cylinders extending downwards where the lower edge is 5.4 cm below the lower edge of the collars that attach the caps. In everyday speech pilots and fuelling personnel refer to this lower edge as a "notch". It is often used as a reference to fill up to the notch when refuelling. When this was done accurately there were 246 litres in the tanks.

8.1.3 Filling method

When filling the tanks the aircraft must be parked on a level ground with wings horizontal and with a positive pitch angle of 4.5°. These instructions were not found in the aircraft manual. A placard was also supposed to be placed next to the fuel openings with instructions on pumping the last 20 litres to each tank slowly, and then wait 2 minutes and fill. Such a placard was not found in the aircraft and upon investigation it was found that the pilots did not know about this filling method. A serviceman at the refuelling service *Eldsneytisafgreidslan hf.* at Reykjavik airport, who filled the tanks at 18.18 on 6 August, did not know that they should be filled that way.

What calls for attention here is that in a checklist dated 5 January 1998, made on account of a regular CAA evaluation of L.Í.O. ehf./Air Charter on 5-6 January 1998, the question whether fuel filling methods were in order is answered positively, cf. Item 6. A question on whether the operator implements provisions of a regulation on fuel filling, RL-R. 4.11, is answered positively, cf. Item 34.

It can only be concluded from this that the management of L.Í.O. ehf./Air Charter did not give the CAA correct information.

8.1.4 On fuel gauges

The aircraft's maintenance documents show that fuel gauges were tested. Pilots said, however, that they were so inaccurate that they did not rely them.

Pilots generally know that fuel gauges of small aircraft like TF-GTI are inaccurate and provide an indication rather than safe knowledge of fuel quantity in tanks. The AAIB considers it therefore important in order to guarantee aviation safety that a pilot visually inspect tanks quantity himself and use available aids such as a dip stick to measure the fuel quantity in them. The tank containing more fuel is to be selected before landing, but that may prove difficult if gauges are unreliable.

8.1.5 Special warning

As further treated in Section 11.1.4, the last airworthiness directives on how to go about putting more fuel than 284 litres into the tanks had not been implemented and appropriate placards were not in place in the aircraft, but only a part of a placard that was found glued into the storage compartment on the right side of the instrument panel. The placard was in English and read as follows:

> FUEL GAUGES ARE NOT CALIBRATED, BASE ALL FUEL CALCULATION ON VISUAL INSPECTION TIME AN[D] CONSUMPTION.

As described in Section 11.1.4, the continuation of the text was missing, so that the meaning is not conveyed.

8.1.6 On fuel refilling 6-7 August 2000

According to fuel receipts and testimony of fuel servicemen the aircraft's main tanks were filled on 6 August at 18.15, so that 229 litres were added to them. If the tanks were filled correctly then there were 340 litres in them, of which 337 were usable. On the other hand it creates some uncertainty regarding the fuel quantity after this refill that the service man did not know about the airworthiness directives about correct procedures of filling the tanks as was described before. Keeping that in mind it is questionable to assume that there were 337 litres in the tanks. It would be closer to the truth to assume 320 litres as F and T did. This will be treated later.

On 7 August at 13.45 120 litres were added to the aircraft's main tanks at Selfoss airport. Fuel was taken from a tanker truck from the Reykjavik airport fuel service *Eldsneytisafgreidslan hf.*

The same day at 17.40 120 litres were added to the aircraft's main tanks and it may be considered certain that the fuel was taken from the same tanker truck or from another from the same company.

No fuel was taken on 7 August in Vestmannaeyjar and according to what the manager of the fuel pump in Selfoss said, which is supervised by the Selfoss aviation club, the pilot of TF-GTI did not buy any fuel from that pump that day.

As for putting fuel in the aircraft's wingtip tanks, the servicemen knew of only one who had pumped fuel into them, only 20 litres per tank, according to what the serviceman thought. The servicemen did not recall the pilots pumping into the aircraft's wingtip tanks themselves.

The fuel serviceman at the Selfoss airport did not see the pilot measure fuel with a stick, however, he remembered having seen the pilot stand in the serviceman's ladder, stretch and put a finger into one of the tanks after 60 litres had been added to it. The serviceman thought that the fuel surface in that tank was 4-5 cm below the notch.

No employee at the airport in Vestmannaeyjar recalled having seen the pilot measure fuel there. On the other hand it may be considered practically certain that the pilot measured the fuel quantity before beginning to fly on 7 August, as the aircraft's logbooks were not available.

8.1.7 What was the fuel consumption?

According to information from the operator it was assumed that the engine used 60 litres/hour and the pilot that flew the aircraft seems to have expected that.

The pilot who flew the aircraft in the evening of 6 August after refuelling at 18.15 estimated endurance to be 5:00 hours, having assumed that there were 337 litres in the main tanks and accordingly a consumption of 67 litres/hour (337:67=5:00).

The engine manufacturer considered, as will be discussed further in the next Chapter, the average consumption to be 72 litres/hour.

The AAIB uses 63 litres/hour for average consumption.

Flying instructors of the Icelandic Flight Academy use 68-69 litres/hour.

No figure is mentioned for fuel consumption in Tern Systems Inc.'s report.

8.1.8 AAIB's conclusion on fuel consumption

The AAIB concludes that the aircraft was flown 485 minutes or 8:05 hours, from the time the tanks were filled on 6 August at 18:15. If there had been 337 litres of usable fuel in the tanks then and later on 240 litres added to the main tanks at Selfoss airport on 7 August, then there would have been a total of 577 litres of fuel in the main tanks to consume in the flights that were of a total duration of 8:05 hours. That does not take into consideration the time it took to taxi before and after flights and run ups.

The flights of TF-GTI on 7 August were different from previous flights in that there were many short flights and therefore many take-offs.

The AAIB asked a specialist from the engine manufacturer to estimate the engine's average consumption in flights between Vestmannaeyjar and Selfoss. His answer was that average consumption was 72 litres per hour; it would be normal for these engines to consume 64-79 litres per hour. These figures included consumption in take-off and climb, which actually increased the consumption by that much on these short flights. The final report then says, cf. Section 1.18.5:

> 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 taken of 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 an altitude of 1000 feet on flights between the Westman Islands and Selfoss. The results of these calculations are given in Table 1.18.5.1.

The table is as follows:

			Flight-time			Con-sumption			Fuel on board		Refuel
Flight	From	Take-off	Climb (min.)	Cruising (min.)	Total (min.)	Climb (litre)	Cruising (litre)	Total (litre)	Before (litre)	After (litre)	(litre)
6 August-00						Main tanks filled in Reykjavik at 18:15					229
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-2000											
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 at 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 at 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	01:40	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	
				hours:	02:02						
Total				**hours:**	**08:05:00**		**litres:**	**565.7**			

The conclusion is that after a flight time of 8:05 hours the consumption had been 565.7 litres, so that there were 11.3 litres remaining after 24 flights (577-565.7=11.3).

The AAIB final report then says, cf. Section 1.18.5.1:

> 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.

The figures above seem to be obtained from the three first flights between Reykjavik and Vestmannaeyjar where average consumption is 63.1 litre/hour, but the other flights between Vestmannaeyjar and Selfoss where the average consumption is 72 litres/hour.

8.1.9 On the fuel system

The fuel system may provide an indication of whether fuel exhaustion may have caused the accident and this is treated in AAIB's final report, Section 1.16.1.2. It says among other things:

> 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.

This is then reiterated in Chapter 2, Analysis, where it says among other things:

> 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 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 driven the fuel pump. If a malfunction had, on the other hand, resulted in the complete stoppage of the engine (i.e. had stopped rotating) then the six lines would have emptied. No sign of such malfunctions were found.

F and T do not comment on this. This supports the conclusions that the cause of the accident was fuel starvation.

8.2 Main points of AAIB's report on fuel starvation

1. There had to be at least 26.5 litres in each wingtip tank and main tanks 2/3 filled, or more precisely they had to contain 227 litres or more in order to use the maximum weight of 3,800 pounds.
2. If filled to the notch there were 246 litres in the main tanks.
3. Neither fuel service men nor pilots knew the correct manner of filling. Instructions thereon were not at the fuel openings.
4. Fuel gauges were unreliable. Placards with directions thereon were not in the correct places in the aircraft. There was one placard in a storage compartment on the right side of the instrument panel, but a part of the text was missing so that the meaning was not conveyed.
5. The main tanks were filled on 6 August 2000 at 18:15 and they will then have contained 337 usable litres, if correctly filled. On 7 August at 13:45 another 120 litres were added. The same day at 17:40 an equal amount was added.
6. At one time 20 litres were pumped to each wingtip tank, but it is not clear when this was done.
7. There is no knowledge of the pilot having measured fuel with a stick, but once with a finger.
8. The aircraft's main tanks had, after refilling on the night of 6 August and with an addition of 240 litres, 577 litres for use. Flights on 7 August took a total of 485 minutes or 8:05 hours, with reference to a consumption of 60 litres per hour.
9. The engine's average consumption between Reykjavík and Vestmannaeyjar was 63 litres per hour. The engine's average consumption between Vestmannaeyjar and Selfoss was 72 litres per hour. Time and consumption in take-off are included in climbing figures.
10. The pilot seems to have assumed a consumption of 60 litres per hour according to information from the operator.
11. The AAIB's conclusion is that there were ca. 12 litres of usable fuel in the aircraft's main tanks when it crashed. It is assumed that fuel from the wingtip tanks was not used.

8.3 The conclusion of Forward and Taylor on fuel calculations

F and T doubt the fuel calculations in the AAIB report and its conclusion. Their report says on this issue in Chapter 3:

> In Para 1.18.5.1 of the Report [AAIB final report], a table of alleged fuel consumption is presented. This table concludes that at the time of the accident, [G]TI had a total of 12 litres of fuel on board and this figure is used to support Conclusion 3.13 that *'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 estimated'. However, it can be shown that the figure of 12 litres is based on dubious assumptions and that if more logical assumptions are used, a significantly different figure is arrived at.

F and T continue with further arguments:

Firstly, the starting point in the calculations is the assumption that the main tanks contained 337 litres of usable fuel. This is the maximum fuel that the main tanks can hold if the procedures for refuelling contained in AD 94-12-8 are followed. These require that the aircraft be on level ground with a positive pitch angle of 4.5 degrees. It also states that when adding fuel to the main tanks, the last 20 litres into each tank should be added slowly and the fuel level checked after two minutes. If necessary the fuel should then be topped up to ensure that the tank contained 337 litres of usable fuel. The Report states that neither the pilots (1.18.5) nor the refuelling person who filled the tanks on 6 Aug 2000 (1.18.5) were aware of the requirements of the AD and it is therefore unreasonable to expect that the main tanks contained the maximum of 340 litres (337 usable). It is suggested that a reasonable working figure for the fuel available at the start of the calculations in the table would be 320 litres.

In Para 1.18.5, it is stated that one return flight from the Westman Islands to Selfoss was completed with the landing gear down. However, the flight times for all return flights are substantially the same from which it can reasonably be concluded that considerably increased engine power was used to maintain the normal cruising speed with the increased drag of the landing gear. This would have incurred a significant fuel penalty. This penalty could not be quantified due to lack of data, but it is reasonable to assume that the increased fuel consumption would have been in the order of 20% or about 5 litres.

The Report states that a figure of 72 litres/hour was used for the flights between Selfoss and the Westman Islands and that this figure included an element for take-off and climb. However there is no mention of the fuel used for start-up and taxiing and while it is acknowledged that this figure would be small for an individual flight, when it is aggregated over 24 flights the amount of fuel becomes significant and further reduces the figure of 12 litres that the Report concludes was the fuel remaining at the time of the accident.

The fuel calculations totally ignore any fuel that may have been in the tip tanks at the time of the accident. A footnote at the end of the table states *'Extra fuel from the auxiliary is not assumed to have been used'*. In Para 1.18.6 it is stated that *'In the original testimony of the pilots they say that 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* (approximately 28 litres) *in them'*. It is not clear from the wording of the report whether this figure refers to the total wing tip tank fuel or the fuel contained in each tank. However, since the relevant AD calls for 7 US gallons in each tip tank, it is reasonable to assume that the pilots were referring to a total of 14 US gallons. Since the report states that at least 4 litres of fuel was found in the right tip tank after the accident, it is reasonable to assume that some fuel was available in the tip tanks at the time of the accident, and it is illogical to exclude this fuel from the calculations.

The Report states in Para 2 that the switch that controls the transfer of fuel from the left tip tank to the left main tank was found in the ON position, but it stated that this could have been moved in either the accident or during the recovery of the wreck. It is an equally valid conclusion that the switch was not moved and that the pilot was transferring usable fuel at the time of the accident. According to the aircraft's flight manual, fuel should not be transferred to a main tank that is in use. The position of the main fuel selector indicated that fuel was being used from the left tank at the time of the accident but the report does not acknowledge the possibility that, like the transfer pump switch, this could have also been moved as a result of impact forces or during the recovery of the wreckage. It is therefore a possibility that, at the time of the accident, the pilot was transferring usable fuel from the left tip tank while supplying fuel to the engine from the right main tank.

The report seems to have made the assumption that the aircraft ran out of fuel and then used evidence in a selective manner to support this assumption. In Para 2, the report states that the pilot may have *'tried'* to obtain fuel from a tip tank. The use of the word 'tried' implies that in the opinion of the writer there was no fuel in the tip tanks to be obtained yet there is clear evidence that there was fuel in the right tip tank and no evidence to suggest that there was no fuel in the left tip tank.

Using the more reasonable assumptions used earlier, it is clear that without the use of tip tank fuel, the aircraft would have run out of fuel before it reached Reykjavik. On the other hand, if tip tank fuel was available, and the report acknowledges that it was, then the conclusion that the aircraft ran out of fuel is unsustainable. The report strongly suggests that the *'tight'* circle made by the pilot on final approach and the allegedly premature turn after receiving instruction to abort the landing were due to his concern over his fuel state. However, throughout his radio exchanges with ATC, the pilot's voice is calm and he readily accepted the delaying circle shortly before landing. These are not the actions of a pilot who thinks that he is about to run out of fuel. Although it is acknowledged that the fuel gauges on this type of aircraft are inaccurate, they are not so inaccurate that a pilot is unaware of a low fuel state.

When the pilot left the Westman Islands, he quoted a fuel endurance of 2.30 hours. Although pilots can be somewhat inaccurate when quoting fuel endurance on a flight plan, it is not reasonable to assume that this pilot was so unaware of the fuel remaining in his aircraft that he would quote an endurance of 2.30 hours when, if the report is to be believed, there was only 32 minutes of fuel available. If the pilot were taking account of 56 litres of fuel held in the tip tanks, then an endurance of about 1.10 hours would be appropriate (25 litres in main tanks plus 56 litres in the tips). A further possibility exists. Given that according to the report, following the aircraft's arrival at Selfoss at 17.37 hrs, the passengers were disembarked, 120 litres of fuel were added to the aircraft's tanks, fresh passengers were embarked and the aircraft taxied to the take-off point, all within 6 minutes, then the possibility of another, unrecorded, refuelling having taken place cannot be excluded. Given the high activity at Selfoss, it is possible that fuel put into [G]TI was invoiced to another aircraft, especially if the aircraft belonged to the same operating company as [G]TI.

From the evidence available, therefore, there are three possibilities relating to the fuel on board [G]TI at the time of the accident:

1 Despite the inaccurate assumptions in the report, usable fuel was exhausted at the time of the accident.
2 The pilot was using the fuel available in the tip tanks and did not run out of fuel.
3 The aircraft underwent an unrecorded refuelling and again, did not run out of fuel.

8.4 Main points in the report of Forward and Taylor

F and T consider it doubtful that there were ca. 12 litres on board the aircraft when it crashed.

1. It being doubtful that the main tanks contained 337 litres of usable fuel.
2. Were correct procedures observed in refuelling? Aircraft position. Addition, 20 litres. Pause 2 minutes. Then a further addition to reach 337 litres.
3. Neither the pilot nor the fuel serviceman who filled the tanks knew about requirements according to airworthiness directives.
4. Unreasonable to assume 337 litres. A reasonable quantity is 320 litres.
5. On one flight from Vestmannaeyjar to Selfoss and back the landing gear was down. Flying hours were substantially the same and it may therefore be assumed that increased engine power was used to maintain a normal cruise speed due to the increased drag of the landing gear. This caused more fuel consumption which may be expected to have amounted to 20% or 5 litres.
6. The flight between Selfoss and Vestmannaeyjar used 72 litres/hour, including take-off and climb. There is, on the other hand, no provision for start-up and taxiing. After 24 flights this starts to make a difference even though that is not the case for every flight and then the 12 litres are reduced.

7. It is doubtful to presume that fuel from wingtip tanks was not used. They most probably contained 56 litres.
8. There is a possibility that the pilot was moving usable fuel from the left wingtip tank while the engine received fuel from the right main tank.
9. F and T suggest strongly that the AAIB assumed in advance the conclusion that the aircraft ran out of fuel and then used "evidence in a selective manner to support this assumption". The words in the AAIB final report that the pilot *"tried"* to obtain fuel from the wingtip tank they understand as AAIB was of the opinion that there was no fuel in the aircraft's wingtip tanks.
10. If the abovementioned assumptions are used as a basis and fuel had not been taken from the wingtip tanks, F and T consider that the aircraft would have run out of fuel before it reached Reykjavík.
11. The tight circle of the final approach and the pilot's calm voice does not indicate that he was worried about the fuel status. In spite of inaccurate fuel gauges nothing indicates that the pilot thought that he did not have enough fuel.
12. It is unlikely that the pilot quoted an endurance of 2:30 hours if he had only 32 minutes of fuel (assuming 32 litres with a consumption of 60 litres per hour). If there had been 56 litres in the wingtip tanks and 25 in the main tanks the endurance would have been about 1:10 hours.

8.5 On the use of wingtip tanks

<u>8.5.1 Unavoidable to take fuel from them</u>

As has been stated above F and T consider it doubtful that only 12 litres of fuel remained in the aircraft's main tanks when the accident took place and illogical not to expect that there was fuel in the wingtip tanks. They feel it is doubtful to assume that there were then 337 litres of usable fuel in the aircraft's main tanks and that the more correct reference is 320 litres, or 17 litres less, cf. Item 1-4 in the Section above. A flight from Vestmannaeyjar to Selfoss with the landing gear down caused more fuel consumption than provided for in the AAIB final report and it may be assumed that the difference is 5 litres, cf. Items 5-6. For flights between Selfoss and Vestmannaeyjar there is no provision for fuel consumption in start-up and taxiing. Even though there is not much difference each time, it begins to matter after 24 flights, cf. Items 7-8. This calls for a comment as F and T talk about 24 flights between Vestmannaeyjar and Selfoss, but there are in fact only 20. No figures on likely fuel consumption due to start-up and taxiing are mentioned. But with reference to the figures that F and T indicate (17+5=22) the main tanks have contained at least 22 litres less than the AAIB assumed and nothing in the wingtip tanks. Then the aircraft would have run out of fuel before it reached Reykjavík.

As stated earlier F and T consider it dubious not to expect that fuel from the wingtip tanks was used.

<u>8.5.2 Instructions on fuel in wingtip tanks</u>

The AAIB final report refers to the initial testimony of the TF-GTI pilots about them having verbal instructions on having a few litres in the wingtip tanks and in later talks they said that they had had 7 US gallons (26.5 litres) in them (cf. Section 1.18.6 in the AAIB final report). It must be kept in mind at this point that the quantity indicated above had to be in each wingtip tank and the main tanks at least 2/3 full, i.e. there had to be 60 US gallons (227 litres) or more in them in order to use the aircraft's maximum weight, 3,800 pounds, or else a conditional maximum weight had to be used, 3,530 pounds. The pilots were not aware of this (cf. Section 1.18.5, p. 13 and Chapter 2, p. 23 in the AAIB final report).

There is a fuel tank in each wing of the Cessna T210L aircraft, from which narrow pipes lead to small holding tanks under the floor in front of each front seat. There is a selection switch between these tanks with three selections "left", "closed", and "right". It is not possible to take fuel from both tanks at the same time. The switch in the wreck was set to the left main tank (Section 1.16.2., p. 7 of the AAIB final report).

The wingtip tanks are connected to the main tank so that electric pumps move fuel from the wingtip tanks to the main tanks and left main tank switch was set to ON in the wreck. Fuel from wingtip tanks may only be pumped to a main tank in horizontal flight and not into the tank that is being used during flight. Even though it is possible that a passenger or the rescuers hit this switch which is a rocker switch, on the right side of the instrument panel, it is not possible to rule out that the pilot tried to get some fuel from a wingtip tank (Chapter 2, p. 23, cf. also Section 1.18.5, p. 13 of the AAIB final report).

According to the above there are indications that the left main tank of the aircraft was being used and the switch of the left wingtip tank was ON, but it is not permitted to pump from a wingtip tank into a tank in use as stated previously.

<u>8.5.3 Did the AAIB assume a conclusion in advance?</u>

As noted above F and T consider it possible that the pilot was trying to move usable fuel from the left wingtip tank while the engine used fuel from the right main tank. This is all unfounded speculation which does not call for further consideration. This applies as well to F and T's assumption from the words of the final report that the pilot "may have '*tried*' to get fuel from a wingtip tank" suggests that the authors of AAIB's final report thought that there was no fuel to be gotten from the fuel tanks. If the text of the final report is read in context, where it treats of it not being possible to rule out that the pilot tried to get fuel from the wingtip tanks, it may just as well be understood as saying that the pilot was trying to transfer fuel between tanks.

F and T say without reservation that the AAIB assumed a conclusion beforehand and then selected proof to support that assumption. These comments are without any substantial arguments.

<u>8.5.4 Fuel in wingtip tanks not used</u>

According to pilots' testimonies previously stated there was fuel in the wingtip tanks. When the contents of the tank were measured after the wreck was brought to a hangar there proved to be 4 litres of fuel and 6 litres of seawater in the right wingtip tank (cf. Section 1.16.1.1). It is therefore clear that there was fuel in the wingtip tanks even though it is unclear how much. It must also be considered that a pilot said that he had never used fuel from wingtip tanks and it may also be pointed out what was said before, that it was required to have at least 26.5 litres of fuel in each wingtip tank in order to use the aircraft's maximum weight, 3,800 pounds (instead of 3,530 pounds as otherwise standard).

As indicated in Section 10.1.1 below and the AAIB final report, Section 1.5 the pilot that died was one of two pilots on TF-GTI's flight to Grímsey on 2 July 2000. In a police report testimony, that the pilot of that flight gave on 18 January 2001, he replied when asked, that the wingtip tanks had been used on that flight and that their function had then been reviewed. It was therefore his opinion that the pilot that died was quite familiar with the function. In Section 1.18.5 of the AAIB final report the pilot, that flew the aircraft TF-GTI from Vestmannaeyjar to Reykjavík in the evening of 6 August, is quoted saying that he did not use fuel from the wingtip tanks on that flight and had in fact never done that when flying TF-GTI.

On these grounds it may be considered likely that fuel from wingtip tanks had not been used when the aircraft crashed, as the Grímsey flight was not a decisive factor in this regard, it being an unusually long flight and across the ocean. It must be reiterated here that this aspect includes uncertainty.

8.6 The report of the instructors of the Icelandic Flight Academy hf.

The committee sought the assistance of Reynir Einarsson, Chief Flight Instructor at the Icelandic Flight Academy hf., Eyjólfur Gunnbjörnsson and Gudmundur H. Sveinbjörnsson, flight instructors at the Academy, for evaluating calculation of how much fuel had been consumed in the aircraft's flights from the time fuel was put into the main tanks at 18:15 on 6 August until the accident took place on 7 August.

Their report is published as an annex to this report but its main points are covered below, in Sections 8.6.1-8.6.5:

8.6.1 The *Jeppesen FliteStar* software used as a basis

The report bases its calculation on 337 litres having been in the aircraft's tanks after refuelling in the evening of 6 August, the same as in the AAIB final report, as there is no other figure to base on.

The fuel consumption plans are made with the flight navigation calculator *FliteStar*, which is a *Jeppesen* product. The software uses information from the TF-GTI flight manual. The software calculates flight time, fuel consumption based on predetermined causal factors that may be adapted to TF-GTI's fuel consumption. The software may be used as a reference to determine the aircraft's course and fuel consumption on the way, assuming that the pilot used the same power settings in his flight.

In VFR the pilot flies along the south coast and then the shortest way to Vestmannaeyjar across the body of water separating the islands from the mainland. Point of reference is a flight altitude of 3000 feet and the weather of 7 August was SE 10 knots with a temperature of about 10°C.

8.6.2 On fuel quantity

1. The aircraft's tanks were filled in the evening of 6 August 2000. The quantity put in then was 229 litres and according to the pilot who flew the aircraft then the main tanks were full at that point. It is uncertain how much fuel was in the wingtip tanks, but the operator's pilots told the AAIB that they had verbal instructions to keep a few litres in them, 26.5 litres to be more precise. Fuel servicemen did not know about the procedure for refuelling according to FAA-note 94-12-8, so that it is most likely that the tanks were not completely full. This accords with the operator's statement that fuel gauges never showed the tanks completely full.

2. If the fuel tanks were filled up to the notch – the lower rim of the collars of the tank filling opening – the pilots knew that the tanks should contain 246 litres. This is a common pilot procedure in Iceland. Endurance was then 4.1 hours without fuel in the wingtip tanks and 4.98 hours with 53 litres in them, but 7.71 hours if the wingtip tanks were full.

This endurance is calculated according to the operator's information that the aircraft used 60 litres per hour. The pilot flying the aircraft on 7 August quoted an endurance of 4.5 hours (4:30) before the first flight. The table shows the endurance calculated according to a consumption of 60 litres per hour.

Table 1.

245 litres (65 USG) in main tanks			340 litres (90 USG) in main tanks			Pilots' report	
Without wingtip tanks	With 53 litres (14 USG) in wingtip tanks	With 123 litres (32.5 USG) in wingtip tanks	Without wingtip tanks	With 53 litres (14 USG) in wingtip tanks	With 123 litres (32.5 USG) in wingtip tanks	6 August	7 August
4.1 hours	4.98 hours	6.15 hours	5.67 hours	6.55 hours	7.71 hours	5.0	4.5

3. The pilot began flying on 7 August without filling the tanks and he estimated the endurance at 4.5 hours (4:30). If that was the case then the main tanks would have contained 275 litres. The AAIB considers that there were 337 litres in the main tanks before the flight in the evening of 6 August. In these calculations it is used as a point of reference that usable fuel was 337 litres because it is impossible to know how much fuel was in fact in the tanks after the refuelling of 6 August 2000. The report does not provide for fuel having been used from the wingtip tanks because they are not expected to be used in normal flight, but only to be able to use the maximum take-off weight of 3800 pounds.

4. The following table shows endurance at different stages of flight assuming a 60 litre consumption per hour and shows how the pilot may have thought about endurance with reference to the actual flight time. There is also a column referring to the *Jeppesen FliteStar* flight software for comparison with the report authors' calculations.

		Hours		Litres	
LEGS	Actual flight-time	Pilot's idea of fuel quantity approximately	Pilot's quote of fuel quantity	60 l/ hour Fuel quantity remaining	Fuel quantity acc. to *FliteStar*
At the beg. of 7 Aug.	-------	4:40	4:30	280	272
# 3 leg	0:28	4:12	4:00	252	238.5
# 4-10 leg	2:10	2:02	-------	122	84.9
Fuel taken 120 l	2:00	4:02	Not recorded	242	204.9
# 11-18 leg	2:22	1:40	-------	100	36.5
Fuel taken 120 l	2:00	3:40	Not recorded	220	156.5
# 19-23 leg	1:30	2:10	2:30	130	65.2
# 24 leg of the accident	***0:32***	***1:38***	-------	***98***	***16.7***

The conclusion is this:

When the 24th leg that ended with the accident was flown the aircraft had been flown for just over half an hour, or 0:32 hours. The pilot, however, thought he had endurance for an hour and a half, 1:38 hours to be more precise.

For legs 19-23 the pilot quoted two and a half hours endurance – 2:30. If consumption was 60 litres per hour then the available fuel was 98 litres. According to the *Jeppesen FliteStar* software 16.7 litres of fuel remained when the accident occurred.

8.6.3 Method of calculating fuel

Calculations of fuel consumption are not quite the same in this report as in the AAIB final report. Here two methods are used to reach a conclusion. First of all the *Jeppesen* navigation software *FliteStar* is used and an attempt made to follow the most likely flight route to Vestmannaeyjar as the report authors know best both from Reykjavík and Selfoss. What follows here is based on calculations according to the *Jeppesen FliteStar* software.

a. Flight altitude between Reykjavík and Vestmannaeyjar used for reference in the *Jeppesen FliteStar* in flight No. 1-2 is about 2500 feet, wind 110° and temperature 10° C at MSL. The authors' conclusion based on the flight time assumes that 56% power was used en route (2300 RPM and 24 inch MP).

b. In flying between Reykjavík and Vestmannaeyjar – first flight of 7 August – the report authors conclude that more power was applied, or 66% (2400 RPM and 26 MP), than in the previous flights due to shorter flight time. The altitude was similar to the evening before as well as the weather conditions.

c. It is assumed that the same power was applied in flights between Vestmannaeyjar and Selfoss in the same weather conditions all that time, but the report authors assume a climb to 2000 feet in their calculations. In the return flight the authors assume a flight altitude of 1000 feet, power setting at 2500 RPM and 27 MP.

d. The last flight was flown at 2000 feet towards Selfoss, then a climb to 4000 feet is assumed until abeam Sandskeid. It is assumed that the pilot descended into Reykjavík and prolonged the approach. The wind was 110° and 10 knots.

e. Fuel measured in litres.

f. Along with taxi fuel in flights 1 and 3 is included a little fuel consumption for engine idling on the airport and run-up, 7.5 litres for each leg. In all other flights it is assumed that only 3.8 litres were used for taxiing and take-off. This is common knowledge in aviation and on which the report authors agree, especially with the short turnaround time between flights. Fuel calculations for climb and descent are based on unaltered flight course to and from airport.

Gudmundur H. Sveinbjörnsson calculated fuel consumption based on flight time and fuel consumption according to a table in the Pilots Operating Handbook, that is enclosed with this report. Those calculations use maximum usable fuel.
Weight: 3400 pounds.
Power use: 56% on the first day, 66% the day the accident took place.
Altitude: 2500 feet in all flights, but assumed 4000 feet altitude in the last flight.
Further explanations are in that report.

Table 2, below, is made according to information on time settings in the AAIB fuel calculations. It demonstrates the AAIB calculations, the calculations of the report authors based on the *Jeppesen FliteStar* software, the calculations of Gudmundur H. Sveinbjörnsson according to the Pilots Operating Handbook, and 60 litre consumption per hour is also used as a reference, relying on what the operator considered average fuel consumption and on the Pilots Operating Handbook. As noted above, there is a little difference between the results. The AAIB calculations are based mostly on actual time of take-off, 56% power and an altitude of 1000 feet. However, the *Jeppesen FliteStar* calculations are based on the most likely flight course, where prevailing weather conditions included a variable wind up to10 knots from 110°, and a temperature of 10° C and generally accepted flying procedures.

Table 2:

.Flight No.	Flight from	Flight-time	Traffic circuit	AAIB's conclusion on fuel consumption	Cons. acc. to *FliteStar*	Cons. acc. to POH	Cons. if 60 l/ hour	Fuel quantity acc. to AAIB	Fuel quantity acc. to *FliteStar*	Fuel quantity acc. to POH	Fuel quantity if 60 l/ hour
Usable fuel at the beginning of 6 August 2000								*337*	*337*	*337*	*337*
1	RK	33		32.5	35.5	32.98	33	304.5	***301.5***	***304.02***	304
2	VM	30	238	33.3	28.8	30.16	30	271.2	***272.7***	***273.86***	274
3	RK	28		30.2	34.2	33.17	28	241	***238.5***	***240.69***	246
4	VM	20	14	23.5	22.8	22.36	20	217.5	***215.7***	***218.33***	226
5	SF	15	6	19.3	19.8	18.16	15	198.2	***195.9***	***200.17***	211
6	VM	21	15	24.2	22.8	23.25	21	174	***173.1***	***176.92***	190*
7	SF	20	24	23.2	23.8	22.63	20	150.8	***149.3***	***154.29***	170*
8	VM	20	114	23.5	22.8	22.36	20	127.3	***126.5***	***131.93***	150
9	SF	15	5	19.3	19.8	18.16	15	108	***106.7***	***113.77***	135
10	VM	19	13	21.8	2.,8	21.47	19	86.2	***84.9***	***92.3***	116
									+ 120 l		
11	SF	16	13	20.1	19.8	19.6	16	186.1	***185.1***	***193.24***	220
12	VM	20	9	23.5	22.8	22.36	20	162.6	***162.3***	***170.88***	200
13	SF	16	25	20.1	19.8	19.06	16	142.5	***142.5***	***151.82***	184
14	VM	21	9	24.3	23.8	23.25	21	118.2	***118.7***	***128.57***	163
15	SF	17	5	20.9	20.8	19.95	17	97.3	***97.9***	***108.62***	146
16	VM	17	15	21.1	19.8	19.68	17	76.2	***78.1***	***88.94***	129
17	SF	16	9	20.1	19.8	19.06	16	56.1	***58.3***	***69.88***	113
18	VM	19	18	22.7	21.8	21.47	19	33.4	***36.5***	***48.41***	94
									+ 120 l		
19	SF	18	6	21.7	21.8	20.84	18	131.7	***134.7***	***147.57***	196
20	VM	20	12	23.5	22.8	22.36	20	108.2	***111.9***	***125.21***	176
21	SF	15	9	19.3	19.8	18.16	15	88.9	***92.1***	***107.05***	161
22	VM	18	13	21.9	20.8	20.57	18	67.0	***71.3***	***86.48***	143
23	SF	19	4	22.4	22.8	21.74	19	44.6	***48,5***	***64.74***	124
24	VM	32	5	33.3	31.8	36.54	32	***11.3***	***16.7***	***28.2***	***92***
Total consumption				**565.7**	**560.3**	**548.8**	**485**				
				Usable fuel remaining				*11.3*	*16.7*	*28.2*	*92*

* Landing gear down.

8.6.4 Conclusion of the flight instructors' report:

1. Usable fuel left in the aircraft's main tanks was between 16.7-28.2 litres when the accident took place. The report authors base calculations on no fuel having been taken from the wingtip tanks, as there is no reliable proof for the pilot having done so. The report authors also point out that there may be a minor error in their calculations due to uncertainty about weather conditions, how the aircraft was flown and a few other factors.

2. It is obvious that there is more **fuel consumption**, especially **due to fuel consumption in taxiing and take-offs on short routes**. For these reasons average consumption would be **more than 60 litres per hour, or between 68-69 litres per hour.** One flight was performed with the landing gear down which lengthened the flying time and thereby increased fuel consumption, but not in a manner suggested by F and T, due to more power being used due to drag. The report authors think that the pilot used the same flying procedure the whole day.

Overview of final conclusion

1. Mistakes in fuel management are by far the most likely cause of low fuel quantity in the tank in use and the engine running out of fuel.
2. When tanks were filled and how much, accords with the pilot having assumed that the fuel consumption was 60 litres per hour.
3. In fact the aircraft consumed more than 60 litres per hour due to short legs, number of take-offs and extensive climbing. The total fuel consumption in 8 hours of flight is therefore 75 litres more than expected.

8.7 The report of Tern Systems Inc.

8.7.1 Major premises used

There is a thorough report by Matthías Sveinbjörnsson engineer at Tern Systems Inc., a company owned by the University of Iceland and the CAA, *Statistical analysis of the estimated fuel level of TF-GTI the 7th August 2000.* This report is attached.

The first Chapter describes objectives and the second Chapter describes methods. The third Chapter details the premises, on the one hand known factors, flight hours, refuelling, number of passengers, altitude, or more precisely that the aircraft flew at 4000 feet a part of the last flight and then unknown factors, fuel quantity at the outset, fuel in wingtips, the effect of the landing gear being down on two legs, altitude and fuel starvation.

Conclusions in the report are on the one hand based on whether it is assumed that the wingtip tanks were used or not. Before going any further is should be considered that the estimated fuel quantity at the time of the accident gives a good indication of whether the aircraft's engine was starved of fuel at that time. However, it must be kept in mind that fuel quantity alone is not enough to determine whether the aircraft lost engine power due to fuel starvation. The effect of low fuel in the tanks must be taken into consideration and that this may have had an effect before fuel in the tanks was depleted, cf. Sections 5.1 and 5.2 of the report. It is worth noting in this respect that fuel starvation may be suffered if fuel quantity goes below 11 USG or 41 litres.

There are considerable odds for the fuel quantity having become low enough– or more precisely less than 11 USG, or 41 litres – for fuel starvation to have occurred at about the time the accident took place. If the wingtip tanks were used, there is a 87-89% probability of the fuel quantity having gone below 11 USG, or 41 litres and a 99% probability assuming that the wingtip tanks were not used, cf. Section 5.2.

The probability of the aircraft having run out of fuel as a function of time when the accident took place, assuming that wingtip tanks were not used and including additional consumption due to landing gear was 94-97%. The effect of having the landing gear down was about 3% at the time the accident took place, cf. Section 5.3.1.

The probability of the aircraft having run out of fuel as a function of time when the accident took place, assuming that wingtip tanks were used and excluding additional consumption due to landing gear is 58-61%. As before, it may be assumed that the effect of including additional consumption due to the landing gear was about 3% when the accident took place, cf. Section 5.3.2.

8.7.2 Final conclusion – Probability of fuel starvation

The final conclusion in Chapter 6 of Tern Systems report and is as follows:

> Here a statistical analysis of the likelihood of fuel starvation of TF-GTI the 7th August 2000 has been described. The model, assumptions and arguments are described and detailed analysis provided of both the results and the sensitivity of the parameters. All known uncertain parameters have been included in the model and their distributions estimated based on constraints derived from known facts and aviation experience.
>
> The results show that there is a 39-46% likelihood that the fuel level at the time of the accident is below the minimum usable fuel if it is assumed that wing-end tanks were used and an 83-89% if [it] is assumed that they were not used. The likelihood that the fuel level is below 11 USG, the lowest fuel level for guaranteed fuel feed to the engine, is 87-92% if it is assumed that the wing-end tanks were used and around 99% likelihood if the wing-end tanks were not included.
>
> It is difficult to determine exactly how much fuel was required to keep the engine running at the time of accident but if the minimum required fuel is estimated with a statistical distribution, the likelihood of fuel starvation is 58-61% if the fuel in the wing-end tanks is included and 94-97% if it is not included.
>
> Based on the fact that the information on the aircraft performance is obtained from the aircraft manual it can be further concluded that the calculated fuel consumption is less than in reality. Performance information from the manual is based on optimal weather conditions, aircraft condition and control of the aircraft which are rare in reality. The fuel consumption is therefore possibly higher than the calculated quantity resulting in a higher likelihood of fuel starvation than estimated in the above analysis.

8.8 Birger Andreas Bull's report

8.8.1 The reference should be 320 litres in the evening of 6 August

One member of the Ad Hoc Investigation Committee undertook to assess specifically the fuel calculations and the major aspects of his report will now be treated, cf. Sections 8.8.1-8.8.6.

It treats especially Section 1.18.5. of AAIB's final report and a table in Section 1.18.5.1 on TF-GTI's flight. He makes no objections, except that he considers it closer to the truth to use as a reference for the calculations that there were 320 litres of usable fuel in the aircraft's main tanks after refuelling at 18.15 on 6 August 2000.

8.8.2 Comments on the Forward and Taylor report

Bull agrees with F and T that it is not likely that the aircraft's main tanks had, at the first flight, been filled with 337 litres of usable fuel, which were supposed to be in them if the correct working method was used. He agrees also with F and T that it would be more sensible to refer to 320 litres having been in the tanks (cf. their report, p. 7). In addition to this he mentions that it is his experience that most pilots do not want spillage from the refuelling opening onto the wings due to danger of fire, smell and damage to the paint. He agrees also with F and T concerning flights with landing gear down that it would increase fuel consumption by 20% or about 5 litres.

For these reasons he has set up a reviewed table based on the table in the report of the instructors of the Icelandic Flight Academy on fuel consumption on 10 July 2003, setting the initial figure to 320 litres. According to those calculations the amount of fuel remaining in the tanks at the time of the accident was only 2.3 litres.

Table 1.

Leg no.	Route Totals *FliteStar*	Taxi (+Run up) *FliteStar*	Actual Fuel Burned *FliteStar*	Fuel Uplift	Fuel remaining **Flight Academy** *FliteStar*		Fuel remain. **Ad Hoc Committee** *FliteStar*
	Decimal corrected by Ad Hoc Committee		Decimal corrected by Ad Hoc Committee		Decimal corrected by Ad Hoc Committee		
					337.0	**337.0**	**320.0**
1	27.8	7.5	35.3		301.7	301.5	284.7
2	25.0	3.8	28.8		272.9	272.7	255.9
3	26.7	7.5	34.2		238.7	238.5	221.7
4	18.6	3.8	22.4		216.3	215.7	199.3
5	15.8	3.8	19.6		196.7	195.9	179.7
6	19.4	3.8	23.2		173.5	173.1	156.5
7	19.9	3.8	23.7		149.8	149.3	132.8
8	18.6	3.8	22.4		127.4	126.5	110.4
9	15.8	3.8	19.6		107.8	106.7	90.8
10	17.7	3.8	21.5		86.3	84.9	69.3
				120.0	206.3	204.9	189.3
11	16.3	3.8	20.1		186.2	185.1	169.2
12	18.8	3.8	22.6		163.6	162.3	146.6
13	16.3	3.8	20.1		143.5	142.5	126.5
14	19.6	3.8	23.4		120.1	118.7	103.1
15	17.0	3.8	20.8		99.3	97.9	82.3
16	16.0	3.8	19.8		79.5	78.1	62.5
17	16.1	3.8	19.9		59.6	58.3	42.6
18	17.7	3.8	21.5		38.1	36.5	21.1
				120.0	158.1	156.5	141.1
19	17.9	3.8	21.7		136.4	134.7	119.4
20	18.5	3.8	22.3		114.1	111.9	97.1
21	15.8	3.8	19.6		94.5	92.1	77.5
22	16.9	3.8	20.7		73.8	71.3	56.8
23	18.9	3.8	22.7		51.1	48.5	34.1
24	28.0	3.8	31.8		19.3	16.7	2.3
Total			557.7	240.0	**19.3**	**16.7**	**2.3**

<u>8.8.3 Comments on the report of the instructors of the Icelandic Flight Academy dated 10 July 2003</u>

Bull considers the way the report authors use the *Jeppesen FliteStar* software to present their calculations go as close as possible to estimating distances, calculation of time periods and fuel consumption. However, an operator who wants to use the program must get an approval thereof from the CAA of the country of operation. It is most common for the Pilot Operating Handbook to be the only manual in flight operations.

Normal values for fuel flow in modern piston engines when cruising is that fuel consumption in them specifically is 0.286 l/hp/hr.[1] This may be demonstrated as a common formula:[2] Horse power (hp) x power setting (0.xx%) x 0.286 = fuel flow in cruising (l/hr.). For example:

With a 75% power setting: 285 x 0.75 x 0.286 = 61.1 l/hr.
With a 66% power setting: 285 x 0.66 x 0.286 = 53.8 l/hr.
With a 56% power setting: 285 x 0.56 x 0.286 = 45.6 l/hr.

Reviewing outcomes on fuel flow from the *Jeppesen FliteStar* software indicates a match with the formulas above.

Bull thinks, from what he can understand from the case documents, that traffic to and from Vestmannaeyjar, and perhaps Selfoss, was rather heavy. For that reason it is likely that TF-GTI had, in some flights, to lengthen its approach or hold due to traffic ahead or on the runway. If that is correct it would have had the effect that the aircraft would have been flown with a higher power setting than expected in order to land at the times upon which the calculations are based. Furthermore, due to heavy traffic, especially to and from Vestmannaeyjar, it is likely that on some flights from Vestmannaeyjar TF-GTI had to wait on taxiways due to other aircraft landing or taxiing from the runway. If that was so it would have increased the fuel consumption a little.

If TF-GTI was flown more track miles it must have been flown at a higher power setting and vice versa (since the flight time is known). If the power setting is higher, then the fuel consumption is also greater, with less fuel remaining after the flight.

There is also another factor to be taken into consideration, that a pilot will not be able to fly exactly along a planned track (and keep the same altitude), especially if he flies manually without using an autopilot set to a GPS waypoint (and altitude hold). If his opinion is taken into consideration the conclusion is that there were somewhat more track miles flown than assumed in the software and thus the power setting must have been higher in order to land at the actual times.

Remarks on table 2 "Fuel Calculation" (*FliteStar*).
In the *FliteStar* sheets for each leg fuel consumption is calculated for separate parts of the leg with one decimal. These figures are then transferred to another table, FUEL CALCULATION, on the same page where they appear without a decimal, except for the Item TAXI where the number is handwritten with one decimal. The total of that column then appears in Table 2 of the Flight Instructors' Report, in column Burn off

[1] This specific fuel -flow consumption refers to amount of fuel (measured in l/hr) to produce 1 hp. (l(hp/hr.)). This value is valid for normal 55-85% power setting in cruising.
[2] See: Norwegian AAIB bulletin no. 34/1999.

FliteStar. As there were 24 legs Bulls feels that it is more correct not to round off the figures in this manner, whereby estimated fuel remaining in the aircraft's main tanks would be 19.3 litres in stead of 16.7 litres at the time of the accident.

8.8.4 Remarks on the Tern System Inc. report

Bull considers the statistical analysis of the report an interesting and smart model for calculating the possibility of fuel starvation. He says he has reviewed the presumptions used in the analysis but does not consider himself qualified to "approve" the mathematical formulas used in the analysis.

Bull considers it more probable, concerning figure 4-4, page 13 "Statistical distribution of the initial fuel in the main tanks of the aircraft," that the top of the curve should be further to the left. It is his opinion that it is most likely that there were 320 litres of usable fuel in the main tanks before first flight (cf. F and T's report).[3]

Concerning Figure 4-5, page 13, "Statistical distribution of the fuel quantity in the wing-end tanks of the aircraft", Bull believes that there were only some very few litres of fuel in the aircraft's wingtip tanks. He does not believe that the pilot succeeded in moving the transfer switch and open up for fuel. If he had managed to open, it is unlikely to have been of use due to the aircraft's attitude, which would have had to have been in level flight (and flown without slip) in order for fuel to feed from the wingtip tank (especially if they only contained a few litres of fuel). Another possibility is that there was some water in this wingtip tank, if it had not been drained for a long time.

Concerning figure 4-8, page 15, "Statistical distribution of the minimum required fuel" Bull believes that the probability of fuel starvation is already great when there are only 2-3 USG in the main tank in use (instead of a reference of 0.75 USG). He refers to his experience of flying C-210 aircraft with the powerful 285-300 hp engine saying that it requires a lot of rudder compensation for a coordinated flight. Everything happened very fast on TF-GTI's go-around. The pilot had flown for a long time that day and may have been late in reacting . Furthermore, a pilot must be very skilled to fly a C-210 aircraft coordinated all the time after he had to abort the landing.

In his report Bull cites the final words of the Tern Systems, Inc. report, which are cited above, and he then says that it is his opinion that the capacity indicated in the aircraft's manual applies to a new aircraft with perfect wings, engine and propeller flown in a manner that is fully accurate. A used aircraft does not have these qualities in reality and therefore such aircraft consume more fuel than provided for in the aircraft flight manual. The conclusion is that the probability of fuel starvation is in fact more than provided for in manuals.

8.8.5 General remarks

On aircraft with fuel injection engines (like the C-210) the fuel mixture must be leaned to a certain fuel-flow value for climb and another for cruise. When descending you also have to check that the engine does not run too hot and on final and before landing the mixture control should be in full rich position.

None of the reports seem to have anything about how the fuel flow was.

[3] This refers to fuel quantity after refueling at 18.15 on 6 August 2000.

If the pilot did not lean the mixture at all, the fuel consumption would have been higher (compared with the Pilot Operating Manual or *Jeppesen FliteStar*). On the other hand, if the pilot had leaned the mixture too much, the engine temperature would have gone too high, which is of course not good for the engine.

Since TF-GTI flew relatively short flights, it is possible that the pilot flew with a higher fuel flow setting than normal, because he did not reach to lean the mixture and at the same time did not want the engine to run too hot.

8.8.6 General opinion

After an aircraft accident without a surviving pilot or passenger, no witness to the fuel situation before the last flight, aircraft not equipped with a flight recorder, no cockpit voice recorder and main fuel tanks not intact, it will not be possible to know exactly what the remaining usable fuel was at the time of the accident. If there had been a large quantity of fuel left in the aircraft's tanks when it hit the sea it is Bull's firm belief that the rescuers would have seen more fuel spill on the sea surface than they did.

According to the C-210 Pilot Operating Handbook (POH) climb speed on a go-around is about 110 mph. In an emergency situation with engine failure and flaps up, a pilot should establish best glide speed at 95 mph. At the time the aircraft's stall speed was 75 mph with flaps up and no engine power. It is Bull's experience that with the C-210 you loose airspeed very rapidly when you simulate loss of engine power in a climb. If a pilot experiences engine failure on a go-around he must therefore be very quick to lower the nose in order for the aircraft not to stall.

8.8.7 Birger Andreas Bull's conclusion

TF-GTI's engine most likely suffered fuel starvation on the go-around out of Reykjavik airport on 7 August 2000.

As a result of the loss of engine power, with a centre of gravity close to aft limit, and with a pilot who was not sufficiently trained to react under such circumstances and possibly fatigued, the aircraft entered a stall and the pilot immediately lost control of it.

8.9 Ronald Schleede's comments on fuel starvation/exhaustion

Ronald Schleede found the calculations performed by the AAIB, using the assumptions they clearly stated, to be reasonable and logical. There were, nevertheless, many variables and unknowns to deal with. However, he found the AAIB analysis objective and thorough. The criticism by F and T, on the other hand, was characterised by speculation that went beyond reasonable assumptions. It is interesting to note that two examinations, each independent of the other (one made by instructors of the Icelandic Flight Academy at the request of the Ad Hoc Investigation Committee, and the other by Tern Systems Inc. at the request of the CAA in Iceland before the Ad Hoc Investigation Committee was appointed) both support the findings of the AAIB in its final report. Highly experienced aviation professionals from the Icelandic Flight Academy conducted one of these analyses, while the other was conducted by University professionals and used a sophisticated statistical evaluation of the various parameters. Again, these evaluations basically supported the findings by the AAIB in its final report. Therefore, the comments of F and T on fuel calculations are rejected.

It is well established and has been undisputed for many years that general aviation aircraft have poor fuel quantity gauges. Numerous accidents have occurred because of the inaccurate information they often provide and because pilots do not observe proper pre-flight procedures to verify the amount of fuel aboard. Without repetitive and expensive calibration of fuel gauges, strict procedures must be followed, including dipping or dripping the tanks to verify the actual quantity of fuel . In view of the multiple legs flown and multiple refuelling of the aircraft and no evidence to demonstrate accurate measuring by the pilot it is quite reasonable to conclude that fuel starvation caused the accident. *(Note: Fuel "starvation" is used in lieu of "exhaustion" because there may have been usable fuel in the auxiliary tanks and the engine was likely starved of fuel with fuel still on board. Fuel "exhaustion" would, on the other hand involve a total lack of fuel aboard).*

8.10 Summary of a probable quantity of fuel when the accident took place

1. The AAIB's conclusion is that there were 12 litres in the main tanks when the accident took place and assumes that fuel from wingtip tanks was not used.
2. The conclusion of F and T was that it should have been assumed that there was less fuel in the main tanks and then the aircraft would have run out of fuel before it reached Reykjavík. It being therefore right to assume that fuel was taken from the wingtip tanks and then the aircraft would have had sufficient fuel.
3. Instructors at the Icelandic Flight Academy have reached the conclusion that there were probably 16.7 litres in the aircraft's main tanks when it crashed.
4. With reference to the aircraft's flight manual and 60 litres/hour there were 28.2 litres in the main tanks when it crashed.
5. The report of Matthías Sveinbjörnsson at Tern Systems Inc. concludes that the probability of fuel having been less than 11 USG, or 41 litres, or at the limit at which the engine is certain to receive sufficient fuel, is from 87% and up to 99% depending on the assumptions used. The probability of lack of fuel when the accident occurred if wingtip tanks were not used is 94-97%, but if the wingtip tanks were used the probability is 58-61%.
6. According to the opinion of Birger Andreas Bull there were 2.3 litres in the aircraft's main tanks when it crashed. It is also his opinion that wing-tip tanks could only have contained some very few litres of fuel and, if the pilot, after loss of engine power, switched the transfer switch on, it would not have been possible to transfer fuel due to the aircraft's attitude, which has to be at level flight and without any slip.
7. It must be kept in mind that it is not enough if there was some fuel in the tanks. Not all fuel is usable and it is possible that the tank that ran out of fuel was selected even though there was some in the other tank. A reminder of the inaccuracy of fuel gauges is in order here.
8. According to the AAIB it cannot be excluded that uncoordinated flight in the turn shifted the little fuel that was left away from the outlet of the selected tank which then led to fuel starvation in the engine which can occur if there are 42 litres (11 USG) or less in the tank according to the aircraft flight manual.

8.11 On a probable fuel quantity at the time of the accident with respect to consumption

It is assumed that there were 320 litres of usable fuel in the aircraft after refuelling on 6 August at 18:15 and an addition of 240 litres on 7 August making a total of 560 litres of usable fuel.

If the aircraft consumed 60 litres on average per hour and was flown 08:05 hours 60 x 8 = 480 l + 5 = 485 – 560 = 75 litres would have remained.

If the aircraft consumed 63 litres on average per hour and was flown 08:05 hours 63 x 8 = 504 l +4 = 508 – 560 = 52 litres would have remained.

If the aircraft consumed 67 litres on average per hour and was flown 08:05 hours 67 x 8 = 536 l +4 = 540 – 560 = 20 litres would have remained.

If the aircraft consumed 72 litres on the average per hour and was flown 08:05 hours 72 x 8 = 576 l + 4 = 580 – 560 = –20 litres / Then it would have been short of 20 litres.

8.12 Conclusion of the Ad Hoc Investigation Committee

It is the firm opinion of the Ad Hoc Investigation Committee and the specialists it has consulted, that all calculations indicate that the engine stoppage was caused by fuel starvation.

9.0 The go-around

9.1 Circle flight – Holding – Approach

In Section 1.1 of the AAIB final report the course of events is described, as the aircraft TF-GTI went on its last flight from Vestmannaeyjar in the evening of 7 August and take-off was at 20:03 according to data from the control tower in Vestmannaeyjar. The course of events on the last leg will be given here.

9.1.1 Course of events according to the AAIB final report

Section 1.1 of the AAIB final report says:

> At 20:27:42 the pilot of TF-GTI reported that he was at Vífilsstadir 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 [Cessna 152 on a training flight] called and reported over Videy 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 Cessna 152. 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 replied 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 that he 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.

9.1.2 Go-around

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's a stall! It's a stall!"

9.1.3 AAIB final report coverage of the course of events

In Chapter 2 of the AAIB final report, Analysis, the above course of events is described thus:

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 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 of 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 F-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 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".

9.1.4 Conclusions in the AAIB final report

Chapter 3 of the AAIB final report, Conclusions, says this:

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 Skerjafjördur.

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.

As will be discussed hereafter in further detail, the Ad Hoc Investigation Committee deems it unlikely that the pilot took the tight circle over the harbour when he turned in the aborted approach because he had doubts about the quantity of fuel on board. It is more likely that he thought he had enough fuel and that other reasons are more probable, see further Section 10.3.

9.1.5 Overview of the circle flight and go-around according to the AAIB report

1. At. 20:27:42. TF-GTI is at Vifilstadir.
2. At approx. 20:29:00 TF-GTI reports over Álftanes.
3. At 20:30:00 TF-GTI is told to be number 3 for landing.
4. At 20:31:27 TF-GTI is coming over the tanks of Örfirisey.
5. At 20:31:52 TF-GTI is ordered to abort approach.
6. At 20:31.54 TF-GTI replies; aborts eastward.
7. TF-GTI turns north abeam Engey.
8. At 20:32:14 TF-GTI is permitted to go ahead and come in with a left turn after the Dornier which was coming over the tanks of Örfirisey.
9. At 20:32:20 TF-GTI confirms left turn and coming after the Dornier aircraft.
10. At 20:33:49 TF-GTI reports over the lake in Reykjavik.
11. At 20:34:10 TF-GTI receives instructions to abort landing and fly a traffic circuit.
12. At 20:35:04 TF-GTI stalls.

9.2 Forward and Taylor on the go-around

9.2.1 The go-around - an important element in the course of events

F and T consider that the go-around is an important element in the course of events just before the accident and cover this in Chapter 7 of their report, but they touch upon the go-around in Chapter 1 where they discuss the aborted approach in general terms.

9.2.1.1 On a tight circle and an untimely turn

In Chapter 1 they criticise the report in general and especially the AAIB theory that fuel starvation caused the engine to stop in the go-around with the consequences that the aircraft crashed. Then they say:

> Similarly, the Report seeks to explain the pilot's actions in making a *'tight'* circle late on the approach and his *'untimely'* turn after the go around on the basis that he thought that he was short of fuel. There is no evidence to support this contention. The term 'tight' when applied to a turn normally implies a small radius or steeply banked. Study of the radar data shows that this particular turn took about 1 minute 50 seconds to complete. This is only marginally less than the time taken to complete a similar turn under Instrument Flying Procedures or when in cloud. In no way could this turn be said to be tight. When challenged in April 2002, the IAAIB sought to justify the term 'tight' by saying that what the Report intended to convey, was that the turn was 'tight' in the sense that the pilot positioned his aircraft too close to the Dornier at the completion of the turn. However, as stated in Para 7, the separation achieved was adequate had the Dornier cleared the runway in a reasonable time. Moreover, the evidence of the RTF tapes indicates that, despite his overlong duty period, the pilot's voice was calm and showed no distress when he was told to delay his approach at a late stage. Regarding the pilot's 'untimely' turn, this could not have been untimely since there was no published procedure for a VFR go-around at Reykjavik and the pilot's action in turning at a safe height was perfectly reasonable and totally legal. However, the Report seeks to bolster its fuel starvation theory on the basis of this action.

9.2.1.2 On timing

In their report F and T say this on timing in chapter 7:

> Reference to the RTF tapes indicates that the Controller had established a separation of about 1 minute 50 seconds between the Cessna 152 and the Fokker 50 and that that allowed the Fokker ample time to clear the runway before the Controller issued a landing clearance to the Cessna. It can be deduced from the evidence that the Dornier was over the pond at about 20:32:40 and [G]TI reported over the pond at 20:33:49. Thus a separation of about 1 minute 10 seconds existed between the two aircraft on short finals. It can also be deduced that the Dornier landed at about 20:33:20. (This assumes an average groundspeed of 75kts from the time that it would have been over the tanks). Assuming that this separation was maintained, the Dornier had about 1 minute 10 seconds to clear the runway.
>
> Information received from the IAAIB following a meeting on 15 April 2002, stated that the Dornier was given clearance to land when it was 1.7 nmls from the threshold and at that time [G]TI was 1.6 nmls behind it. Assuming that this separation was maintained, and there would have had to be an unreasonable difference in the ground speeds of the two aircraft to reduce the separation significantly in the short time remaining before [G]TI was instructed to go-around, the time difference between the two aircraft would have been 1 min 17 seconds assuming a ground speed of 75kts for [G]TI. So it can be seen that from an analysis of both the time and distance data available, that there was at least one minute ten seconds separation between the two aircraft when [G]TI was instructed to go-around. This implies that the Dornier had one minute ten seconds to clear the runway before [G]TI could be cleared to land. Flight trials conducted during April 2002 in similar wind conditions that existed on 7 August 2000, established that a Dornier of the same type as ICB-753 required between 15 and 20 seconds from touchdown to decelerating to a speed at which it could safely turn off the runway. These were normal landings with no excessive use of retardation devices. Given this data, the Dornier should have been in a position to clear the runway to the left at 20:33:40 at the latest. However, it was still on the runway at

> 20:34:10 because it was at this time that [G]TI received the instruction to go around. There is therefore a minimum of [50[1]] seconds unaccounted for if, as the Controller stated, the Dornier was still on the runway when [G]TI was instructed to go-around.

Then F and T refer to their clients' reports shortly after the accident that the pilot of the Dornier aircraft had after touchdown and receiving instructions from the air traffic controller, '753 clear left to ramp' taxied along the runway. But to the AAIB he had said 'a few months after the accident' that he had cleared the runway to the left and taxied parallel to the runway before he had crossed it to his parking stand. F and T say that if this is correct and the aircraft were as separated from each other as has been described above, there should have been enough time to give [G]TI clearance to land with sufficient notice. And then F and T ask: "So why was [G]TI given a very late go-around instruction?"

The Dornier aircraft had received clearance to land at 20:33:04 and after this, according to F and T, the air traffic controller communicated on telephone with the air traffic control of Keflavík because of inbound traffic and he seemed to be relaxed and content that traffic flow was under control. At this time F and T consider that the Dornier was landing and [G]TI reported 'over the lake'. It was then said that it was "number one". At that time the Dornier was instructed to „clear left to ramp". It is not clear from the report (AAIB final report) or the printout where the Dornier was when the instruction was given. Then F and T say:

> Given the distraction of the communication with Keflavik and the fact that the Controller was alone at the Visual Control position at the time, it is possible that he was, in fact, unaware of the position of the Dornier, when he issued the taxi instruction. The instruction to *'clear left to ramp'* was given at 20:33:52. Such an instruction would not normally be given until an aircraft had landed and was on its landing roll. The instruction to [G]TI to go-around was given at 20:34:10, some 18 seconds after the Dornier was apparently safely on the runway. This would have been adequate time for the Dornier to clear directly to the left at the end of its landing run and clear the runway for [G]TI. So why did it not do so? It is probable that the Dornier pilot did in fact backtrack the runway, as he initially stated, and that the Controller was unaware of this until he suddenly noticed the runway conflict and ordered [G]TI to go-around. Although this sequence of events is not reflected in the report, given the evidence now available relating to the separation of the two aircraft on short final, and the initial statement of the Dornier pilot, such a sequence must now be considered. The question must also be asked as to why the Controller, if he was aware of the developing conflict on the runway, allowed [G]TI to descend to *'70 to 100 feet'* (his own words) before issuing a go-around instruction.
>
> Previous information from the IAAIB stated that when the Dornier was given clearance to land, [G]TI was 1.6 nmls behind it. A subsequent request from the authors produced the response that the minimum track distance between the two aircraft was about 0.9 nmls at the point at which the Dornier was about to land. Unless [G]TI was flying at a totally unreasonable speed, these figures are incompatible and it is therefore clear that a complete review of the radar data is required to resolve this anomaly.

<u>9.2.2 Overview of the circle flight and go-around in Forward and Taylor's report</u>

General comments:

1. According to the radar data the round flight took 1 minute and 50 seconds, thus the statement of the AAIB final report on a tight circle is not valid.
2. The AAIB final report statement on untimely turn in the missed approach is not valid. The turn was at a safe altitude, was perfectly reasonable and absolutely legal.

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[1]Note: Here F and T say 50 seconds, but the numbers that they mention indicate 30 seconds, not 50 (20:34:10-20:33:40=30).

Timing in Forward and Taylor's report.

1. At approx. 20:32:40 the Dornier was over the lake according to deductions which can be made from the data.
2. At 20:33:49 TF-GTI reports over the lake in Reykjavík.
3. The separation between the two aircraft was 1 minute and 10 seconds (20:33:49-20:32:40 = 1 min. 9 sec.) on the final.
4. At approx. 20:33:20 the Dornier lands according to what can be deduced. An average ground speed of 75 kts is assumed.
5. Assuming that this speed was maintained the Dornier had about 1 minute 10 seconds to clear the runway.
6. The Dornier received clearance to land when it was 1.7 nmls from the runway threshold according to information at a meeting on 15 April 2002.
7. TF-GTI was then 1.6 nmls behind it.
8. The difference between the aircrafts' ground speed was hardly such that the above-mentioned separation diminished significantly.
9. The time difference would then have been 1 minute and 17 seconds. (75 kts = 75 nmls/h; 1.25 nmls per minute (60 seconds); 1.6 nmls = 1 minute and 16.8 seconds (17 seconds)).
10. The analysis of time and distance data showed at least 1 minute and 10 seconds separation between the aircrafts and the Dornier then had 1 minute and 10 seconds to clear the runway.
11. The Dornier required 15-20 seconds from touchdown to decelerate to safely turn to clear the runway.
12. The Dornier could have cleared the runway no later than at 20:33:40 but it was still on the runway at 20:34:10 when TF-GTI received instructions to go-around.
13. The Dornier backtracked the runway after landing according to what F and T's clients said the Dornier pilot had said.
14. The pilot told AAIB a few months later that he had taxied off the runway to the left and back parallel to it.
15. If the Dornier pilot had done this there should have been enough time for TF-GTI to land.
16. They ask why TF-GTI received such late instructions.
17. At 20:33:04 the Dornier received clearance to land.
18. At 20:33:52 the Dornier received the instruction to clear left to ramp. It is possible that the air traffic controller was not aware of the position of the Dornier.
19. At 20:34:10 instructions were given on the go-around for TF-GTI, approx. 18 seconds after the Dornier was, as it seems, safely on the runway.
20. The Dornier had enough time to taxi straight to the left at the end of its landing run and clear the runway for [G]TI. So why did the Dornier not do so?
21. It is probable that the Dornier did in fact backtrack the runway, as the pilot initially stated, and that the Controller was unaware of this until he suddenly noticed the runway conflict.
22. It is necessary to reconsider the course of events. Why did the air traffic controller permit TF-GTI to descend down to 70-100 feet before he ordered the go-around if he saw the possibility of conflict?
23. Disagreement on the distance between the Dornier aircraft and TF-GTI, on the one hand 1.6 nmls and on the other hand 0.9 nmls demonstrates the need for a review of the radar data.

9.3 AAIB and CAA answers

9.3.1 AAIB answers

In its answers of 2 October 2002 to F and T's report the AAIB makes these comments, cf. Chapter 7:

> At a meeting of the AAIB with the report authors they were shown data that demonstrated the separation of a Dornier aircraft and TF-GTI on final approach which was about 0.9 nautical miles. They also received information on the Dornier aircraft having been 1.7 miles on final approach when landing clearance was given but the report authors wrongly claim that the AAIB gave them information saying that TF-GTI was at that time 1.6 nautical miles behind a Dornier on final approach. The report authors use this information to demonstrate that the Dornier aircraft had taken an abnormally long time to clear the runway after landing. Radar data that AAIB has in its possession and was shown to the report authors show that TF-GTI was 0.9 nautical miles behind a Dornier aircraft on the final approach. With reference to a normal approach speed for TF-GTI and the separation between the aircraft on final approach there is nothing that indicates that the Dornier aircraft was an abnormally long time on the runway. Nor does this correspond to the testimony of witnesses.

9.3.2 CAA answers

In the report of the Director General of Civil Aviation there are comments on the abovementioned statement of F and T and it is also pointed out that in their deliberations on why the Dornier aircraft had not cleared the runway and why the air traffic controller gave the Cessna aircraft TF-GTI instruction to abort landing this late, their timing of the course of events is somewhat different from the AAIB. It then says, cf. the Analysis Report, Chapter 7:

> The new time sequence is based on an unconfirmed interview of their (F &T) clients with the pilot of the Dornier aircraft which does not conform with the testimony provided by himself and others before the AAIB. For this reason the description of events as presented in the F&T report is highly improbable. This presentation of events is especially strange in view of the fact that the time tagged radar data on the tracks of both aircraft are unambiguous and clear and are officially available.

9.4 The conclusions of the Ad Hoc Investigation Committee on the go-around

9.4.1 Inaccurate information

F and T's conclusions on the TF-GTI circle flight are founded on inaccurate information. They overlooked that the radar data shows beyond doubt other timing, distances and altitudes than those which they use in their analysis. They estimated for example that it took close to two minutes (approx. one minute and 50 seconds) to fly the circle TF-GTI flew to create adequate distance behind the Dornier ICB-753 aircraft which came first, but this time is widely acknowledged in normal circle flight. In reality the flight took about one minute – more precisely about 50 seconds – which is in accordance with what is stated in the AAIB final report.

Two members of the Ad Hoc Investigation Committee, Ronald Schleede and Kjartan Norddahl reviewed the radar data and verified that the AAIB conclusion that it took about one minute to make the 360° circle is correct.
On the other hand, what F and T maintain, that it took 1 minute 50 seconds to make such a circle, is incorrect.

Therefore F and T's opinions are rejected.

9.4.2 Estimated timing

Various comments have to be made on F and T's timing of the circle flight and the go-around. Reference is made to RTF tapes of communication that "*indicates* that the Controller had established a separation of about 1 minute 50 seconds [...]" between the aircrafts. Then "*data*" is mentioned from which "conclusions may be drawn" without precision on what data is referred to. Also that "it *can* also be deduced that the Dornier landed at about 20:33:20." It then continues: "*Assuming* that this separation was maintained, the Dornier had about 1 minute 10 seconds to clear the runway." And this is added: "*Assuming* that this separation was maintained [...]." Then F and T refer to "*their clients' reports* shortly after the accident" that the pilot of the Dornier aircraft had turned and backtracked along the runway. On the pilot's statement to the contrary reference is made to his testimony to the AAIB which "*appears* to have been given a few months after the accident." F and T continue and say that it is "*possible*" that the Controller was in fact unaware of the position of the Dornier aircraft when he issued the taxi instruction and then that it was "*probable* that he did in fact backtrack the runway as he initially said [to F and T's clients] and that the Controller was unaware of this until he suddenly noticed the runway conflict [...]."[2]

Although many things remain uncertain about TF-GTI's flight on 7 August 2000, there are so many hypotheses here and therefore uncertain grounds that F and T's comments can in no way be significant.

9.4.3 Rules lacking on VFR go-around

It seems that there is a lack of clear information to pilots in the AIP on how the go-around should be conducted when approach is aborted according to VFR rules. Information to pilots describes how go-around should be conducted in IFR, but they are unclear on VFR.

In the AAIB final report, Section 1.18.10, this is said on go-around:

> 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."

Where go-around is treated in the AAIB final report, Chapter 2, Analysis, the abovementioned text from the AIP is quoted:

> [T]he 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.

F and T point out that the pilot's turn in the go-around could not have been untimely as there was no published go-around procedure for VFR flight in Reykjavík and they add:

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[2] The italics above are by the Ad Hoc Investigation Committee.

> Conclusion 3.19 - At the time of the accident there were no rules in the AIP relating to the procedure to be adopted by pilots following a VFR go-around so this conclusion is invalid.

AAIB makes this comment on the above statement by F and T in its answers to their report dated 2 October 2002:

> Conclusion 3.19 There is a comment on AAIB's conclusion that the pilot did not perform the go-around according to Aeronautical Information Publication rules, citing a lack of rules regarding go-around in VFR flight. There are rules at Reykjavik airport concerning flight routes in order to reduce noise in the airport vicinity. It should be noted here that the same rules usually apply to go-around as take-off. It is the AAIB's conclusion that the pilot did not abide by these rules in the go-around.

The Ad Hoc Investigation Committee considers it insufficient to refer to take-off procedure as the AAIB final report does, as quoted above. It must be kept in mind that take-off and go-around are different things. The committee considers that the go-around cannot be compared to flight procedures according to rules on noise. Here clearer rules are lacking which the committee proposes be set.

Finally, it must be kept in mind that the go-around itself was neither the cause of the accident nor a probable consequence thereof, but only one factor in the course of events that led to TF-GTI having to abort landing and perform a go-around which resulted in an accident.

10.0 The human factor

10.1 High stress

The Ad Hoc Investigation Committee looked especially into the fact that the AAIB final report tried little to explain why the TF-GTI pilot did not succeed as he should have in controlling the aircraft when the engine lost power as referred to above. It is most probable that fatigue was the cause, as the pilot's day of work had been long with short pauses as has been described before. There seems to have been considerable stress because of necessary tasks in relation to the annual festival in Vestmannaeyjar where numerous passengers needed transportation over a short time.

The AAIB comments to the Ad Hoc Investigation Committee draft report dated 19 January 2005 state that the form used was according to instructions on the form of final reports in the 8th Edition of Annex 13 to the Convention on International Civil Aviation published in July 1994. Which contains no mention of a human factor treatment. The same applies to the 9th Edition of Appendix 13 which was published in July of 2001 (International Standards and Recommended Practices. Annex 13 to the Convention on International Civil Aviation. Aircraft Accident and Incident Investigation. Ninth Edition July 2001. International Civil Aviation Organization). However, a special analysis of this factor is provided for in the Manual of Aircraft Accident and Incident Investigation, part IV, Reporting , Doc 9756. First edition 2003. International Civil Aviation Organization. Thus requirements on instructions and preparation of final reports had changed after the accident. Even though this is acceptable, it is the opinion of the Ad Hoc Investigation Committee that nothing stood in the way of the AAIB treating this factor specifically in its report. The Human Factors Training Manual. First Editions 1998. International Civil Aviation Organization, Doc 9683, contains rather thorough instructions on how to address the underlying human factors. Furhtermore, it may be mentioned that those involved in flight safety have placed a growing emphasis on investigating the human factor. In many states it has become customary to probe ever deeper into the events preceding aircraft accidents than the accidents themselves.

10.1.1 On the pilot

The pilot was a 28 year old male, an Icelandic citizen. His first flight certificate was a student license issued by the CAA on 24 June 1993. His private pilot license was issued on 25 May 1994. When the accident occurred he was holder of a commercial pilot license IIIrd class/aircraft issued on 2 January 1996 and valid until 31 January 2001.

Ratings in the pilot's license were as follows: Single engine land aircraft up to 5700 kg and night rating, dated 2 January 1996. IFR rating dated 4 November 1996, and flight instructor rating dated 21 July 1997. Type ratings were as follows: PN-68 dated 1 November 1996, C-310 dated 15 April 1999 and MEP (multi-engine land piston aircraft) dated 18 August 1999.

The pilot began working at L.Í.O. ehf./Air Charter Iceland and worked there since. According to the pilot's logbooks and other data, his total flight time was 1266:43 hours when the accident occurred, of which a total of 181:33 hours were during the last 90 days. His total flight time on the Cessna 210 type was all on this aircraft, TF-GTI, a total of 27:06 hours.

According to the pilot's logbook, his flight time during the 28 days before the accident was 81:30 hours, of which 12:06 hours were in Cessna 210. He had recorded 3:30 hours of flight in the USA on 5-6 December 1998 on a Cessna 206, a type which is similar to Cessna 210.

His first flight on TF-GTI according to the logbook was 1:24 hours on 20 June 2000 with another pilot from the operator. On 2 July he went three flights with the same pilot who signed for this as a "C-210 Check" in his logbook. According to TF-GTI's flight log there were passengers on board in addition to the two pilots on these two flights.

After this the pilot went on one flight alone in the aircraft, or for 1:08 hours, before he transported passengers as a pilot in command. Total flight time for these flights was 5:46 hours. These training flights were according to current rules.

The last time the pilot was trained in a flight procedures trainer (AST-300) was on 23 June 1999. The training took 1:54 hours according to the pilot's logbook. According to the logbook he stood an aptitude test for his rights (multi-engine aircraft and IFR rating) on a special training flight from Reykjavik on 12 July 2000 in a Cessna 402 aircraft. Furthermore, he passed health inspection Ist class for his flying rights on 16 June 2000.

It was revealed in the investigation that the pilot was second pilot in TF-GTI's flight to Grímsey on 2 July 2000, where fuel was used from the aircraft's wingtip tanks. (What has been stated above is from Section 1.5 of AAIB's final report.)

10.1.2 Flight incident at Húsafell in 1999

On 10 July 1999 the pilot flew the aircraft TF-GTM, a twin engine Partenavia P-68, from Reykjavík to Hornafjördur. Takeoff in Reykjavík was at 10:06 and landing at Hornafjördur at 11:22. The flight took 1:16 hours. From there the tour was planned for Húsavík and the pilot estimated a 1:00 hour flight time with an endurance of 3:30 hours. The aircraft took off from Hornafjördur at 11:49 and landed in Húsavík at 12:53. Flight time from Húsavík to Keflavík was estimated 1:30 hours and endurance 02:30 hours. Departure from there was at 14:20 and landing at Húsafell at 15:45. These timings are from Reykjavík tower memos and the aircraft had then been flying for 215 minutes or 3:35 hours, i.e. flight time (airborne). This does not include time for run-up or taxiing on runways.

At Húsavík there were difficulties in starting the right engine and after attempts for 30 minutes the engine started. During this time the other engine was running. There was one passenger in the aircraft, he did not like the prospects of the trip and asked that another aircraft be sent for, which was not possible.

Once the engine had been started the aircraft took off at 14:20 and flew IFR according to plan. The passenger reportedly said that he was not satisfied with the flight and encouraged the pilot to land as soon as possible due to a great headwind and limited fuel. He reportedly saw on the aircraft's fuel gauges that the right tank was empty but the left tank showed ¼. According to an entry at the Reykjavík tower the pilot called at 15:30 and said he was low on fuel on one engine. Shortly after he closed IFR and planned to fly VFR to Reykjavík. The pilot then said that he planned to go to Húsafell, but was not sure that he would succeed. State of alert preparations were begun there, police was sent for and search and rescue teams called out, but the pilot landed safely even though one witness who has good knowledge of flying described the landing as quite dangerous according to a memo from AAIB's Chief

Investigator who went to the scene. The AAIB Chief Investigator measured fuel quantity which proved to be 6 cm deep in each tank. According to gauges the fuel quantity stood at ¼ in each tank. The AAIB did not consider it necessary to investigate the case further and sent it to the CAA. The CAA sent an inspector to Húsafell to inspect the aircraft. There is no information available on how the aircraft got back to Reykjavík.

It is the opinion of the Ad Hoc Investigation Committee that AAIB did not have a reason to investigate the incident formally. However, the CAA sent men to the scene, as mentioned above. Further to that a CAA inspector wrote a letter to the director of operations at L.Í.O. ehf./Air Charter Iceland dated 13 July requesting a copy of the flight schedule and load sheet for the abovementioned flight which was initially planned from Húsavík to Keflavík. When the requested documents had arrived the CAA inspector sent the operator a letter dated 21 July 1999 where he was reminded to urge his pilots to complete all flight documents, including IFR flight plans and make sure that correct flight altitudes and flight routes were selected according to aircraft capacity. Passenger weight in the company's operatons manual also need to be adjusted according to a new regulation on the calculation of weight and balance in flight operations of 11 November 1997.

In spite of this the Ad Hoc Investigation Committee is of the opinion that it would have been right to make a formal report on the incident in order to have available information that is as clear as possible. This would have contributed to flight safety and stringent requirements must be made in this respect of those involved in commercial aviation operations.

The incident at Húsafell is based on a memo of the AAIB Chief Investigator at that time, written Monday 12 July 1999, an air traffic controller entry at the Reykjavík tower on 10 July 1999 and an AAIB analytical report sent to the Ad Hoc Investigation Committee upon its chairman's request on 23 August 2004.

<u>10.1.3 Flight duty exceeding 13 hours</u>

Ronald Schleede, member of the Ad Hoc Investigation Committee, gathered information on human factors in the hope of finding explanations for the various errors in judgement, decision-making, and the pilot's reactions when the engine lost power and the accident occurred. The following Sections are based on his report, cf. Sections 10.1.2-10.1.3.

The AAIB investigation revealed that the pilot exceeded the 10 hours limit which is put on flight duty, he went many flights with little time for rest and nourishment. His flight duty had lasted over 13 hours. On the other hand it is not clear how long he had been awake continuously before the accident. The CAA says in its comments on the AAIB draft report of 29 December 2000, that rules permit longer flight duties because of unforeseeable circumstances (cf. Section 1.17.2). This conclusion, however, is invalid in these circumstances. The fact remains that the pilot was tired and this contributed to what he overlooked.

<u>10.1.4 The role of fatigue in aircraft accidents</u>

If generally recognised literature on the role of pilot fatigue in aircraft accidents and old aircraft accidents reports are consulted, this strengthens the conclusion that pilot fatigue contributed to the cause of the accident on 7 August 2000. The Transportation Safety Board of Canada (TSBC) has compiled a guide for the investigation on how fatigue may be considered a causal factor in aircraft accidents. In the guide it is pointed out that it is an internal document to the board. Information there has been gathered from various sources without proper attribution to those sources. A list of general references is provided at the end of this Chapter. The guide contains a comprehensive list of the effects of fatigue on human (pilot) performance.

Following is what are considered relevant effects of fatigue and stated in the TSBC literature and generally accepted by aviation safety professionals.

> *Fatigue generally affects performance.*
>
> *Interest and motivation can for short periods overcome the effects of fatigue, but they are limited and they can end with little or no warning.*
>
> *Fatigue can have a large affect on a person's ability to respond to stimuli. If the response fails it affects reaction both to normal, abnormal and emergency stimuli. In a fatigued state, it can take longer to perceive stimuli, longer to interpret or understand them. When they have been identified it takes longer to take necessary action.*
>
> *Fatigue affects the ability to judge distance, speed and time.*
>
> *Fatigue can have a profound effect upon problem solving ability. In studies to determine the effects of fatigue on problem solving ability, it was found that after 18 hours awake, people showed a 30% decrement in performance and after 48 hours, the impairment averaged 60%.*
>
> *There is a risk that fatigue can lead a man to forgetting or ignoring normal checks or procedure and reversion to old habits. He would tend to recall operational events inaccurately.*
>
> *Mood is likely to be affected by fatigue, the effects of which are that people are less likely to converse, are less likely to perform low-demand tasks, are more irritable, are more distracted by discomfort and show carelessness.*
>
> *Fatigue can reduce attention, the effects of which are that people overlook or misplace sequential task elements, become preoccupied with single tasks or elements and are less aware of their poor performance.*
>
> *When alertness is impaired, people may fix their focus on a minor problem, when there is a risk of a major one; may fail to anticipate danger, may display automatic behaviour syndrome. People may fail to appreciate the gravity of a problem or situation, may display flawed logic and may apply inappropriate corrective reactions.*
>
> *Fatigue can result in reduced motivation to perform well. This can translate into a willingness to take risks and a laxity in safety that would normally not be tolerated when normally alert.*

Some past aircraft accident investigations have illustrated the adverse effects of fatigue and the causal relationship to those accidents. An example is the National Transportation Safety Board USA (NTSB) final report of the Continental Airlines DC-9 wheels up landing accident

(Report No. NTSB/AAR-97/01). The NTSB concluded that the flight crew's degraded performance was consistent with the effects of fatigue, but that there was insufficient information to determine the extent to which fatigue contributed to the accident.

In the final report of the American Airlines MD-82 approach and landing accident, the NTSB stated that the captain and first officer had been on duty 13 hours and 13 minutes, and 13 hours and 33 minutes respectively. Both had been continuously awake for at least 16 hours and 21 minutes. These numbers are quite similar to the duty time for the pilot of TF-GTI. The NTSB stated in its conclusion on the probable causes of the accident that fatigue and situational stress associated with the landing circumstances caused that procedures were not correct and that this contributed to the cause of the accident. These circumstances included i.a. deteriorating weather and the pressure not to have to divert to an alternate airport after a very long duty day.

The NTSB furthermore issued the following conclusions, from which the numbering is taken:

> 17. The flight crewmembers' performance during the accident flight was degraded as evidenced by their operational errors and impaired decision-making.
>
> 18. The flight crewmembers' focus on expediting the handling because of impending weather contributed to their degraded performance.
>
> 19. The flight crewmembers' degraded performance was consistent with the known effects of fatigue.[1]

It is clear that the above conclusions published by the NTSB might also be drawn from the evidence of the TF-GTI flight prior to the accident. The pilot of TF-GTI had a very long duty day (about 13 hours) and was under pressure to complete multiple flights in minimal time. Therefore, his errors of judgment, decision-making and performance of routine tasks and his difficulties dealing with emergency tasks were probably caused by fatigue[2].

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[1] Here reference is only made to these numbered Items from a longer report.

[2] Scientific literature on the part of fatigue in aircraft accidents:
Circadian Technologies (1995). *The CANALERT guide for locomotive engineers and their families.* Cambridge, MA: Author. Coleman, R.M. (1986). *Wide awake at 3:00 a.m. By choice or by chance.* New York: W.H. Freeman and Company.
Dinges, D.F. (1995). Performance effects of fatigue. In *Fatigue Symposium Proceedings* (pp. 41-46) Washington, DC: NTSB.
Gander, P.H., Graeber, R.C., Connell, L.J., and Gregory, K.B. (1991). *Crew factors in flight operations:* VII. *Factors influencing sleep timing and subjective sleep quality in commercial long-haul flight crews* (NASA Technical Memorandum No. 103852). Moffet Field, CA: NASA Ames Research Center.
Gander, P.H., Gregory, K.B., Connell, L.J., Miller, D.L., Graeber, R.C., and Rosekind, M.R. (1996). *Crew factors in flight operations VII*: Psychophysiological responses to overnight cargo operations (NASA Technical Memorandum No. 110380). Moffet Field, CA: NASA Ames Research Center.
Graeber, R.C. (1988). Aircrew fatigue and circadian rhythmicity. In E.L. Wiener and D.C. Nagel (Eds.), *Human factors in aviation* (pp. 305-344). San Diego, CA: Academic Press.
Green, R.G., Muir, H., James, M., Gradwell, D., Green. R.L. (1991). Human factors for pilots. Hants, UK: Avebury Technical.
Moore-Ede, M. (1993). *The twenty four hour society.* Reading, MA: Addison-Wesley.
National Defence, Directorate of Flight Safety. (1984). *Human factors guide for the conduct of aircraft accident investigation* (B-GA-015-001/FP-001). Ottawa: Author. Rosekind, M.R., Graeber, R.C., Dinges, D.F., Connell, L.J., Rountree, M.S., Spinweber, C.L., and Gillen, K.A. (1994). *Crew factors in flight operations IX*: *Effects of planned cockpit rest on crew performance and alertness in long-haul operations* (NASA Technical Memorandum No. 105539). Moffet Field, CA: NASA Ames Research Center.

The pilot's actions should now be considered more closely in the light of what has been said above.

10.2 IFR flight

At 20:19:15 when the aircraft was about 24 nmls from Reykjavík and was climbing to an altitude of 4,000 feet approaching Hellisheidi, the pilot called the approach control of Reykjavík airport and asked for clearance for IFR flight as further described in the AAIB final report, Section 1.1. In Chapter 2, Analysis, of the AAIB final report it then says:

10.2.1 From the AAIB final report

> 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 the IFR but was only registered for VFR and limited night VFR.
>
> The pilot had a valid commercial pilot's license 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 Hellisheidi was regarded as questionable, but that the route over Thingvellir and Mosfellsheidi 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 Hellisheidi.
>
> 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 Hellisheidi.
>
> When the aircraft approached the Reykjanes mountain ridge, the pilot probably thought it not advisable to attempt VFR flight over Hellisheidi. 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 radar image, near Sandskeid. 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 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. [See also AAIB final report Sections 1.7.1-1.7.5, 1.17.2 and 1.18.5].

10.2.2 Unauthorised to fly IFR

The pilot's IFR flight according to what is said in the beginning of the text above, does not conform to rules, but the following may be mentioned to explain the pilot's actions:

The pilot knew that due to the weather conditions he would fly IFR only for a short while, which proved to be the case, he flew 4:35 minutes.

The pilot's reasoning was probably that thereby he could finish the flight on scheduled time instead of returning to Selfoss, land there and delay the flight for an indefinite time.

It was clear for VFR flight through Thingvellir and Mosfellsheidi but this loop would have lengthened the flight. The pressure to finish the flight on time was perhaps the reason why the pilot did not choose that route.

Pressure to complete the flight must have been extraordinarily strong because of the atmosphere that is generally prevalent at the flight operator L.Í.O. ehf./Air Charter Iceland and the restlessness that characterizes the weekend of the annual festival at Vestmannaeyjar.

The most likely explanation why the pilot conducted the flight as he did, is that his judgement and ability were to some extent impaired because of fatigue, as he had had a long duty day and in many respects in difficult circumstances. As has been traced here above, it is a known fact that pressure and the stress that follows can cause fatigue, which dulls people's judgement, i.a. pilots, and impairs their performance. The pilot's behaviour in this last flight is undoubtedly an example thereof.

For these reasons strict rules on maximum length of duty are necessary and that it be ensured that they are adhered to. In this respect the flight operator bears a heavy responsibility as well as the pilot himself. The pilot should have stopped flying around 17:00 on 7 August 2000. He should have been aware of this. It should also be considered that it may sometimes be difficult for pilots to adhere to rules because of pressure from flight operators when there is a lot of work. He who adheres to the rule may risk being fired, since employment security of young pilots is often uncertain.

It is clear that the pilot broke rules with IFR flight in clouds, with passengers, according to a VFR flight plan.

It should, however, be borne in mind here that there are no indications that the IFR flight played any part in the accident.

10.3 What did the pilot know about fuel quantity?

In Chapter 9.0 above, fuel quantity in the aircraft's tanks has be covered in detail. It has not been established that the pilot checked how much fuel was in the tank when he went the first flight on 7 August. It may nevertheless be considered highly likely that he did. The fuel servicemen did not know whether the pilot filled himself the wing tip tanks. He reported an endurance of 4:30 hours. The pilots of L.Í.O. ehf./ Air Charter Iceland did not know the correct procedure for replenishment (cf. AAIB final report, cf. Section 1.17.1) and it is probable that the pilot who died didn't either. It is also not likely that he trusted the fuel quantity gauge any more than other pilots at L.Í.O. ehf./Air Charter Iceland (cf. Chapter 2, Analysis, of AAIB's final report).

He twice refuelled the aircraft on 7 August, 240 litres in total, but there is no record, however, of him checking the fuel quantity in the aircraft tanks except for once by dipping his finger into the fuel opening. The flight operator L.Í.O. ehf./Air Charter Iceland reported that the aircraft engine consumed 60 litres per hour and the pilot will have referred to that consumption per hour (cf. AAIB's final report, Section 1.18.5).

His error seems to be principally in that he, like others, did not know that the engine consumed more than reported, at least 63 and more likely 68-69 l/hour for which there is strong evidence in Chapter 8.0 above, covering the fuel starvation and therefore the pilot thought he had more fuel than he in fact had.

As indicated above, cf. Section 9.1.4, it is not safe to assume, as the AAIB final report does, that the pilot took a tight circle in the earlier go-around because he may have had doubts about the quantity of fuel aboard. It is much more likely that if he thought he was running out of fuel, he would have reported this or simply landed the aircraft and answered for it afterwards. This option must have seemed, in the eyes of a professional pilot, a more desirable option than to run out of fuel in flight. Once more, pilot fatigue is likely to have played a large part in these errors in judgement and decision-making.

10.4 Pilot reactions to loss of engine power

<u>10.4.1 A loss of engine power does not have to cause an accident</u>

The AAIB final report says that eye witnesses near the coast who saw the aircraft first noticed it when they heard an abnormal sound in the engine running. They thought that the aircraft had reached a 500 feet altitude and it was in almost level flight or slow climbing when it took a left turn. The bank angle increased and at the same time the aircraft fell into a steep spiral flight and crashed into the sea about 350 meters from the shore. The aircraft broke apart and sank about 6 meters with everyone aboard. (Chapter 1.1). It the says in Chapter 2, Analysis:

> 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 in 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 airspeed 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 airspeed in a glide to a controlled emergency ditching on the ocean.

The AAIB conclusion on a probable cause is that the pilot did not push the nose of the aircraft over immediately in order to maintain or acquire sufficient airspeed for an emergency ditching on the sea after the engine lost power, cf. Section 3.23.

It is noteworthy that F and T do not cover this causal factor of the accident at all.

<u>10.4.2 In search of explanations of the pilot's reactions</u>

It is clear that the pilot made an error which certainly could be attributed to fatigue after a long day of work as has been said before. In search of explanations of the pilot's reactions the following stands out:

1. The pilot pushed the aircraft's nose over too late because his mind was otherwise occupied, probably trying to restart the engine or trying to set the fuel tank selector to another tank.
2. The aircraft was heavy on controls and also tail heavy. The pilot's reactions were not strong and decisive enough. The aircraft did therefore not reach enough gliding speed and stalled.
3. The propeller blades went in a finer pitch than is laid out in the aircraft handbook and this reduced speed.
4. It is possible that a passenger took hold of the controls which is known to have happened in some cases and that this happened in desperation. Even though this would have happened for just one instant it would have caused the gliding speed not to increase as it should.
5. The AAIB final report shows that the pilot had all credentials and passed all relevant competence tests, cf. Section 1.5. In the final report there are, however, a few points indicating that the knowledge and training of pilots was inadequate, such as their ignorance of correct refuelling procedure, information on fuel consumption, insufficient records, too long flight duty, etc. The circumstances that the pilot of TF-GTI found himself in called for a solid training and resolute reactions to save the aircraft. In order to avoid stalling and to recover the aircraft from a stall pilots have to receive practical training in the relevant technique and the pilot must receive this training for every single aircraft type he flies. It may thus be assumed here that fatigue and insufficient training contributed both to the pilot's reactions.
6. Finally, it should be pointed out that doubts about these points should be interpreted to the pilot's advantage as neither he nor other persons in the aircraft could witness what really happened.

11.0 On the operation and surveillance thereof

11.1 On the operation of L.Í.O. ehf./Air Charter Iceland

An overview will be provided here of the operations of L.Í.O. ehf./Air Charter Iceland, but F and T conclude from the engine history which is covered in a special Chapter herein, that it gives rise to many questions on the company operations and the CAA surveillance of these operations, cf. Chapter 6 of their report, cf. also Section 5.3.2 hereinabove. In addition, fuel issues, education and training of pilots, making of reports and log books can be mentioned. First the company's operations will be covered and the CAA's surveillance of these operations in the following Section, and finally the CAA surveillance of flights to and from Vestmannaeyjar.

11.1.1 Journey logbook

A journey logbook was kept, but it was not aboard the aircraft. It was kept at the office of the operator L.Í.O. ehf./Air Charter Iceland at Reykjavík airport. There were no entries in special columns for fuel on board after each flight and the status of the engine time-in-service gauge.

On each page of the logbook there was a column for technical remarks, but there were no provisions for the confirmation of the pilot in command which is required for each flight, cf. Art. 11.5.1 of the regulation on air transport No. 641/1991 with subsequent amendments. (AAIB final report, Section 1.17.1).

What is stated here is then reiterated in Chapter 2, Analysis, of the final report.

It was also mentioned in the AAIB final report that the last entry in the journey logbook was on 6 August 2000. The last flight that evening was missing and the 22 flights the aircraft made on 7 August (Section 1.17.1).

The final report gives an account of the number of flights and the number of passengers according to the journey logbook. However, it cannot be seen from the aircraft documents how much fuel was aboard at the beginning of a flight or its distribution in the aircraft's four tanks. There were no entries on the 21 flights the aircraft took on 7 August 2000 before it went on its last flight to Reykjavík from Vestmannaeyjar. Information on take-offs and landings were obtained from the control tower in Vestmannaeyjar and in Reykjavík. The total flight time according to this information was 422 minutes or 7:02 hours. (AAIB final report, Section 1.17.1).

Art 19 (d) of the Aviation Act No. 60/1998 states that Icelandic aircraft shall have an aircraft logbook. This means a book which is called a journey logbook in Art. 11.5 of the regulation on air transport No. 641/1991. According to the provisions of the regulation it is requested that entries be made in a way that they may not be subsequently erased. The logbook entries shall be made at once which implies that they should be made after each flight before the pilot in command leaves or takes on another flight. If it is to be possible to make the journey logbook entries as described above, it is inevitable that it should be aboard the aircraft and the CAA says that this has repeatedly been pointed out to flight operators. An implementation whereby the pilot cannot make the entries in the journey logbook at the end of a flight must be considered absolutely unacceptable.

<u>11.1.2 Operations manual</u>

The operations manual was not updated whereby the operator violated Art. 4.2.2.1 of regulation No. 641/1991 on commercial air transport operation by neglecting to update changes to the regulation concerning his operations directly into the operations manual. The CAA reiterated to the operator that he must update and correct the operations manual according to the new regulations, cf. telefax of 13 October 1999 on gross weight and balance (cf. regulation No. 651/1997), and by e-mail on 1 November 1999 concerning the time of flight, duty, and rest (regulation No. 650/1997).

The completion of the review of the drafted operations manual of L.Í.O. ehf./Air Charter Iceland was delayed, the reason was that the draft primarily addressed the implementation of new rules based on JAR-OPS 1 which was uncertain would come into force for operators operating aircraft with a maximum gross weight of less than 10 tons. It is clear that the operator was aware that he must abide by the older operations manual while the new was not ratified along with the regulations that may have come forth since the operations manual was last formally validated.

It is worth mentioning that the operator subscribed to material of the CAA regulations and was sent regulation marked R 4.5B 28/02 1998 in March 1998, probably 17 March. He should thus have known about the regulation provisions on flight time and duty limitations and rules on rest.

<u>11.1.2.1 Fuel and oil records</u>

A fuel and oil record was not among the data the operator presented to the AAIB. Such a record shall be kept for each flight according to Section 10.3.1 in the operator's operations manual and the abovementioned provisions of the regulation on commercial air transport operation. These records shall be preserved for at least three months. For these reasons the pilots did neither have available a comparison of fuel consumption and flight time, nor an overview of the fuel quantity in the tanks (final report, Section 1.17.1)

This is then emphasised in Chapter 2, Analysis, of the final report with the following words:

> 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 operator said to the police that requirements to keep fuel and oil records are fulfilled by keeping fuel purchase receipts and in addition pilots always report on the operational flight plan how much fuel reserve they have for each flight, or more precisely what the endurance is.

Such receipts alone do not meet the provisions of regulation No. 641/1991, cf. Section 4.2.9.1 on commercial air transport operation: on the other hand fuel purchase receipts and operational flight plans are sufficient when endurance is reported. It is thus clear that the operator did not meet the abovementioned provisions in that there was no operational flight plan available where endurance was reported and fuel purchase receipts were available. The flight operator shall control that operational flight plans are made, that the operator receive a copy thereof and that they are prepared and preserved as they should.

11.1.2.2 Duty time limitations – Rest time schedules for pilots

The regulation provisions on flight time and duty time limitations in force or rest time schedules for pilots were not in the manual, but should have been. (AAIB final report, Section 1.17.2).

The Ad Hoc Investigation Committee considers that the basis should be the advertisement on the implementation of rules on flight and duty time limitations for flight crew No. 650/1997 (Section Q of JAR-OPS 1). With the abovementioned advertisement minimum rules on flight crew flight and duty time limitations took effect which the operator was obliged to comply with, as its implementation was postponed only until 1 March 1998, cf. advertisement No. 686/1998.

There is more that one way to fulfill the requirements of Section 1075 (a-b) of JAR-OPS 1. Usually a duty schedule is made for a fairly long period in advance, accessible to all pilots. Changes to the schedule are not always published separately although they are entered into it. On the other hand, all real duty and flight time for each pilot should be entered in a special register so that it may be proven that the JAR-OPS 1 rules have been followed.

In this respect there is no difference made between large and small flight operators, but the methods may differ depending on whether the flights are scheduled or non-scheduled. The duty register of an operator with irregular flights may for example only be for one day at a time. It may occur that tasks change with little notice, and then it is not required to make a special duty register, but still it must be ensured that the provisions of Section Q of JAR-OPS 1, on duty and rest time for those at work or called in for work, are adhered to.

A flight operator who does not inform his pilot of how long a duty may be, neglects his duties.

The operator has always been responsible for organising flights in such a manner that rules on flight and rest time are observed. The rules in Art 4.2.10.3 of regulation No. 641/1991 on commercial air transport operation shall be in the operating manual. It is the responsibility of the operator and director of operations to ensure that they are observed and to organise operations in such a manner as to make this possible. According to this the director of operations shall control that the pilots' duty time is organised and that the rules set are followed. He is responsible for the operations but the responsibility for the flight itself lies with the pilot in command. The director of operations shall provide that system and lay out the procedures so that the operations may be organised, but the pilot in command shall be responsible for the preparation of flights and that set rules are observed, including rest time.

According to JAR-OPS 1 1135 b) a freelance pilot shall keep a special register of his duty time and present it to the operators using his services. Otherwise this is in the hands of the operator.

Generally a duty schedule shall be made and presented to regularly employed as well irregularly employed pilots. If this is difficult because of task status the pilot shall be informed specifically when his duty is over and rest time begins.

11.1 3 Aircraft flight manual

The modifications that were made to the aircraft 28 December 1996 are treated in the AAIB final report, cf. Section 1.18.1. The final report says i.a.:

> 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 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, the 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.

As further covered elsewhere in the final report the pilots at L.Í.O. ehf./Air Charter Iceland were unaware that these modifications had a limiting effect on the permitted maximum weight of the aircraft. (AAIB final report, Section 1.17.1).

The AAIB final report then says, cf. Chapter 2, Analysis:

> The aircraft flight manual (Owner's Manual) for an unmodified 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.

Here is the conclusion of the Ad Hoc Investigation Committee:

1. There was an Owner's Manual in the wreck for an unmodified Cessna T210L, but the aircraft was modified 28 December 1996 as stated before.
2. The supplements for operating the wing tip tanks were not in the aircraft.
3. Information on limitations of permissible maximum weight and altered speed limits could not be found in the wreck.
4. Information on permitted payload which had been placed in the owner's manual applied to an unmodified aircraft.

5. The pilot was not aware that the modifications had a limiting effect in the maximum weight of the aircraft.

11.1.4 Airworthiness directive

The last airworthiness directive the Federal Aviation Administration of the United States, the aircraft's manufacturing country, which was issued and 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 the aircraft.

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 74 US gallons (284 litres) of fuel. As pointed out elsewhere, it was necessary to make sure that the aircraft was parked on a level ground, that its nose was at a positive pitch angle of 4.5° and that the caps of the main fuel tanks were fastened properly.

Point C was divided into two points. Point C_1 prescribed testing the fuel gauges for the tanks to confirm that they indicated correctly when the tanks were empty.

If this was not carried out, then point C_2 should be followed and the gauges marked 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 quantity gauges:

> FUEL GAUGES ARE NOT CALIBRATED, BASE ALL FUEL CALCULATION 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 part of the label was glued into a storage compartment on the right side of the instrument panel, it read:

> FUEL GAUGES ARE NOT CALIBRATED, BASE ALL FUEL CALCULATION ON VISUAL INSPECTION TIME AN[D] CONSUMPTION.

No indications of other markings were found in or on the wreck. As can be seen on the picture beneath, the latter part of the text is missing on the placard on the instrument panel of the aircraft.

The picture shows the placard on the aircraft's instrument panel.

Point D was also divided into two parts. According to point D_1 another type of refueling neck was to be installed in the fuel tanks as well as caps, or a warning alongside the original refueling neck according to D_2. There were no indications that this part of the AD had been implemented. The placard which was supposed to have the following inscription was not found on the wreck:

> 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 JAS, Inc. had carried out point C_1, checking the gauges of the fuel tanks on 15 June 1999, but the mechanic's signature was missing. Therefore 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 separately. The director of L.Í.O. ehf./Air Charter Iceland had confirmed that the gauges functioned but that they did not show "full tanks" when the tanks were full. The pilots regarded the fuel gauges to be so unreliable that they said they never trusted them.

The ADs were to be implemented no later than 22 July 1995.
(AAIB final report, Section 1.18.2).

Finally, the following should be reemphasised in these words, cf. Chapter 2, Analysis:

> 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_1 of AD 94-12-8 had been implemented, whereas in fact points A, C_1 or C_2 and D_1 or D_2 should have been implemented.
>
> 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° up. 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.

It then says:

> In the aircraft's logbook 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 bases 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.

From the above it is clear that the technical manager did not sufficiently ensure that all ADs had been implemented. He was not under strict obligation to inspect the aircraft himself, he seems to have used a copy of an AD notes list from a accredited workshop but it would have been preferable to use more precise methods. On the other hand it cannot be seen that any regulation provisions were violated even though these methods were used. It must, however, be pointed out that an aircraft owner is obligated, according to Art. 26 of the Aviation Act No. 60/1998, to ensure that an aircraft in use is airworthy and he is responsible for it having a valid airworthiness certificate. It is then is the hands of the technical manager to implement, cf. regulation on commercial air transport operation No. 641/1991, Art. 3.3.4. According to Art. 20 (c) of the Aviation Act airworthiness depends on that the regulations and instructions of the aviation authorities on maintenance management be implemented.

11.1.5 Passenger lists

The flight operator, L.Í.O. ehf./Air Charter Iceland presented a list with the first names of 300 passengers that were transported from Vestmannaeyjar on 7 August 2000. The last names of 37 passengers were included, but there was no other information on the other passengers. Among those, the age of two girls was mentioned, three and six years of age. The gender breakdown was 186 males and 114 females. The list did not specify when each passenger left Vestmannaeyjar, with which plane he or she travelled or where to. (AAIB final report, Section 1.17.1).

According to Art 19 of the Aviation Act No. 69/1998, an aircraft in flight shall have:

> f. a passenger list, if the aircraft is in international flight on which the names of passengers shall figure, the airport where they boarded and the destination airport; the passenger list shall also be available at the boarding airport and this is also valid for domestic flights.

It is clear from the above that these provisions were far from being met. It cannot be seen what passengers were on board each aircraft. Copies of the flight tickets with identification of each flight were not left at the boarding place. In addition to the abovementioned provision there are directives in the Aeronautical Information Publication (AIP-RAC 2-4 Art. 1.3) that a flight schedule and a list of names and addresses should be deposited. It is therefore clear that registration of a first name only is not traceable.

11.1.6 AAIB's main comments on the operations of L.Í.O. ehf./Air Charter Iceland

11.1.6.1 Load sheets, take-off weight, centre of gravity

In Chapter 2, Analysis, of the AAIB final report the main comments on the operations of L.Í.O. ehf./Air Charter Iceland are summarised. The following is said:

> 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 June 16 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 that 3800 lbs. The centre of gravity was somewhat far aft but nevertheless within permitted limits.

11.1.6.2 Pilots at L.Í.O. ehf./Air Charter Iceland

11.1.6.2.1 Shortage of take-off and landing weight forms

The AAIB final report says this on the pilots' work, Section 1.17.1:

> 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 cannot 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 the 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.

11.1.6.2.2 No data on loading

It appears that pilots did not leave any documents which could be useful to verify whether the loading of the aircraft had been within authorised limits. (AAIB final report, Section 1.17.1, see Chapter 2, Analysis).

11.1.6.3 On the aircraft engine's fuel consumption

In the AAIB final report, Section 1.18.5, this is said on the aircraft engine's fuel consumption:

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

It then says in Chapter 2, Analysis:

> As early as in the preparation of the flight from Reykjavik 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 Reykjavik 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 Reykjavik 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.

From this it may be concluded that the operator did not provide its pilots with accurate information on the engine's fuel consumption, although some of them may have suspected that it consumed more. The operator has clearly based his information on consumption in cruises on other routes. Flight on 7 August was unusual in that there were many take-offs, many landings, taxiing, waiting, and run-ups. It can be concluded that the pilot of TF-GTI based his endurance estimate on that the engine consumed 60 litres per hour although other pilots assume more consumption.

11.1.6.4 Overview of the comments above

1. Registration in the journey logbook was insufficient.
2. A fuel and oil record was not in the operations manual among the data the operator presented to the AAIB.
3. The regulation provisions on flying and duty time limitations in force or rest time schedules for pilots were not in the manual.
4. The operations manual lacked all information on the consequences of flying the aircraft after its modification 28 December 1996.
5. There were no forms available from the operator for compiling weight and balance records. A loading registry and balance calculations were not available for flight since 16 June 2000.
6. Not all parts of the airworthiness directives had been implemented according to their requirements. The description of the refuelling procedures beyond 284 litres had not been put into the flight manual. Markings on fuel tanks quantity gauges were insufficient. The pilots did not trust the gauges.
7. The ADs list was based on an insufficient list from the United States.
8. Passenger lists were inadequate and not according to law.

9. The pilots were not aware of the effect of the modifications made 28 December 1996 on the permitted maximum weight of the aircraft. They were not aware that Airworthiness Directives (ADs) had been issued concerning the aircraft's fuel gauges and on procedures for refuelling.
10. The pilots did not have accurate information on the engine's fuel consumption. It seems that the pilot of TF-GTI based his endurance estimate on the engine consuming 60 litres per hour.

It is now in order to examine the CAA's surveillance role.

11.2 On the CAA surveillance of the operation of L.Í.O. ehf./Air Charter Iceland

11.2.1 Legal provisions

There are provision on aviation administration in Chapter II of the Aviation Act No. 60/1998. Art. 5 says:

> The Minister of Transport is responsible for aviation administration.

Art. 6 says:

> The Icelandic Civil Aviation Administration is a special organisation under the control of the Director-General of Civil Aviation who has executive power according to this law and other laws and government regulations in the field of air traffic.

Art. 1 of regulation No. 441/1997 on the CAA, its organisation and tasks, says:

> The Civil Aviation Administration controls that laws, regulation and directives on aviation operation are implemented, with special emphasis on flight safety.

What has been revealed in the above Sections demonstrates that the L.Í.O. ehf./Air Charter Iceland was in no way flawless. Rules were breached and good working methods were far from being observed.

The CAA surveillance is carried out mainly in two ways. On the one hand by controlling that maintenance is carried out right and on the other hand by controlling the aviation operation itself.

11.2.2 Aircraft maintenance

There was a written contract between L.Í.O. ehf./Air Charter Iceland and the aircraft maintenance and repair firm G. V. Sigurgeirsson dated 28 December 1994. The firm was in charge of maintenance and technical direction of aircrafts registered in L.Í.O. ehf/Air Charter Iceland operation. The operation is under the regulation on air transport No. 641/1991 with subsequent amendments and according to Art. 3.3.4 the operator's technical director is responsible for all aspects of technical direction and maintenance, such as procurement of spare parts, interpretation of airworthiness certificates and maintenance planning.

Iceland is a member of the Joint Aviation Authorities (JAA). In accordance with the JAR rules the working methods of the CAA changed, but the JAR-145 rules which apply to the maintenance companies and JAR-OPS which concern the operators it is required that the undertakings establish a quality control system and appoint a quality managers. Both of these must be approved by the CAA.

In addition, the undertakings must submit a quality manual, containing written working procedures, for their operations for a CAA approval. With these quality systems in commercial aviation undertakings a 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 evaluation is carried out in accordance with the plan.

The AAIB final report then says, cf. Section 1.17.3.1:

> 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 the 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 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 audits 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 the irregularity by confirming the implementation by an inspection after the objection was received.

11.2.3 Aviation operation

According to the regulation No. 641/1991 on commercial air transport operation, L.Í.O. ehf./Air Charter Iceland does not need to have a quality system or an appointed quality manager because the rules of the JAA countries on aviation operations (JAR-OPS) which were in force when the accident occurred only included operators of aircraft with a maximum gross weight of over 10 tons and/or intended to carry 20 or more passengers. The entry into force of the requirements was postponed by an advertisement of the Minister of Transport on 9 March 1998. Thus regulation No. 641/1991 on air transport still applies to the operations of L.Í.O. ehf./Air Charter Iceland. As a result the undertaking does not need to have a quality system nor a quality manager.

Surveillance by the CAA of aviation operations of such operators is thus carried out by formal inspection and surveillance flights, where an inspector of the CAA surveys the preparation and execution of flights by the undertaking.

According to information from the CAA there were no plans made for evaluation and/or inspection of the operation of L.Í.O. ehf./Air Charter Iceland for 1999 and 2000. The AAIB final report then says, cf. Section 1.17.3.2:

> The ICAA has informed the AAIB that a formal evaluation of the operation 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 fulfill 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 AAIB 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.

What has been said above demonstrates that the CAA surveillance was not active enough and did not provide necessary control. It is especially significant that L.Í.O. ehf./Air Charter Iceland operations were only formally evaluated in January 1998, but apart from that the surveillance consisted in conversations and correspondence. There were no plans made for evaluation and/or inspection of L.Í.O. ehf./Air Charter Iceland operations for the years 1999 and 2000.

F and T do not cover this aspect especially and from that it may be concluded that they support the AAIB' opinion.

11.3 CAA surveillance of operations in Vestmannaeyjar

<u>11.3.1 Aviation safety at the annual festival of Vestmannaeyjar 2000</u>

F and T discuss aviation safety in Vestmannaeyjar on 7 August 2000 in Chapter 8 of their report. First they refer to Art. 1 of regulation No. 441/1997 on the CAA, its organisation and tasks, where it says:

> The Icelandic Civil Aviation Administration (ICAA) shall supervise that Acts Regulations and Instructions on aviation activities are enforced, **placing special emphasis on flight safety**. (authors' emphasis)

They subsequently refer to the following in the AAIB final report, cf. Section 1.17.3:

> 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.

Then they make mainly two comments on the CAA activities in Vestmannaeyjar on that day.

The former is that the CAA personnel overlooked that one pilot – presumably the one who died – had significantly exceeded his legal maximum flight hours or they had failed to take action if they had noticed this.

The latter is that there seems not to have been any employee of the Flight Safety Department on duty in Vestmannaeyjar. They express their astonishment that no measures were made for surveillance of flight safety issues, although the CAA was aware of the volume and nature of the flight operations. Had this been done it is probable that the fact that one pilot had been on duty far exceeding the legal maximum hours would have caught attention.

Then they say:

> Even though a significant number of ICAA staff were present, their efficacy seems to have been in doubt. There are entries in both the Westman Islands and Reykjavik Air Traffic logs relating to the difficulty in contacting members of the ICAA when urgently needed. Air Traffic Controllers do not enter matters of this nature in their logs unless there is a very good reason and they feel that the circumstances warrant it because there is a safety or serious operational matter involved. It was also alleged that some members of the ICAA were at times unfit to carry out their duties in a professional manner and that some members of the ICAA entered into the spirit of the Festival to the detriment of their aviation duties.
>
> The ICAA state that they have increased their surveillance of flying operations at subsequent Festivals.

11.3.2 CAA field of activities

Here the CAA and its employees are accused of not having taken any measures in order to attend to aviation safety issues as there was reason to. This having contributed to the pilot significantly exceeding permitted maximum flight hours. In relation to this a reference is made to entries in air traffic logs relating to the difficulty in contacting members of the CAA when urgently needed. F and T should have explained this further, e.g. by giving examples.

It is not within the field of activities of the CAA but of the operators to ensure that pilots do not exceed permitted flight hours, and the pilots themselves must consider this and bear some responsibility. Although it is by no means a good example to exceed the 10 hour maximum flight hours, a 13 hours duty will hardly be considered a major fault. A duty of such duration is permitted in unforeseen circumstances. What deserves criticism is that these circumstances were by no means unforeseen.

Furthermore F and T imply with unclear wording that the CAA personnel did not stand its duties as they should, and their statements can only be interpreted in a way that they were not fit to work because of alcohol consumption. The CAA has investigated this and has rejected these accusations.

They give neither examples nor refer to any evidence to support their statement. There may be normal explanations as to why it was difficult to contact personnel, but F and T did not bother to investigate it further.

12.0 Rescue part

12.1 Criticism by Forward og Taylor on limited coverage in the AAIB final report

In Chapter 9 of their report, F and T examine what the possibilities of survival after the accident were. They say the following:

> Paragraph 1.15 of the report provides a half page description of the rescue operation and the position of the wreckage and offers as analysis (properly contained in part 2) the following: *'From the injuries sustained by the persons, they can be assumed to have lost consciousness upon 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.'*
>
> No attempt was made in the report to provide the factual information relevant to this statement and appropriate to part 1, neither was there any further analysis in part 2 nor any conclusions or safety recommendations in parts 3 and 4 relating to the survival aspects.
>
> [...]
>
> A subsequent report, dated 12 March 2002, goes a long way towards redressing these omissions and it is hoped that in future the IAAIB will address them at the time. However one sentence in this later report, namely *'The organization and administration of the rescue operations, as well as the medical treatment of the injured, are generally, however, outside of the arena of the IAAIB in its reports'* suggests that there may still be a problem and that in future the survival aspects may continue to be less than completely covered by the IAAIB.
>
> International guide lines, in the form of the ICAO Manual of Aircraft Accident and Incident Investigation, spell out the need to *'determine the facts, conditions and circumstances pertaining to the survival or non-survival of the occupants of the aircraft'*. The earlier version, not replaced until late in 2000, stressed that this was *'equally important'* to determining the facts, conditions and circumstances relevant to the causes of the accident. The point being made is that the purpose of the investigation is to make safety recommendations aimed at reducing the number of injuries and fatalities and that in many (but not all) accidents this may be accomplished by addressing both causal factors and survival aspects in equal measure.

They recommend that in the future the survival parts be a part of the investigation of aircraft accidents and firmly dealt with, as they are important not in the least because the largest aircrafts using Reykjavík airport transport a greater number of passengers.

12.2 Responses from the Aircraft Accident Investigation Board

To this the AAIB makes the following comment in Chapter 8 of its report:

> The report authors comment on the AAIB not having sufficiently covered this part in its report on the accident. To support this they say that in an earlier version of ICAO's Manual of Aircraft Accident and Incident Investigations there were guidelines that require a more detailed investigation than the one undertaken by the AAIB. This version of the manual was, however, altered some time before the AAIB's report was issued. The AAIB later investigated this part according to the said instructions upon request by the Minister of Transportation.

12.3 Report on rescue part

The above-mentioned comment by F and T is justified and the Ad Hoc Investigation Committee supports it. It is surprising that the rescue part was not given more attention in the investigation. The AAIB comments on the Ad Hoc Investigation Committee draft report dated 19 January 2005 state that in making the final report the AAIB relied on guidelines on the form of such reports in the 8th Edition of Annex 13 published in July of 1994. Annex 13 of the Convention on International Civil Aviation and the abovementioned ICAO manual of Aircraft Accident Investigation part IV, Doc 9756, published in 2003 (cf. section 10.1) on reporting, contain guidelines on final report format where possibilities of aircraft accident survival are considered. The abovementioned Annex was published in 2003 after the AAIB report was issued so that AAIB's work will not be assessed based on that, however the Ad Hoc Investigation Committee would like to draw attention to two things. Firstly, that before part IV of the manual was published, the ICAO Manual on Aircraft Accident Investigation applied, Doc 6920, which is from early 1970. That manual has a whole chapter on aircraft accident survival possibilities – on search, rescue prospects and other possibilities. Secondly it has been general practice in many countries to provide an account of how search, rescue and other measures used to make people survive aircraft accidents, including when aircraft land in water. In spite of the words "a short description of search, evacuation and rescue..." in Annex 13 there was nothing to prevent the AAIB from investigating these aspects more thoroughly than was done at the beginning of the inspection. If others were supposed to report on rescue, e.g. the Coast Guard or ICE-SAR, cf. rules No. 207/1990 on the organisation and supervision of search and rescue at sea and along the coast of Iceland, it should have been mentioned in the AAIB final report. It is a generally accepted procedure of those who investigate and write reports on the effects of aircraft accidents to pay special attention to rescue possibilities.

This was improved with an additional report issued on 12 March 2002 with the title: *Report on the rescue part of the accident when the aircraft TF-GTI crashed at Skerjafjördur on 7 August 2000.* It was accompanied by a report by two physicians, one of whom is a specialist in orthopedic surgery, the other a specialist in accident and emergency medicine. It is therefore expected that these parts will receive closer attention in the future.

The Ad Hoc Investigation Committee considers that the measures taken included everything humanly possible to save the lives of those in the aircraft and another methodology would not have helped in these circumstances. Nevertheless an open mind must be kept for improvements, as there may occur emergencies in larger aircrafts.

12.4. Emergency plans

F and T consider that these should have been attended to in the accident investigation although there were no clear indications as to whether the manner of their implementation would have influenced the consequences of the accident. However, they specifically point out that the mobilisation method of the Civil Protection in Iceland should be looked into more closely. They propose that the Civil Protection in Iceland always be mobilised when an aircraft accident occurs, not only when at least 15 persons are on board. The arguments for this are that upon mobilisation information may be inexact, the procedures of the Civil Protection of Iceland include “a double-check of the procedures of other organisations” and it is suitable that the first reactions to an accident be strong, since it is easier to decrease the alert than increase it.

The Ad Hoc Investigation Committee supports that special attention be given to the emergency plans and that they be continuously reviewed.

13.0 Overview of the conclusions of the AAIB final report and Forward and Taylor's comments

13.1 Forward and Taylor's Assessment of the AAIB final report

F and T review the quality of the AAIB investigation and final report in Chapter 1 of their report where their final conclusions are presented. These are based on the Chapter in the AAIB final report entitled "Conclusions. Probable causal factors are marked with an asterisk." Finally, it is right to review the AAIB conclusions and the comments of F and T with regard to what has been accounted for in this report.

13.1.1 Issue of an airworthiness certificate

AAIB final report:

> 3.1 - The aircraft TF-GTI had valid registration and airworthiness certificates for commercial air transport operations, issued by the CAA.

F and T's report:

> Conclusion 3.1. This states that the aircraft had a valid airworthiness certificate. Given the dubious history of the engine detailed in Para 1.18.14 of the report this conclusion must be treated with caution.

Here F and T seem to confuse the issues whether the certificate was valid and whether it should have been issued. The aircraft certainly had a valid airworthiness certificate although the conclusion is that it should not have been issued in the circumstances, and in fact the AAIB criticises its issue. It was valid until revoked. This comment by F and T seems to be based on a misunderstanding of the nature of actions of the authority.

13.1.2 Instrument flight

AAIB final report:

> 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.

F and T's report:

> Conclusion 3.4 Although the flight was notified as VFR, it was conducted in part, as IFR. Since the aircraft was not authorised for IFR flight when operated commercially, this conclusion is inaccurate.

This comment by F and T can be accepted. Wording in the AAIB final report could have been more precise.

13.1.3 Passenger list

AAIB final report:

> 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.

F and T's report:

> Conclusion 3.10 Although a passenger list was not found, no evidence is offered to support the conclusion that one was not made. This appears to be an assumption.

A list of passengers in the last flight from the Westman Islands on 7 August has not been found. The available passenger lists were not made according to the instructions of the Aviation Act. Since the law requires that such a list be made, the burden of proof of their making is on the flight operator, not on the Civil Aviation Organization or the Aircraft Accident Investigation Board.

13.1.4 Fuel and oil records

AAIB final report:

> 3.11[1]* - 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.

F and T's report:

> Conclusion 3.11 Since the flying operation on the day of the accident comprised some 20 short flights, normal records, which would have related to significantly longer flights, would have been of little use to the pilot in calculating the fuel available to him at the start of his final flight. Indeed, the IAAIB had to consult experts to determine what the fuel consumption would have been in these unusual circumstances. It was therefore not because records had not been kept that the pilot did not have the information, it was because this information was not readily available to him.

F and T's conclusion that it would not have been very useful to make fuel and oil records must be considered odd. Although it would not have been right to trust them blindly, they would, with appropriate reservation, have been of guidance. In addition it must be kept in mind that holding such records and to having them available is required by law, irrespective of how the information they contain is assessed.

13.1.5 Did the pilot check the fuel quantity?

The AAIB report:

> 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.

F and T's report:

> Conclusion 3.12 - Where is the evidence that the pilot did not ascertain the quantity of fuel in the aircraft's tanks? In Para 1.18.5 of the Report,[AAIB final report] it is stated that none of the employees at the Westman Islands recall seeing the pilot measure the fuel when it was there. The fact that no one recalls seeing him check the fuel does not mean that he did not do so, especially given the high level of activity at the airfield on that day. Given the short duration of the flights on that day, a check of the fuel at Selfoss would have been equally valid. There is no record of any evidence taken from personnel at Selfoss relating to this.

Witness testimonies are surely not unfailing evidence, but in this case there are no other available. It is not sufficient for F and T to say that although no one recalls seeing the pilot check the fuel this does not mean that he did not do so. To maintain this some facts must be

[1] Probable cause factors are marked with an asterisk *.

pointed out which would weaken the testimonies of these persons. From the high level of activity in the Westman Islands it may just as well be deduced that the pilot did not take the time to measure the fuel. It is not correct that there is no record of any evidence taken from a serviceman at Selfoss. In the AAIB final report, Section 1.18.5, an employee at the Selfoss airfield is quoted saying that he did not see the pilot measure the fuel with a dipstick, but on the other hand he did see him stand on the serviceman's ladder and put his finger into the tank after 60 litres had been added to it. In addition to this all calculations that have been made clearly indicate that fuel starvation stopped the engine and caused the accident. This supports the suspicion that the pilot did not sufficiently ascertain the fuel quantity in the aircraft's tanks.

13.1.6 Underestimation of fuel consumption

This factor is covered by F and T in Items 3.13-3.15

AAIB final report:

> 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.

F and T's report:

> Conclusion 3.13 - This statement is only valid if the aircraft did in fact run out of fuel rather than suffer fuel starvation due to mis-selection of the fuel system controls.

This comment of F and T is difficult to understand. Statements on underestimation of fuel consumption and overestimation of fuel quantity by no means have to indicate that the aircraft ran out of fuel, they could just as well indicate fuel starvation which then means that the fuel had run so low in the main tanks that it was not usable or that is was in the reserve tanks and that they could not be opened in time.

AAIB final report:

> 3.14 - No mechanical malfunctions were found in the investigation of the accident which could explain the engine's loss of power.

F and T's report:

> Conclusion 3.14 - This conclusion is valid only because no serious attempt was made to identify other possible causes for the power loss.

It can of course always be maintained that the accident could be investigated further and the Ad Hoc Investigation Committee can accept this. The committee considers that it would have been right to investigate the engine closer than was done, e.g. by taking it apart and examine its individual components. Analysing the oil further than was done would also have been better. Nonetheless, the conclusion of the Ad Hoc Investigation Committee is that such an investigation would not have changed the AAIB's conclusion that fuel starvation caused the engine to stop.

AAIB final report:

> 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.

F and T's report:

> Conclusion 3.15 - Whereas conclusion 3.13 implies that the aircraft ran out of fuel, this conclusion appears to acknowledge that there may well have been fuel available but not used due to mis-selection. This is not compatible with Conclusion 3.13.

Here arguments are stretched beyond what is permissible. The conclusion in 3.13 does by no means have to signify that fuel exhaustion nor, in other words, that all the tanks were empty. It only signifies that the engine was starved of fuel because the fuel was too low in the selected tank to keep the engine going, even though there may have been fuel in other tanks that was not available, either because they could not be selected in time or because of uncoordinated flight. This comment of F and T's is therefore not taken seriously and does not contribute to the investigation.

13.1.7 Extra strain on the pilot

AAIB final report:

> 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.

F and T's report:

> Conclusion 3.16 - This Conclusion states that *'extra'* strain was placed on the pilot due to the Air Traffic situation. Extra to what? Again, the Report seems to be suggesting that the pilot was under strain due to his being aware that he was short of fuel. As stated elsewhere, there is no evidence that the pilot was under any strain.

Here F and T ask what extra strain there was. In fact the AAIB answers this in the Item above. The aircraft comes into heavy air traffic when it approaches for landing and the pilot must be more aware than before when he was cruising without disturbances from other traffic. It is perfectly in accordance with circumstances that this causes extra strain. Pilots may be under additional strain although it may not be heard in their voice. Nothing is mentioned here on the pilot's thoughts about fuel quantity and possible fuel exhaustion, so here F and T are making up the AAIB's thoughts.

13.1.8 Tight circle before the final approach – The circle flight

AAIB final report:

> 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.

F and T's report:

> Conclusion 3.18 - This conclusion attributes the lack of separation between [G]TI and the Dornier to the action of the pilot of [G]TI in making a sharp (tight?) turn so that when the aircraft was approximately

> over the threshold of the runway ICB-753 was still on the runway. The inbound turn was commenced following the air traffic controller's instructions to that effect. As explained elsewhere, the lack of separation was probably due to the time that the Dornier remained on the runway after landing.

The Ad Hoc Investigation Committee has reached the conclusion that F and T did not correctly assess the time the circle flight took before the final approach. They deem it to have taken a little less than 2 minutes and thus the circle was not as tight as the AAIB stated, but the AAIB deems that the flight took a little less that one minute and the Ad Hoc Investigation Committee accepts this after review of the recorded radar data. Due to the tight circle the separation between the aircraft was insufficient and therefore it was decided to abort the approach.

<u>13.1.9 Missed approach not according to rules?</u>

AAIB final report:

> 3.19 - The pilot did not execute the missed approach in accordance to 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.

F and T's report:

> Conclusion 3.19 - At the time of the accident there were no rules in the AIP relating to the procedure to be adopted by pilots following a VFR go-around so this conclusion is invalid.

The comment of F and T is valid as there were no rules at Reykjavík airport for missed approach.

<u>13.1.10 Pilot's doubts on the fuel quantity</u>

AAIB final report:

> 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.

F and T's report:

> Conclusion 3.20 - There is no evidence to support this conclusion.

This comment is without cause as it is only said in the final report that a tight circle and an untimely turn "could be an indication [...]", therefore this does not refer to any proof. The Ad Hoc Investigation Committee, on the other hand, does not support this in the AAIB's final report, cf. Item 10.3 above.

<u>13.1.11 TF-GTI flight altitude</u>

AAIB final report:

> 3.21 - The pilot of TF-GTI was ascending, had retracted the landing gear and flaps and the aircraft had reached an altitude of about 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.

F and T's report:

> Conclusion 3.21 - Part of this conclusion states categorically that the aircraft had reached a height of 500 feet. There is no evidence to support such a categorical statement.

The AAIB's final report says that the aircraft had attained an altitude of *about* 500 feet, therefore the AAIB final report makes no categorical statement.

It is not accepted that *nothing* supports the statement that the aircraft was in an altitude of 500 feet. This is supported by statements of witnesses among which are pilots and air traffic controllers, and the aircraft could also be seen on radar which would not have been if it had flown at a lower altitude. On the other hand, there may be an error in the assessment of the aircraft's altitude and therefore it would perhaps have been better to make further reservations on this point in the AAIB final report.

14.0 General comments on the report by Forward and Taylor

14.1 Forward og Taylor's task defined

In the preamble of their report Forward and Taylor describe their task such that the relatives of those who died engaged them in order to:

1. study the accident report and any other evidence that is available
2. comment upon the evidence (so far as it is available)
3. comment upon the conduct of the investigation (so far as this is possible)
4. comment upon the accident report in terms of its overall quality, its completeness, its findings and its safety recommendations (if any)
5. make any recommendations considered appropriate concerning the investigation process
6. make any recommendations considered appropriate concerning the report and its findings
7. investigate any relevant details deemed to be important in connection with the accident and concerning any of the parties involved

> As instructed our objective has been to comment upon the investigation of the accident and upon the final accident report and, bearing in mind that much reassessment always goes on prior to the completion of the final report, commenting upon earlier, draft reports may appear to be inappropriate. However after studying some earlier drafts and the changes made to them we have found it necessary to consider these but only in so far as they may shed light upon the investigation process.
>
> This report and its conclusions and recommendations are addressed to the relatives of those who died in the hope that useful lessons will be learned to help prevent accidents and loss of life in the future.

At the close of their introduction the authors add this:

> ICAO stresses that the sole purpose of an investigation and report is to prevent accidents and loss of life in the future and not to apportion blame; in this report we have this same purpose and we trust that the report and its conclusions will be used in this same spirit.

14.2 Presentation of their report

Although there are various useful comments in F and T's report it is clear from what is said in Chapter 13 that their report is not compiled as objectively as would have been expected and in too many instances their criticism of the AAIB final report relies on farfetched hypotheses. In this respect their presentation is disappointing. Hereafter a few additional examples of this will be shown to emphasise what has already been said.

<u>14.2.1 Generally on the report.</u>

When F and T's report is examined it may be seen that they do not always observe the objectivity that should be maintained in investigating aircraft accidents and incidents. They tend to accuse individuals who are employed at the ICAA and also members of the Aircraft Accident Investigation Board as well as blaming the organisations themselves. This is perhaps understandable considering the task they were given which is described above and was mainly to provide an opinion of the investigation, the documents on which it was based and reports that were made, especially the final report, but not to investigate the safety factors related to the accident.

Although F and T declare in the abovementioned text that the report is compiled for the sole purpose of preventing accidents, it shows in several places signs of undue belittlement of the persons involved in the accident investigation.

14.2.2 Competent AAIB investigators?

The Ad Hoc Investigation Committee felt several of F and T's comments disparaging and defaming and not presented as an honest and objective assessment of the investigation process and analysis of facts. Thus they say in Chapter 4 on the subject of engine seizure:

> k. Given the nature of the impact with the water that the [G]TI experienced, it should have been possible for a competent investigator to determine the position of the cowl flaps from witness marks on the cowl flaps and surrounding structure. This does not appear to have been done so it must remain a possibility that the flaps were closed.

These are speculations, which would have been necessary to investigate further, especially when keeping in mind that F and T had the opportunity to examine the wreck, including the cowl flaps, but they clearly did not. It is possible that the wording is influenced by the task they were entrusted with as stated previously.

14.2.3 Are the demands of the ICAO minimum requirements?

F and T's report also contains random evaluation and conclusions that are not fully founded. For example, the statement in the introduction to the report is based on the wrong assumption that ICAO standards are minimum standards agreed upon by the 188 member countries, many of which are underdeveloped and without the financial capacity to operate a satisfactory aviation administration. Most countries try therefore to maintain higher standards in all areas of aviation administration and F and T assume that Iceland chooses to be among those countries rather than be compared to the others where less requirements are made.

The contrary is true: ICAO's aim is to set safety standards for flight operations if the countries have accepted the organisation's rules and committed to implement them. It is true, however, that many countries do not follow these rules nor implement them. Despite this it is not correct that the ICAO rules aim at less than full aviation safety.

As further explained in Section 2.2.3 above, the flight safety in Iceland was reviewed by the ICAO and its experts reached the conclusion in their final report of June 2001 that Iceland compared well to 33 neighbouring countries and even better in comparison to 120 countries. Finally, they pointed out that the AAIB, which conducted aircraft accident investigations was an independent body and met all directives and other conditions laid out by the ICAO.

14.2.4 Aircraft accident investigation facilities

Another misleading statement is in the introduction where it says:

> It has been stated that Iceland meets the requirements of ICAO with respect to aircraft accident investigation (apart from the IAAIB not having its own facilities for the storage and study of aircraft wreckage).

Here F and T base on the incorrect condition that thereby the AAIB does not meet the requirements of ICAO because it does not have such a facility. ICAO has not set any rules regarding such facilities and no direct requirements thereon are found in its instructions, although it would certainly be for the benefit of the activity as a whole to obtain such a facility where budget and circumstances permit.

Few countries offer a permanent facility to preserve and investigate aircrafts wrecks. In many more countries there is no such facility but hangars are used or other buildings that are used temporarily as needed. For this reason it is misleading and in fact incorrect what F and T imply that Iceland does not meet the requirements of the ICAO.

14.2.5 Seizure and fuel calculations

The main points in F and T's criticism concern the potential engine seizure and the fuel calculations in the AAIB final report.

The seizure is covered in Chapter 7 above. F and T's coverage is characterised by guesswork that is barely realistic such as that en engine that has become stuck due to overheating or seizure turns normally when cooled and this probably means when it falls into cold sea, cf. Section 7.3.1, and rather dubious conclusions, cf. Section 7.3.2.

On fuel calculations this is said among other things:

> The investigation appears to have come to the conclusion at an early stage that the primary cause of the accident was fuel starvation for whatever reason and thus only evidence that supported this conclusion was given weight in the subsequent analysis. [cf. Chapter 1].

Then they say:

> The report seems to have made the assumption that the aircraft ran out of fuel and then used evidence in a selective manner to support this assumption. [cf. Chapter 3].

Words such as these contain a clear insinuation on sloppy work procedures of the AAIB. Apart from this F and T neglect to support their conclusions with their own calculations.

14.2.6 Various comments by the Ad Hoc Investigation Committee

F and T discuss in length the timing and the circumstances of the aborted approach of the TF-GTI and definitely question the AAIB analysis in the final report. Their argumentation has obvious defaults and some points in their criticism are founded on poor evidence, cf. Section 9.0 above and especially Section 9.4.2.

In their coverage of the history of the engine, F and T present the hypothesis that it had been new from a Cessna 402. This is covered in Section 5.0 above, cf. especially Sections 5.3.1-5.3.4 and 5.4.1. Their input only complicates the matter. It is therefore normal to ask: Where did they get this information? Is this based on facts or presented as a guess or hypothesis which is difficult to ascertain and is only misleading?

In Chapter 7 of their report F and T maintain that a Dornier aircraft was taxied back on the runway, which they base on what their clients relate they have heard the pilot say shortly after the accident. The pilot, on the other hand, maintained to the AAIB that he taxied parallel to the runway. This raises doubts and one may ask, what the facts are and why do they make use of this almost as if it were facts if it is not true? The Ad Hoc Investigation Committee has reviewed the matter and cannot but agree that the AAIB conclusions are founded but what F and T say can only be misleading.

F and T refer to control tower sound recordings of conversations between the air traffic controller and the pilots in the go-around before the aborted approach, cf. Chapters 3 and 7 of their report. This demonstrates that they have obtained access to the recordings. In view of the legislation in force when the accident took place this would not have been illegal, but it may be disputed whether it conforms with international legal obligations that Iceland has undertaken, cf. Annex 13, paragraph 5.12 (Non-disclosure of records).

On the other hand it is clear that the sound recordings were not used in order to improve flight safety and prevent accidents, but in order to bring charges against persons.

An example of F and T's criticism, which can hardly be considered appropriate is their comment on what the AAIB final report says about the CAA preparations in Vestmannaeyjar before the annual festivities:

> Despite this, the ICAA personnel at the Westman Islands on the day of the accident failed to notice that at least one pilot, that of [G]TI, was significantly exceeding his legal maximum flying hours, or if they had noticed then they failed to take any action. [Chapter 8].

The pilot did not exceed any maximum flight hours. On the other hand he exceeded by over 3 hours the limits set for flight duties, but these are two different things. It is not clear here whether F and T are misleading or whether they have made a serious error.

A reminder is in order of their innuendo that CAA personnel did not perform their duties in the Westman Islands on the festive days because they were taking part in the amusements, cf. Section 11.3.1 above.

Finally, unfounded speculation may be mentioned. F and T consider that an unregistered fuel replenishment in addition to the two registered on 7 August cannot be ruled out, or that replenishment was registered to another aircraft, cf. Section 8.3. Then they maintain that although no passenger list was found this does not prove anything regarding the making of such a list according to the provisions of the Aviation Act.

15.0 Final conclusions - Overview

1. This report is an attempt to shed light on the aircraft accident at Skerjafjördur on 7 August 2000. For this reason many points have been included from earlier reports, in order that the viewpoints of those who have dealt with the matter may be presented clearly, cf. Chapter 1.
2. Iceland complies well with the ICAO requirements on flight safety, cf. Chapter 2.
3. The Aircraft Accident Investigation Committee is an independent body. There is no indication of it being under any undue pressure from other governmental bodies, resulting in influence on its investigations or conclusions, cf. Chapter 3.
4. The CAA should neither have registered the aircraft TF-GTI nor issued an airworthiness certificate for it because of its unclear history and the insufficient documents that came with it, cf. Chapter 4.
5. The engine history and background were unclear, as documentation was inadequate, with little being known about the engine's origin and treatment until 1994/96. All of this should have been an indications to the CAA to ask for further documentation on the engine and to have it examined in particular, as well as the aircraft before it was registered and issued an airworthiness certificate. Nothing suggests, however, that these insufficiencies contributed to the causes of the accident, cf. Chapter 5.
6. Neither laws nor any other rules were violated, even if the engine was released 4 days after the accident. On the other hand, it may be said to have been unfortunate to release it so soon, especially when the repercussions are kept in mind, cf. Chapter 6.
7. It is very unlikely that the engine seized or stopped due to overheating, cf. Chapter 7.
8. Fuel starvation is the most likely cause of the engine failure during the aborted approach in the evening of 7 August 2000, cf. Chapter 8.
9. There are several uncertainties about the TF-GTI circle before its final approach and the following aborted approach. Rules on aborted VFR approach flight are lacking at the Reykjavik airport, cf. Chapter 9.
10. Fatigue after a long, hard workday, and insufficient training were factors in the pilot's poor judgement and decision-making, and in his responses when the engine stopped, cf. Chapter 10.
11. Much was inadequate in the flight operations of L.Í.O. ehf./Air Charter Iceland. The CAA surveillance of the flight operator was unsatisfactory. On the other hand there was no noticeable flaw in the CAA surveillance of flight operations with regard to the annual festivities in Vestmannaeyjar during the long August weekend of 2000, cf. Chapter 11.
12. The criticism in F and T's report of 4 October 2002 of insufficient investigation into the rescue factor with regard to the aircraft accident on 7 August and little discussion of that in the AAIB final report is valid, but the AAIB had already remedied this through an additional report on 12 March 2001. The comment on the mobilisation of rescue teams is useful, cf. Chapter 12.
13. Many comments by F and T on the AAIB investigation and final report are not valid, cf. Chapter 13.
14. There are various flaws in Forward and Taylor's report, as regards content, arguments, analysis and presentation, although it contains some valid comments and good suggestions, cf. Chapter 14.
15. Based on the above, the Ad Hoc Investigation Committee's main conclusion regarding the cause of the accident is as follows: TF-GTI's engine suffered fuel starvation on the go-around out of Reykjavik airport on 7 August 2000 which resulted in loss of power. As the result of the loss of engine power, with the centre of gravity close to the aft

limit, and the pilot's being insufficiently trained to react to such circumstances, and also with the pilot's being fatigued, the aircraft stalled and the pilot lost control of it.

16. In regard to flight safety in Iceland, to the position and circumstances of the AAIB and to the investigation of the aircraft accident in Skerjafjördur on 7 August 2000 reference is made to Sections 2.2.3.1-2.2.3.3 in this report. The Ad Hoc Investigation Committee agrees with the main points there.

16.0 Safety recommendations

16.1 Recommendations of the Aircraft Accident Investigation Board

The AAIB final report made the following recommendations for improving flight safety:

> **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 fulfills 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 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 to 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.

16.2 Recommendations of the Ad Hoc Investigation Committee

The Ad Hoc Investigation Committee supports the above-mentioned recommendations, but recommends in addition:

The Ad Hoc Investigation Committee recommends that the Minister of Transport implement the following improvements:

1. That the AAIB acquire enough funds to obtain its own facilities for the preservation and examination of aircraft wrecks and components from them.
2. That the AAIB be secured access to sufficient funds to arrange for the necessary JAA-approved facilities and technical equipment for functionally testing engines or other aircraft components that have been involved in accidents.

The Ad Hoc Investigation Committee recommends that the Civil Aviation Administration improve its work procedures by the following points, in consultation with the Ministry of Transport, where ever applicable:

1. That the surveillance of smaller flight operators and those in charge of aircraft maintenance become stricter, cf. Sections 4.5 and 4.6 in the AAIB final report. That

special attention be paid to operators' providing accurate, proper reports, certificates and other documents.

2. That the CAA review not only its work procedures upon registering used aircraft, cf. recommendations in the AAIB final report, Section 4.2, but also upon issuing airworthiness certificates.
3. That the practical training of pilots working for small flight operators be improved in order that they receive training on every type of aircraft they fly.
4. That special emphasis be placed on the compliance of those in commercial aviation with the requirements to keep fuel and oil records and the careful preparation of plans for fuel and oil reserves.
5. That monitoring become stricter of whether passenger lists are kept according to the dictates of law.
6. That a different wording be considered for air traffic controllers when there are engine near an airport, so that permission to land will not be mentioned, as this could possibly cause a misunderstanding.
7. That clear rules be set on aborted approach during VFR flight.
8. That emergency plans receive special consideration and undergo constant revision.

The Ad Hoc Investigation Committee recommends that the Aircraft Accident Investigation Board improve its work procedures by the following points, in consultation as applicable with the Ministry of Transport and others that may be concerned:

1. That rules of procedure be set on the preservation of aircraft wrecks and components from them which cannot be preserved at the AAIB's own facilities.
2. That aircraft wrecks and components from them which may provide information on the cause of an accident not be released until an appropriate time has elapsed after the issue of a final report and until all parties concerned have had the opportunity to acknowledge the content of the report and present comments. That nothing be released if there are indications of criminal behaviour, except in consultation with the police and perhaps also the prosecuting authority.
3. That an engine involved in an accident similar to that which is the object of this report be sent to a recognised engine workshop approved for work on the engine type in question and be taken apart, with a report being made of the conclusions. A representative of the AAIB shall be present and shall oversee work while the engine is being torn apart and examined. The workshop should not have been involved in maintenance for the engine that was in the accident. A recognised workshop is a station recognised according to JAR 145 or FAR 145 and accepted by the JAA.
4. That the AAIB examine as exactly as possible the human factor in the cause of aircraft accidents.

REPORT ON FUEL CALCULATION
FUEL CALCULATION OF THE ACCIDENT OF TF-GTI ON AUGUST 7TH 2000 AT REYKJAVÍK AIRPORT

Annex I

REYKJAVÍK 10TH JULY 2003

REPORT ON
FUEL CALCULATION

Fuel calculation
of the accident of TF-GTI on August 7th 2000 at Reykjavik Airport, Iceland

Report made by
Reynir Einarson, B-757 Pilot and CFI
Eyjólfur Gunnbjörnsson, B-757 Pilot and FI
Guðmundur H. Sveinbjörnsson, FI

REYKJAVIK 10th JULY 2003

Reykjavik, 10.july 2003

To: Mr. Sigurður Líndal
Professor of Law
University of Iceland

From: Mr. Reynir Einarsson, CFI, B-757 pilot
Mr. Guðmundur H. Sveinbjörnsson, FI
Mr. Eyjólfur Gunnbjörnsson, FI ,B757 pilot

The Fatal Accident of TF-GTI, Fuel calculation.

Preamble

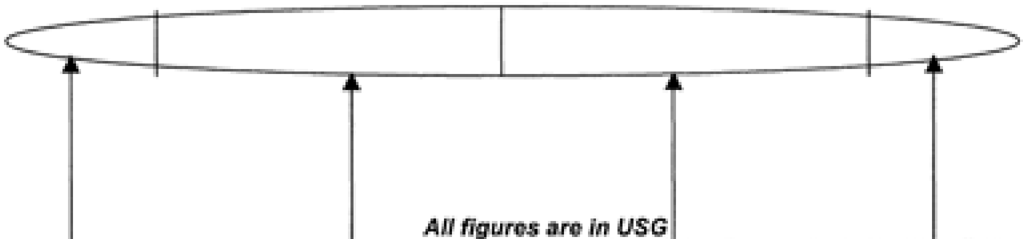
The authors, Reynir Einarsson, Guðmundur H. Sveinbjörnsson and Eyjólfur Gunnbjörnsson were engaged by Mr. Sigurður Líndal, as a consultants on the fuel calculation regarding the 2 reports which were made by The Icelandic Air Accident Investigation Board (IAAIB) and the report of Mr. Forward and Mr. Taylor, regarding the fatal accident of TF-GTI on the 7th of August 2000 in Reykjavik, Iceland.

The main objective was to establish a fuel calculation and usage of fuel as close to the reality on the day of the fatal accident of TF-GTI. The following report is based on those 2 reports and the known practiced methods of pilots operating in Iceland. One has to bear in mind that the fuel calculation is based on the Pilots Operating Handbook (POH) and the flight times from the IAAIB report. This report is in not in any means trying to change the official IAAIB report or Mr. Forward's and Mr.Taylor's report or trying to diminish their vital work around accident investigation, although we do not agree with some of their opinions.

Aircraft Statistics and Fuel Calculations Figures

Cessna 210 Centurion is a high performance, six seater, retractable undercarriage aircraft, which was manufactured first around 1959. It has been constantly updated from that time with some variants to its system, engines and fuselage. The TF-GTI was a Cessna T210L Centurion II variant, manufactured in September 1973 (serial no. 21060050), with a Teledyne Continental TSIO-520-H engine (six piston, turbocharged – (the letter T in T210) and 285 horsepower). It had a maximum speed of 175 knots, maximum cruising speed of 171 knots, long-range cruising speed of 134 knots and an initial climb rate of 950 feet per minute. Maximum range with reserve is 1065 Nautical Mile. These figures are from the Cessna 210L variant.

Following figures are for the TF-GTI and drawn from the reports.

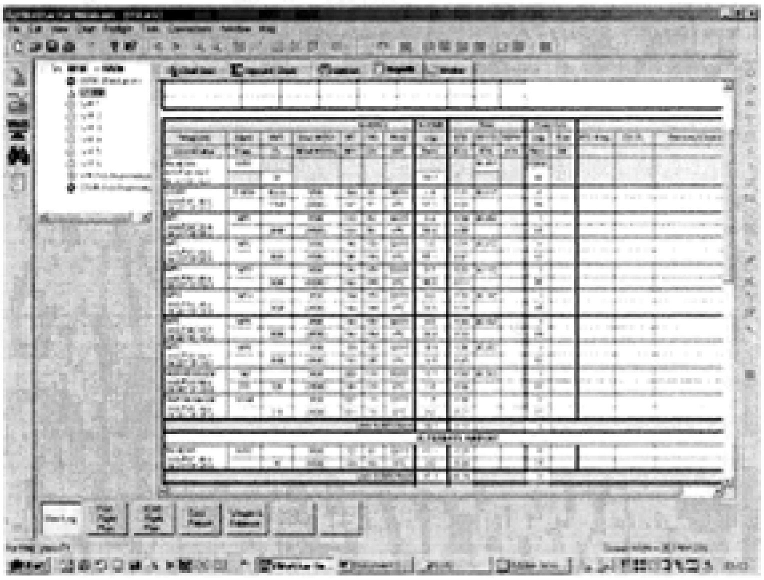


All figures are in USG

Left Wing Tip Tank		***Left Main Fuel Tank***		***Right Main Fuel Tank***		***Right Wing Tip Tank***	
Max Fuel	**16.5**	Max Fuel	**45**	Max Fuel	**45**	Max Fuel	**16.5**
Usable	**16.25**	Usable	**44.5**	Usable	**44.5**	Usable	**16.25**

Maximum Fuel Capacity: 90 + 33 = ***123 USG (465 Liter or 738 lbs)***
Maximum Usable Fuel: 89 + 32.5 = ***121.5 USG (460 Liter or 729 lbs)***

According to the table Figure 6.6 in IAAIB report the maximum fuel is 534 lbs (337 Liters) and all calculations are based on that figure in the table. As a result as the endurance and range calculations are void, however the fuel consumption is the same. In that case we will use those figures as a basis for our calculation. As a supportive matter we will use a Jeppesen product called Flitestar, which is a flight navigation calculator, which includes a Cessna 210 in it. It



calculates the flight time and fuel consumption from pre-determined factors, which can be adjusted to the fuel consumption of TF-GTI. This program will make a supporting matter regarding the actual flight path of the aircraft and its fuel consumption Enroute.

The following picture on the side is a sample of the flight made from Reykjavík to Vestmannaeyjar, as practiced in VFR flight. The flight path takes the pilot around the southern coastline towards the shortest way across the channel towards Vestmannaeyjar, with an average flight altitude of 3000 feet and with prevailing weather on that day (SE 10 knots and a temperature of around 10° Celsius).

The conversion factors used in this report are as follows;

1 USG AVGAS = 6 lbs
1 USG AVGAS = 3.7854 Liter
1 Liter AVGAS = 0.26417 USG
1 Liter AVGAS = 1.58502 lbs

The statistics of fuel

1. TF-GTI was filled with fuel on the evening of 6th of August 2000. The fuel received was 229 liters (60.5 USG) and according to the pilot, the aircrafts main tanks were full. It is a question about the wing tip tanks, as the pilots told the IAAIB that they had a verbal request by the operator that there should be several liters remaining in them, or as later they said 26.5 ltr (7 USG). The fuel employee was also not aware off a special fuelling method use in accordance with FAA AD note 94-12-8, so most likely the main tanks were not completely full. That is in accordance with the statement of the operator that the fuel gauges never showed completely full tanks.
2. The pilots knew that if the fuel tanks were filled up to the brink of the fuel filler strut inside the tank, it should have 246 ltr (65 USG). This has been a known method of pilots around Iceland. That figure gives one 4.1 hrs of endurance without the wing tip tank, and 4.98 hrs with 53 ltr (14 USG) in the wing tip fuel included and 7.71 hrs with wing tip tanks full. This endurance is calculated out from the operator's information that TF-GTI used 60 Liter/hour. The pilot operating on the 7th of August gave up 4.5 hours of endurance before his first flight.

Following is a table of endurance calculated from an average of 60 Liter/hour.
Table 1

245 ltr (65 USG) in main tanks			340 ltr (90 USG)			Pilots report	
Without wing tip	With 53 ltr (14 USG) in wing tip	With 123 ltr (32.5 USG) in wing tip	Without wing tip	With 53 ltr 14 USG in wing tip	With 123 ltr 32.5 USG in wing tip	6th August	7th August
4.1 hrs	4.98 hrs	6.15 hrs	5.67 hrs	6.55 hrs	7.71 hrs	5.0	4.5

3. The flight on the 7th of August started with no fuelling by the pilot and he estimated the fuel endurance of 4.5 hrs. If that would be the case he would have had approximately 275 liter (71 USG) in the main tanks. The IAAIB gives an estimate of starting with 337 liters (89 USG) before the flight on 6th of August. We also use max useable fuel 337 liter (89 USG) in our calculation, because there is no way of knowing how much fuel was actually in the tanks after the fuelling on the 6th of August 2000. We don't take into account the fuel in the wingtip tanks, because we believe it was not intended for use in daily operation, but only to gain the maximum take-off weight of 3800 lbs.

4. Following table shows endurance in different stages of the flights based on fuel flow of 60 litres per hour and shows a possible thinking of the pilot of endurance, according to the actual flight time. Also there is a column with the Flitestar calculation, as a reference to our calculation.

LEGS	***Actual Flight time***	***Hours***		***Litre***	
		Pilot thinking fuel remaining Approx.	***Pilot reported fuel remaining***	***60 Litre/hr. Fuel remaining***	***Flitestar Fuel remaining***
Start of 7th Aug.	------	4:40	4:30	280	272
# 3 leg	0:28	4:12	4:00	252	238.5
# 4 –10 leg	2:10	2.02	-----	122	84.9
Fuelling 120 L.	2:00	4:02	No report	242	204.9
# 11-18 leg	2:22	1:40	-----	100	36.5
Fuelling 120 L.	2:00	3:40	No report	220	156.5
# 19-23 leg	1:30	2:10	2:30	130	65.2
# 24 Leg at time of accident	***0:32***	***1:38***	***-----***	***98***	***16.7***

Fuel calculation method

The calculation of fuel burns, are somewhat different between IAAIB and ours. We use 2 methods' to get our conclusion. First of all, we use the navigation product from Jeppesen, called Flitestar, we tried to follow the most likely flight path and altitude, from our knowledge towards the Vestmannaeyjar, both from Reykjavik and from Selfoss. Following are the basis of our Jeppesen Flitestar calculation;

a. Flight altitude between Reykjavik and Vestmannaeyjar in Jeppesen Flitestar are in flight no.1, 2 around 2500 feet, with a wind of light and variable to 110° -10 knots and 10° Celsius at MSL (Mean Sea Level). That pilot uses to our conclusion 56 % power Enroute (2300 RPM and 24 MP) according to the flight time.
b. Flight altitude between Reykjavik and Vestmannaeyjar on the no.3 flight (first flight of 7th August) was to our conclusion made on more power setting, or 66 % power (2400 RPM and 26" MP), than the previous flight, due to shorter flying time. The altitude and weather condition were similar to the evening before.
c. The flights from Vestmannaeyjar to Selfoss were made at same power and weather condition all the time, except there we calculated that he would climb to 2000 feet. But in the return flight we used 1000 feet and power setting of 2500 RPM and 27" MP.
d. The last flight was made at 2000 feet towards Selfoss, than a climb was calculated to 4000 feet until reaching abeam Sandskeið. There he would lower down again into Reykjavik with a prolonged approach. The wind was 110°10 kts.
e. The fuel calculated is in Liters.
f. Taxi fuel in sequence no 1 and 3 have included some engine taxi and run up of 7,5 Liter (2 USG) per leg. All other flights have 3,8 Liters (1 USG) for taxi and take off only. This has been, a known practice in this operation before and we support it with the actual short turnaround time between flights. The fuel calculation in climb and descent is based on constant profile to or from the airports.

The other fuel calculation, was made by Mr. Guðmundur Sveinbjörnsson, based on flight time and POH fuel table and is following this report as well. In these calculations maximum useable fuel is used.

Weight 3400 lbs
Power settings: 56 % on the first day but 66% on the day off the accident
Altitude: All flight are in 2500 feet but the last one which is calculated in 4000'
Further explanations are on that report.

A table (table 2) was made from information based on the times in the IAAIB fuel calculation, and shows IAAIB calculations our Flitestar calculations, Mr. Guðmundur calculations and calculations based on 60 ltr (15,8 USG) per hour based on operator knowledge off average fuel usage. As previously mentioned, there is a slight difference between them. The IAAIB calculation is mainly based upon the actual takeoff times, 56 % power at 1000 feet. However our Flitestar calculation are based on the most probable flight track which is adjusted to known flight times of each flight, with weather conditions prevailing from variable to 110° at 10 knots and 10° Celsius temperature, and known operating procedures.

Table 2 Fuel Calculation

Note all figures are minutes and Liter.

Flight no.	Flight from	Flight time	Turn around	Burn off IAAIB	**Burn off Flitestar**	**Burn off based on POH**	Burn off 60 Ltr/hour	Remaining IAAIB	**Remaining Flitestar**	**Remaining based on POH**	Remaining 60 Ltr/hour	
Useable fuel at beginning of 6th August 2000.								***337***	***337***	***337***	***337***	
1	RK	33		32,5	35,5	32,98	33	304,5	***301,5***	***304,02***	304	
2	VM	30	238	33,3	28,8	30,16	30	271,2	***272,7***	***273,86***	274	
3	RK	28		30,2	34,2	33,17	28	241	***238,5***	***240,69***	246	
4	VM	20	14	23,5	22,8	22,36	20	217,5	***215,7***	***218,33***	226	
5	SF	15	6	19,3	19,8	18,16	15	198,2	***195,9***	***200,17***	211	
6	VM	21	15	24,2	22,8	23,25	21	174	***173,1***	***176,92***	190	***Gear down***
7	SF	20	24	23,2	23,8	22,63	20	150,8	***149,3***	***154,29***	170	***Gear down***
8	VM	20	114	23,5	22,8	22,36	20	127,3	***126,5***	***131,93***	150	
9	SF	15	5	19,3	19,8	18,16	15	108	***106,7***	***113,77***	135	
10	VM	19	13	21,8	21,8	21,47	19	86,2	***84,9***	***92,3***	116	
									Fuel added 120 ltr			
11	SF	16	13	20,1	19,8	19,06	16	186,1	***185,1***	***193,24***	220	
12	VM	20	9	23,5	22,8	22,36	20	162,6	***162,3***	***170,88***	200	
13	SF	16	25	20,1	19,8	19,06	16	142,5	***142,5***	***151,82***	184	
14	VM	21	9	24,3	23,8	23,25	21	118,2	***118,7***	***128,57***	163	
15	SF	17	5	20,9	20,8	19,95	17	97,3	***97,9***	***108,62***	146	
16	VM	17	15	21,1	19,8	19,68	17	76,2	***78,1***	***88,94***	129	
17	SF	16	9	20,1	19,8	19,06	16	56,1	***58,3***	***69,88***	113	
18	VM	19	18	22,7	21,8	21,47	19	33,4	***36,5***	***48,41***	94	
									Fuel added 120 ltr			
19	SF	18	6	21,7	21,8	20,84	18	131,7	***134,7***	***147,57***	196	
20	VM	20	12	23,5	22,8	22,36	20	108,2	***111,9***	***125,21***	176	
21	SF	15	9	19,3	19,8	18,16	15	88,9	***92,1***	***107,05***	161	
22	VM	18	13	21,9	20,8	20,57	18	67	***71,3***	***86,48***	143	
23	SF	19	4	22,4	22,8	21,74	19	44,6	***48,5***	***64,74***	124	
24	VM	32	5	33,3	31,8	36,54	32	***11,3***	***16,7***	***28,2***	***92***	
	Total burnoff			**565,7**	**560,3**	**548,8**	**485**					
					Remaining Useable fuel			***11,3***	***16,7***	***28,2***	***92***	

From this table and figures, one can see that our calculation shows that the useable fuel remaining in the main tanks is between 16,7 and 28,2 ltr (4,4 and 7,4 USG)

Conclusion

1. Useable fuel remaining in the main tanks where between 16,7 and 28,2 ltr (4,4 and 7,4 USG) at the time of the accident. We don't use any calculation allowance of the wing tip tanks (53 Litre), as we don't have any certain proof of that the pilot used it. There can also be a slight error factor in our calculation, which is caused by uncertainty of atmospheric condition, the operation of the aircraft along with other unknown factors.

2. There is definite higher ***fuel usage***, which is mainly ***caused by taxi fuel requirement and take-offs on the short flights***. The average burn off would be ***higher than 60 Liter per hour, or between 68 and 69 Litre/hr.*** due to above reasons. One flight was made with gear stuck down and it prolonged the flying time, thus increasing the fuel burn-off, not as the report of Mr. Forward and Mr. Taylor implied that the fuel burn off would increase due to drag and therefore higher power settings. We estimate that the pilot used the same method of flying all throughout the day.

Summary of conclusions

1. Poor fuel management, most likely caused the pilot to run out of fuel in the tank which was selected.

2. Time of fueling and amount on the 7th of August 2000 match 60 ltr /hr. thinking.

3. The aircraft was using more than 60 ltr/ hr. or between 68 and 69 ltr/hr. due to short flights and numbers of take off and climbs. Therefore the total burn off in the 8 hours of flight time, escalates up to 75 ltr. more burn off than expected.

This report is made from our best knowledge and experience, although there is a great difficulty in getting an accurate conclusion due to number on uncertainty factors.

Sincerely,

Reynir Einarsson

Sign. Reynir Einarsson

Eyjólfur Gunnbjörnsson.

Sign. Eyjólfur

Guðmundur H. Sveinbjörnsson

Sign. Guðmundur H. Sveinbjörnsson

Fuel calculations for TF-GTI on 6 and 7.8 2000.

In these calculation I tried to take in account as many factors as possible but due to uncertainty in operation of the aircraft that day there is always possible to question some of them.

These calculations are based on following

Fuel consupsons	POH
Time to climb	POH
Power settings	Time and distant in flight 1 and 3 and normal practice
Altitude	Normal practice
Average Wgt	3400 Lbs
Airspeed in Climb	110
Take off and run up USG	2
Take off only USG	1

Runup only before flight 1 and 3
decent on cruise power down to 1000 AGL
Last 2 min in each flight are on 15 " MP for final decsent and landing
No fuel in wing end tanks used
Main tanks full 340 Ltr

Altitude		**Power settings**	
All flight except the last one	2500'	First two flight	56%
The last flight BIVM - BIRK	4000'	Others	65%

Summary
The Flights on 6 and 7. 8. 2000

6.8.2000
The flight from Reykjavik to Vestmannaeyjar and back where in 2500'and on 56 % power it took total 63 min
Total burn off on these 2 flight where 16,7 USG or 63,2 Ltr
Average 60,3 Ltr/Hour

7.8.2000
The flight from Reykjavik to Vestmannaeyjar and between Vestmannaeyjar and Selfoss where in 2500'and on 65% power
Total time in these flights where 6,5 hours
Total burn off in these flights where 118,7 USG or 449,7 Ltr
Average 69,2 Ltr/Hour

Flight from Vestmannaeyjar to Reykjavik where on 65% power and part of the way in 4000'
Total time in this flight Was 32 min
Total burn off in that flight where 9,42 USG or 35,6 Ltr
Average 65,1 Ltr/Hour

Conclusion

Total flight of 8 hours and 5 min
Total fuel burn off was 548,8 Ltr or 145 USG
Maximum Useable fuel at the time of accident at BIRK 28,16 Ltr or 7,44 USG

Average 67,89 Ltr/hour
This is total 63,78 Ltr more burn off than average 60 Ltr/hour
With average 60 Ltr/hour there would have been 92 ltr remaining

Calculations

Total fuel avelable Ltr

BIRK	337
Uplift	240
Wing ends	0

Climb

Burnoff (USG) in climb

Altitude	3400 Lbs
1000	0,434
2200	0,9548
2500	1,085
3500	1,519
4000	1,736
5000	2,17

Time to Climb

Altitude	3400 Lbs
1000	00:54
2200	01:58
2500	02:15
3500	03:09
4000	03:36
5000	04:30

Burnoff in cruise	USG /hour	USG / min
56% power	12,5	0,21
65% power	14,16	0,24
75% power	16,3	0,27
15'' Final descent	8,89	0,15

	Qnt	Burn off USG each	Burn off USG total	Time each	Time total
Take off and run upp	2	2,00	4,00		
Take off without run up	22	1,00	22,00		
Numer of climbs to 2200'	11	0,95	10,50	01:58	21:46
Numer of climbs to 2500'	12	1,09	13,02	02:15	03:00
Numer of climbs to 4000'	1	1,74	1,74	03:36	03:36
Total climb	24		51,26		52:23
Goaround at BIRK	1	0,25	0,25		
Correction for last 2 min on 15"	24	0,30	-7,112		
Cruise 56% power	58	0,21	12,08		
Cruise 65% power	375	0,24	88,5		
Total time in Cruise	433				
Total time in climb	52:23				
Total flight time	485				
Total burn off USG	144,98				
Total burn off Ltr	548,84				
Total fuel avelable Ltr	577				
Fuel at the time of accident Ltr	28,16				
Fuel at the time of accident USG	7,44				

Guðmundur Heimir Sveinbjörnsson

Guðmundur Heimir Sveinbjörnsson

NAVIGATION LOG

BIRK -> BIVM
(Page 1 of 1)

JEPPESEN
FliteStar

EPORT DATE	January 15, 2003	AIRCRAFT TYPE	Cessna
NAVDATA EXP. DATE	June 15, 2000	AIRCRAFT TAIL #	TF-GTI

WAYPOINTS (FIXES)		ROUTE / MEA(MSA)	BEG ALT / END ALT	MC / MH	FUEL(L) LEG / REM	DIST(SM) LEG / REM	SPD(MPH) TAS / EST GS	ETE / CUMM	ATA / ATE	WIND / OAT	POWER
BIRK Reykjavik N 64° 07' 48.0 W 21° 56' 26.0					336.9	76.2					
WP1 N 64° 05' 26.8 W 21° 37' 55.7	CLIMB		45	125	4.5	3.9	96	**00:02:43**		110@10	Climb Power
		(5500)	2500	**125**	332.4	72.4	85	00:02:43		10°C	
	CRUISE		2500	125	1.9	5.8	157	**00:02:24**		110@10	2300/24
		(5500)	2500	**125**	330.5	66.6	145	00:05:07		10°C	
WP2 N ... 34' 59.9 W ... 13' 09.0	CRUISE		2500	147	18.0	55.5	157	**00:22:48**		110@10	2300/24
		(5500)	2500	**146**	312.5	11.1	146	00:27:56		8°C	
BIVM Vestmanna... N 63° 25' 30.0 W 20° 16' 45.0	CRUISE		2500	207	0.6	1.8	157	**00:00:43**		110@10	2300/24
		(3600)	2500	**203**	311.9	9.2	154	00:28:39		10°C	
	DESCNT		2500	207	2.8	9.2	129	**00:04:24**		110@10	Descent Power
		(3600)	300	**202**	309.1	0.0	126	00:33:03		10°C	
				ROUTE TOTALS	27.8	76.2		00:33:03			

FUEL CALCULATION	TIME	FUEL(L)	RESERVE	TIME	FUEL(L)
Climb + T/O	0:02	5	Contingency 0%	0:05	4
Cruise	0:25	20	Alternate Fuel	0:00	0
Descent	0:00	0	Holding / Final Reserve	0:45	35
Approach	0:04	3	Additional Fuel	0:00	0
Total Trip Fuel	0:33	28	**Minimum Required Fuel**	1:23	67
Ta... *Taxi +Run up*		*7,5*0	Extra Fuel	5:42	270
B... Off	0:33	28	**Loaded Block Fuel**	7:05	337
Actual Fuel Burned		*35,6*	Actual Remaining Fuel		*301,5*

NOTES:

NAVIGATION LOG

BIVM -> BIRK
(Page 1 of 1)

2.

JEPPESEN *FliteStar*

REPORT DATE	January 15, 2003	AIRCRAFT TYPE	Cessna
NAVDATA EXP. DATE	June 15, 2000	AIRCRAFT TAIL #	TF-GTI

WAYPOINTS (FIXES)		ROUTE / MEA(MSA)	BEG ALT / END ALT	MC / MH	FUEL(L) LEG / REM	DIST(SM) LEG / REM	SPD(MPH) TAS / EST GS	ETE / CUMM	ATA / ATE	WIND / OAT	POWER
BIVM Vestmanna... N 63° 25' 30.0 W 20° 16' 45.0					301.6	78.0					
WP1 N 63° 35' 15.4 W 20° 17' 12.2	CLIMB		318	016	4.0	4.1	96	**00:02:25**		110@10	Climb Power
		(3600)	2500	**023**	297.5	73.9	100	00:02:25		8°C	
	CRUISE		2500	016	2.1	7.2	157	**00:02:40**		110@10	2300/24
		(3600)	2500	**020**	295.4	66.7	161	00:05:06		8°C	
WP2 N [illegible]° 49' 29.5 W [illegible] 51' 51.4	CRUISE		2500	330	6.8	24.1	157	**00:08:37**		110@10	2300/24
		(3600)	2500	**332**	288.6	42.7	167	00:13:44		8°C	
WP3 N 64° 04' 23.0 W 21° 33' 24.1	CRUISE		2500	327	7.6	27.1	157	**00:09:41**		110@10	2300/24
		(5500)	2500	**329**	281.0	15.6	168	00:23:26		8°C	
WP4 N 64° 09' 58.3 W 21° 55' 59.5	CRUISE		2500	318	1.2	4.1	157	**00:01:28**		110@10	2300/24
		(5500)	2500	**319**	279.8	11.4	168	00:24:54		8°C	
	DESCNT		2500	318	2.5	8.9	128	**00:03:49**		110@10	Descent Power
		(5500)	587	**319**	277.3	2.5	140	00:28:44		8°C	
BIRK Reykjavik N 64° 07' 48.0 W 21° 56' 26.0	DESCNT		587	204	0.8	2.5	126	**00:01:13**		110@10	Descent Power
		(5500)	45	**199**	276.6	0.0	122	00:29:58		10°C	
				ROUTE TOTALS	25.0	78.0		00:29:58			

FUEL CALCULATION	TIME	FUEL(L)	RESERVE	TIME	FUEL(L)
Climb + T/O	0:02	4	Contingency 0%	0:05	4
Cruise	0:22	18	Alternate Fuel	0:00	0
Descent	0:03	2	Holding / Final Reserve	0:00	0
Approach	0:01	1	Additional Fuel	0:45	35
Total Trip Fuel	0:30	25	**Minimum Required Fuel**	1:20	64
Taxi		3,8 0	Extra Fuel	5:01	238
Burn Off	0:30	25	**Loaded Block Fuel**	6:21	302
Actual Fuel Burned		28,8	Actual Remaining Fuel		272,8

NOTES:

NAVIGATION LOG

BIRK -> BIVM
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JEPPESEN
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3.

REPORT DATE	January 15, 2003	AIRCRAFT TYPE	Cessna
NAVDATA EXP. DATE	June 15, 2000	AIRCRAFT TAIL #	TF-GTI

WAYPOINTS (FIXES)		ROUTE / MEA/(MSA)	BEG ALT / END ALT	MC / MH	FUEL(L) LEG / REM	DIST(SM) LEG / REM	SPD(MPH) TAS / EST GS	ETE / CUMM	ATA / ATE	WIND / OAT	POWER
BIRK Reykjavik N 64° 07' 48.0 W 21° 56' 26.0					272.6	70.4					
WP1 N 64° 04' 58.7 W 21° 49' 11.2	CLIMB		45	150	3.6	3.1	96	**00:02:09**		110@10	Climb Power
		(5500)	2000	**148**	269.0	67.3	85	00:02:09		9°C	
	CRUISE		2000	150	0.6	1.8	172	**00:00:40**		110@10	2400/27
		(5500)	2000	**149**	268.3	65.5	161	00:02:50		9°C	
WP2 N 6[illegible]° 33' 47.6 W [illegible]° 31' 56.0	CRUISE		2000	151	18.5	53.2	172	**00:19:46**		110@10	2400/27
		(5500)	2000	**149**	249.8	12.3	161	00:22:36		9°C	
BIVM Vestmanna... N 63° 25' 30.0 W 20° 16' 45.0	CRUISE		2000	158	1.7	5.5	145	**00:02:26**		110@10	2400/20
		(3600)	2000	**156**	248.1	6.9	135	00:25:03		9°C	
	DESCNT		2000	158	2.2	6.9	128	**00:03:29**		110@10	Descent Power
		(3600)	250	**156**	245.9	0.0	118	00:28:32		9°C	
			ROUTE TOTALS		26.7	70.4		00:28:32			

FUEL CALCULATION	TIME	FUEL(L)	RESERVE	TIME	FUEL(L)
Climb + T/O	0:02	4	Contingency 0%	0:05	4
Cruise	0:22	21	Alternate Fuel	0:00	0
Descent	0:00	0	Holding / Final Reserve	0:00	0
Approach	0:03	2	Additional Fuel	0:45	35
Total Trip Fuel	0:29	27	**Minimum Required Fuel**	1:19	66
Taxi *Taxi + Runup*		*8.5* 0	Extra Fuel	4:22	206
Block Off	0:29	27	**Loaded Block Fuel**	5:41	273
Actual Fuel Burned		*34.5*	Actual Remaining Fuel		*238.5*

NOTES:

NAVIGATION LOG

BIVM -> BISF
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JEPPESEN *FliteStar*

4.

REPORT DATE	January 15, 2003	AIRCRAFT TYPE	Cessna
NAVDATA EXP. DATE	June 15, 2000	AIRCRAFT TAIL #	TF-GTI

WAYPOINTS (FIXES)		ROUTE / MEA/(MSA)	BEG ALT / END ALT	MC / MH	FUEL(L) LEG / REM	DIST(SM) LEG / REM	SPD(MPH) TAS / EST GS	ETE / CUMM	ATA / ATE	WIND / OAT	POWER
BIVM Vestmanna... N 63° 25' 30.0 W 20° 16' 45.0					238.5	53.5					
WP1 N 63° 32' 06.7 W 20° 12' 26.6	CLIMB		318	034	3.1	3.0	96	**00:01:51**		110@10	Climb Power
		(3600)	2000	**040**	235.4	50.5	97	00:01:51		10°C	
	CRUISE		2000	034	1.6	4.9	168	**00:01:45**		110@10	2500/25
		(3600)	2000	**037**	233.8	45.5	169	00:03:36		10°C	
WP2 ... 36' 27.3 ... 20' 27.9	CRUISE		2000	338	2.0	6.5	168	**00:02:10**		110@10	2400/26
		(3600)	2000	**340**	231.8	39.1	178	00:05:47		8°C	
WP3 N 63° 58' 35.4 W 21° 07' 17.2	CRUISE		2000	335	9.5	31.3	168	**00:10:32**		110@10	2400/26
		(3600)	2000	**337**	222.3	7.7	178	00:16:20		8°C	
	DESCNT		2000	335	1.0	3.5	129	**00:01:31**		110@10	Descent Power
		(3600)	1239	**337**	221.3	4.2	139	00:17:51		10°C	
SE Selfoss N 63° 55' 44.0 W 21° 02' 03.0 397 ...	DESCNT		1239	159	1.4	4.2	127	**00:02:10**		110@10	Descent Power
		(3600)	318	**157**	219.9	0.0	117	00:20:02		10°C	
				ROUTE TOTALS	18.6	53.5		00:20:02			

FUEL CALCULATION	TIME	FUEL(L)
Climb + T/O	0:01	3
Cruise	0:14	13
Descent	0:01	1
Approach	0:02	1
Total Trip Fuel	0:20	19
Taxi		3,8 0
Burn Off	0:20	19
Actual Fuel Burned		22,8

RESERVE	TIME	FUEL(L)
Contingency 0%	0:05	4
Alternate Fuel	0:00	0
Holding / Final Reserve	0:30	24
Additional Fuel	0:00	0
Minimum Required Fuel	0:55	46
Extra Fuel	4:04	192
Loaded Block Fuel	4:59	238
Actual Remaining Fuel		215,4

NAVIGATION LOG

BISE-> BIVM
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JEPPESEN *FliteStar*

5.

REPORT DATE	January 15, 2003
NAVDATA EXP. DATE	June 15, 2000
AIRCRAFT TYPE	Cessna
AIRCRAFT TAIL #	TF-GTI

WAYPOINTS (FIXES)		ROUTE / MEA(MSA)	BEG ALT / END ALT	MC / MH	FUEL(L) LEG / REM	DIST(SM) LEG / REM	SPD(MPH) TAS / EST GS	ETE / CUMM	ATA / ATE	WIND / OAT	POWER
SELFO N 63° 55' 45.0 W 21° 02' 16.0					215.1	41.8					
BIVM Vestmanna... N 63° 25' 30.0 W 20° 16' 45.0	CLIMB		65	164	1.7	1.7	109	00:01:01		110@10	Climb Power
		(3600)	1000	160	213.4	40.2	99	00:01:01		10°C	
	CRUISE		1000	164	12.9	36.0	174	00:13:04		110@10	2500/27
		(3600)	1000	162	200.5	4.2	165	00:14:06		10°C	
	DESCNT		1000	164	1.2	4.2	144	00:01:52		110@10	Descent Power
		(3600)	65	161	199.3	0.0	134	00:15:58		10°C	
			ROUTE TOTALS		15.8	41.8		00:15:58			

FUEL CALCULATION	TIME	FUEL(L)	RESERVE	TIME	FUEL(L)
Climb + T/O	0:01	2	Contingency 0%	0:05	4
Cruise	0:13	13	Alternate Fuel	0:00	0
Descent	0:00	0	Holding / Final Reserve	0:45	35
Approach	0:01	1	Additional Fuel	0:00	0
Total Trip Fuel	0:16	16	**Minimum Required Fuel**	1:06	55
Taxi		3,8 0	Extra Fuel	3:26	160
Burn Off	0:16	16	**Loaded Block Fuel**	4:32	215
Actual Fuel Burned		19,8	Actual Remaining Fuel		195,9

NAVIGATION LOG

BIVM -> BISF
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6.

JEPPESEN *FliteStar*

REPORT DATE	January 15, 2003	AIRCRAFT TYPE	Cessna
NAVDATA EXP. DATE	June 15, 2000	AIRCRAFT TAIL #	TF-GTI

WAYPOINTS (FIXES)		ROUTE MEA/(MSA)	BEG ALT / END ALT	MC / MH	FUEL(L) LEG / REM	DIST(SM) LEG / REM	SPD(MPH) TAS / EST GS	ETE / CUMM	ATA / ATE	WIND / OAT	POWER
BIVM Vestmanna... N 63° 25' 30.0 W 20° 16' 45.0					196.2	57.4					
WP1 N 63° 32' 06.7 W 20° 12' 26.6	CLIMB		318	034	3.1	3.4	110	**00:01:51**		110@10	Climb Power
		(3600)	2000	**040**	193.1	54.0	110	00:01:51		10°C	
	CRUISE		2000	034	1.5	4.5	168	**00:01:36**		110@10	2500/25
		(3600)	2000	**037**	191.7	49.5	169	00:03:27		10°C	
WP2 [illegible] 36' 27.3 [illegible] 20' 27.9	CRUISE		2000	338	2.0	6.5	168	**00:02:10**		110@10	2400/26
		(3600)	2000	**340**	189.7	43.0	178	00:05:38		8°C	
WP3 N 64° 00' 08.0 W 21° 09' 12.3	CRUISE		2000	336	10.4	34.3	168	**00:11:33**		110@10	2400/26
		(3600)	2000	**337**	179.2	8.7	178	00:17:12		8°C	
	DESCNT		2000	336	0.6	2.5	147	**00:00:57**		110@10	Descent Power
		(5500)	1520	**338**	178.6	6.2	157	00:18:09		10°C	
SE Selfoss N 63° 55' 44.0 W 21° 02' 03.0 397	DESCNT		1520	163	1.8	6.2	145	**00:02:45**		110@10	Descent Power
		(5500)	318	**160**	176.8	0.0	135	00:20:55		10°C	
				ROUTE TOTALS	19.4	57.4		00:20:55			

FUEL CALCULATION	TIME	FUEL(L)	RESERVE	TIME	FUEL(L)
Climb + T/O	0:01	3	Contingency 0%	0:05	4
Cruise	0:15	14	Alternate Fuel	0:00	0
Descent	0:00	1	Holding / Final Reserve	0:30	24
Approach	0:02	2	Additional Fuel	0:00	0
Total Trip Fuel	0:21	19	**Minimum Required Fuel**	0:56	47
Taxi		3,8 0	Extra Fuel	3:09	149
Burn Off	0:21	19	**Loaded Block Fuel**	4:05	196
Actual Fuel Burned		22,8	Actual Remaining Fuel		173,1

NOTES:

Gear down

NAVIGATION LOG

BISE-> BIVM
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JEPPESEN *FliteStar*

7.

...PORT DATE	January 15, 2003	AIRCRAFT TYPE	Cessna
NAVDATA EXP. DATE	June 15, 2000	AIRCRAFT TAIL #	TF-GTI

WAYPOINTS (FIXES)		ROUTE / MEA(MSA)	BEG ALT / END ALT	MC / MH	FUEL(L) LEG / REM	DIST(SM) LEG / REM	SPD(MPH) TAS / EST GS	ETE / CUMM	ATA / ATE	WIND / OAT	POWER
SELFO N 63° 55' 45.0 W 21° 02' 16.0					172.9	53.8					
WP1 N 63° 59' 51.6 W 21° 09' 34.7	CLIMB		65	340	1.7	2.0	109	**00:01:01**		110@10	Climb Power
		(3600)	1000	**343**	171.2	51.8	118	00:01:01		10°C	
	CRUISE		1000	340	1.3	4.0	174	**00:01:18**		110@10	2500/27
		(3600)	1000	**342**	169.9	47.8	184	00:02:19		10°C	
BIVM Vestmanna... N... 25' 30.0 W... 16' 45.0	CRUISE		1000	163	15.7	43.7	174	**00:15:52**		110@10	2500/27
		(3600)	1000	**161**	154.2	4.2	165	00:18:11		10°C	
	DESCNT		1000	163	1.2	4.2	144	**00:01:52**		110@10	Descent Power
		(3600)	65	**161**	153.0	0.0	134	00:20:04		10°C	
				ROUTE TOTALS	19.9	53.8		00:20:04			

FUEL CALCULATION	TIME	FUEL(L)	RESERVE	TIME	FUEL(L)
Climb + T/O	0:01	2	Contingency 0%	0:05	4
Cruise	0:17	17	Alternate Fuel	0:00	0
Descent	0:00	0	Holding / Final Reserve	0:45	35
Approach	0:01	1	Additional Fuel	0:00	0
Total Trip Fuel	0:20	20	**Minimum Required Fuel**	1:10	59
Taxi		3,5 0	Extra Fuel	2:27	114
Burn Off	0:20	20	**Loaded Block Fuel**	3:37	173
Actual Fuel Burned		23,8	Actual Remaining Fuel		149,3

N...ES:

Gear down

NAVIGATION LOG

BIVM -> BISF
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8.

JEPPESEN
FliteStar

…PORT DATE	January 15, 2003	AIRCRAFT TYPE	Cessna
NAVDATA EXP. DATE	June 15, 2000	AIRCRAFT TAIL #	TF-GTI

WAYPOINTS (FIXES)		ROUTE / MEA(MSA)	BEG ALT / END ALT	MC / MH	FUEL(L) LEG / REM	DIST(SM) LEG / REM	SPD(MPH) TAS / EST GS	ETE / CUMM	ATA / ATE	WIND / OAT	POWER
BIVM Vestmanna... N 63° 25' 30.0 W 20° 16' 45.0					149.5	55.0					
WP1 N 63° 32' 06.7 W 20° 12' 26.6	CLIMB		318	034	3.1	3.4	110	**00:01:51**		110@10	Climb Power
		(3600)	2000	**040**	146.4	51.6	110	00:01:51		10°C	
	CRUISE		2000	034	1.5	4.5	168	**00:01:36**		110@10	2500/25
		(3600)	2000	**037**	145.0	47.0	169	00:03:27		10°C	
WP2 N… 36' 27.3 W… 20' 27.9	CRUISE		2000	338	2.0	6.5	168	**00:02:10**		110@10	2400/26
		(3600)	2000	**340**	143.0	40.6	178	00:05:38		8°C	
WP3 N 63° 59' 04.9 W 21° 08' 14.7	CRUISE		2000	335	9.7	31.8	168	**00:10:43**		110@10	2400/26
		(3600)	2000	**337**	133.3	8.7	178	00:16:21		8°C	
	DESCNT		2000	335	0.9	3.8	146	**00:01:26**		110@10	Descent Power
		(3600)	1278	**337**	132.4	5.0	157	00:17:48		10°C	
SE Selfoss N 63° 55' 44.0 W 21° 02' 03.0 397 ...	DESCNT		1278	159	1.4	5.0	144	**00:02:13**		110@10	Descent Power
		(3600)	318	**157**	130.9	0.0	134	00:20:01		10°C	
				ROUTE TOTALS	18.6	55.0		00:20:01			

FUEL CALCULATION	TIME	FUEL(L)	RESERVE	TIME	FUEL(L)
Climb + T/O	0:01	3	Contingency 0%	0:05	4
Cruise	0:14	13	Alternate Fuel	0:00	0
Descent	0:01	1	Holding / Final Reserve	0:30	24
A…ach	0:02	1	Additional Fuel	0:00	0
Total Trip Fuel	0:20	19	**Minimum Required Fuel**	0:55	46
Taxi		38 0	Extra Fuel	2:11	103
Burn Off	0:20	19	**Loaded Block Fuel**	3:06	150
Actual Fuel Burned		228	Actual Remaining Fuel		1265

NAVIGATION LOG

BISE-> BIVM
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JEPPESEN *FliteStar*

9.

[illegible]PORT DATE	January 15, 2003	AIRCRAFT TYPE	Cessna
NAVDATA EXP. DATE	June 15, 2000	AIRCRAFT TAIL #	TF-GTI

WAYPOINTS (FIXES)		ROUTE / MEA(MSA)	BEG ALT / END ALT	MC / MH	FUEL(L) LEG / REM	DIST(SM) LEG / REM	SPD(MPH) TAS / EST GS	ETE / CUMM	ATA / ATE	WIND / OAT	POWER
SELFO N 63° 55' 45.0 W 21° 02' 16.0					126.2	41.8					
WP1 N 63° 53' 34.9 W 20° 58' 59.5	CLIMB		65	164	1.7	1.7	109	**00:01:01**		110@10	Climb Power
		(3600)	1000	**161**	124.5	40.2	99	00:01:01		10°C	
	CRUISE		1000	164	0.5	1.3	174	**00:00:28**		110@10	2500/27
		(3600)	1000	**162**	124.0	38.9	165	00:01:29		10°C	
WP2 N [illegible] 27' 05.0 W [illegible] 18' 53.5	CRUISE		1000	164	12.5	34.7	174	**00:12:36**		110@10	2500/27
		(3600)	1000	**162**	111.6	4.2	165	00:14:06		9°C	
	DESCNT		1000	164	0.6	2.1	144	**00:00:54**		110@10	Descent Power
		(3600)	542	**161**	111.0	2.1	135	00:15:01		10°C	
BIVM Vestmanna... N 63° 25' 30.0 W 20° 16' 45.0	DESCNT		542	166	0.6	2.1	143	**00:00:57**		110@10	Descent Power
		(3600)	65	**163**	110.4	0.0	134	00:15:58		10°C	
			ROUTE TOTALS		15.8	41.8		00:15:58			

FUEL CALCULATION	TIME	FUEL(L)	RESERVE	TIME	FUEL(L)
Climb + T/O	0:01	2	Contingency 0%	0:05	4
Cruise	0:13	13	Alternate Fuel	0:00	0
Descent	0:00	1	Holding / Final Reserve	0:45	35
Approach	0:00	1	Additional Fuel	0:00	0
Total Trip Fuel	0:16	16	**Minimum Required Fuel**	1:06	55
T[illegible]		3,8 0	Extra Fuel	1:32	71
B[illegible] Off	0:16	16	**Loaded Block Fuel**	2:38	126
Actual Fuel Burned		19,8	Actual Remaining Fuel		106,4

NAVIGATION LOG

BIVM -> BISF
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JEPPESEN
FliteStar

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REPORT DATE	January 15, 2003	AIRCRAFT TYPE	Cessna
NAVDATA EXP. DATE	June 15, 2000	AIRCRAFT TAIL #	TF-GTI

WAYPOINTS (FIXES)		ROUTE / MEA(MSA)	BEG ALT / END ALT	MC / MH	FUEL(L) LEG / REM	DIST(SM) LEG / REM	SPD(MPH) TAS / EST GS	ETE / CUMM	ATA / ATE	WIND / OAT	POWER
BIVM Vestmanna... N 63° 25' 30.0 W 20° 16' 45.0					106.6	52.2					
WP1 N 63° 32' 06.7 W 20° 12' 26.6	CLIMB		318	034	3.1	3.4	110	**00:01:51**		110@10	Climb Power
		(3600)	2000	**040**	103.5	48.8	110	00:01:51		10°C	
	CRUISE		2000	034	1.5	4.5	168	**00:01:36**		110@10	2500/25
		(3600)	2000	**037**	102.1	44.3	169	00:03:27		10°C	
WP2 N[illegible] 36' 27.3 [illegible] 20' 27.9	CRUISE		2000	338	2.0	6.5	168	**00:02:10**		110@10	2400/26
		(3600)	2000	**340**	100.1	37.8	178	00:05:38		9°C	
WP3 N 63° 58' 14.3 W 21° 06' 19.6	CRUISE		2000	335	8.9	29.1	168	**00:09:47**		110@10	2400/26
		(3600)	2000	**337**	91.2	8.7	178	00:15:26		9°C	
	DESCNT		2000	335	1.3	5.1	146	**00:01:58**		110@10	Descent Power
		(3600)	1015	**337**	90.0	3.6	156	00:17:24		10°C	
SE Selfoss N 63° 55' 44.0 W 21° 02' 03.0 397 ...	DESCNT		1015	161	1.0	3.6	144	**00:01:36**		110@10	Descent Power
		(3600)	318	**159**	88.9	0.0	134	00:19:01		10°C	
				ROUTE TOTALS	17.7	52.2		00:19:01			

FUEL CALCULATION	TIME	FUEL(L)	RESERVE	TIME	FUEL(L)
Climb + T/O	0:01	3	Contingency 0%	0:05	4
Cruise	0:13	12	Alternate Fuel	0:00	0
Descent	0:01	1	Holding / Final Reserve	0:30	24
Approach	0:01	1	Additional Fuel	0:00	0
Total Trip Fuel	0:19	18	**Minimum Required Fuel**	0:54	45
Taxi		3,8 0	Extra Fuel	1:18	61
Burn Off	0:19	18	**Loaded Block Fuel**	2:12	107
Actual Fuel Burned		21,8	Actual Remaining Fuel		84,9

NAVIGATION LOG

BISE-> BIVM
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JEPPESEN *FliteStar*

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REPORT DATE	January 15, 2003	AIRCRAFT TYPE	Cessna
NAVDATA EXP. DATE	June 15, 2000	AIRCRAFT TAIL #	TF-GTI

WAYPOINTS (FIXES)		ROUTE / MEA(MSA)	BEG ALT / END ALT	MC / MH	FUEL(L) LEG / REM	DIST(SM) LEG / REM	SPD(MPH) TAS / EST GS	ETE / CUMM	ATA / ATE	WIND / OAT	POWER
SELFO N 63° 55' 45.0 W 21° 02' 16.0					205.0	43.4					
WP1 N 63° 53' 34.9 W 20° 58' 59.5	CLIMB		65	164	1.7	1.7	109	**00:01:01**		110@10	Climb Power
		(3600)	1000	**161**	203.4	41.7	99	00:01:01		10°C	
	CRUISE		1000	164	0.5	1.3	174	**00:00:28**		110@10	2500/27
		(3600)	1000	**162**	202.9	40.4	165	00:01:29		10°C	
WP2 N [illegible] 28' 39.7 W [illegible] 14' 33.7	CRUISE		1000	159	12.9	35.9	174	**00:13:04**		110@10	2500/27
		(3600)	1000	**157**	190.0	4.5	165	00:14:34		10°C	
	DESCNT		1000	159	0.2	0.7	145	**00:00:17**		L&V	Descent Power
		(3600)	856	**159**	189.8	3.8	145	00:14:51		13°C	
BIVM Vestmanna... N 63° 25' 30.0 W 20° 16' 45.0	DESCNT		856	215	1.0	3.8	144	**00:01:36**		110@10	Descent Power
		(3600)	65	**210**	188.7	0.0	143	00:16:27		10°C	
				ROUTE TOTALS	16.3	43.4		00:16:27			

FUEL CALCULATION	TIME	FUEL(L)	RESERVE	TIME	FUEL(L)
Climb + T/O	0:01	2	Contingency 0%	0:05	4
Cruise	0:13	13	Alternate Fuel	0:00	0
Descent	0:00	0	Holding / Final Reserve	0:45	35
Approach	0:01	1	Additional Fuel	0:00	0
Total Trip Fuel	0:16	16	**Minimum Required Fuel**	1:06	55
Taxi		5,8 0	Extra Fuel	3:13	150
Burn Off	0:16	16	**Loaded Block Fuel**	4:19	205
Actual Fuel Burned		19,8	Actual Remaining Fuel		185,1

NOTES:

Fuel 120 l6.

NAVIGATION LOG
BIVM -> BISF
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JEPPESEN *FliteStar*

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REPORT DATE	January 15, 2003	AIRCRAFT TYPE	Cessna
NAVDATA EXP. DATE	June 15, 2000	AIRCRAFT TAIL #	TF-GTI

WAYPOINTS (FIXES)		ROUTE / MEA/(MSA)	BEG ALT / END ALT	MC / MH	FUEL(L) LEG / REM	DIST(SM) LEG / REM	SPD(MPH) TAS / EST GS	ETE / CUMM	ATA / ATE	WIND / OAT	POWER
BIVM Vestmanna... N 63° 25' 30.0 W 20° 16' 45.0					184.9	55.5					
WP1 N 63° 32' 06.7 W 20° 12' 26.6	CLIMB		318	034	3.1	3.4	110	**00:01:51**		110@10	Climb Power
		(3600)	2000	**040**	181.8	52.1	110	00:01:51		10°C	
	CRUISE		2000	034	1.5	4.5	168	**00:01:36**		110@10	2500/25
		(3600)	2000	**037**	180.3	47.6	169	00:03:27		10°C	
WP2 N [illegible] 36' 27.3 W [illegible] 20' 27.9	CRUISE		2000	338	2.0	6.5	168	**00:02:10**		110@10	2400/26
		(3600)	2000	**340**	178.3	41.1	178	00:05:38		9°C	
WP3 N 63° 59' 13.3 W 21° 08' 43.5	CRUISE		2000	335	9.9	32.4	168	**00:10:54**		110@10	2400/26
		(3600)	2000	**337**	168.5	8.7	178	00:16:33		9°C	
	DESCNT		2000	335	0.9	3.5	147	**00:01:20**		110@10	Descent Power
		(3600)	1331	**337**	167.6	5.2	156	00:17:53		10°C	
SE Selfoss N 63° 55' 44.0 W 21° 02' 03.0 **397** ...	DESCNT		1331	158	1.5	5.2	144	**00:02:20**		110@10	Descent Power
		(3600)	318	**156**	166.1	0.0	134	00:20:13		10°C	
				ROUTE TOTALS	18.8	55.5		00:20:13			

FUEL CALCULATION	TIME	FUEL(L)	RESERVE	TIME	FUEL(L)
Climb + T/O	0:01	3	Contingency 0%	0:05	4
Cruise	0:14	13	Alternate Fuel	0:00	0
Descent	0:01	1	Holding / Final Reserve	0:30	24
Approach	0:02	2	Additional Fuel	0:00	0
Total Trip Fuel	0:20	19	**Minimum Required Fuel**	0:55	46
Taxi		3,50	Extra Fuel	2:56	138
Burn Off	0:20	19	**Loaded Block Fuel**	3:51	185
Actual Fuel Burned		22,8	Actual Remaining Fuel		162,3

NAVIGATION LOG

BISE-> BIVM
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JEPPESEN *FliteStar*

13

[illegible]PORT DATE	January 15, 2003	AIRCRAFT TYPE	Cessna
NAVDATA EXP. DATE	June 15, 2000	AIRCRAFT TAIL #	TF-GTI

WAYPOINTS (FIXES)		ROUTE / MEA(MSA)	BEG ALT / END ALT	MC / MH	FUEL(L) LEG / REM	DIST(SM) LEG / REM	SPD(MPH) TAS / EST GS	ETE / CUMM	ATA / ATE	WIND / OAT	POWER
SELFO N 63° 55' 45.0 W 21° 02' 16.0					162.8	43.4					
WP1 N 63° 53' 34.9 W 20° 58' 59.5	CLIMB		65	164	1.7	1.7	109	**00:01:01**		110@10	Climb Power
		(3600)	1000	**161**	161.1	41.7	99	00:01:01		10°C	
	CRUISE		1000	164	0.5	1.3	174	**00:00:28**		110@10	2500/27
		(3600)	1000	**162**	160.6	40.4	165	00:01:29		10°C	
WP2 N[illegible] 28' 39.7 W[illegible] 14' 33.7	CRUISE		1000	159	13.0	36.2	174	**00:13:11**		110@10	2500/27
		(3600)	1000	**157**	147.6	4.2	165	00:14:41		10°C	
	DESCNT		1000	159	0.1	0.4	145	**00:00:10**		110@10	Descent Power
		(3600)	916	**157**	147.5	3.8	135	00:14:51		10°C	
BIVM Vestmanna... N 63° 25' 30.0 W 20° 16' 45.0	DESCNT		916	215	1.0	3.8	144	**00:01:36**		110@10	Descent Power
		(3600)	65	**210**	146.4	0.0	143	00:16:27		10°C	
				ROUTE TOTALS	16.3	43.4		00:16:27			

FUEL CALCULATION	TIME	FUEL(L)	RESERVE	TIME	FUEL(L)
Climb + T/O	0:01	2	Contingency 0%	0:05	4
Cruise	0:13	14	Alternate Fuel	0:00	0
Descent	0:00	0	Holding / Final Reserve	0:45	35
Approach	0:01	1	Additional Fuel	0:00	0
Total Trip Fuel	0:16	16	**Minimum Required Fuel**	1:06	55
T[illegible]		580	Extra Fuel	2:18	108
B[illegible] Off	0:16	16	**Loaded Block Fuel**	3:24	163
Actual Fuel Burned		198	Actual Remaining Fuel		1425

NAVIGATION LOG
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JEPPESEN
FliteStar

REPORT DATE	January 16, 2003	AIRCRAFT TYPE	Cessna
NAVDATA EXP. DATE	June 15, 2000	AIRCRAFT TAIL #	TF-GTI

WAYPOINTS (FIXES)		ROUTE / MEA/(MSA)	BEG ALT / END ALT	MC / MH	FUEL(L) LEG / REM	DIST(SM) LEG / REM	SPD(MPH) TAS / EST GS	ETE / CUMM	ATA / ATE	WIND / OAT	POWER
BIVM Vestmanna... N 63° 25' 30.0 W 20° 16' 45.0					142.6	58.0					
WP1 N 63° 32' 06.7 W 20° 12' 26.6	CLIMB		318	034	3.1	3.4	110	**00:01:51**		110@10	Climb Power
		(3600)	2000	**040**	139.5	54.6	110	00:01:51		10°C	
	CRUISE		2000	034	1.5	4.5	168	**00:01:36**		110@10	2500/25
		(3600)	2000	**037**	138.0	50.1	169	00:03:27		10°C	
WP2 N... 36' 27.3 ...20' 27.9	CRUISE		2000	338	2.0	6.5	168	**00:02:10**		110@10	2400/26
		(3600)	2000	**340**	136.1	43.6	178	00:05:38		9°C	
WP3 N 63° 59' 59.6 W 21° 10' 29.1	CRUISE		2000	335	10.6	34.9	168	**00:11:44**		110@10	2400/26
		(3600)	2000	**336**	125.4	8.7	178	00:17:23		9°C	
	DESCNT		2000	335	0.5	2.2	147	**00:00:51**		110@10	Descent Power
		(3600)	1572	**337**	124.9	6.5	157	00:18:15		10°C	
SE Selfoss N 63° 55' 44.0 W 21° 02' 03.0 397 ...	DESCNT		1572	157	1.9	6.5	145	**00:02:53**		110@10	Descent Power
		(3600)	318	**155**	123.0	0.0	134	00:21:09		10°C	
				ROUTE TOTALS	19.6	58.0		00:21:09			

FUEL CALCULATION	TIME	FUEL(L)	RESERVE	TIME	FUEL(L)
Climb + T/O	0:01	3	Contingency 0%	0:05	4
Cruise	0:15	14	Alternate Fuel	0:00	0
Descent	0:00	1	Holding / Final Reserve	0:30	24
A...oach	0:02	2	Additional Fuel	0:00	0
Total Trip Fuel	0:21	20	**Minimum Required Fuel**	0:56	47
Taxi		3,8 0	Extra Fuel	2:01	95
Burn Off	0:21	20	**Loaded Block Fuel**	2:57	143
Actual Fuel Burned		23,8	Actual Remaining Fuel		118,7

NAVIGATION LOG

BISE-> BIVM
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JEPPESEN
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REPORT DATE	January 16, 2003	AIRCRAFT TYPE	Cessna
NAVDATA EXP. DATE	June 15, 2000	AIRCRAFT TAIL #	TF-GTI

WAYPOINTS (FIXES)		ROUTE MEA/(MSA)	BEG ALT / END ALT	MC / MH	FUEL(L) LEG / REM	DIST(SM) LEG / REM	SPD(MPH) TAS / EST GS	ETE / CUMM	ATA / ATE	WIND / OAT	POWER
SELFO N 63° 55' 45.0 W 21° 02' 16.0					118.6	45.2					
WP1 N 63° 53' 34.9 W 20° 58' 59.5	CLIMB		65	164	1.7	1.7	109	**00:01:01**		110@10	Climb Power
		(3600)	1000	**161**	116.9	43.5	99	00:01:01		10°C	
	CRUISE		1000	164	0.5	1.3	174	**00:00:28**		110@10	2500/27
		(3600)	1000	**162**	116.4	42.2	165	00:01:29		10°C	
WP2 N… 28' 09.6 W… 11' 21.2	CRUISE		1000	158	13.7	38.0	174	**00:13:51**		110@10	2500/27
		(3600)	1000	**156**	102.7	4.2	164	00:15:21		10°C	
	DESCNT		1000	158	0.0	0.1	145	**00:00:01**		110@10	Descent Power
		(3600)	988	**156**	102.7	4.1	132	00:15:22		10°C	
BIVM Vestmanna... N 63° 25' 30.0 W 20° 16' 45.0	DESCNT		988	240	1.1	4.1	144	**00:01:40**		110@10	Descent Power
		(3600)	65	**235**	101.7	0.0	148	00:17:03		10°C	
				ROUTE TOTALS	17.0	45.2		00:17:03			

FUEL CALCULATION	TIME	FUEL(L)	RESERVE	TIME	FUEL(L)
Climb + T/O	0:01	2	Contingency 0%	0:05	4
Cruise	0:14	14	Alternate Fuel	0:00	0
Descent	0:00	0	Holding / Final Reserve	0:45	35
Approach	0:01	1	Additional Fuel	0:00	0
Total Trip Fuel	0:17	17	**Minimum Required Fuel**	1:07	56
Taxi		3,8 0	Extra Fuel	1:21	63
B… Off	0:17	17	**Loaded Block Fuel**	2:28	119
Actual Fuel Burned		20,8	Actual Remaining Fuel		97,9

NAVIGATION LOG

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JEPPESEN *FliteStar*

REPORT DATE	January 16, 2003	AIRCRAFT TYPE	Cessna
NAVDATA EXP. DATE	June 15, 2000	AIRCRAFT TAIL #	TF-GTI

WAYPOINTS (FIXES)		ROUTE / MEA(MSA)	BEG ALT / END ALT	MC / MH	FUEL(L) LEG / REM	DIST(SM) LEG / REM	SPD(MPH) TAS / EST GS	ETE / CUMM	ATA / ATE	WIND / OAT	POWER
BIVM Vestmanna... N 63° 25' 30.0 W 20° 16' 45.0					97.8	47.1					
WP1 N 63° 32' 36.7 W 20° 09' 24.3	CLIMB		318	042	3.1	3.4	110	**00:01:51**		110@10	Climb Power
		(3600)	2000	**048**	94.7	43.7	108	00:01:51		10°C	
	CRUISE		2000	042	1.9	5.7	168	**00:02:01**		110@10	2500/25
		(3600)	2000	**046**	92.8	38.0	167	00:03:53		10°C	
WP2 N[illegible] 36' 27.3 [illegible] 20' 27.9	CRUISE		2000	325	2.2	7.2	168	**00:02:24**		110@10	2400/26
		(3600)	2000	**327**	90.7	30.9	179	00:06:18		9°C	
SELFO N 63° 55' 45.0 W 21° 02' 16.0	CRUISE		2000	334	6.7	22.1	168	**00:07:26**		110@10	2400/26
		(3600)	2000	**336**	83.9	8.7	178	00:13:45		9°C	
	DESCNT		2000	334	2.1	8.6	145	**00:03:19**		110@10	Descent Power
		(3600)	338	**336**	81.8	0.1	155	00:17:04		9°C	
SE Selfoss N 63° 55' 44.0 W 21° 02' 03.0 397 ...	DESCNT		338	118	0.0	0.1	143	**00:00:03**		110@10	Descent Power
		(3600)	318	**119**	81.8	0.0	128	00:17:07		10°C	
		ROUTE TOTALS			16.0	47.1		00:17:07			

FUEL CALCULATION	TIME	FUEL(L)	RESERVE	TIME	FUEL(L)
Climb + T/O	0:01	3	Contingency 0%	0:05	4
Cruise	0:11	11	Alternate Fuel	0:00	0
Descent	0:03	2	Holding / Final Reserve	0:30	24
Approach	0:00	0	Additional Fuel	0:00	0
Total Trip Fuel	0:17	16	**Minimum Required Fuel**	0:52	44
Taxi		3,8 0	Extra Fuel	1:09	54
Burn Off	0:17	16	**Loaded Block Fuel**	2:01	98
Actual Fuel Burned		19,8	Actual Remaining Fuel		78,1

NAVIGATION LOG

BISE-> BIVM
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17.

JEPPESEN
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[illegible]PORT DATE	January 16, 2003	AIRCRAFT TYPE	Cessna
NAVDATA EXP. DATE	June 15, 2000	AIRCRAFT TAIL #	TF-GTI

WAYPOINTS (FIXES)		ROUTE / MEA(MSA)	BEG ALT / END ALT	MC / MH	FUEL(L) LEG / REM	DIST(SM) LEG / REM	SPD(MPH) TAS / EST GS	ETE / CUMM	ATA / ATE	WIND / OAT	POWER
SELFO N 63° 55' 45.0 W 21° 02' 16.0					78.2	42.7					
WP1 N 63° 53' 34.9 W 20° 58' 59.5	CLIMB		65	164	1.7	1.7	109	**00:01:01**		110@10	Climb Power
		(3600)	1000	**161**	76.5	41.0	99	00:01:01		10°C	
	CRUISE		1000	164	0.5	1.3	174	**00:00:28**		110@10	2500/27
		(3600)	1000	**162**	76.1	39.7	165	00:01:29		10°C	
WP2 N[illegible] 32' 44.7 [illegible] 19' 41.6	CRUISE		1000	158	11.3	31.2	174	**00:11:24**		110@10	2500/27
		(3600)	1000	**156**	64.8	8.5	164	00:12:53		10°C	
BIVM Vestmanna... N 63° 25' 30.0 W 20° 16' 45.0	CRUISE		1000	187	1.5	4.2	174	**00:01:29**		110@10	2500/27
		(3600)	1000	**184**	63.3	4.3	168	00:14:23		10°C	
	DESCNT		1000	187	1.2	4.3	144	**00:01:52**		110@10	Descent Power
		(3600)	65	**183**	62.1	0.0	138	00:16:15		10°C	
ROUTE TOTALS					16.1	42.7		00:16:15			

FUEL CALCULATION	TIME	FUEL(L)	RESERVE	TIME	FUEL(L)
Climb + T/O	0:01	2	Contingency 0%	0:05	4
Cruise	0:13	13	Alternate Fuel	0:00	0
Descent	0:00	0	Holding / Final Reserve	0:45	35
Approach	0:01	1	Additional Fuel	0:00	0
Total Trip Fuel	0:16	16	**Minimum Required Fuel**	1:06	55
T[illegible]		3,8 0	Extra Fuel	0:30	23
B[illegible] Off	0:16	16	**Loaded Block Fuel**	1:36	78
Actual Fuel Burned		19,8	Actual Remaining Fuel		58,3

NAVIGATION LOG

BIVM -> BISF
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18.

REPORT DATE	January 16, 2003	AIRCRAFT TYPE	Cessna
NAVDATA EXP. DATE	June 15, 2000	AIRCRAFT TAIL #	TF-GTI

WAYPOINTS (FIXES)		ROUTE / MEA(MSA)	BEG ALT / END ALT	MC / MH	FUEL(L) LEG / REM	DIST(SM) LEG / REM	SPD(MPH) TAS / EST GS	ETE / CUMM	ATA / ATE	WIND / OAT	POWER
BIVM Vestmanna... N 63° 25' 30.0 W 20° 16' 45.0					58.0	52.5					
WP1 N 63° 32' 36.7 W 20° 09' 24.3	CLIMB		318	042	3.1	3.3	109	00:01:51		110@10	Climb Power
		(3600)	2000	048	54.9	49.1	108	00:01:51		9°C	
	CRUISE		2000	042	1.9	5.7	168	00:02:01		110@10	2500/25
		(3600)	2000	046	53.1	43.5	167	00:03:53		9°C	
WP2 N [illegible] 57' 35.9 [illegible] 05' 54.2	CRUISE		2000	333	10.2	33.4	168	00:11:14		110@10	2400/26
		(3600)	2000	334	42.9	10.0	178	00:15:08		9°C	
	DESCNT		2000	333	1.8	7.2	146	00:02:46		110@10	Descent Power
		(3600)	610	335	41.1	2.8	156	00:17:55		10°C	
SELFO N 63° 55' 45.0 W 21° 02' 16.0	DESCNT		610	157	0.8	2.8	143	00:01:16		110@10	Descent Power
		(3600)	65	155	40.3	0.0	133	00:19:11		10°C	
				ROUTE TOTALS	17.7	52.5		00:19:11			

FUEL CALCULATION	TIME	FUEL(L)	RESERVE	TIME	FUEL(L)
Climb + T/O	0:01	3	Contingency 0%	0:05	4
Cruise	0:13	12	Alternate Fuel	0:00	0
Descent	0:02	2	Holding / Final Reserve	0:30	23
Approach	0:01	1	Additional Fuel	0:00	0
Total Trip Fuel	0:19	18	**Minimum Required Fuel**	0:54	45
Taxi	3,8	0	Extra Fuel	0:17	13
Burn Off	0:19	18	**Loaded Block Fuel**	1:11	58
Actual Fuel Burned		21,8	Actual Remaining Fuel		36,5

NAVIGATION LOG

BISE-> BIVM

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19.

JEPPESEN *FliteStar*

REPORT DATE	January 16, 2003	AIRCRAFT TYPE	Cessna
NAVDATA EXP. DATE	June 15, 2000	AIRCRAFT TAIL #	TF-GTI

WAYPOINTS (FIXES)		ROUTE / MEA(MSA)	BEG ALT / END ALT	MC / MH	FUEL(L) LEG / REM	DIST(SM) LEG / REM	SPD(MPH) TAS / EST GS	ETE / CUMM	ATA / ATE	WIND / OAT	POWER
SELFO N 63° 55' 45.0 W 21° 02' 16.0					156.5	48.1					
WP1 N 63° 53' 34.9 W 20° 58' 59.5	CLIMB		65	164	1.7	1.7	109	**00:01:01**		110@10	Climb Power
		(3600)	1000	**161**	154.8	46.4	99	00:01:01		10°C	
	CRUISE		1000	164	0.5	1.3	174	**00:00:28**		110@10	2500/27
		(3600)	1000	**162**	154.3	45.1	165	00:01:29		10°C	
WP2 N [illegible] 33' 40.5 W [illegible] 07' 59.1	CRUISE		1000	149	12.5	34.6	174	**00:12:41**		110@10	2500/27
		(3600)	1000	**148**	141.8	10.4	164	00:14:11		10°C	
BIVM Vestmanna... N 63° 25' 30.0 W 20° 16' 45.0	CRUISE		1000	223	2.0	5.9	174	**00:02:01**		110@10	2500/27
		(3600)	1000	**219**	139.7	4.5	175	00:16:13		10°C	
	DESCNT		1000	223	1.2	4.5	144	**00:01:52**		110@10	Descent Power
		(3600)	65	**218**	138.5	0.0	144	00:18:05		10°C	
				ROUTE TOTALS	17.9	48.1		00:18:05			

FUEL CALCULATION	TIME	FUEL(L)	RESERVE	TIME	FUEL(L)
Climb + T/O	0:01	2	Contingency 0%	0:05	4
Cruise	0:15	15	Alternate Fuel	0:00	0
Descent	0:00	0	Holding / Final Reserve	0:45	35
Approach	0:01	1	Additional Fuel	0:00	0
Total Trip Fuel	0:18	18	**Minimum Required Fuel**	1:08	57
Taxi		38 0	Extra Fuel	2:08	100
Burn Off	0:18	18	**Loaded Block Fuel**	3:16	156
Actual Fuel Burned		24,8	Actual Remaining Fuel		1397

NOTES:

Fuel 120 lbr.

NAVIGATION LOG

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REPORT DATE	January 16, 2003	AIRCRAFT TYPE	Cessna
NAVDATA EXP. DATE	June 15, 2000	AIRCRAFT TAIL #	TF-GTI

WAYPOINTS (FIXES)		ROUTE / MEA(MSA)	BEG ALT / END ALT	MC / MH	FUEL(L) LEG / REM	DIST(SM) LEG / REM	SPD(MPH) TAS / EST GS	ETE / CUMM	ATA / ATE	WIND / OAT	POWER
BIVM Vestmanna... N 63° 25' 30.0 W 20° 16' 45.0					135.0	55.1					
WP1 N 63° 33' 02.4 W 20° 08' 00.1	CLIMB		318	045	3.1	3.3	110	**00:01:51**		110@10	Climb Power
		(3600)	2000	**051**	131.9	51.7	108	00:01:51		10°C	
	CRUISE		2000	045	2.1	6.4	168	**00:02:19**		110@10	2400/26
		(3600)	2000	**049**	129.8	45.3	166	00:04:11		10°C	
WP2 N[illegible] 58' 09.9 [illegible] 06' 54.4	CRUISE		2000	332	10.7	35.2	168	**00:11:50**		110@10	2400/26
		(3600)	2000	**333**	119.1	10.0	179	00:16:01		9°C	
	DESCNT		2000	332	1.6	6.4	146	**00:02:27**		110@10	Descent Power
		(3600)	770	**333**	117.5	3.6	156	00:18:29		10°C	
SELFO N 63° 55' 45.0 W 21° 02' 16.0	DESCNT		770	158	1.0	3.6	143	**00:01:38**		110@10	Descent Power
		(3600)	65	**156**	116.5	0.0	133	00:20:07		10°C	
				ROUTE TOTALS	18.5	55.1		00:20:07			

FUEL CALCULATION	TIME	FUEL(L)	RESERVE	TIME	FUEL(L)
Climb + T/O	0:01	3	Contingency 0%	0:05	4
Cruise	0:14	13	Alternate Fuel	0:00	0
Descent	0:02	2	Holding / Final Reserve	0:30	23
Approach	0:01	1	Additional Fuel	0:00	0
Total Trip Fuel	0:20	19	**Minimum Required Fuel**	0:55	46
Taxi		3,8 0	Extra Fuel	1:53	89
Burn Off	0:20	19	**Loaded Block Fuel**	2:48	135
Actual Fuel Burned		22,8	Actual Remaining Fuel		111,9

NAVIGATION LOG

BISE-> BIVM
(Page 1 of 1)

21.

JEPPESEN *FliteStar*

[illegible]EPORT DATE	January 16, 2003	AIRCRAFT TYPE	Cessna
NAVDATA EXP. DATE	June 15, 2000	AIRCRAFT TAIL #	TF-GTI

WAYPOINTS (FIXES)		ROUTE / MEA(MSA)	BEG ALT / END ALT	MC / MH	FUEL(L) LEG / REM	DIST(SM) LEG / REM	SPD(MPH) TAS / EST GS	ETE / CUMM	ATA / ATE	WIND / OAT	POWER
SELFO N 63° 55' 45.0 W 21° 02' 16.0					111.7	41.8					
WP1 N 63° 53' 34.9 W 20° 58' 59.5	CLIMB		65	164	1.7	1.7	109	**00:01:01**		110@10	Climb Power
		(3600)	1000	**161**	110.0	40.2	99	00:01:01		10°C	
	CRUISE		1000	164	0.5	1.3	174	**00:00:28**		110@10	2500/27
		(3600)	1000	**162**	109.5	38.9	165	00:01:29		10°C	
WP2 [illegible] 27' 00.7 [illegible] 18' 53.5	CRUISE		1000	164	12.5	34.7	174	**00:12:36**		110@10	2500/27
		(3600)	1000	**162**	97.0	4.2	165	00:14:06		10°C	
	DESCNT		1000	164	0.6	2.1	144	**00:00:56**		110@10	Descent Power
		(3600)	527	**161**	96.4	2.1	135	00:15:02		10°C	
BIVM Vestmanna... N 63° 25' 30.0 W 20° 16' 45.0	DESCNT		527	165	0.6	2.1	143	**00:00:55**		110@10	Descent Power
		(3600)	65	**162**	95.8	0.0	133	00:15:58		10°C	
			ROUTE TOTALS		15.8	41.8		00:15:58			

FUEL CALCULATION	TIME	FUEL(L)	RESERVE	TIME	FUEL(L)
Climb + T/O	0:01	2	Contingency 0%	0:05	4
Cruise	0:13	13	Alternate Fuel	0:00	0
Descent	0:00	1	Holding / Final Reserve	0:45	35
Approach	0:00	1	Additional Fuel	0:00	0
Total Trip Fuel	0:16	16	**Minimum Required Fuel**	1:06	55
T[illegible]		350	Extra Fuel	1:13	57
B[illegible] Off	0:16	16	**Loaded Block Fuel**	2:19	112
Actual Fuel Burned		19,8	Actual Remaining Fuel		92,1

NAVIGATION LOG

BIVM -> BISF
(Page 1 of 1)

22.

JEPPESEN *FliteStar*

EPORT DATE	January 16, 2003	AIRCRAFT TYPE	Cessna
NAVDATA EXP. DATE	June 15, 2000	AIRCRAFT TAIL #	TF-GTI

WAYPOINTS (FIXES)		ROUTE / MEA(MSA)	BEG ALT / END ALT	MC / MH	FUEL(L) LEG / REM	DIST(SM) LEG / REM	SPD(MPH) TAS / EST GS	ETE / CUMM	ATA / ATE	WIND / OAT	POWER
BIVM Vestmanna... N 63° 25' 30.0 W 20° 16' 45.0					92.1	50.0					
WP1 N 63° 34' 11.4 W 20° 14' 27.1	CLIMB		318	024	3.1	3.5	110	**00:01:51**		110@10	Climb Power
		(3600)	2000	**030**	89.0	46.6	112	00:01:51		10°C	
	CRUISE		2000	024	2.1	6.6	168	**00:02:19**		110@10	2400/26
		(3600)	2000	**028**	86.9	40.0	170	00:04:11		10°C	
WP2 N ° 57' 28.3 05' 37.0	CRUISE		2000	334	9.1	29.9	168	**00:10:04**		110@10	2400/26
		(3600)	2000	**335**	77.8	10.0	178	00:14:15		10°C	
	DESCNT		2000	334	1.8	7.4	146	**00:02:51**		110@10	Descent Power
		(3600)	571	**336**	76.0	2.6	156	00:17:06		10°C	
SELFO N 63° 55' 45.0 W 21° 02' 16.0	DESCNT		571	157	0.7	2.6	143	**00:01:10**		110@10	Descent Power
		(3600)	65	**155**	75.2	0.0	133	00:18:17		10°C	
				ROUTE TOTALS	16.9	50.0		00:18:17			

FUEL CALCULATION	TIME	FUEL(L)	RESERVE	TIME	FUEL(L)
Climb + T/O	0:01	3	Contingency 0%	0:05	4
Cruise	0:12	11	Alternate Fuel	0:00	0
Descent	0:02	2	Holding / Final Reserve	0:30	23
Approach	0:01	1	Additional Fuel	0:00	0
Total Trip Fuel	0:18	17	**Minimum Required Fuel**	0:53	44
Ta		3,8 0	Extra Fuel	1:01	48
B l Off	0:18	17	**Loaded Block Fuel**	1:54	92
Actual Fuel Burned		20,8	Actual Remaining Fuel		71,3

NAVIGATION LOG
BISE-> BIVM
(Page 1 of 1)

23.

JEPPESEN
FliteStar

[illegible]EPORT DATE	January 16, 2003	AIRCRAFT TYPE	Cessna
NAVDATA EXP. DATE	June 15, 2000	AIRCRAFT TAIL #	TF-GTI

WAYPOINTS (FIXES)		ROUTE / MEA(MSA)	BEG ALT / END ALT	MC / MH	FUEL(L) LEG / REM	DIST(SM) LEG / REM	SPD(MPH) TAS / EST GS	ETE / CUMM	ATA / ATE	WIND / OAT	POWER
SELFO N 63° 55' 45.0 W 21° 02' 16.0					71.3	50.9					
WP1 N 63° 57' 50.4 W 21° 05' 39.7	CLIMB		65	343	1.7	2.0	109	**00:01:01**		110@10	Climb Power
		(3600)	1000	**346**	69.6	48.9	118	00:01:01		10°C	
	CRUISE		1000	343	0.3	1.0	174	**00:00:18**		110@10	2500/27
		(3600)	1000	**345**	69.3	47.9	184	00:01:19		10°C	
WP2 N[illegible] 32' 48.8 [illegible] 13' 04.9	CRUISE		1000	155	14.2	39.3	174	**00:14:22**		110@10	2500/27
		(3600)	1000	**153**	55.1	8.6	164	00:15:42		10°C	
BIVM Vestmanna... N 63° 25' 30.0 W 20° 16' 45.0	CRUISE		1000	210	1.4	4.2	174	**00:01:27**		110@10	2500/27
		(3600)	1000	**206**	53.6	4.4	173	00:17:09		10°C	
	DESCNT		1000	210	1.2	4.4	144	**00:01:52**		110@10	Descent Power
		(3600)	65	**205**	52.4	0.0	142	00:19:01		10°C	
				ROUTE TOTALS	18.9	50.9		00:19:01			

FUEL CALCULATION	TIME	FUEL(L)	RESERVE	TIME	FUEL(L)
Climb + T/O	0:01	2	Contingency 0%	0:05	4
Cruise	0:16	16	Alternate Fuel	0:00	0
Descent	0:00	0	Holding / Final Reserve	0:45	35
Approach	0:01	1	Additional Fuel	0:00	0
Total Trip Fuel	0:19	19	**Minimum Required Fuel**	1:09	58
Ta[illegible]		38 0	Extra Fuel	0:17	14
B[illegible] Off	0:19	19	**Loaded Block Fuel**	1:26	71
Actual Fuel Burned		22,8	Actual Remaining Fuel		48,5

NAVIGATION LOG

BIVM -> BIRK
(Page 1 of 2)

24.

JEPPESEN *FliteStar*

[R]EPORT DATE	January 16, 2003	AIRCRAFT TYPE	Cessna
NAVDATA EXP. DATE	June 15, 2000	AIRCRAFT TAIL #	TF-GTI

WAYPOINTS (FIXES)		ROUTE / MEA(MSA)	BEG ALT / END ALT	MC / MH	FUEL(L) LEG / REM	DIST(SM) LEG / REM	SPD(MPH) TAS / EST GS	ETE / CUMM	ATA / ATE	WIND / OAT	POWER
BIVM Vestmanna... N 63° 25' 30.0 W 20° 16' 45.0					48.6	84.4					
WP1 N 63° 35' 15.4 W 20° 17' 12.2	CLIMB		318	016	3.1	3.5	109	**00:01:51**		110@10	Climb Power
		(3600)	2000	**022**	45.5	80.9	113	00:01:51		9°C	
	CRUISE		2000	016	2.3	7.7	156	**00:02:53**		110@10	2300/24
		(3600)	2000	**020**	43.2	73.2	160	00:04:45		9°C	
WP2 [illegible]° 56' 37.5 [illegible] 09' 55.0	CRUISE		2000	330	9.0	31.6	156	**00:11:23**		110@10	2300/24
		(3600)	2000	**332**	34.2	41.6	167	00:16:08		7°C	
	CLIMB		2000	330	3.9	4.8	113	**00:02:19**		110@10	Climb Power
		(3600)	4000	**332**	30.4	36.8	123	00:18:27		7°C	
WP3 N 64° 04' 23.0 W 21° 33' 24.1	CRUISE		4000	325	4.1	14.8	160	**00:05:13**		110@10	2300/24
		(5500)	4000	**326**	26.3	22.0	171	00:23:41		7°C	
WP4 N 64° 06' 05.0 W 21° 39' 17.4	DESCNT		4000	322	0.9	3.5	151	**00:01:18**		110@10	Descent Power
		(5500)	3342	**323**	25.4	18.5	162	00:24:59		7°C	
EL Ellidavatn N 64° 04' 52.0 W 21° 46' 15.0 335	DESCNT		3342	267	1.0	3.8	150	**00:01:26**		110@10	Descent Power
		(5500)	2625	**264**	24.4	14.7	158	00:26:25		8°C	
WP5 N 64° 06' 34.9 W 21° 59' 08.1	DESCNT		2625	305	0.2	0.8	148	**00:00:17**		110@10	Descent Power
		(5500)	2500	**305**	24.2	13.9	159	00:26:42		9°C	
	CRUISE		2500	305	0.3	1.0	157	**00:00:22**		110@10	2300/24
		(5500)	2500	**305**	23.9	12.9	168	00:27:05		9°C	
	DESCNT		2500	305	1.2	5.0	148	**00:01:52**		110@10	Descent Power
		(5500)	1560	**305**	22.7	7.9	159	00:28:57		10°C	
WP6 N 64° 10' 29.1 W 21° 59' 20.7	DESCNT		1560	017	1.2	4.5	145	**00:01:48**		110@10	Descent Power
		(5500)	652	**022**	21.6	3.4	149	00:30:46		9°C	
BIRK Reykjavik N 64° 07' 48.0 W 21° 56' 26.0	DESCNT		652	173	1.0	3.4	143	**00:01:31**		110@10	Descent Power
		(5500)	45	**170**	20.6	0.0	135	00:32:18		10°C	
				ROUTE TOTALS	28.0	84.4		00:32:18			

NAVIGATION LOG

BIVM -> BIRK
(Page 2 of 2)

JEPPESEN *FliteStar*

24.2

REPORT DATE	January 16, 2003	AIRCRAFT TYPE	Cessna
NAVDATA EXP. DATE	June 15, 2000	AIRCRAFT TAIL #	TF-GTI

FUEL CALCULATION	TIME	FUEL(L)	RESERVE	TIME	FUEL(L)
Climb + T/O	0:01	3	Contingency 0%	0:05	4
Cruise	0:25	22	Alternate Fuel	0:00	0
Descent	0:03	2	Holding / Final Reserve	0:00	0
Approach	0:01	1	Additional Fuel	0:45	35
Total Trip Fuel	0:32	28	**Minimum Required Fuel**	1:22	67
Taxi		3,8 0	Extra Fuel	0:00	-18
Burn Off	0:32	28	**Loaded Block Fuel**	1:00	49
Actual Fuel Burned		31,8	Actual Remaining Fuel		16,7

NOTES:

TERN SYSTEMS INC.

STATISTICAL ANALYSIS OF THE ESTIMATED FUEL LEVEL OF TF-GTI THE 7TH AUGUST 2000

Annex II

REYKJAVÍK 11TH JUNE 2003

Tern Systems Inc.

Statistical analysis of the estimated fuel level of TF-GTI the 7th August 2000

Rep # TERN-20030611-01
Version 1.0

Revision History

Date	Version	Description	Author
11/06/2003	1.0	Final version	Matthías Sveinbjörnsson

Contents

1 Introduction

1.1 Objective

The 7th of August 2000 a tragic accident occurred when TF-GTI, a Cessna 210, crashed in Skerjafjörður. Since then two investigations on the causes of the accident have been done, one by the Icelandic Air Accident Investigation Board (IAAIB) and the other by B.M.E. Forward and A.F. Taylor, independent accident investigators. The possibility that fuel starvation was the cause of the loss of engine power was evaluated in both reports.

The objective of this work is to analyze with statistical methods the likelihood that the aircraft lost its engine power due to fuel starvation.

1.2 Scope

Here only statistical methods are used to evaluate the likelihood that the aircraft lost its engine power due to fuel starvation. The assumptions and calculations made by IAAIB and Forward and Taylor are not to be the evaluated here.

1.3 Definitions and abbreviations

IAAIB	Icelandic Air Accident Investigation Board
RK	Reykjavik airport
SF	Selfoss airport
VM	Vestmannaeyjar airport
USG	United States Gallon.

1.4 References

"Skýrsla um flugslys M-05100/AIG-24", *Rannsóknanefnd flugslysa*, Reykjavík, 23.mars, 2001.

B.M.E. Forward, A.F. Taylor, "A review of the report and circumstances relating to the fatal accident to Cessna 210 TF-GTI on 7 August 2000", September 2001

Aircraft Handbook Cessna T210L, Centurion II.

1.5 Overview

In Chapter 2 the methodology used is described.

In Chapter 3 the assumptions, simulation runs and the parameters used are described.

In Chapter 4 the model is reviewed.

In Chapter 5 the results are presented.

In Chapter 6 the final conclusions are made.

In Appendix A a mathematical description of the model is provided.

In Appendix B is a calculation of the total flying time.

In Appendix C is a sensitivity analysis of the model.

2 Methodology

In this analysis the Aircraft operating handbook is used for the aircraft performance and fuel burn. The methodology is similar to the one used by the IAAIB which is mainly based on power setting, flight time and altitude for fuel burn calculations. The initial fuel and added fuel is used to estimate the available fuel. By comparing the fuel burn and available fuel it is possible to evaluate wheatear the aircraft had run out of fuel at the time of the accident. The main difference between the methodology used here and the one the IAAIB used is that here statistical approximation is used on the parameters that where not known with great deal of certainty instead of using only the most likely value. In addition to that descent was calculated directly and a higher power setting was used. Monte Carlo simulation was used. The software used was Analytica 2.0.5, made by Lumina Decision Systems Inc. and Table Curve 5.0, made by AISN Software Inc. was used to analyze the results.

3 Assumptions

Here the assumptions and parameters used in this analysis are described. The parameters are categorized in certain and uncertain parameters and the remarks made by Forward and Taylor regarding the IAAIB's fuel calculations are considered.

In the calculations made by the IAAIB the wing-end tanks where not included as the board concluded that it was very unlikely that they had been used. Forward and Taylor concluded that it was illogical not to include them because of the minimum fuel required to be in the tanks in accordance to AD note 94-12-8.

In light of this, two simulations where used to evaluate the fuel quantity in regard to the different assumptions.

1) The wing-end tanks where used.

2) The wing-end tanks where **not** used.

3.1 Certain parameters

- **Flying time**

It is known by some degree of certainty how long the aircraft was airborne from the time its tanks where filled on the 6th of August 2000, and it was 8 hours and 5 minutes in 24 legs. In the IAAIB report take-off and landing times were set forth at Selfoss, Vestmannaeyjar and Reykjavik. Both in Vesmannaeyjar and Reykjavik air traffic controllers were on duty so the take-off and landing times would have been fairly accurate but in Selfoss no one was logging those times so the difference from the actual time could have been more. It could be that there have been differences from the logged and actual times although those differences could have equaled each other out with the number of time loggings made. The total flying time could have been the same as in the IAAIB report but in a statistical analysis as this the differences have to be included.

- **Added fuel**

It is known how much fuel was added to the aircraft on three occasions.

- The main fuel tanks where filled at 18:15 on the 6th of August 2000 with 229 liters of fuel at Reykjavik airport.
- The 7th of August at 13:45 120 liters of fuel where added to the tanks at Selfoss.
- At 17:40 the same day again 120 liters where added to the aircraft tanks.

- **Altitude**

It is known that the aircraft was flying at 4000 feet when it came to Reykjavik for the last time.

- **Number of passengers**

It is difficult to estimate the weight of the aircraft but it is known when the aircraft had passengers and when it didn't.

3.2 Uncertain parameters

- **Initial fuel**

To fill the main tanks of the aircraft a certain technique had to be applied as described in the IAAIB report:

> … if more than 75 USG where to be set in the main tanks, the aircraft had to be level and the nose of the aircraft raised by 4,5° and the fuel caps properly attached.
>
> … The aircraft TF-GTI had four fuel tanks. The main tanks where two and contained 90 USG or 340 liters of those 337 usable. Special procedures had to be carried out to fill the main tanks as described in the airworthiness instructions so that it was certain that 340 liters where in them. The aircraft had to have the proper attitude and the last 20 liters had to be added slowly on each tank and checked again after two minutes and filled again. During the investigation of the accident it came apparent that the pilots where not aware of this procedure.

In addition to this the aircraft had wing-end tanks which contained 33 USG or 125 liters and of those 32,5 USG or 123 liters where usable. The fuel in the wing-end tanks could only be transferred from to the main tanks in cruise and only into the tank that was not in use.

It can be seen that in order to fill the main tanks special procedure had to be applied. It is not certain that these procedure where used and therefore difficult to state the initial fuel quantity on the aircraft.

- **Wing-end tanks**

The IAAIB report states that in order to be able to use 3800 pounds maximum take-off weight at least 7 USG had to be in each wing-end tank. It further reports that the pilots the board spoke to did not all seem to be aware of this. They initially stated that they had only several liters in each tank but later stated that they had 7 USG. In addition to this the "Eldsneytisafgreiðslan á Reykjavíkurflugvelli", the fuel service provider, had only once pumped fuel in the wing-end tanks. The IAAIB concluded therefore that it was unlikely that the wing-end tanks were used and the board didn't include them in their calculations on the fuel level.

Forward and Taylor pointed out that because 4 liters of fuel where found in the right wing-end tank of the aircraft after the accident and the initial statements of the pilots indicated that they always had a few liters in the tanks it was illogical to exclude them totally.

It can therefore be apparent there is uncertain how much fuel was in the wing-end tanks and difficult to conclude if they where overall used.

- **Power setting of the aircraft**

It is difficult to say with any certainty which power setting was used. In the IAAIB report 56% power was used which was based on calculated average speed of 157 MPH. Here it is assumed that the power setting is higher which based on the conclusion that 56% is unusually low in respect to normal power setting and the fact that the average speed is based on optimum conditions and a flight profile which is not known. In addition to that it is difficult to estimate power setting during descent and fuel burn information in descent is not available.

- **Gear down**

The aircraft was flown with the gear down on two legs. The IAAIB concluded that the effects of this were that the cruising speed of the aircraft decreased and therefore the flying time increased but the power setting of the aircraft remained the same. No additional fuel burn was therefore added due to this in the IAAIB calculations as the increased fuel burn is included in the increased flying time.

Forward and Taylor did not agree as they assumed that the flying time had not increased on the legs where the aircraft was flying with the gear down. They concluded that a fuel burn increase of 20% or about 5 liters should have been added to the calculations.

- **Altitude**

Because the aircraft was flying out of radar coverage between Vestmannaeyjar and Selfoss it was not possible to state with certainty the altitude of the aircraft. It was only possible to see the altitude from radar data and radio communications relatively close to Reykjavik. It is known that the aircraft was flying at 4000 feet on its last leg to Reykjavik.

- **Fuel starvation**

In the IAAIB report it is noted that under certain circumstances fuel starvation can occur although the fuel level is higher than the minimum usable fuel. This can occur when the fuel level is under 11 USG in the main tanks. It is there for not possible to state with certainty the fuel level required to keep the engine running in the attitude the aircraft was in when it lost its engine power.

3.3 The flights of TF-GTI

Here a table with information on the flight of TF-GTI is set forth. The information is from the IAAIB report and will be referred to in this report.

Leg	From	To	Take-off	Flying time (min)	Fuel added (liters)
6-Aug-00					229
1	RK	VM	18:24	33	
2	VM	RK	22:55	30	
7-Aug-00					
3	RK	VM	07:53	28	
4	VM	SF	08:35	20	
5	SF	VM	09:01	15	
6	VM	SF	09:31	21	
7	SF	VM	10:16	20	
8	VM	SF	12:30	20	
9	SF	VM	12:55	15	
10	VM	SF	13:23	19	
					120
11	SF	VM	13:55	16	
12	VM	SF	14:20	20	
13	SF	VM	14:45	16	
14	VM	SF	15:20	21	
15	SF	VM	15:46	17	
16	VM	SF	16:18	17	
17	SF	VM	16:44	16	
18	VM	SF	17:18	19	
					120
19	SF	VM	17:43	18	
20	VM	SF	18:13	20	
21	SF	VM	18:40	15	
22	VM	SF	19:07	18	
23	SF	VM	19:29	19	
24	VM	RK	20:03	32	
			Total:	**8:05**	469

Table 3-1. The flights of TF-GTI in accordance with the IAAIB report.

4 Model

4.1 Description

The certain and uncertain parameters previously described as well as information on the flight of TF-GTI where set up in the following model. The elliptical forms represent uncertain variables and the boxes represent calculation module.

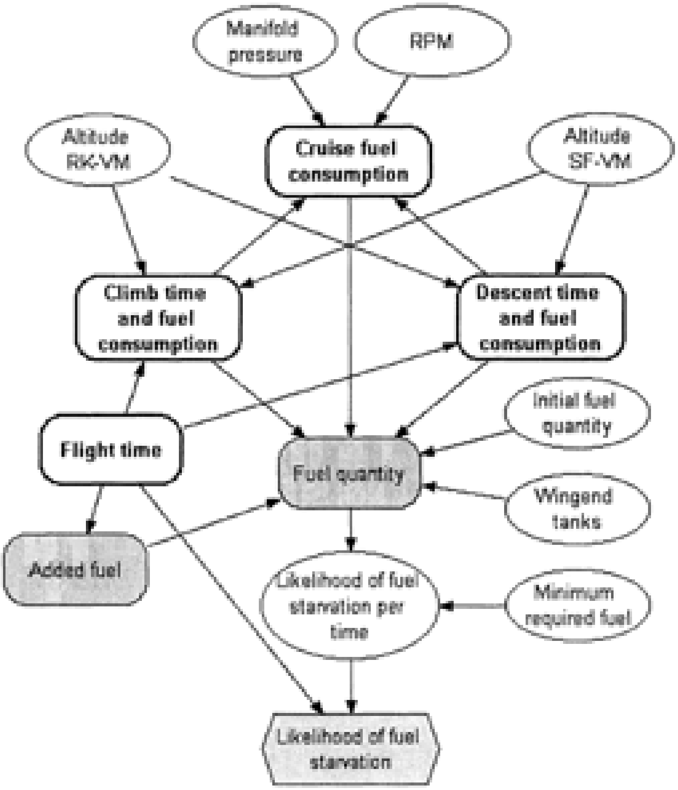


Figure 4-1. Schematic representation of the model used in this analysis. The elliptical forms represent uncertain variables and the boxes represent calculation module.

A mathematical definition of the model is given in Appendix A.

4.1.1 Altitude RK-VM

This random variable in the model gives the altitude of the aircraft between Reykjavík and Vestmannaeyjar.

Likelihood

It is estimated that there is a 60% likelihood that the aircraft was flying at 2000 feet between Reykjavík and Vestmannaeyjar and 40% likelihood that the aircraft was flying at 3000 feet.

Arguments

In order to pass Hellisheiði aircraft have to fly at a minimum of 2000 feet and when an aircraft flies higher than 3000 feet it has to contact Reykjavik Control. In addition to this the ceiling was 3000 feet according to the IAAIB report when the accident happened. It is therefore most likely that the aircraft was flying between 2000 and 3000 feet but closer to 2000 feet according to conversations with pilots.

4.1.2 *Altitude SF-VM*

This random variable in the model gives the altitude of aircraft between Selfoss and Vestmannaeyjar.

Likelihood

It is estimated that there is a 70% likelihood that the aircraft was flying at 1000 feet between Selfoss and Vestmannaeyjar and 30% likelihood that the aircraft was flying at 2000 feet.

Arguments

In the IAAIB report it was estimated that the aircraft was flying at 1000 feet between Selfoss and Vestmannaeyjar although it is possible that it was flying somewhat higher. There is a small to nil chance it was flying lower than 1000 feet due to flight over water.

4.1.3 *RPM*

This random variable in the model gives the RPM of the engine in cruise.

Likelihood

It is assumed that there is a 5% chance for 2500 RPM, 45% chance for 2400 RPM, 45% chance for 2300 RPM and 5% chance for 2200 RPM.

Arguments

This statistical distribution was based on pilot experience. It was thought to be most likely that the aircraft was being operated at 2400 RPM or 2300 RPM but it was difficult to say which one was used. In addition to that it was thought to be unlikely that the aircraft was being operated under 2300 RPM and it is rare that aircraft are being operated at full power.

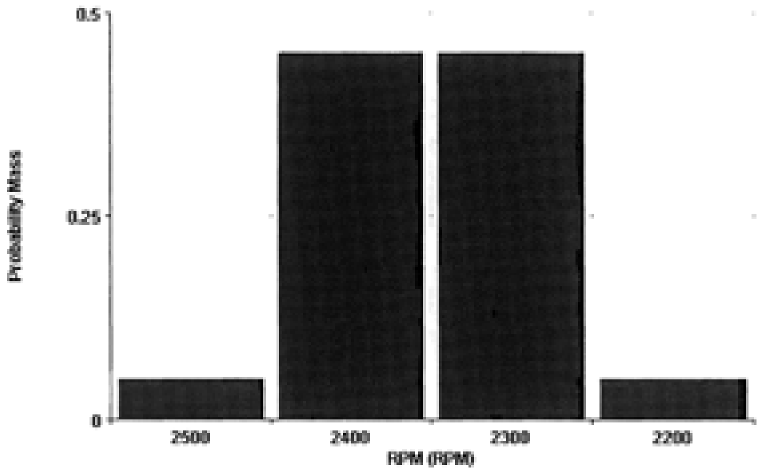


Figure 4-2. Statistical distribution of RPM.

4.1.4 *Manifold pressure*

This random variable in the model gives the manifold pressure of the engine in cruise.

Likelihood

It is assumed that there is a 5% chance for 27.5 MP, 45% chance for 26 MP, 45% chance for 24 MP and 5% chance for 22 MP.

Arguments

This statistical distribution was based on pilot experience. It was thought to be most likely that the aircraft was being operated at 26 MP or 24 MP but it was difficult to say which one was used. In addition to that it was thought to be unlikely that the aircraft was being operated under 24 MP and it is rare that aircraft are being operated at full power.

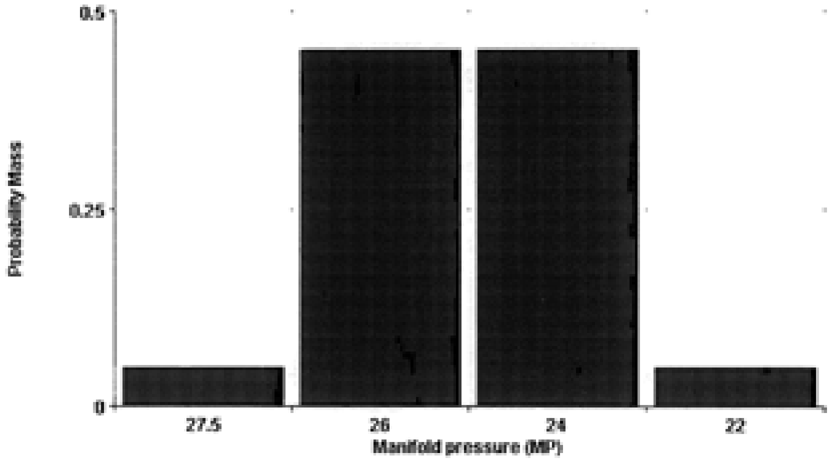


Figure 4-3. Statistical distribution of the manifold pressure.

4.1.5 *Initial fuel*

This random variable in the model gives the initial fuel on the aircraft after the first refueling at the 6th of August 2000 at 18:15.

Likelihood

It was assumed that the likelihood followed a beta-distribution with $\alpha_1 = 5$ and $\alpha_2 = 1.5$. The higher limit is 90 USG and the lower limit is 85 USG.

Arguments

This distribution was chosen in accordance with the special procedures required to fill the main tanks and the maximum fuel capacity.

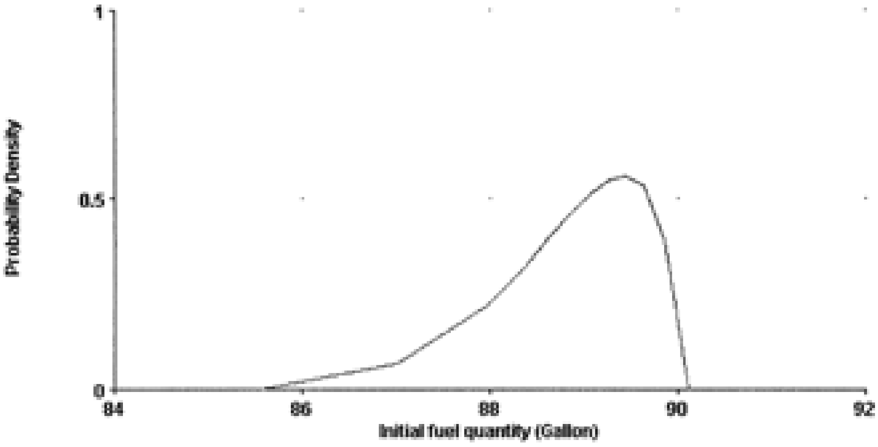


Figure 4-4. Statistical distribution of the initial fuel in the main tanks of the aircraft.

4.1.6 *Wing-end tanks*

This random variable in the model gives the fuel in the wing-end tanks of the aircraft.

Likelihood

It was assumed that the likelihood followed a beta-distribution with $\alpha_1 = 3$ and $\alpha_2 = 1.5$. The higher limit is 14 USG and the lower limit is 0 USG.

Arguments

This distribution was selected based on the fact that 14 USG was the minimum required fuel and nothing suggests that there would have been more fuel on them. It was also possible that there was no fuel in the tanks although it was unlikely.

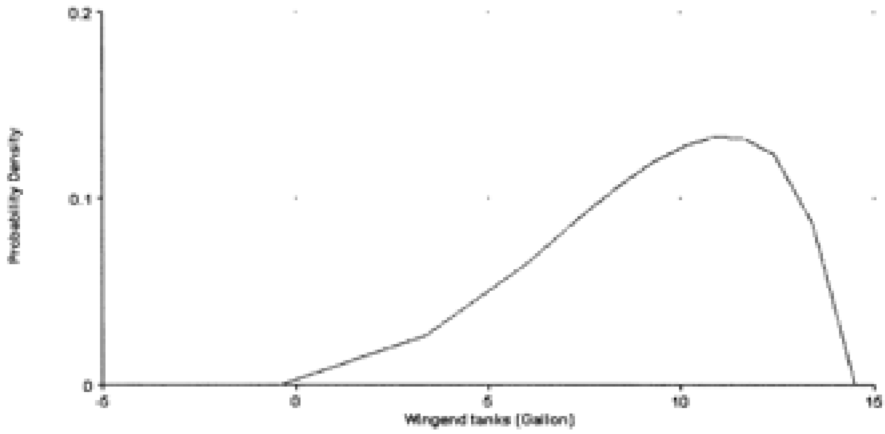


Figure 4-5. Statistical distribution of the fuel quantity in the wing-end tanks of the aircraft.

4.1.7 *Descent time and fuel consumption*

In this calculation module the random variables *Altitude RK-VM* and *Altitude SF-VM* were used and the corresponding descent time and fuel consumption during descent calculated. The variable Flying time was also used in the calculations to find when the aircraft had descended. The information on landing times from the IAAIB report and the altitudes were used to estimate the start of descent and when it ended.

As there is no information on fuel burn during descent and descent procedures can vary uniform statistical distributions were used for those parameters. The mid values were selected as 30 lbs/hour and 500 ft/min that were based on conversations with Cessna and pilots. The descent parameter was therefore between 300 and 700 ft/min and the fuel burn between 40 lbs/hour and 60 lbs/hour.

The height of the airports was taken into consideration. The descent on leg 24 was from 4000 feet.

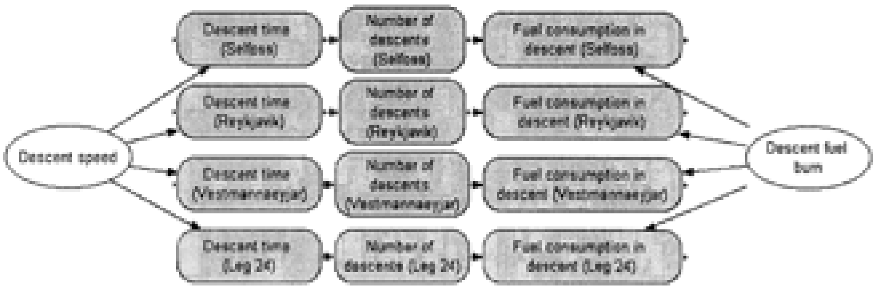


Figure 4-6. Schematic representation of the descent times and descent consumption.

4.1.8 *Climb time and fuel consumption*

In this calculation module the random variables *Altitude RK-VM* and *Altitude SF-VM* were used and the corresponding climb time and fuel consumption during climb calculated. The variable Flying time was also used in the calculations to find when the aircraft had descended. The information on take-off times from the IAAIB report and the altitudes were used to estimate the start of climb and when it ended. The climb time and consumption were based on the Aircraft manual. The fuel consumption in the manual includes run up and take-off. The height of the airports was taken into consideration. The climb on leg 24 was to 4000 feet.

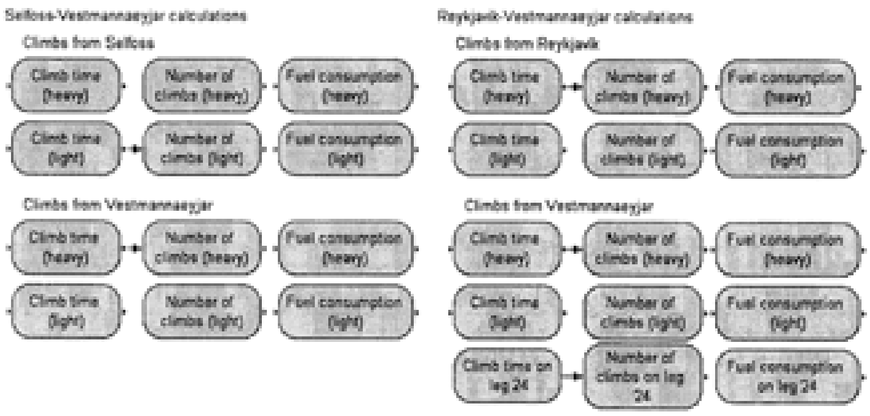


Figure 4-7. Schematic representation of the climb times and climb consumption.

4.1.9 *Cruise fuel consumption*

In this module the performance information from the aircraft manual was used to estimate the fuel burn in cruise based on a given RPM and manifold pressure.

4.1.10 *Minimum required fuel*

This random variable in the model gives the minimum required fuel to keep the engine running.

Likelihood

It was assumed that the likelihood followed a triangular-distribution with higher limit 11 USG, lower limit 0.75 USG and the most likely value 0.75 USG.

Arguments

This distribution was in accordance with the information given in the Cessna Pilot Safety Supplement where it states that with less than 11 USG in the main tanks uncoordinated flight can cause fuel starvation of the engine. The lower limit of the distribution was selected in accordance with the minimum usable fuel.

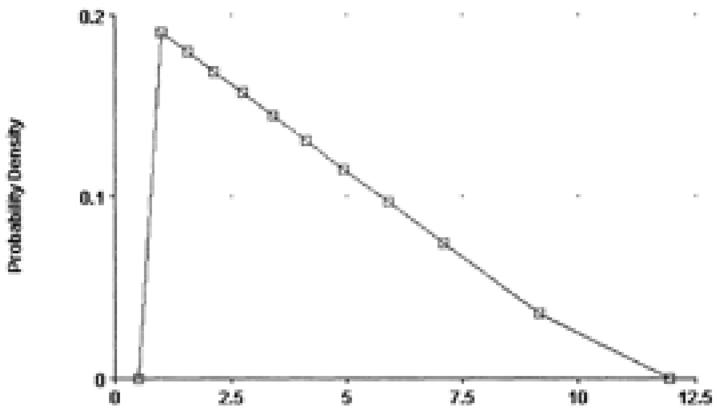


Figure 4-8. Statistical distribution of the minimum required fuel (USG).

4.1.11 Fuel quantity

In this calculation module the total fuel consumption of the aircraft and the fuel quantity at a given point in time was calculated. It used all of the variables in the model to do that.

4.1.12 Likelihood of fuel starvation

In this calculation module it was evaluated whether the aircraft had sufficient fuel at a given point in time. From that information it was possible to calculate the likelihood of fuel starvation for every point in time. Fuel starvation was expected when the fuel level was lower than *Minimum required fuel*.

4.1.13 Flight time

Flight times on the flight legs are in the IAAIB report. They are based on information on take-off and landing times. It is possible that there are deviation from logged times and actual times. In this calculation module the flight times on the flight legs were calculated as random variables. The deviations were assumed to be independent and equally distributed three minutes give or take in the times at Selfoss and one minute in Vestmannaeyjar and Reykjavik.

The mean value for the total flying time was the same as the total flying time in the IAAIB report and the standard deviation was the same as the value in the calculations in Appendix B.

Mean value	8.083 hours
Minimum value	7.797 hours
Mid value	8.09 hours
Maximum value	8.436 hours
Standard dev.	0.1345 hours

These times were used to estimate the start times of climbs and descents in the model.

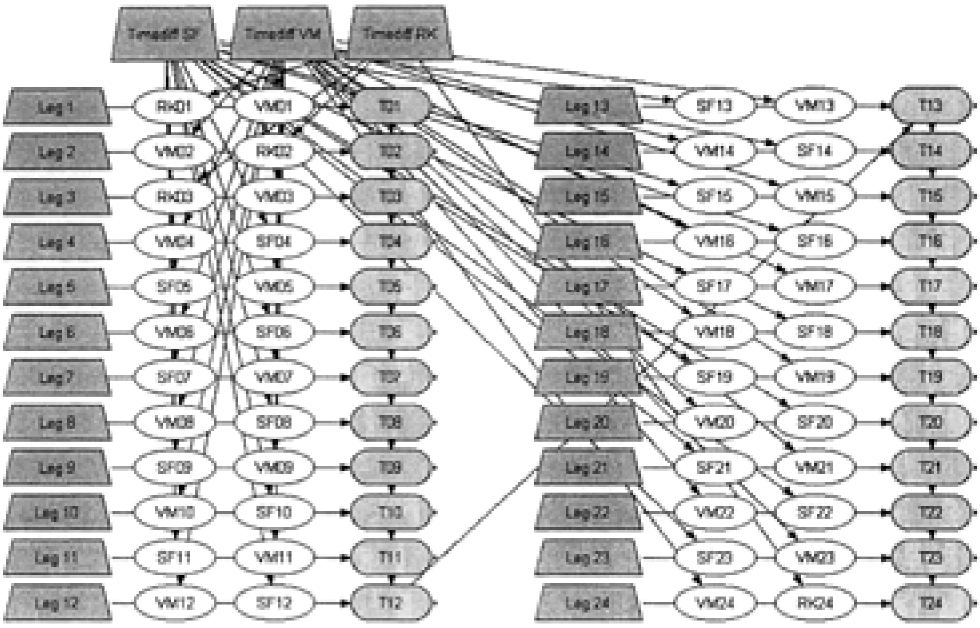


Figure 4-9. Schematic representation of the flight times. The trapeze shapes are constants, the elliptical shapes are random variables and the boxes are calculation modules. The calculation modules T01-T24 are the cumulative times after the given flight leg.

4.1.14 The effects of the gear being down on two legs.

Both in the IAAIB report and Forward and Taylor report it is mentioned that the gear was down on two legs. The IAAIB concludes that the effects would have been that the flying time would have increased with unchanged power setting but Forward and Taylor conclude that this would have had increased the total fuel consumption as the flying time between Selfoss and Vestmannaeyjar did not increased and therefore it should be assumed that the aircraft was operating at a higher power setting. Based on the information at hand it should be clear that the leg from Selfoss to Vestmannaeyjar was 5 minutes longer and the leg from Vestmannaeyjar to Selfoss was 1 minute longer. It should therefore be apparent that the flying time increased although the difference is small on the leg from Vestmannaeyjar. It is therefore unlikely that the aircraft was being operated on a higher power setting on the latter leg in addition to the fact that the likelihood of higher power setting is included in the variables of the model.

Forward and Taylor estimated that the additional fuel consumption due to this could have been 5 liters or about 1.25 USG using higher power setting on both legs.

To explore the possible influence on the model it was run both with 5 liter additional consumption and without it. A uniform random variable between 3 and 7 liters was used for this purpose.

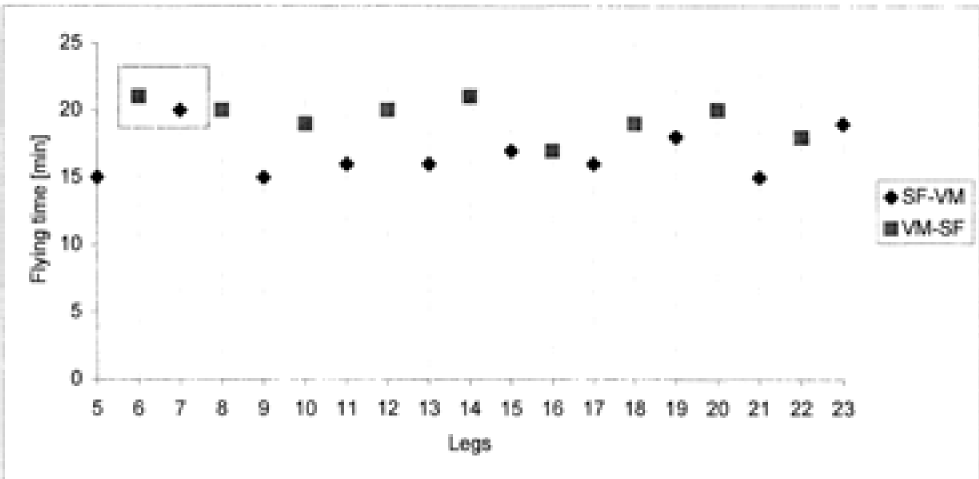


Figure 4-10. Flying times on the legs between Vestmannaeyjar and Selfoss. The orange box shows the legs with the gear down.

5 Results

5.1 Description

As described in the beginning of this report two basic runs where done because of different conclusions by the IAAIB and Forward and Taylor. They where:

1) Assumed that the wing-end tanks where used.

2) Assumed that the wing-end tanks where **not** used.

Here, on one hand, the results of the calculated fuel quantity at a given time both with and without wing-end tanks, and on the other hand, the results of the likelihood of fuel starvation when the accident happened with and without wing-end tanks are presented. In Appendix C a sensitivity analysis on the model is described which was done in order to evaluate how changes in the assumptions affected the results.

5.2 Fuel quantity

The estimated fuel quantity at the time of accident gives a good indication on whether the aircrafts engine suffered fuel starvation. It should however be noted that the fuel quantity alone should not be used to estimate whether the aircraft had engine problems due to fuel starvation. Fuel starvation of the engine could have been experienced before the fuel in the tanks would have been exhausted. This will be examined in further detail in the next section where the likelihood of fuel starvation will be examined.

Viewing the fuel quantity changes with time does not only give information on the fuel quantity alone but also verification on the model itself.

When these results are examined it might seem unusual that the fuel quantity can be negative but with that kind of presentation it is not implied that that would have been the case in reality. Those values indicate the fuel quantity required by the aircraft to reach that point in time. In those instances in the simulation the flights where classified as being fuel exhausted earlier. Flights were never the less analyzed further for the statistical analysis.

The main results of the estimated fuel quantity can be seen in Table 5.1.

		Minimum	**Mid**	**Mean**	**Maximum**	**Standard Deviation**
With wing-end tanks	**Without gear**	-13.9 USG	2.6 USG	2.8 USG	19.8 USG	7.22 USG
	With gear	-17.1 USG	2.2 USG	1.5 USG	21.2 USG	6.72 USG
Without wing-end tanks	**Without gear**	-23.9 USG	-6.4 USG	-6.6 USG	12.1 USG	7.62 USG
	With gear	-30.4 USG	-6.9 USG	-7.9 USG	14.1 USG	7.13 USG

Table 5-1. Estimated fuel quantity.

In the table it can be seen that the mean value of the estimated fuel quantity, if the effects of the gear is disregarded and the wing-end tanks are thought to have been used, is about 2.8 USG and –6.6 USG if the wing-end tanks are not thought to have been used. If the effects of the gear are included the estimated fuel quantity is 1.5 USG with the wing-end tanks and –7.9 USG without them. If the distribution of the estimated fuel quantity is expected to follow a normal distribution the following certainty values and the likelihood of the fuel quantity being lower than 11 USG, the level where fuel starvation could occur, see Table 5.2.

		Mean	Standard Deviation	0.75 USG	11 USG	95% (1.6452)	85% (1.0364)
With wing-end tanks	**Without gear**	2.8 USG	7.22 USG	38.82%	87.19 %	14.68 USG	10.28 USG
	With gear	1.5 USG	6.72 USG	45.56%	92.12 %	12.56 USG	8.46 USG
Without wing-end tanks	**Without gear**	-6.6 USG	7.62 USG	83.26%	98.95 %	4.48 USG	0.39 USG
	With gear	-7.9 USG	7.13 USG	88.75%	99.60 %	3.83 USG	-0.51 USG

Table 5-2. Statistical analysis of the estimated fuel quantity in USG.

It is therefore apparent that there is a significant possibility that the fuel quantity was low enough to cause fuel starvation. The results show that there is 39-46% likelihood that the fuel level is below the minimum usable fuel if it is assumed that wing-end tanks were used and 83-89% if is assumed that they are not used. The likelihood that the fuel level is below 11 USG is 87-92% likelihood if it is assumed that the wing-end tanks were used and around 99% likelihood if the wing-end tanks were not included.

5.2.1 Fuel quantity with the wing-end tanks

Figures 5-1 and 5-2 show how the fuel quantity changes with flying time if the usage of the wing-end tanks is included and the effects of the gear being down is not included. It can be seen how the added fuel after leg 11 and 18 lift the estimated fuel quantity at around 4 hour and 6.5 hours. It can also be seen how the standard deviation increases with time and that the gap between maximum and minimum values widens as time progresses. The fuel quantity at the last fill up is low.

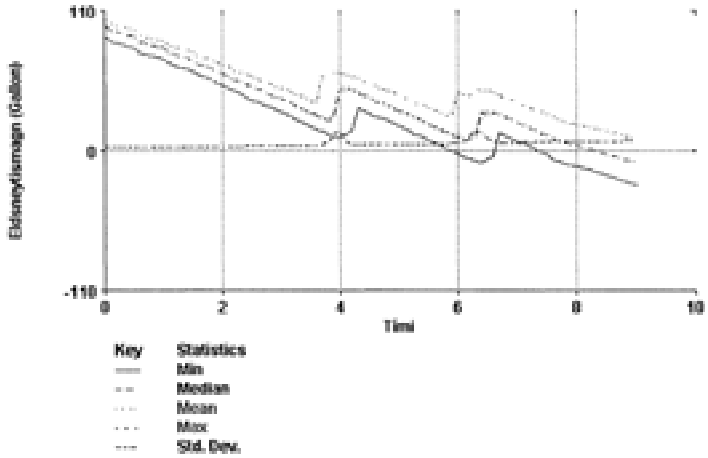


Figure 5-1. The fuel quantity at a given point in time with the wing-end tanks and no added fuel consumption due to the gear being down. The green color shows the maximum value, the blue the mid value, the pink the mean value, the red the minimum value and the black the standard deviation.

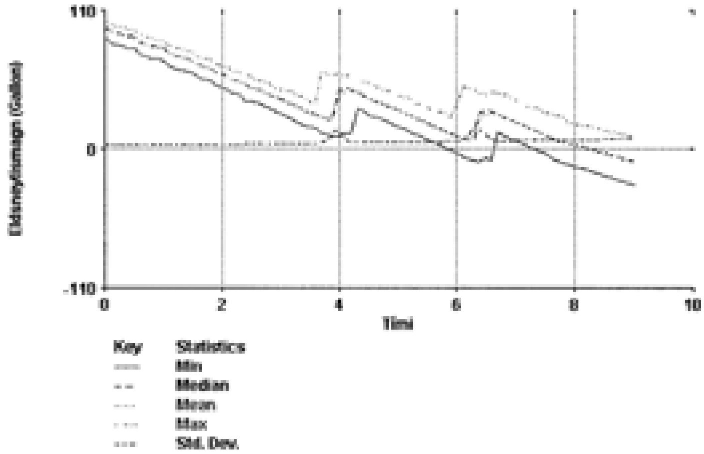


Figure 5-2. The fuel quantity at a given point in time with the wing-end tanks and added fuel consumption due to the gear being down. The green color shows the maximum value, the blue the mid value, the pink the mean value, the red the minimum value and the black the standard deviation.

5.2.2 Fuel quantity without the wing-end tanks

Figures 5-3 and 5-4 show similar information as Figures 5-1 and 5-2 but without the wing-end tanks being used. It can be seen that the fuel quantity is lower and at the time of the last fill up the mean quantity is close to zero. The mean value crosses the zero axis between 7.6 and 7.7 hours.

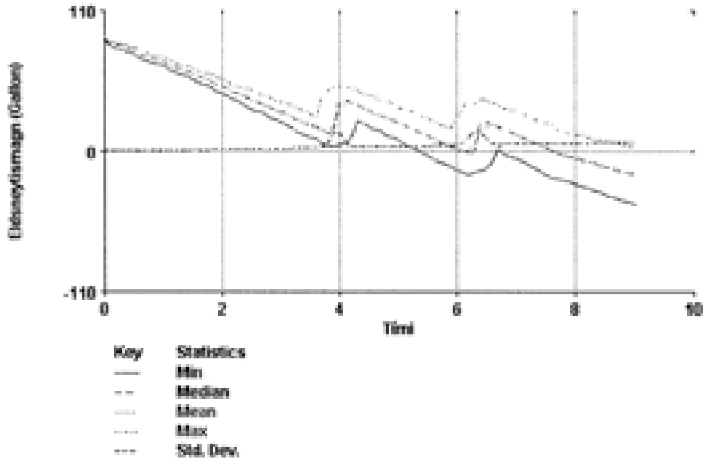


Figure 5-3. The fuel quantity at a given point in time WITHOUT the wing-end tanks and no added fuel consumption due to the gear being down. The green color shows the maximum value, the blue the mid value, the pink the mean value, the red the minimum value and the black the standard deviation.

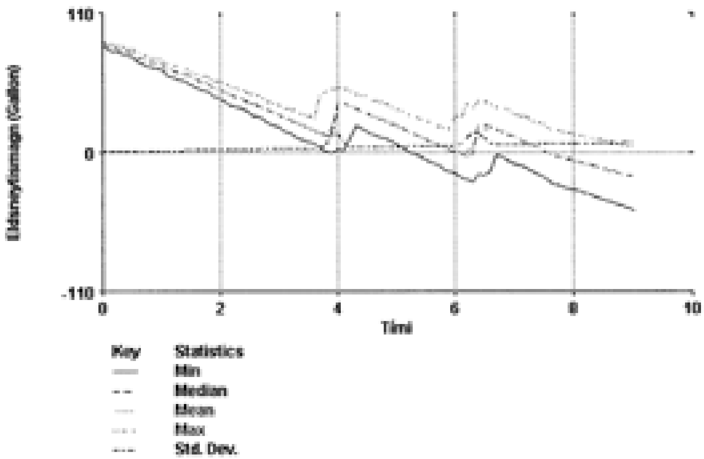


Figure 5-4. The fuel quantity at a given point in time WITHOUT the wing-end tanks and added fuel consumption due to the gear being down. The green color shows the maximum value, the blue the mid value, the pink the mean value, the red the minimum value and the black the standard deviation.

5.3 Likelihood of fuel starvation

When the likelihood of fuel starvation is calculated the random variable *Minimum required fuel* is used. The fuel quantity is not only used but the fuel quantity required to keep the engine running is also estimated.

At the time of accident the likelihood for fuel starvation is as seen in Table 5.3.

		Likelihood of fuel starvation
With wing-end tanks	Without gear	57.5 %
	With gear	61.0 %
Without wing-end tanks	Without gear	93.5 %
	With gear	96.5 %

Table 5-3. Likelihood of fuel starvation at the time of accident.

The likelihood of fuel starvation is greatly influenced by the fuel refills and as the likelihood of fuel starvation at the time of accident is of concern the time period where those effects are present are excluded.

5.3.1 Likelihood of fuel starvation without wing-end tanks

Figure 5-5 shows how the likelihood of fuel starvation is at a given point in time without the wing-end tanks being used. The Table Cure 2D software was used to find the function that fitted best to the cumulative distribution.

The mean value in the distribution is 7.42 hours which is the most likely point in time that the aircraft would have fuel starvation. The cumulative likelihood at that time is 50%. As previously described there is 94% likelihood that the aircraft had fuel starvation at the time of accident.

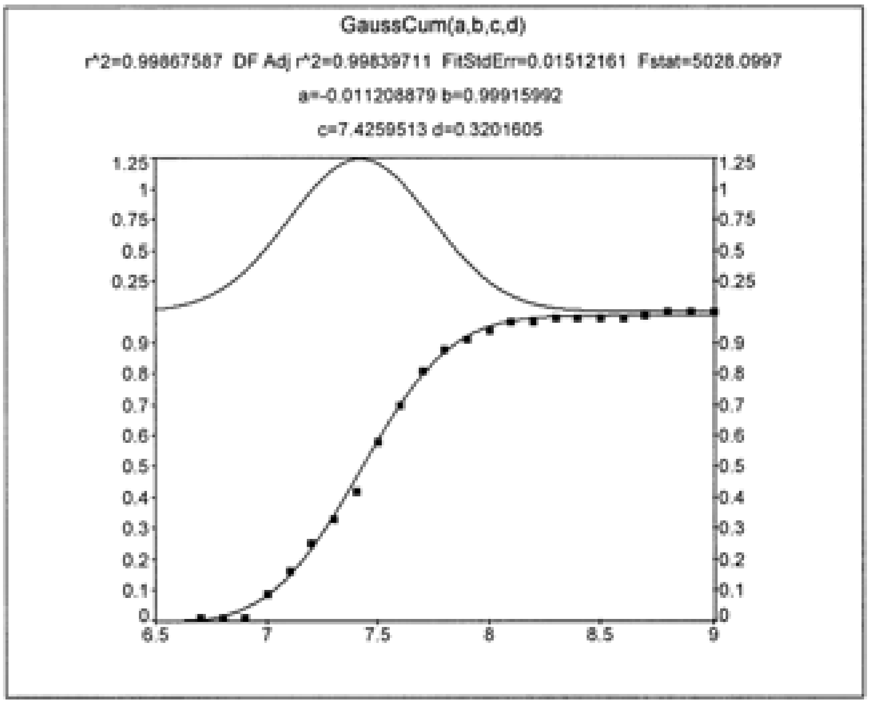


Figure 5-5. Likelihood of fuel starvation as a function of time without the wing-end tanks and no additional fuel consumption due to the gear down.

Figure 5-6 shows similar information as Figure 5-5. In Figure 5-6 the effects of gear being down are included.

It can be seen that the mean value of the distribution has moved to an earlier point in time i.e. 7.39 hour. This is due to more fuel consumption with the gear down. In addition to that it can be seen that the standard deviation has increased somewhat which is caused by the increased variance in the added fuel consumption which adds to the total variance. The likelihood of fuel starvation is 97% when the accident occurred.

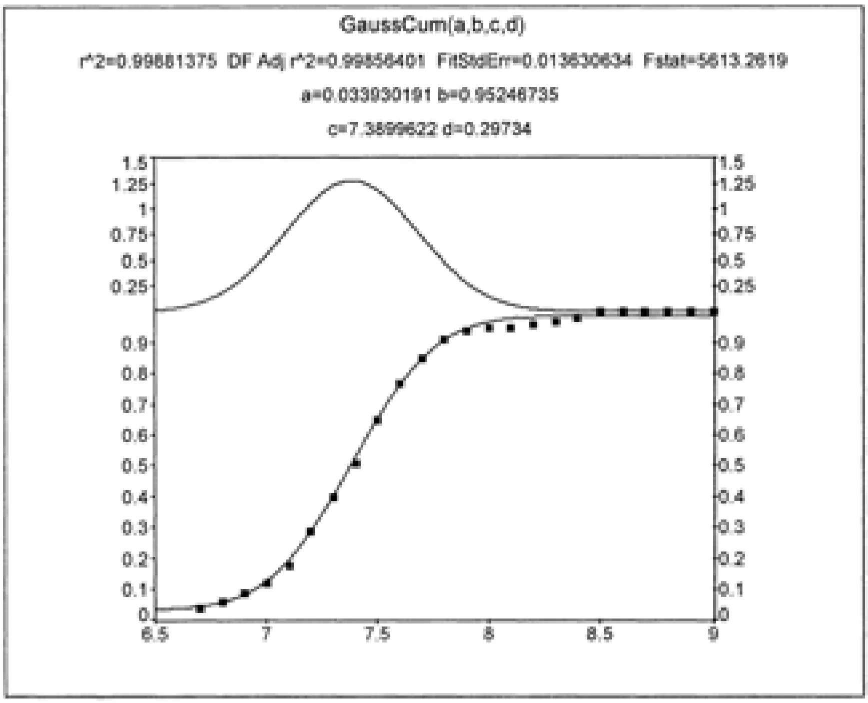


Figure 5-6. Likelihood of fuel starvation as a function of time without the wing-end tanks and additional fuel consumption due to the gear down.

It can be seen from Figures 5-5 and 5-6 and Table 5-3 that the likelihood of fuel starvation at the time of accident if the wing-end tanks would not have been used are 94-97%. The effects of adding fuel consumption due to having the gear down on two legs adds 3% likelihood at the time of the accident.

5.3.2 Likelihood of fuel starvation with wing-end tanks

Figures 5-7 and 5-8 show the likelihood of fuel starvation with the wing-end tanks being used. Figure 5-7 shows the likelihood when the effects of the gear in not included and Figure 5-8 when it is included.

By comparing Figures 5-5 and 5-6 where the wing-end tanks are not included it can be seen that the most likely value has risen to 7.93 hours when the gear is not included and 7.86 hours when it is included. Table 5-3 showed that the cumulative likelihood is 58% and 61% based on whether the added fuel consumption due to the gear is included. The Figures are consistent with that information. It can also be seen that the variance is more which can be explained with the added variance with more random variables.

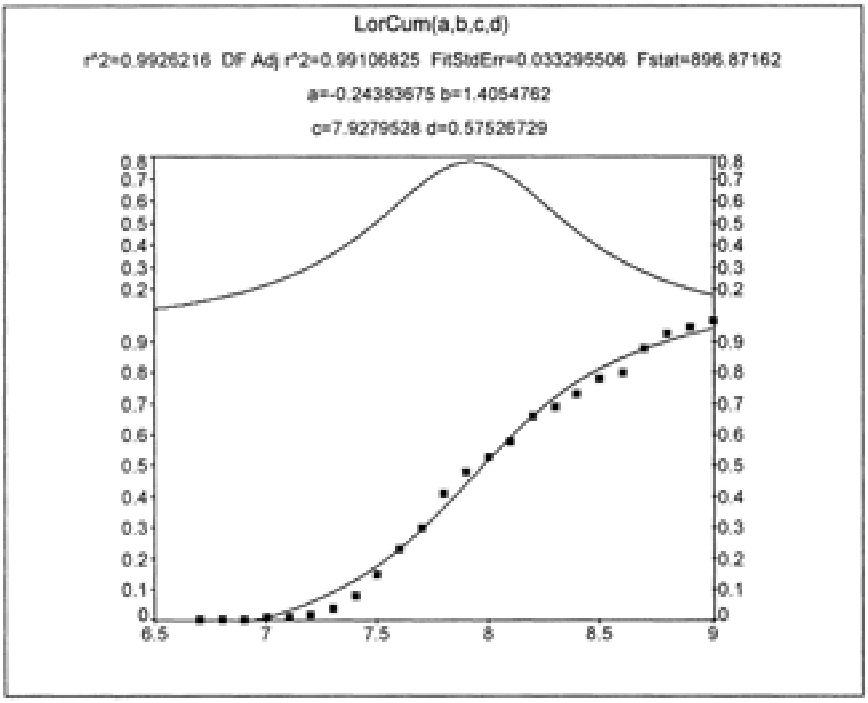


Figure 5-7. Likelihood of fuel starvation as a function of time with the wing-end tanks and no additional fuel consumption due to the gear down.

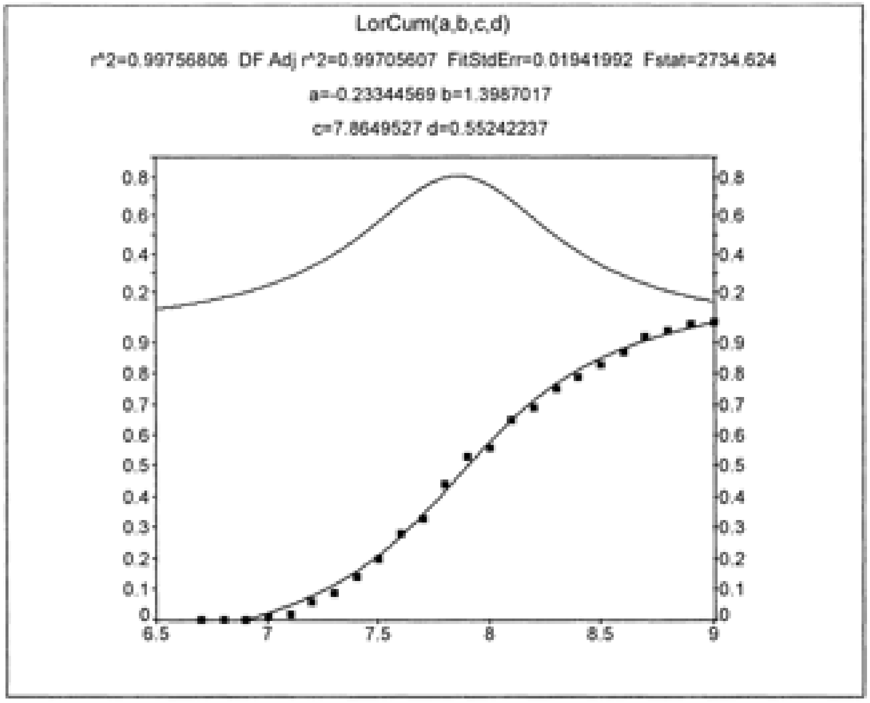


Figure 5-8. Likelihood of fuel starvation as a function of time with the wing-end tanks and additional fuel consumption due to the gear down.

These results indicate that the likelihood of fuel starvation at the time of accident were 58-61%. The added fuel consumption due to having the gear down on two legs add 3% to the likelihood of fuel starvation.

5.4 Sensitivity analysis

A sensitivity analysis was done on the model and extensive description of is in Appendix C. It showed which parameters had the most impact on the fuel quantity and the likelihood of fuel starvation.

I should be noted that in the sensitivity analysis the effects of the changes are being examined. The values and distributions used are not considered to be likely.

The sensitivity analysis showed that the parameters that were related to fuel consumption had significant impact on the results. *Altitude RK-VM, Altitude SF-VM* and *Variance in time logging* had little impact on the results. Added fuel consumption due to the gear being down was minimal mainly because of little changes in the analysis but it was directly related to the fuel quantity.

6 Conclusion

Here a statistical analysis of the likelihood of fuel starvation of TF-GTI the 7th August 2000 has been described. The model, assumptions and arguments are described and detailed analysis provided of both the results and the sensitivity of the parameters. All known uncertain parameters have been included in the model and their distributions estimated based on constraints derived from known facts and aviation experience.

The results show that there is a 39-46% likelihood that the fuel level at the time of the accident is below the minimum usable fuel if it is assumed that wing-end tanks were used and an 83-89% if is assumed that they are not used. The likelihood that the fuel level is below 11 USG, the lowest fuel level for guaranteed fuel feed to the engine, is 87-92% if it is assumed that the wing-end tanks were used and around 99% likelihood if the wing-end tanks were not included.

It is difficult to determine exactly how much fuel was required to keep the engine running at the time of accident but if the minimum required fuel is estimated with a statistical distribution, the likelihood of fuel starvation is 58%-61% if the fuel in the wing-end tanks is included and 94-97% if it is not included.

Based on the fact that the information on the aircraft performance is obtained from the aircraft manual it can be further concluded that the calculated fuel consumption is less than in reality. Performance information from the manual is based on optimal weather conditions, aircraft condition and control of the aircraft which are rare in reality. The fuel consumption is therefore possibly higher than the calculated quantity resulting in a higher likelihood of fuel starvation than estimated in the above analysis.

Appendix A Mathematical description of the model

$Leg_{Num,t} = [1\ldots24]$
$Leg_{Start\ time}$ ={0, 0.55, 1.05, 1.51, 1.85, 2.1, 2.45, 2.78, 3.11, 3.36, 3.68, 3.95, 4.28, 4.55, 4.9, 5.18, 5.46, 5.73, 6.05, 6.35, 6.68, 6.93, 7.23, 7.55}
$Leg_{End\ time}$ ={0, 0.55, 1.05, 1.51, 1.85, 2.1, 2.45, 2.78, 3.11, 3.36, 3.68, 3.95, 4.28, 4.55, 4.9, 5.18, 5.46, 5.73, 6.05, 6.35, 6.68, 6.93, 7.23, 7.55, 8.08}

$C_{t,\ Loading} = \min(1, (t - Leg_{Start\ time}) / ClimbTime_{Height,\ Loading}) + Leg_{Num,t}$ if $t \geq Leg_{Start\ time}$

$ClimbTime_{Height,\ Loading}$ = Height [feet] / (($ClimbRate_{Height,\ Loading}$ [feet/min] + $ClimbRate_{0,\ Loading}$ [feet/min]) / 2) / 60 [sec/min]

$ClimbRate_{Height,\ Loading} = (ClimbRate_{5000,\ Loading} - ClimbRate_{0,\ Loading}) / 5000 * Height + ClimbRate_{0,\ Load}$

$ClimbFuel_{Height,\ Loading} = (ClimbFuel_{5000,\ Loading} - ClimbFuel_{0,\ Loading}) / 5000 * Height + ClimbFuel_{0,\ Loading}$

$D_t = \max(0, 1 + (t - Leg_{End\ time}) / DescentTime) + Leg_{Num,t}$ if $t < Leg_{End\ time}$

DescentFuel = DescentTime [sec] * 30 [lbs/hour] / 6 [Gallon/lbs]

DescentTime = Height [feet] / 500 [feet/min] * 60 [min/hour]

Loading = { Heavy if Leg_{Num}={} | Light if Leg_{Num}={} }

$Height_{SF\text{-}VM}$ = { 1000 w.p 70% ;
2000 w.p. 30% }

$Height_{SF\text{-}RK}$ = { 2000 w.p. 60% ;
3000 w.p. 40% }

Manifold pressure = { 27.2 w.p. 5%;
26 w.p. 45%;
24 w.p. 45%;
22 w.p. 5% }

R.P.M. = { 2500 w.p. 5%;
2400 w.p. 45%;
2300 w.p. 45%;
2200 w.p. 5%}

$Added\ Fuel_t$ = { 120 [liters] / 3.785 [liters/gallon] $t > 3.68$
240 [liters] / 3.785 [liters/gallon] $t > 6.05$ }

Initial fuel = beta(5,1.5)
Wing-end tank fuel = beta(3,1.5)

$Fuel\ Flow_{Manifold\ pressure,\ RPM}$ = Information from the aircraft manual

$Fuel\ Consumption_t = (t - \Sigma (C_{t,\ Loading} * ClimbTime_{Height,\ Loading}) - \Sigma (D_t * DescentTime)) * Fuel\ Flow_{Manifold\ pressure,\ RPM} + C_{t,\ Loading} * ClimbFuel_{Height,\ Loading} + D_t * DescentFuel$

$Fuel_t$ = Initial fuel + $Added\ Fuel_t$

$Fuel\ Level_t = Fuel_t - Fuel\ Consumption_t$

Minimum Required Fuel = triangular(0.75,0.75,11)

$P_{fuel\ starvation,\ t}$ = *if* Fuel Level $_t$ < Minimum Required Fuel *then (fuel starvation) else (no fuel starvation)*

Appendix B Calculation of the total flying time

In the IAAIB report times for departures and arriavals at Selfoss where 19 and theVestmannaeyjum and 28 in Reykjavík.

X_S = Uniform(-3,3) (1)

$X_{V\&R}$ = Uniform(-1,1) (2)

The variance for uniform distributed variables is:

$$V(X) = \frac{(b-a)^2}{12} \quad (3)$$

and therefore the variance for those variables is:

$V[X_S]$= 3 (4)

$V[X_{V\&R}]$= 1/3 (5)

It is now assumed that there random variables are independent and therefore the following calculation can be used:

$$\begin{aligned} V[X_{Total}] &= \text{sum}(\ V[X_S]\ ) + \text{sum}(\ V[X_{V\&R}]\ ) \quad (6) \\ &= 19 * V[X_S] + 28 * V[X_{V\&R}] \\ &= 66.3334 \end{aligned}$$

The mean for those random variables is 0 and therefore the mean for the total is also 0.

The standard deviation is:

$$\begin{aligned} \sigma &= \text{sqrt}(V[X_{Total}]) \quad (7) \\ &= 8.14 \end{aligned}$$

In accordance with the Central Limit Theorem the sum of independent random variables is a normal distribution when the number of variables increases and therefore the following distribution for the variance of the total flying time can be assumed to be the following:

$N(0,8.14)$

Appendix C Sensitivity analysis

In order to assess which parameter in the simulation had the most impact on the statistical results a sensitivity analysis used. The parameters viewed are the estimated fuel quantity at the time of accident and the likelihood of fuel starvation. The wing-end tanks are included as well as the effects of having the gear down on two legs.

Appendix C.1 Manifold pressure

C.1.1 Random variable variations

The following manifold pressure likelihood distribution was used:

	27.5 MP	26 MP	24 MP	22 MP
Sensitivity analysis 1	0.05	0.05	0.85	0.05
Sensitivity analysis 2	0.05	0.25	0.65	0.05
Sensitivity analysis 3	0.05	0.45	0.45	0.05
Sensitivity analysis 4	0.05	0.65	0.25	0.05
Sensitivity analysis 5	0.05	0.85	0.05	0.05

Table C-1. The likelihood for different manifold pressure for the sensitivity analysis. The values in Sensitivity analysis 3 where used in the report.

The highest and lowest manifold pressure was not changed but the likelihood for 26 and 24 MP was changed from 0.05 (5%) to 0.85 (85%).

C.1.2 Change in results

C.1.2.1 Fuel

The change in estimated fuel at the time of accident can be seen in the following Table:

	Minimum	Median	Mean	Maximum	Std
Sensitivity analysis 1	-14.69	5.385	4.787	21.27	6.371
Sensitivity analysis 2	-18.57	3.281	3.07	18.85	6.967
Sensitivity analysis 3	-19.49	2.023	1.427	23.16	8.146
Sensitivity analysis 4	-19.62	-1.079	-0.3116	26.36	7.667
Sensitivity analysis 5	-18.4	-2.351	-1.768	22.47	7.005

Table C-2. The estimated fuel at the time of accident for different manifold pressure settings. The values in Sensitivity analysis 3 where used in the report.

The Table shows that with lower manifold pressure the fuel quantity increases and vice versa. The highest mean is 4.8 USG and the lowest is -1.8 USG. The mean has therefore changed by 5 USG for different likelihood of the manifold pressure.

C.1.2.2 Likelihood of fuel starvation

The change in the likelihood of fuel starvation at the time of accident can be seen in the following Table:

	Likelihood of fuel starvation
Sensitivity analysis 1	44.5 %
Sensitivity analysis 2	51.5 %
Sensitivity analysis 3	61.0 %
Sensitivity analysis 4	76.0 %
Sensitivity analysis 5	80.5 %

Table C-3. The change in likelihood of fuel starvation at the time of accident for different manifold pressure. The values in Sensitivity analysis 3 where used in the report.

The likelihood can change from 45% to 81% based on the likelihood distribution of the manifold pressure, a span of 35%.

Appendix C.2 RPM

C.2.1 Random variable variations

The following RPM likelihood distribution was used:

	2500 RPM	2400 RPM	2300 RPM	2200 RPM
Sensitivity analysis 1	0.05	0.05	0.85	0.05
Sensitivity analysis 2	0.05	0.25	0.65	0.05
Sensitivity analysis 3	0.05	0.45	0.45	0.05
Sensitivity analysis 4	0.05	0.65	0.25	0.05
Sensitivity analysis 5	0.05	0.85	0.05	0.05

Table C-4. The likelihood distribution of the RPM. The values in Sensitivity analysis 3 where used in the report.

The highest and lowest RPM where not changed but the likelihood of 2300 RPM and 2400 RPM where changed from 0.05 (5%) to 0.85 (85%) as for the manifold pressure.

C.2.2 Change in results

C.2.2.1 Fuel

The change in estimated fuel at the time of accident can be seen in the following Table:

	Minimum	Median	Mean	Maximum	Std
Sensitivity analysis 1	-10.48	3.906	3.903	20.78	6.75
Sensitivity analysis 2	-16.16	2.708	2.609	22.84	7.677
Sensitivity analysis 3	-17.26	2.347	1.493	19.75	7.869
Sensitivity analysis 4	-19.35	0.863	0.19	22.05	7.473
Sensitivity analysis 5	-17.83	-1.715	-0.7978	24.5	7.559

Tafla C-5. The estimated fuel at the time of accident for different RPM settings. The values in Sensitivity analysis 3 where used in the report.

The Table shows that with lower RPM the fuel quantity increases and vice versa. The highest mean is 3.9 USG and the lowest is -0.8 USG. The mean has therefore changed by 4.7 USG for different likelihood of the RPM.

C.2.2.2 Likelihood of fuel starvation

The change in the likelihood of fuel starvation at the time of accident can be seen in the following Table:

	Likelihood of fuel starvation
Sensitivity analysis 1	55.5%
Sensitivity analysis 2	57.5%
Sensitivity analysis 3	61.0%
Sensitivity analysis 4	69.0%
Sensitivity analysis 5	75.5%

Tafla C-6. The change in likelihood of fuel starvation at the time of accident for different RPM. The values in Sensitivity analysis 3 where used in the report.

The likelihood can change from 56% to 76% based on the likelihood distribution of the manifold pressure, a span of 20% which is less than when the manifold pressure was changed.

Appendix C.3 Altitude between VM and RK

C.3.1 Random variable variations

The following likelihood distribution for the altitude between VM and RK was used:

	2000 feet	3000 feet
Sensitivity analysis 1	0.00	1.00
Sensitivity analysis 2	0.40	0.60
Sensitivity analysis 3	0.60	0.40
Sensitivity analysis 4	1.00	0.00

Table C-7. The likelihood distribution of the altitude between VM and RK. The values in Sensitivity analysis 2 where used in the report.

Here the likelihood is changed from being 100% for 3000 feet to being 100% for 2000 feet with two steps between.

C.3.2 Change in results

C.3.2.1 Fuel

The change in estimated fuel at the time of accident can be seen in the following Table:

	Minimum	Median	Mean	Maximum	Std
Sensitivity analysis 1	-20.06	1.317	1.281	19.02	7.558
Sensitivity analysis 2	-22.44	1.759	1.341	18.33	7.594
Sensitivity analysis 3	-18.07	1.594	1.538	21.72	7.722
Sensitivity analysis 4	-19.35	1.282	1.625	21.97	7.604

Table C-8. The estimated fuel at the time of accident for different likelihood distribution of the altitude between VM and RK. The values in Sensitivity analysis 2 where used in the report.

Here that with higher altitude results in lower fuel quantity and vice versa. The highest mean is 1.6 USG and the lowest is 1.3 USG. The mean has therefore changed by 0.3 USG for different likelihood of the altitude.

C.3.2.2 Likelihood of fuel starvation

The change in the likelihood of fuel starvation at the time of accident can be seen in the following Table:

	Likelihood of fuel starvation
Sensitivity analysis 1	66.5%
Sensitivity analysis 2	62.0%
Sensitivity analysis 3	63.5%
Sensitivity analysis 4	64.5%

Table C-9. The change in likelihood of fuel starvation at the time of accident for different likelihood distribution of the altitude between VM and RK. The values in Sensitivity analysis 2 where used in the report.

The likelihood can change from 64% to 66% based on the altitude, a span of 2%.

Appendix C.4 Altitude between SF-VM

C.4.1 Random variable variations

The following likelihood distribution for the altitude between SF and VM was used:

	1000 feet	2000 feet
Sensitivity analysis 1	1.00	0.00
Sensitivity analysis 2	0.70	0.30
Sensitivity analysis 3	0.30	0.70
Sensitivity analysis 4	0.00	1.00

Table C-10. The likelihood distribution of the altitude between SF and VM. The values in Sensitivity analysis 2 where used in the report.

Here the likelihood is changed from being 100% for 3000 feet to being 100% for 2000 feet with two steps between.

C.4.2 Change in results

C.4.2.1 Fuel

The change in estimated fuel at the time of accident can be seen in the following Table:

	Minimum	Median	Mean	Maximum	Std
Sensitivity analysis 1	-18.94	1.734	1.814	19.44	7.655
Sensitivity analysis 2	-22.69	2.392	1.404	19.17	7.676
Sensitivity analysis 3	-18.07	1.295	1.083	18.39	7.49
Sensitivity analysis 4	-19.35	0.6721	0.7267	18.43	7.152

Table C-11. The estimated fuel at the time of accident for different likelihood distribution of the altitude between SF and VM. The values in Sensitivity analysis 2 where used in the report.

Here that with higher altitude results in lower fuel quantity and vice versa. The highest mean is 1.8 USG and the lowest is 0.7 USG. The mean has therefore changed by 1.1 USG for different likelihood of the altitude.

C.4.2.2 Likelihood of fuel starvation

The change in the likelihood of fuel starvation at the time of accident can be seen in the following Table:

	Likelihood of fuel starvation
Sensitivity analysis 1	63.0%
Sensitivity analysis 2	62.5%
Sensitivity analysis 3	66.0%
Sensitivity analysis 4	68.0%

Table C-12. The change in likelihood of fuel starvation at the time of accident for different likelihood distribution of the altitude between SF and VM. The values in Sensitivity analysis 2 where used in the report.

The likelihood changed from 63% to 68% based on the altitude, a span of 5%.

Appendix C.5 Initial fuel

C.5.1 Random variable variations

The following likelihood distribution for the initial fuel:

	α_1	α_2	Upper limit	Lower limit
Sensitivity analysis 1	9	1.5	90	85
Sensitivity analysis 2	7	1.5	90	85
Sensitivity analysis 3	5	1.5	90	85
Sensitivity analysis 4	3	1.5	90	85
Sensitivity analysis 5	1.5	1.5	90	85

Table C-13. Beta distributions where used in the sensitivity analysis of the initial fuel. The distribution in Sensitivity analysis 3 where used in the report.

The upper and lower limit where not changed but α1 was changed from 1.5 to 9. The following figure shows the distributions.

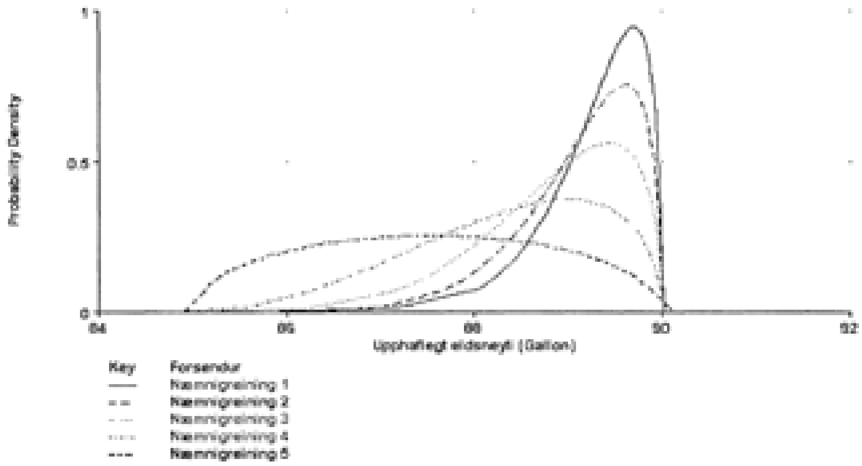


Figure C-1. The distributions used in the sensitivity analysis on the initial fuel.

C.5.2 Change in results

C.5.2.1 Fuel

The change in estimated fuel at the time of accident can be seen in the following Table:

	Minimum	Median	Mean	Maximum	Std
Sensitivity analysis 1	-19.16	1.779	1.976	20.62	7.492
Sensitivity analysis 2	-24.34	2.06	1.691	19.71	7.588
Sensitivity analysis 3	-17.23	0.9488	1.342	21.99	7.648
Sensitivity analysis 4	-16.59	1.12	0.9838	22.98	7.908
Sensitivity analysis 5	-21.44	0.08035	0.1865	17.96	8.073

Table C-14. The estimated fuel at the time of accident for different likelihood distribution of the initial fuel. The values in Sensitivity analysis 3 where used in the report.

The mean fuel is higher with higher α_1 . The highest mean is 2.0 USG and the lowest is 0.2 USG. The mean has therefore changed by 1.8 USG for different likelihood of the initial fuel.

C.5.2.2 Likelihood of fuel starvation

The change in the likelihood of fuel starvation at the time of accident can be seen in the following Table:

	Likelihood of fuel starvation
Sensitivity analysis 1	64.5%
Sensitivity analysis 2	61.5%
Sensitivity analysis 3	65.0%
Sensitivity analysis 4	64.5%
Sensitivity analysis 5	71.5%

Table C-15. The change in likelihood of fuel starvation at the time of accident for different likelihood distribution of the initial fuel. The values in Sensitivity analysis 3 where used in the report.

The likelihood can change from 65% to 72% based on the likelihood distribution of the manifold pressure, a span of 7% which is less than when the manifold pressure was changed.

Appendix C.6 Wing-end tanks

C.6.1 Random variable variations

The following likelihood distribution for the fuel in the wing-end tanks:

	α_1	α_2	Upper limit	Lower limit
Sensitivity analysis 1	9	1.5	14	0
Sensitivity analysis 2	6	1.5	14	0
Sensitivity analysis 3	3	1.5	14	0
Sensitivity analysis 4	1.5	1.5	14	0
Sensitivity analysis 5	1.5	3.0	14	0

Table C-16. Beta distributions where used in the sensitivity analysis of the wing-end tank fuel. The distribution in Sensitivity analysis 3 where used in the report.

The upper and lower limit where not changed but α_1 was changed from 1.5 to 9 and α_2 was changed from 1.5 to 3. The following figure shows the distributions.

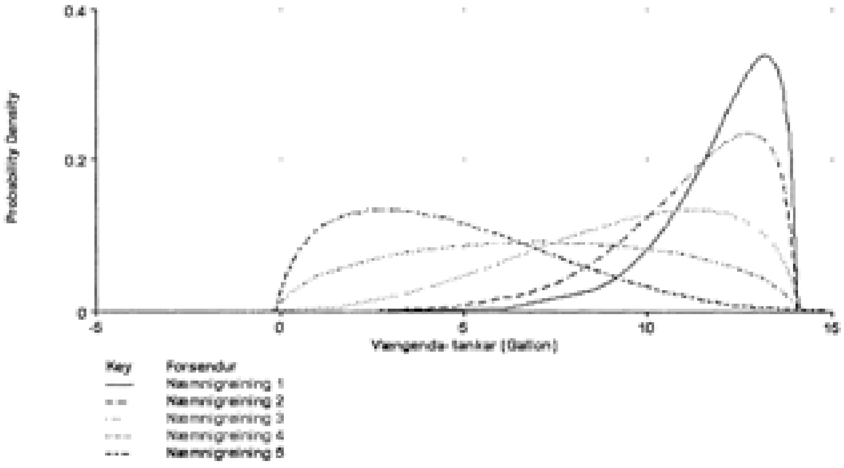


Figure C-2. The distributions used in the sensitivity analysis of the wing-end tank fuel.

C.6.2 Change in results

C.6.2.1 Fuel

The change in estimated fuel at the time of accident can be seen in the following Table:

	Minimum	**Median**	**Mean**	**Maximum**	**Std**
Sensitivity analysis 1	-20.02	3.887	4.202	22.68	7.406
Sensitivity analysis 2	-23.58	3.212	3.288	21.78	7.518
Sensitivity analysis 3	-18.22	1.087	1.342	19.82	7.41
Sensitivity analysis 4	-20.97	-0.1282	-0.8356	20.7	7.74
Sensitivity analysis 5	-26.83	-2.995	-3.132	15.1	7.962

Table C-17. The estimated fuel at the time of accident for different likelihood distribution of the wing-end tank fuel. The values in Sensitivity analysis 3 where used in the report.

The highest mean is 4.2 USG and the lowest is -3.1 USG. The mean has therefore changed by 7.3 USG for different likelihood of the wing-end tank fuel.

C.6.2.2 Likelihood of fuel starvation

The change in the likelihood of fuel starvation at the time of accident can be seen in the following Table:

	Likelihood of fuel starvation
Sensitivity analysis 1	52.0%
Sensitivity analysis 2	58.0%
Sensitivity analysis 3	67.0%
Sensitivity analysis 4	75.0%
Sensitivity analysis 5	80.5%

Tafla C-18. The change in likelihood of fuel starvation at the time of accident for different likelihood distribution of the wing-end tank fuel. The values in Sensitivity analysis 3 where used in the report.

The likelihood can change from 52% to 81% based on the likelihood distribution of the manifold pressure, a span of 29% which is less than when the manifold pressure was changed.

Appendix C.7 Minimum fuel

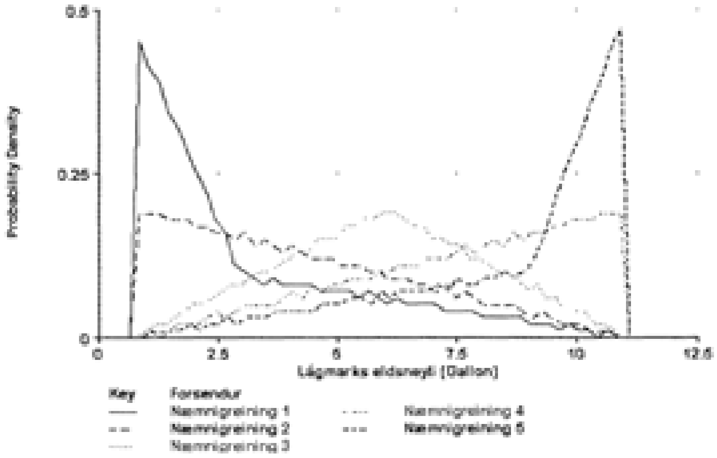
C.7.1 Random variable variations

The following likelihood distribution for the minimum fuel:

Sensitivity analysis 1	Distribution with the following points (0.75,0),(0.75,5),(3,1),(11,0)
Sensitivity analysis 2	Triangular distribution with maximum likelihood at 0.75 and 0 likelihood at 11 USG
Sensitivity analysis 3	Triangular distribution with maximum likelihood at 6 USG and 0 likelihood at 0 USG and 11 USG
Sensitivity analysis 4	Triangular distribution with maximum likelihood at 11 USG and 0.75 USG
Sensitivity analysis 5	Distribution with the following points (0.75,0),(9,1),(11,5),(11,0)

Table C-19. The distributions used in the sensitivity analysis of the minimum fuel. The values in Sensitivity analysis 3 where used in the report.

The distributions can be viewed in the following figure:



Mynd C-3. The distributions used in the sensitivity analysis of the minimum fuel.

C.7.2 Change in results

C.7.2.1 Fuel

The change in estimated fuel at the time of accident can be seen in the following Table:

	Minimum	Median	Mean	Maximum	Std
Sensitivity analysis 1	-24.01	1.454	1.538	19.57	7.539
Sensitivity analysis 2	-24.03	1.47	1.42	21.88	7.563
Sensitivity analysis 3	-16.45	1.239	1.342	17.14	7.655
Sensitivity analysis 4	-21.93	1.86	1.497	21.49	7.661
Sensitivity analysis 5	-21.39	1.516	1.533	20.57	7.727

Table C-20. The estimated fuel at the time of accident for different likelihood distribution of the minimum fuel. The values in Sensitivity analysis 2 where used in the report.

From those results it can be concluded that changes in the minimum fuel distributions has little change on the final fuel results.

C.7.2.2 Likelihood of fuel starvation

The change in the likelihood of fuel starvation at the time of accident can be seen in the following Table:

	Likelihood of fuel starvation
Sensitivity analysis 1	57.0%
Sensitivity analysis 2	63.5%
Sensitivity analysis 3	68.5%
Sensitivity analysis 4	77.5%
Sensitivity analysis 5	80.0%

Table C-21. The change in likelihood of fuel starvation at the time of accident for different likelihood distribution of the minimum fuel. The values in Sensitivity analysis 2 where used in the report.

The likelihood can change from 57% to 80% based on the likelihood distribution of the manifold pressure, a span of 23% which is less than when the manifold pressure was changed.

Appendix C.8 Variance in time logging

C.8.1 Random variable variations

The following variations where used in the time logging calculations:

	VM	RK	SF
Sensitivity analysis 1	1	1	2
Sensitivity analysis 2	1	1	3
Sensitivity analysis 3	1	1	4
Sensitivity analysis 4	0	0	3
Sensitivity analysis 5	1	1	3
Sensitivity analysis 6	2	2	3

Table C-22. Variations in time logging used for sensitivity analysis. The values in Sensitivity analysis 2 and 5 where used in the report.

Here on one hand the variation is changed at SF by one minute and on the other at VM and RK by one minute.

C.8.2 Change in results

C.8.2.1 Fuel

The change in estimated fuel at the time of accident can be seen in the following Table:

	Minimum	Median	Mean	Maximum	Std
Sensitivity analysis 1	-20.74	0.9402	1.542	22.29	7.366
Sensitivity analysis 2	-21.25	1.806	1.434	22.71	7.432
Sensitivity analysis 3	-17.4	0.8458	1.369	18.43	7.368
Sensitivity analysis 4	-20.27	1.459	1.484	24.76	7.777
Sensitivity analysis 5	-16.96	1.91	1.52	19.93	7.862
Sensitivity analysis 6	-18.03	1.694	1.495	23.54	7.54

Table C-23. The estimated fuel at the time of accident for different variances in time logging. The values in Sensitivity analysis 2 and 5 where used in the report.

It is difficult to see any notable changes. The variances from the mean are minimal but it should be noted that when the variance in the time logging at VM and RK the standard deviation decreases.

C.8.2.2 Likelihood of fuel starvation

The change in the likelihood of fuel starvation at the time of accident can be seen in the following Table:

	Likelihood of fuel starvation
Sensitivity analysis 1	60.0%
Sensitivity analysis 2	66.0%
Sensitivity analysis 3	60.5%
Sensitivity analysis 4	64.5%
Sensitivity analysis 5	61.5%
Sensitivity analysis 6	61.0%

Table C-24. The change in likelihood of fuel starvation at the time of accident for different variances in time logging. The values in Sensitivity analysis 2 and 5 where used in the report.

The changes of the likelihood of fuel starvation are minor with different variances in time logging.

Appendix C.9 Descent rate and fuel consumption during descent

C.9.1 Random variable variations

The following variations where used for the descent rate and fuel consumption during descent variables:

	Fuel consumption during descent		Descent rate	
Sensitivity analysis 1	30	50	300	700
Sensitivity analysis 2	40	60	300	700
Sensitivity analysis 3	50	70	300	700
Sensitivity analysis 4	40	60	200	500
Sensitivity analysis 5	40	60	300	700
Sensitivity analysis 6	40	60	400	800

Table C-25. Variations used for descent rate and fuel consumption during descent in the sensitivity analysis. The values in Sensitivity analysis 2 and 5 where used in the report.

Here on one hand the fuel consumption is changed by 10 pound/hour and the other the descent rate is changed by 100 feet/min.

C.9.2 Change in results

C.9.2.1 Fuel

The change in estimated fuel at the time of accident can be seen in the following Table:

	Minimum	Median	Mean	Maximum	Std
Sensitivity analysis 1	-15.7	2.926	3.362	19.52	7.347
Sensitivity analysis 2	-24.12	1.416	1.357	20.79	7.536
Sensitivity analysis 3	-15.66	-1.182	-0.4532	17.39	7.515
Sensitivity analysis 4	-16.34	3.196	3.357	25.7	7.454
Sensitivity analysis 5	-18.73	1.602	1.434	20.9	7.643
Sensitivity analysis 6	-17.91	0.8672	0.415	22.52	7.799

Table C-26. The estimated fuel at the time of accident for different descent rate and fuel consumption during descent. The values in Sensitivity analysis 2 and 5 where used in the report.

The mean can change by 4.1 USG when the fuel consumption during descent is changed and 2.9 USG when the descent rate is changed.

C.9.2.2 Likelihood of fuel starvation

The change in the likelihood of fuel starvation at the time of accident can be seen in the following Table:

	Likelihood of fuel starvation
Sensitivity analysis 1	57.5%
Sensitivity analysis 2	66.0%
Sensitivity analysis 3	69.5%
Sensitivity analysis 4	52.5%
Sensitivity analysis 5	63.5%
Sensitivity analysis 6	65.0%

Table C-27. The change in likelihood of fuel starvation at the time of accident for different descent rate and fuel consumption during descent. The values in Sensitivity analysis 2 and 5 where used in the report.

The likelihood can change from 58% to 70% when the fuel consumption during descent is changed and from 52% to 65% when the descent rate is changed.

Appendix C.10 Landing gear

C.10.1 Random variable variations

The following variations where used for the additional fuel consumption due to the landing gear:

	Minimum	Maximum
Sensitivity analysis 1	1 liters	5 liters
Sensitivity analysis 2	2 liters	6 liters
Sensitivity analysis 3	3 liters	7 liters
Sensitivity analysis 4	4 liters	8 liters
Sensitivity analysis 5	5 liters	9 liters

Table C-28. The upper and lower limits in uniform distributions for the additional fuel consumption due to the landing gear. The values in Sensitivity analysis 2 and 5 where used in the report.

C.10.2 Change in results

C.10.2.1 Fuel

The change in estimated fuel at the time of accident can be seen in the following Table:

	Minimum	Median	Mean	Maximum	Std
Sensitivity analysis 1	-18.76	3.174	2.041	22.1	7.88
Sensitivity analysis 2	-18.39	1.48	1.646	18.79	7.342
Sensitivity analysis 3	-19.63	1.632	1.427	22.74	8.112
Sensitivity analysis 4	-19.93	0.7984	1.067	25.84	7.785
Sensitivity analysis 5	-17.04	1.38	0.9571	21.95	7.794

Table C-29. The estimated fuel at the time of accident for different distributions of the additional fuel consumption due to the gear. The values in Sensitivity analysis 3 where used in the report.

The mean can change by 1 USG when the additional fuel consumption due to the gear down.

C.10.2.2 Likelihood of fuel starvation

The change in the likelihood of fuel starvation at the time of accident can be seen in the following Table:

	Likelihood of fuel starvation
Sensitivity analysis 1	57.0%
Sensitivity analysis 2	61.0%
Sensitivity analysis 3	60.5%
Sensitivity analysis 4	65.0%
Sensitivity analysis 5	65.0%

Table C-30. The change in likelihood of fuel starvation at the time of accident for different distributions of the additional fuel consumption due to the gear. The values in Sensitivity analysis 3 where used in the report.

The likelihood can change from 57% to 65% for different distributions of the additional fuel consumption.

AAIB COMMENTS ON THE REPORT OF THE AD HOC COMMITTEE APPOINTED TO INVESTIGATE AN AIRCRAFT ACCIDENT IN THE INLET OF SKERJAFJÖRÐUR ON 7 AUGUST 2000

Annex III

REYKJAVÍK 19 JANUARY 2005

January 19, 2005

Professor emeritus Sigurður Lindal

Subject: AAIB comments on the report of the Ad hock committee appointed to investigated an aircraft accident in the inlet of Skerjafjördur on 7 August 2000

The Icelandic Aircraft Accident Investigation Board (AAIB) wants to thank the Ad hock committee for giving the Board the opportunity to comment on the report into the accident in the inlet of Skerjafjördur 7 August 2000.
The AAIB welcomes the report which reflects a thorough and professional investigation work.

The conclusions of the report are generally in harmony with the conclusions of the AAIB report published 23 March 2001. New issues are raised in the Ad hock report such as the human factor and therefore the report is in compliance with current international reporting procedures. In addition recommendations are made in order to further improve investigation work of the AAIB.

The AAIB wants to make the following comments:

Preface:
In first paragraph in the preface it is stated that the AAIB declared in a letter dated 3 October 2002 that further research was needed due to the aircraft accident. This statement is not correct. In this letter the board recommended that an Ad hock committee should be established to lay down an in depended judgment on the conclusions of AAIB final report into the accident and perhaps additional safety recommendations.

Chapter 5.5 Conclusion and chapter 5.6 overview
In the first and fifth paragraph in chapter 5.5 and in item number six in chapter 5.6 it is stated that the aircraft engine was overhauled by JAS, Inc. This is not correct. The engine was overhauled by Gold Star Aviation Accessories 15. December 1996. JAS, Inc only performed 100 hour (annual) inspection on the aircraft and engine.

Chapter 6.6 Conclusion and chapter 6.7 overview
In the first paragraph of chapter 6.6 it is stated that it is not clear when the engine was released, but 2-4 days after the accident have been mentioned.

Documents in the position of the AAIB show that the engine was released after it was inspected 4 days after the accident. The same applies to item 1 in chapter 6.7.

Chapter 10 The human factor

In chapter 10 it is stated that the AAIB final report tried little to explain why the TF-GTI pilot did not succeed as he should have in controlling the aircraft when the engine lost power. When writing the final report the AAIB followed the Appendix "Format of the final report" in the eight edition of Annex 13 which was issued in June 1994. The Appendix does not cover the human factor. The same applies to the Appendix in the ninth edition of Annex 13 that was issued in July 2001. The human factor is however covered in "Manual of Aircraft Accident and Incident Investigation, part IV, Reporting (Doc 9756)" which was issued by ICAO 2003. It should be stated in the report in the opinion of the AAIB that the format of the final report in guidance documents and international agreements changed after the AAIB issued the final report.

Chapter 12 Rescue part

Limited coverage in the AAIB final report of the possibilities of survival after the accident. When writing the final report the AAIB followed the Appendix "Format of the final report" in the eight edition of Annex 13 which was issued in June 1994. The following is to be covered regarding survival aspects according to the Appendix: Brief description of search, evacuation and rescue, location of crew and passengers in relation to injuries sustained, failure of structures such as seats and seat-belt attachments. According to new law on aircraft accident investigation the rescue part should be given additional attention in future investigations.

Epilog

It is of vital importance to the AAIB that the report reflects a thorough and complete investigation. Our comments are made to improve the report. Should the Ad hock committee require additional information the AAIB is more than willing to provide further assistance.

Sincerely,

On behalf of the Aircraft Accident Investigation Board

Þormóður Þormóðsson Chief Inspector of Accidents	Þorkell Ágústsson Deputy Chief Inspector of Accidents

ANALYSIS PAPER

COMMENTS BY THE ICAA ON THE FINAL DRAFT REPORT OF THE SPECIAL INVESTIGATIVE COMMITTEE (SIC) ON THE AIR ACCIDENT IN SKERJAFJÖRÐUR ON 7 AUGUST 2000

APPENDICES B-C

Annex IV

REYKJAVÍK 25. JANUARY 2005

Analysis Paper

25 January 2005

To: Special Investigative Committee
From: Icelandic Civil Aviation Administration

Subject: Comments by the ICAA on the final draft report of the Special Investigative Committee (SIC) on the air accident in Skerjafjörður on 7 August 2000.

Introduction.

As stated in the preamble of the draft report of the SIC the committee defined its task as being to "peruse and evaluate the reports and analyses" that are enumerated in this section. The committee would also review: "other aspects that the reading of the aforementioned material would prompt".

As to be expected the report of the Air Accident Investigation Board (AAIB) on this accident is a primary document in this context. For this reason it needs to be said that even if the ICAA stated its concurrence with the AAIB conclusions on the most probable cause of the accident this did not apply to all the findings and conclusions that are found in the AAIB report. This position was clearly stated in the comments of the ICAA on the final draft of the AAIB report as per the attached copy of the letter of the ICAA to the AAIB dated 16.03.2001. In the comments on the final draft of the Special Investigative Committee, which is presented in this paper, a number of the findings of the AAIB final report will be addressed.

Subjects addressed.

This paper addresses and provides comments on two topics in the final conclusions section of the SIC draft report (section 15) that the ICAA believes are not valid as presented and scrutinized in the light of all available facts. The statements in question are the following:

» "The CAA should neither have registered the aircraft TF-GTI nor issued an airworthiness certificate for it because of its unclear history and insufficient documents that came with it."
» "Many things were wanting in the flight operations of L.Í.O. ltd./Air Charter Iceland. The CAA surveillance of the flight operator was not satisfactory…"

The first statement appears to express the view that the ICAA should have refused in general to register the aircraft and to issue a certificate of airworthiness. The latter reflects, in the view of the ICAA, a very misleading picture of the way in which surveillance of the flight operations were conducted. This paper and the accompanying appendices provide a detailed discussion of these statements as well as the conclusions on the engine that appear in item 5 in the final conclusions section of the committee report. In addition a few observations are made on other items that the ICAA would like to put forward.

Registration and the issuance of an airworthiness certificate.

Registration.

The registration of aircraft is governed by chapter III of the Icelandic Aviation Act no. 60/1998, in particular paragraphs 9, 10, 12 and 14 as presented by the attached memorandum by the ICAA legal office identified as Appendix A. As stated in this document it is clear that the registration of an aircraft into the Icelandic Registry does not require the aircraft to be airworthy. The only requirement is that a type certificate, issued by the ICAA or endorsed by the ICAA, is on hand and that documents regarding the ownership and operational control of the aircraft are available. The ownership of the aircraft in question has not been doubted. Also the existence of a type certificate was available in the FAA data base. Furthermore a report on deregistration of the aircraft in the United States was on hand.

The ICAA was therefore obligated by law to register TF-GTI in the Icelandic Registry of Aircraft. No requirement exists for the aircraft to be airworthy at the time of registration. The statement (by the SIC) to the effect that the ICAA should have refused to register the aircraft is consequently unfounded.

The legal aspects of the registration are presented in more detail in the memorandum of Appendix A. The technical aspects of the registration are discussed in the memorandum of the ICAA Flight Safety Division in Appendix B.

Issuance of a certificate of airworthiness.

The legal provisions for the issuance of a Certificate of Airworthiness (CofA) can be found in Chapter IV of the Icelandic Aviation Act no. 60/1998. Paragraph 22 states that: "If it is verified by an inspection or in some other way that an aircraft is airworthy the ICAA shall issue a certificate of airworthiness for this aircraft". Para. 20 defines the requirements that must be met for an aircraft to be airworthy although it does not specify what documents should accompany an application for an airworthiness certificate. Para. 21 states that "the ICAA is permitted to delegate the inspection and surveillance (of the aircraft) to an Icelandic or foreign party or foreign authority that is selected by the ICAA and has competence".

Documentation of the Aircraft.

All necessary documents were available in order to allow an assessment to be made as to whether the airworthiness requirements were met that would allow the issuance of a certificate of airworthiness. The ICAA inspector had no reason to doubt these documents in the view of the fact that the aircraft had been inspected by a competent party, i.e. a licensed JAR-145 repair station.

A maintenance record was available for the aircraft. New logbooks had been prepared based on verified documentation on its condition. This was done as logbooks providing the maintenance history of the aircraft from its date of manufacture were not available. The ICAA refutes the statement that is made in the AAIB report that "The renewal of the logbooks was not performed in accordance with recognized practices of the aviation industry". Advisory Circular No. 43-9C, section 12 describes what should be done if these documents have been lost or destroyed. It is concluded that the method used for the renewal of the logbooks were in general terms keeping with these procedures.

A signed list of AD notes accompanied the application for a CofA. This list had been prepared by the JAR-145 maintenance station that had performed an annual inspection of the aircraft. It was compared with the list available from the FAA on published AD notes for this type of aircraft. The ICAA inspector consequently had no reason to anticipate that the inspection by the JAR-145 repair station had been incomplete and that the AD directives had not been carried out in an appropriate manner. An investigation after the accident revealed that the markings on the wing regarding refueling of the aircraft were in all probability missing and that the inspection by the repair station was lacking in this respect.

In the aforementioned conclusion of the AAIB on the issuance of the certificate of airworthiness (page 21 in the AAIB report) the following statement is made: "Despite the fact that all necessary documentation, officially required for the issuance of the CofA, was on hand, there was reason for criticism, inter alia because of their unsatisfactory appearance". This states that in the opinion of the AAIB all the required documentation was available at the time of the issuance of the CofA. The report of the AAIB offers no explanation as to what was lacking in the preparation of the documentation (as seen by the board). The ICAA does not accept the argument that unsatisfactory appearance of these documents was a reason for turning down the application in general. On the other hand the ICAA agrees with the view that the appearance of the documentation should have been better and more articulate. However it is clear that the appearance of documents as such cannot be considered a reason for the turning down of an application for a CofA.

History of the aircraft

In the final conclusions of he special committee, item 4, it is stated that the ICAA should not have registered nor issued a certificate of airworthiness for this aircraft "due to its unclear history and the incomplete documentation, as per chapter 4". As previously stated and detailed in Annex B the original logbooks of the aircraft were missing. Consequently little was known about its history before 1994. This is not a unique situation as indicated by the fact that accepted procedures are available for such situations as referred to earlier. Based on the Aviation Act no. 60/1998 and standard procedures on the issuance of a certificate of airworthiness the only objective of the documentation is <u>to ascertain the condition of the aircraft and its components</u> at the time of issuance of a new or reissued certificate. The information that came to light later about questionable use of this aircraft during some period of its life consequently has no bearing on its airworthiness.

On the engine of the aircraft.

Much discussion has taken place on the history of the engine of the aircraft. This is considered in some detail in Appendix B. Regardless of the views that have been expressed no one has doubted the fact that the engine was of the H-type as specified by the type certificate of the aircraft. This engine had been overhauled by an approved maintenance facility in the US which by Icelandic and US rules means that its hours are set to zero. Speculations by the AAIB about the lack of information about the total hours of the engine or the propeller consequently are irrelevant to its airworthiness. There are no indications that there were any bogus parts in the engine which has been a matter of concern to the aviation industry. The only conclusion that can be drawn is that the engine was airworthy.

Transition from the US environment.

It was clear to the ICAA Flight Safety Division that the aircraft was entering an operating environment in Iceland that was different from the one in which it had been operated in the US as discussed in Appendix B. Firstly, this called for a special maintenance program approved by the ICAA in accordance with the regulation on air transport. In the second instance its maintenance would be performed by a JAR-145 maintenance facility. Thirdly the maintenance status of the aircraft was compared with the approved maintenance program. This ensured the bridging of the aircraft's maintenance status as a private aircraft in the US to the commercial environment in Iceland. Thus the ICAA was obligated to issue an Icelandic airworthiness certificate for this aircraft. Had the aircraft been transferred in the US from the private to the commercial category of operation a new CofA would not have been issued. The only change that would have taken place was that a new maintenance program would have been established for the aircraft. This has been confirmed by the FAA in response to an inquiry from the ICAA. An overhaul of the engine and the propeller would not have been repeated by a FAR-145 repair station.

The history of the aircraft and the US operating environment is repeatedly referred to in the AAIB report. It is not clear that the board sought the confirmation of the FAA and/or the NTSB of the statements made in the report about the US operating environment. This also applies to the information which in the AAIB report are said to have been obtained from the JAA regarding conformity inspections.

Conclusion regarding the issuance of the CofA.

The following facts are established:

- » All necessary documentation for the issuance of a CofA was available.
- » The ICAA has always accepted certificates and properly prepared documentation that have been received from the FAA environment and has not had a reason for doubting these documents.
- » At the time of issuance of the CofA there was nothing that indicated that the information received from the US could not be trusted nor has this emerged at a later date.
- » The engine and propeller had been overhauled. Neither one had any life limited parts (mandatory retirement parts).

» The aircraft had been signed off by an approved maintenance facility in the US with a renewed CofA.
» A thorough inspection (annual inspection) of the aircraft and associated documentation had been performed by an approved JAR-145 maintenance facility in order to bridge the aircraft into an operation under the air transport regulation in Iceland.
» There was no indication that obligatory modifications in accordance with AD notes had not been carried out.

For these reasons the ICAA had an obligation to issue the CofA on the basis of the available data. Any suspicion by the ICAA inspector that the directive on the markings at the refueling point had not been carried out would have resulted in a delay of the issuance of the CofA until this situation had been corrected.

Surveillance of the operation of LIO by the ICAA.

As stated in the accompanying memorandum from the ICAA Flight Safety Division (Appendix C) the surveillance of the operation of LIO was more extensive and formal than reflected by the AAIB report. In fact the AAIB report does not indicate that any overall investigation of this subject was undertaken by the board. On the contrary general conclusions seem to have been drawn from the reply by the ICAA to a general inquiry by the AAIB on this subject and information regarding the operation of TF-GTI during the short period of operation of this aircraft. However, in the draft report of the Special Investigative Committee it is mentioned that the ICAA repeatedly insisted that the operator update its manual of operations.

The conclusions of the ICAA Flight Safety Division, as provided in Appendix C, regarding the flight operation are in broad terms the following:

1. It is clear that substantial surveillance of the flight operations of LIO and intervention by the ICAA Flight Safety Division were performed during the time period from the beginning of 1998 until the accident. The flight safety division considered itself as having a clear picture of the way in which air operations of this company were being conducted.
2. The ICAA agrees that a full audit of the headquarters of the company should have been undertaken in first half of the year 2000 in accordance with the policy of carrying out such an audit on a biannual basis. An audit of the headquarters that was undertaken in September of 2000, about a month after the accident, did not reveal any signs of general deterioration of the operation since the previous audit although the discrepancies in updating various documents that had been previously observed were again detected in addition to the deficiencies in the operation of TF-GTI.
3. Critical remarks were repeatedly submitted by the ICAA to the operator. However, the ICAA lacked the legal instruments in order to enforce the necessary corrections other than the termination of the air operator license. In the view of the ICAA such a termination would only have been feasible when safety critical discrepancies had been detected in the company's operation. It should be mentioned that at that time the ICAA had repeatedly been accused

of being overly zealous in its surveillance of air operators and the implementation of JAA regulations.

4. The company had experienced no serious incidents prior to the accident that would have warranted major action by the ICAA. This was also the view of the AAIB that shortly after the accident saw no reason for halting the operation of the company in the light of the information that the board had gather in the primary phase of the investigation.

There is every indication that the operation of LIO was in general well within limits during the period from January 1998 until the accident. However, it is clear that the operation of TF-GTI was not performed in the same way as other operations of LIO during its short service time with the company. It is also clear that there were general deficiencies in the operation of the company on the day of the accident.

Appendix B

24. January 2005

Flight Safety Division´s memo concerning the registration of TF-GTI and issuance of its Airworthiness Certificate.

The Registration Process

The application for a Certificate of Registration for the aircraft was dated 8. June 2000 (Form SKR-01). The form stipulates the information required by article 13 of the Icelandic Aviation Act nr.60/1998 together with the applicant's signature. The form contains a list of eight items to support the application.

1. Previous Certificate of Registration (FAA) and a Certificate of Airworthiness copy.
2. Bill of Sale.
3. Confirmation of deregistration from the state of last registration (USA) and statement of lien status.
4. Information on the nationality (Citizenship) of the applicant.
5. Radio station license.
6. Aircraft Flight Manual for type.
7. Customs declaration for import.
8. Insurance Certificate.

The Icelandic Aviation Act nr.60/1998, Chapter III, article 10 to 13 stipulates the requirements for the registration of aircraft in Iceland. The requirements are briefly as follows (see page 25 in the Report of the Special Investigating Committee).

- The requirement of ownership being of Icelandic nationality or a formal exemption to that requirement, (article 10).
- An aircraft shall have been removed from the foreign register prior to being eligible for registration in Iceland, (article 11)
- An aircraft shall not be registered unless it is Type Certificated by the ICAA or it has a Type Certificate, accepted by same, (article 12).
- The application shall be in writing. The applicant (owner/holder) must present evidence of ownership and documentation of authorisation to fulfill the requirements of aforementioned article10 to 12 of the Aviation Act . Further, information of where the aircraft was manufactured and when. (Article13).

Therefore, there are no requirements in the Icelandic Aviation Act nr.60/1998 for presentation of neither the former Certificate of Airworthiness at the time of application for Registration of an aircraft, nor the Radio Station license, Airplane Flight Manual, customs declaration for import and Insurance Certificate.

The reason for the items being included in the Application Form for Registration is, that in most cases it is the applicant's intention to have the Certificate of Airworthiness issued in due course. Therefore it would be advantageous to have this

information at hand a.s.a.p. Besides, the Airplane Flight Manual is closely related to the Type Certificate.
It is appropriate to point out that there are no requirements for the presence of an Airworthiness Certificate when an aircraft is registered in Iceland. This fact is specifically addressed in the Exposition for the Icelandic Aviation Act nr.60/1998.

The application of June 8. 2000 included all the documents that are stipulated in the application form items 1-8, excluding item 4 that concerns citizenship, since that information was already at hand at the ICAA. The ICAA confirmed that the Type Certificate meets ICAA requirements (i.e. Type Certificate Data Sheet nr.3A21 from FAA).

The application was clear and the documents were presented in an adequate manner, except for an error in the year of manufacture, where 1974 was erroneously written instead of 1973. On the other hand, the aircraft serial number and the registration markings were unambiguous, so there was no question, which aircraft the documents referred to. The above mentioned documents are and were valid and it cannot be determined in which accident report these documents are being disputed.

> ***The ICAA had neither material substantiation to reject the application for registration, nor to request additional documentation and it would have been a breach of the Equality Rule, stipulated in Icelandic Law, as well as Chapter III of the Aviation Act, to deny a qualified owner of his rights to register a Type Certificated aircraft from a state of manufacture, that is acceptable to the ICAA. Therefore it was the obligation of the ICAA to register the aircraft without delay on the basis of the documentation submitted.***

The Certificate of Airworthiness

A signed application form for the issue of a Certificate of Airworthiness was received on June 8. 2000.

Requirements for airworthiness.

Requirements for airworthiness of aircraft are found in article 20 of the Icelandic Aviation Act nr.60/1998. The principal requirements are as follows:

a. That the aircraft is designed to accepted standards.
   - This is confirmed by the Type Certificate.
b. The aircraft is manufactured by a certified manufacturer.
   - This is confirmed by the Type Certificate.
c. That scheduled maintenance and surveillance of the aircraft conforms to rules and instructions of the aviation authorities regarding maintenance control and the use of approved maintenance facilities, overhaul, repairs, alterations and installation of equipment.
   - This will be dealt with in more detail hereinafter.
d. The aircraft complies with governmental environmental requirements.
   - This is confirmed by its Type Certificate.

e. The aircraft is insured.
   - The insurance certificate was available.

According to the IAAIB and the Special Investigating Committee reports there is no doubt that the requirements of items a, b, d and e are in compliance. Therefore it is only item c, which will be considered

It is not stipulated directly , in Icelandic regulations, which documents must be presented with the application for the issuance of a Certificate of Airworthiness , to demonstrate that the requirements of item c, are satisfied. On the other hand, in this case, the requirements are to be found in the Regulation for Commercial Transportation nr.641/1991, especially Chapter 6 and the Regulation nr.477/1994 concerning requirements for approved maintenance facilities. The documents that were present at the time of issue of the Certificate of Airworthiness were used as the basis for evaluation of whether the requirements of item c, had been fulfilled are the following apart from the application form itself:

- Documents that were presented with the application of registration, i.e. Airplane Flight Manual, Radio Station License, former Certificate of Airworthiness and former Certificate of Registration .
- Type Certificate.
- Maintenance Program and log books.
- Signed list certifying that all ADs (AD Compliance Report) have been complied with.
- Annual inspection Maintenance Release issued by an approved JAR-145 Maintenance Organisation.
- Weight and Balance Report.

Audit and checks by the Airworthiness Inspector of the Flight Safety Department:

Prior to Airworthiness Certificate issuance for the aircraft, the Airworthiness Inspector checked the following:

- *The Application*: It was correctly filled out. All information was in place, although it could have been filled out in a tidier manner.
- *Maintenance logbooks*: Original log book(s) from day one were not available. However, a new airframe log book had been prepared on the basis of a notarized statement by a previous owner dated February 15. 1996 stating, that the airframe total flight hours at that time were 3.390 hrs. He also had stated that the aircraft had never sustained any damage. The applicant also stated that the aircraft had not been in use from 1994 until 1999. Further supporting evidence was that the aircraft engine had been overhauled in 1996 and still stood at 0 (zero) hours at the time a maintenance check had been carried out in 1999. In the application it was stated that the total flight time since new (TSN) was 3.431 hrs. when the application for a Certificate of Airworthiness was received. The Airworthiness Inspector had no reason to contest the applicant's data since it is not uncommon that small aircraft stand around idle for several years.
- The Aircraft log book contained an *Airworthiness Release* issued by a JAR-145 approved Maintenance Organisation, which certified that all maintenance had been carried out in accordance with its approved Maintenance Program.

- At that time, a current *listing of Airworthiness Directives*, commonly named an AD note list, had been prepared and certified by the applicant's Technical Director. The Technical Director had established this listing in his maintenance control system on June 8. 2000. The Airworthiness Inspector compared this listing with the FAA AD listing of published Airworthiness Directives to verify the all ADs were on the list, that had been issued for this type of aircraft.
- STCs (supplements to the Type Certificate) and FAA Form 337 (Major Modifications and Alterations) forms were present for modifications that had been embodied on the aircraft.
- *Weight and Balance Report:* The Weight & Balance Report indicated that the aircraft had been weighed on July 16. 1999.
- The Airworthiness Inspector had inspected the aircraft for conformity with its Type Certificate and verified that the equipment installed fulfilled ICAA requirements. This inspection revealed nothing that would cause the inspector to be in doubt of the airworthiness of the aircraft. In contrast, all aspects appeared to be in good order and the aircraft in good condition.

With this inspection of documentation and physical check of the aircraft, it was verified that the airworthiness requirements of article 20 of the Icelandic Aviation Act nr.60/1998 were met. Furthermore, the requirements of Regulation for Commercial Transportation # 641/1991 and Regulation # 477/1994, concerning JAR-145 maintenance for Commercial Transportation.

"Conformity Inspection"

When an aircraft is transferred from one Regulatory Environment to another, it is necessary to verify, that the aircraft meets all the requirements of its new environment. This verification process is often called a "Conformity Inspection" and consists this case primarily in:

1. Envisage the Regulatory Environment that this aircraft had to comply with in relation to airworthiness. These are found in Regulation for Commercial Transportation, nr.641/1991, particularly in Chapter 8 and in Regulation nr.477/1994, concerning JAR-145 maintenance for Commercial Transportation, which stipulates that any aircraft that is used for commercial transportation must be maintained by such a Maintenance Organisation (article 145.1).
2. An approved Maintenance Program must be available.
3. The maintenance status must be compared with the approved Maintenance Program and it verified, that all maintenance, required by the Approved Maintenance Program, has been accomplished.

In the Special Investigating Committee's Report it is claimed that the JAR-145 Maintenance Organisation should have carried out a more detailed inspection than an "Annual Inspection" and that according to the JAA, an Annual Inspection would be the minimum. It cannot be established what this means and it is therefore necessary to emphasize the following:

- There is no reference to any document that reveals this opinion of the JAA. The JAA has not published any rules or guidelines relating to the kind of inspection that should be carried out to fulfill the requirement, that aircraft, engaged in commercial transportation, shall be maintained i.a.w. JAR-145. Current commercial transport regulations were explicit in this regard, stating that aircraft should be maintained i.a.w. an Approved Maintenance Program. In JAR-145, a requirement for maintenance organizations, it is stipulated, that aircraft engaged in Commercial Transportation must be maintained by a JAR-145 approved organization.

- When an airplane is to be operated commercially and has been transferred from another Regulatory Environment or from another operator, a so-called "bridging" inspection must be carried out, i.e. to compare the maintenance status of the aircraft with the Approved Maintenance Program that the operator intends to use to control its maintenance. With the introduction of JAR OPS-1, this item was added. i.e. to verify that equipment, stipulated in Chapters K and L were present. If an Annual Inspection of TF-GTI had not been due at that time, it would have been sufficient to perform just the items, if any, that were required by the operator's maintenance program, but were not included in the last annual inspection, which was performed by JAS Inc, in USA. In reality, it is the maintenance status of the aircraft to its Approved Maintenance Program that determines how detailed an inspection need to be, when entering the JAA environment. In some cases, only a minor maintenance inspection has to be carried out by the JAR-145 Maintenance Organization, prior to being operated in commercial air transportation, even when being transferred from another Regulatory Environment.

Since an Annual Inspection for this type of aircraft includes all scheduled inspections it is logical to "bridge" the differences of the former regulatory environment and the new one, by performing an annual inspection i.a.w. the new Maintenance Program at a JAR-145 approved Maintenance Organisation,

> *The IAAIB's and the Special Investigating Committee's Reports' reference to a more detailed "Conformity Inspection" that should have been carried out, over and above the annual inspection, is unfounded, and it is difficult to establish what that inspection would consist of. The JAA has neither defined the term "conformity inspection" in its Regulations nor described any special inspection as a "conformity inspection".*

Former logbooks and incomplete list

On pages 15, 16 and 27 the Special Investigating Committee's Report mentions a few point that were meant to justify that a Certificate of Airworthiness should not have been issued for this aircraft. These points are primarily from the IAAIB report and are to be found on page 16 in the Special Investigating Committee's Report and are quoted below:

1. "Not all documents for commercial operation registration, relating to maintenance, such as former log books and other maintenance documentation, were available."
   It is clear that all historical records relating to maintenance were not at hand. It is, however, unclear and unexplained what is meant by "other documentation".

All historical documentation need not be at hand for the issue of a Certificate of Airworthiness. On the other hand, any outstanding items that cannot be verified in the historical records that are at hand, must be addressed. The annual inspection at the JAR-145 Maintenance Organisation covered this and before that, at the FAA approved Repair Station, JAS Inc.

2. "The replacement and reissue of the log books were not in compliance with aviation industry accepted practices."
The ICAA is neither aware of how the IAAIB came to that conclusion, nor are there any references or hints given, to which accepted practices it refers. Since no life limited parts are used in the engine, it was simple to compile new log books after it had been overhauled. In the Exposition for the Icelandic Aviation Act of 1998 it is pointed out that "grannskoðun" is a translation of the English word "overhaul" and would cause the flight hours of the pertinent aircraft or its components to be "zeroed". It is therefore normal for the engine- and propeller log books to show 0 hours after overhaul.
3. "The Airworthiness Directive list had been incomplete, since it was based on an inadequate AD list that was part of the aircraft documentation from USA."
The alleged incompleteness of this AD list was not elaborated on. The ICAA is in possession of two lists that came with the aircraft and has studied them, now and compared with the FAA listing. The lists contained all Airworthiness Directives that had been issued for the type, when these lists were compiled. On one list, which comes from ADLOG (Aircraft Maintenance Record Keeping System) company, it appears which directives are applicable and whether they are repetitive. The other list compiled by JAS Inc. contains all directives, but Mr. Thorleifur Juliusson only certifies the directives that were accomplished by JAS Inc. Those that had been previously complied with, were accounted for in an acceptable manner, except AD 94-12-08. Those ADs that had been previously accomplished, including AD 94-12-08, were all of the nature to be easily verified by inspection if they had been accomplished or not. It is therefore incorrect in the IAAIB reports that "Flugvelaverkstaedi GVS" was not in possession of adequate documentation to produce a new AD list. On the other hand, it is clear, that the labels, as required by AD 94-12-08, were not found in the aircraft wreckage and it is therefore likely that their absence may have been the result of GVS's omission of the part of the AD, pertaining to the labels.
4. "An Annual Inspection had been performed on June 9. 2000 but it could not be established from the log book that a Conformity Inspection had been carried out."
As previously mentioned here above, an Annual Inspection is carried out by a JAR-145 Maintenance Organisation i.a.w. an approved Maintenance Program, which in reality is a harmonisation- or "Conformity check".
5. "The presentation of documents had been shoddy and therefore inadequate"
The ICAA is aware of, that some of the documentation could have been presented in a neater manner, however, no documentation required was missing. The readability of associated documentation was fair and there was no misunderstanding what the documents stood for. Therefore it is unfounded, that the documentation had been inadequate for that reason.
6. "The engine lacked markings and the maintenance records lacked information on cylinder compression check".

It is unclear what *that the engine lacked markings* means. It will be discussed below under the heading "Engine". The engine had a normal data plate. Concerning the cylinder compression check, the implication appears to be the lack of documentation of the actual figures that resulted from the compression check, the documentation only stating that the result was in order and within prescribed limits. It is agreed, that the procedure to write down the actual pressure values is preferable.

It is difficult to apprehend, which further documentation the ICAA should have demanded in an objective and fair manner. The ICAA could have, without any doubt, demanded the presentation of another tidier application and a list of all items that the JAR-145 organization checked or accomplished. It would, however, have been in contradiction with general practice and equality to demand such a list unless there was a motive. With this in mind and that the aircraft appeared to be in good order, all required documentation was at hand, and in addition to that – had a valid Certificate of Airworthiness when the aircraft was flown from the United States of America to Iceland. It is difficult to determine why the ICAA should have called for further documentation. Not the least, since in ICAO Annex 8, Chapter 3, Part 2, article 3.2.4 it is pointed out, that it is permissible to issue a Certificate of Airworthiness on the basis of a Certificate of Airworthiness from another member state and is further described in the exposition for the Aviation Act of 1964, which states:

> "It is not required by law to conduct an inspection of an aircraft, prior to issuance of an Airworthiness Certificate, if airworthiness can be positively proven in another manner, f. ex. by the certification of an inspection that has been validated by a foreign body (Authority)".

It must therefore be assumed that the Type Certificate and the Certificate of Airworthiness issued by FAA ensure the general technical airworthiness of the aircraft and that an annual inspection i.a.w. an Approved Maintenance Program, carried out by a JAR-145 Approved Maintenance Orgamization, ensure conformity with Icelandic Regulations for Commercial Transportation.

From the aforementioned it cannot be concluded that a Certificate of Airworthiness should never have been issued for the aircraft. On the contrary, all documentation was available for the issuance of the Certificate of Airworthiness and the documents that were presented were no prerequisite that any further documentation was needed. This presumption of the IAAIB was therefore simply incorrect. It would have been considered dubious and contrary to standard public administration practices, if the ICAA had questioned the competency of the JAR-145 Organization and the LIO's Technical Manager in this particular case by refusing to issue the Airworthiness Certificate.

Annual Inspection and issue of the Certificate of Airworthiness.

The Annual Inspection was carried out by an Approved JAR-145 Maintenance Organisation and in the documentation, that accompanied the application for the Certificate Airworthiness, was, amongst others, one signed document which stated that all ADs had been complied with. Later it was implied that the Maintenance

Organisation had not verified the presence of certain labels during the Annual Inspection, that are required by AD 94-12-08 and by STC SA4300WE. ICAA Flight Safety Department inspectors generally presuppose, that those persons that have been certified by the ICAA to carry out and certify certain tasks, are trustworthy. The Airworthiness Inspector had no reason to doubt that the presence of the labels had been verified. It is further clear that if the Inspector had had any reason to suspect, that the labels might not be in place, then the aircraft would not have been issued with an Airworthiness Certificate at that moment.

> ***It is clear, that the moment it had been confirmed that the label had been put in place, the Airworthiness Certificate would have been issued. The ICAA could not refuse to issue the Airworthiness Certificate after it had been certified by an authorised person, that all items of an Annual Inspection had been performed, as is required by a JAR-145 Maintenance Orgarnisation. Therefore there is no logic in the statement, that a Certificate of Airworthiness should never have been issued for the aircraft.***

The engine

The engine type/model Teledyne Continental TSIO-520-ECH has no life-limited parts installed, which otherwise would have lead to a "Mandatory Retirement" of such part(s) when due. At overhaul of this type of engine, the condition of parts is established by inspections and measurements i.a.w. the manufacturer's instructions (Overhaul Manual, SBs etc). There are no requirements that age or prior usage of individual parts of the engine, prior to the overhaul, are available.
In the course of his inspection, the Airworthiness Inspector checked the engine Data Plate and observed, that the engine was an H type engine and therefore was in conformity with the Aircraft Type Certificate. Additionally, he found that the engine had been changed from an E type to an H type. He did not comment on this fact, since it was in conformance with the maintenance release, that was issued by the Overhaul facility and that it is not uncommon for engines to be modified. Maintenance Release for the overhaul, 100 hr. inspection and the annual inspection for the engine were at hand, when the Airworthiness Certificate was issued. Nothing has been pointed out that should have raised suspicion on the part of the inspector. It cannot be established why the inspector should have had any reason to demand more detailed information relating to the engine or doubt its airworthiness.

On Pages 39-45 in the Special Investigating Committee's Report is detailed information relating to modifications of this type of engines. There it is stated amongst other things, that it would be difficult to change the engine from an -E to an -H type, since the engine blocks are so different. On Page 44 it is stated that it is unlikely that the engine had been modified, e.g. for reason of the large number of replacement parts that are required for that purpose. It appears that the possibility that the engine had been assembled from two or more different engines has not been considered. I.a.w. instructions in Teledyne Continental SB M75-6R1, approved by the FAA, this action is perfectly legal, provided the engine is assembled with approved parts. The same document describes how to identify a Data Plate of an engine, that has been modified to another type, by stamping the letter "C" prior to the new designated letter "H". Service instructions (TCM) SIL00-9, on the other hand, refers to the procedure that must be followed, when a Data Plate must be replaced. Despite of fewer parts being transferred from the E engine to the H engine, it is permissible to use its Data Plate to identify the change from the "E" engine to the "H" engine. Whether such a modification is economical or not is another matter. With reference to the additional information now available, all indications are, that a perfectly normal, but perhaps a rather rare modification was performed.

> ***Since the engine was clearly a -H type engine, the Data Plate was normal, and the engine was in conformity with its Type Certificate, then the Airworthiness Inspector had neither prerequisites for further comments nor to request additional documentation.***
> ***Furthermore, it is now apparent, that the modification indicated by the Data Plate is quite normal, even though it may be rare and therefore no reason for not issuing a Certificate of Airworthiness for the aircraft.***

A comment
The Report of the Special Investigating Committee, Page 28 states: "With this there is not taken a stance on if the aircraft was actually airworthy. And nothing indicates that these anomalities played any role in the accident....."
In addition, it is appropriate to point out, that nothing in the investigation of the aircraft wreckage, or in the operation and maintenance while the aircraft operated in Iceland, indicates, that it had not been in perfectly good technical order. However, it is likely that the labels were missing.

FLUGMÁLASTJÓRN ÍSLANDS
Icelandic Civil Aviation Administration

Appendix C

31 January 2005

Flight Safety Division's memo concerning The Icelandic Civil Aviation Administration's (ICAA´s) surveillance of the LÍO Flight Operation.

It is evident in Icelandic Air Accident Investigation Board's (IAAIB) report, as in the report of the Special investigation committee (SIC) that the flight operation of the company in question was deficient on day of the accident. That view has been supported by the Flight Safety Division in a letter to the Police Commissioner in Reykjavík dated the 21st of September 2000.

On the other hand, surveillance and auditing documents of the Flight Operations Section of the Flight Safety Division (see attachment 1) show that the ICAA's surveillance of the company's flight operation was both wider in scope and more formal than stated in the IAAIB's report.

The scope of ICAA´s surveillance of the flight operations of LÍÓ.

A comprehensive audit at the headquarters of the company was carried out in January 1998 and again in September of the year 2000, i.e. approximately one month after the accident. From the time of the January 1998 audit until the time of the accident the ICAA intervened formally with the operation of the company on eleven separate occasions on which some parts of the operation were dealt with, such as insufficient preparation of documents, as well as other remarks and general operational surveillance. (See attachment 1, documents numbered 7-17).

In addition there was correspondence regarding the registration of aircraft on the Air Operators Certificate (AOC) of the company and the revision of the new company operations manual. The ICAA had in the year of 1996 acquired information from the Danish Civil Aviation Administration regarding their surveillance of small Flight Operators. This information indicated that less stringent rules were applied concerning surveillance of Operators with aircraft with a Maximum Take-off Mass under 10 tons. The scope of surveillance was in fact dependent on judgement and based on the scope and nature of the relevant operation. The ICAA´s procedures assumed a comprehensive audit to be performed at two year intervals.

IAAIB´s conclusion regarding the scope of surveillance appears to be solely based on an e-mail dated the 9th of September 2000 from the Flight Safety Division to the IAAIB stating in general terms that the most recent formal audit of the flight operations of the company had been made in January 1998 with subsequent surveillance through meetings and correspondence with the Operator. Such general phrasing seems to have given rise to incorrect interpretation and far reaching conclusions on behalf of the IAAIB. As evident by the supporting documents, there was considerable control of the company's operation during this period through surveillance and follow up of deviations, all of which were formally documented. The correspondence with the company's Director of operation was frequent, particularly because he also served as a confidant to the ICAA regarding the flight operation.

In the coverage of the IAAIB and the Special Investigation Committee (SIC) there is a remark stating that the ICAA had not performed a comprehensive audit of the company's flight operations from January 1998 until the time of the accident in August 2000 and that no such audit had been scheduled. This remark seems to be the basis of the IAAIB´s conclusion on page 131 and in the report of the specially investigation committee stating that: „ The ICAA´s surveillance of the operator had not been effective enough and did not provided necessary control".

The ICAA agrees that a comprehensive audit of the company's headquarters would have been desirable in the first half of the year 2000. The reason such an audit of the company's headquarters was not carried out at the time was the company's ongoing program of preparing a new operational manual which fulfilled the requirements of JAR-OPS 1. It was therefore decided to delay such an audit until the Flight Operations Section had finished approval of the new Flight Operations Manual that the company had submitted for examination. A request had already been made by the company to the ICAA to utilize the new manual which was in itself a statement of willingness on behalf of the company to start the implemention to the JAR-OPS 1 requirements without delay. A comprehensive audit of their headquarters in September 2000, i.e. approximately one month following the accident, and an examination of flight documents few days after the accident, revealed that for the main part, the company's operation was in reasonable order, although there were some non-conformities. The most important non-conformities where indeed the ones that the Flight Operations Section had repeatedly insisted that should be corrected. However, it became clear during the investigation of the accident, that the operation of the aircraft TF-GTI, had not been in accordance with the company operations manual on the day of the accident.

> ***Although a comprehensive audit of the company's headquarters in the first half of the year 2000 would have been desirable, there were no known deviations in the company's operations of such a nature as to give cause to special surveillance of the operation.***

The effectiveness of the surveillance.

The fact that the ICAA had repeatedly and in a formal manner requested that certain non-conformities, e.g. the chapter that deals with the flight and duty time in the Flight Operations Manual were corrected, indicates that the ICAA´s legal strength of enforcement was extremely limited. ICAA´s only option at the time would have been to initiate the process to withdraw the Air Operators Certificate and thereby bringing the operation to a complete halt. Considering the fact that the company already possessed the regulation regarding flight and duty time, it is doubtful that withdrawing the Air Operators Certificate could qualify as proper public administrative practices, considering the nature of the non-conformity concerned. ICAA´s lack of enforcement power in such cases has since been acknowledged in practice with the changes of articles 28, 82 and article 136 to the Aviation Act in the year 2002. These changes provided the ICAA with more comprehensive measures and power to gather information and to enforce corrective actions than previously.

It can be agreed that the ICAA´s surveillance was not sufficiently effective as is stated in the report of the Special Investigation Committee, page 131. First and foremost the reason is, that the necessary enforcement measures were not available to the ICAA at the time.

LÍO´s control of its flight operation.

The ICAA´s audits of LÍOs flight operations in September of the year 2000 and its follow up did not reveal anything that would justify limiting or shutting down the operation there and then. The audit included inspections of the documention of the operation back in time such as passenger lists and flight-duty hour records. Futhermore, the September 2000 audit confirmed the results of a ICAA´s spot check carried out three days after the accident on the records of Mass and Balance, Flight Plans and Passenger lists. The documents inspected were satisfactory.
At a meeting between the ICAA and the IAAIB on the 17th of August 2000, the ICAA asked the IAAIB officially as to whether anything had been brought to light during the initial investigation of the accident that indicated the need of special action. The IAAIB´s response was very decisively that such was not the case. In addition it can be stated that no incident relating to the operation of LÍÓ had occurred from 1995 until August 2000 that the IAAIB had decided to investigate.

It can not be assumed that the operation of LÍO had serious deficiencies during the period from 1995 until 2000 although the revision of the Operations Manual was irregular. The ICAA maintained constant pressure on the operator although the means for enforcing corrective action were lacking. There is no indication that a comprehensive audit of the headquarters in the first half of the year 2000 would have revealed anything that was not already known as no new or unknown non-conformities had been detected in the headquarters audit carried out in September that year.

The incident at Húsafell on 2 July 1999.

In the discussion of human factors aspects provided in the report of the Special Investigation Committee, it can be surmised (see bottom of page 112) that the ICAA did not investigate an incident that occurred on the 2nd of July 1999 when TF-GTM landed at the airfield of Húsafell. The fact is that an inspector of the ICAA (former airline captain) came to the scene. He examined the fuel quantity in the tanks of the aircraft and conclude that the aircraft was far from being low on fuel. Both the pilot and the Operator were requested to provide explanations regarding the conduct of this flight as well as its Flight Plan and Mass and Balance Records. The documents were examined and subsequently an official letter was sent to the Operator directing him to improve the quality of the company's documentation. It was concluded by the ICAA, that there was no reason for criticizing the fact that the Pilot in Command should choose not to continue the flight to Keflavík.

The ICAA formally investigated this incident and with an appropriate follow-up as shown in document no. 11 in attachment 1.

Training.

Reference is made to Attachment 2 with the title: "The holder of an Airline Pilot's License no 3322" with regard to the important conclusion 8.8.7, page 99 in the report of the Special Investigation Committee, where it is stated that the pilot of the aircraft had not received adequate training. This document reveals that the pilot had received more training than the minimum training required by regulations. In addition he had received special training as a Flight Instructor and had trained student pilots in Emergency Procedures as well as having completed various Proficiency Checks where Emergency Procedures are part of the checks. As stated in IAAIB´s report, the pilot had a total of 1267 Flying Hours. Those included 205 hours as a Flight Instructor.

Additional Documents

1. **Attachment 1: Documents containing surveillance of the Flight Operations of LÍO.**
2. **Attachment 2: The holder of an Airline Transport Pilot's License nr 3322.**

RESPONSES OF THE AD HOC INVESTIGATION COMMITTEE

Annex V

REYKJAVÍK MAY 2005

RESPONSES OF THE AD HOC INVESTIGATION COMMITTEE

1.0 On initial registration of the aircraft

Documents for the aircraft's initial registration required by law were formally available and that fact is in no way disputed. However, keeping in mind the aircraft's unclear history between 1973-1994, it would have been more accurate for CAA registration staff to look more closely into the documents in order to consider what they implied. The Analysis Report of the CAA Director General to the Minister of Transport of 4 October 2002, which is cited in Section 5.3.4 of the Ad Hoc Investigation Committee report, states that due to extensive discussions on the engine and because it did not have an original data plate, the CAA changed its "work procedures in registering such aircraft". After this "the risk of an aircraft or an engine with incorrect or falsified documentation being registered in Iceland is small at this time". (cf. Chapter 6 of the Analysis Report of the Director General of Civil Aviation).

The CAA conclusion is now as follows:

> **The ICAA had neither material substantiation to reject the application for registration, nor to request additional documentation and it would have been a breach of the Equality Rule, stipulated in Icelandic Law, as well as Chapter III of the Aviation Act, to deny a qualified owner of his rights to register a Type Certificated aircraft from a state of manufacture that is acceptable to the ICAA. Therefore it was the obligation of the ICAA to register the aircraft without delay on the basis of the documentation submitted.** (Memo dated 25 January 2005, Appendix B, p. 2, bold lettered there.)

It may be pointed out that the AAIB draft report mentions a type certificate but not the final report, cf. Section 4.2.2 of the Ad Hoc Investigation Committee final report.

The issue is not, in fact, whether legally required documents were available but whether they were reviewed as critically as circumstances required. If that had been done, there would have been grounds for requesting further documents with reference to the investigation rule in Article 10 of the Administrative Procedures Act No. 37/1993, which is as follows:

> An authority shall ensure that a case is sufficiently investigated before a decision thereon is reached.

This indicates that the CAA is fully authorised to take a suitable time for reviewing and requesting documents from the applicant without violating the principle of equality or rule of prompt handling, cf. Article 9 of the Administrative Procedures Act.

2.0 On the issue of an airworthiness certificate

<u>2.1 Aircraft documents</u>

It has not been questioned whether all documents formally required for issuing a certificate of airworthiness were available, however, there was reason to comment on their unsatisfactory preparation. This is confirmed in CAA Analysis paper of 25 January 2005 where it says: "...the ICAA agrees with the view that the appearance of the documentation should have been better and more articulate." The appearance of the documents should, however, not in any way have caused the application for a certificate of airworthiness to be rejected (p. 3). This is reiterated in the Memo, Appendix B, dated 24 January 2005:

> The ICAA is aware of, that some of the documentation could have been presented in a neater manner, however, no documentation required was missing. The readability of associated documentation was fair and there was no misunderstanding what the documents stood for. Therefore it is unfounded that the documentation had been inadequate for that reason (cf. p. 6, item 5).

This recognises in some respects that the documents could have been neater and filled out more thoroughly.

2.2 History of the aircraft - Issue of airworthiness certificate

As previously mentioned, not much is known about the aircraft's history before 1994, but it was built in 1973. Maintenance records or log books were not available from the beginning. Under circumstances such as these it is the opinion of the CAA, and with reference to applicable laws and other standards used when issuing an airworthiness certificate, that the only objective is to confirm the status of the aircraft and its components at the point in time when an initial or renewed airworthiness certificate is to be issued.

The Director of CAA's Flight Safety Division says in a report to the police dated 19 January 2001, that CAA staff looked at the aircraft shortly after it arrived in Iceland in 1999, and it was memorable that the aircraft seemed to be in an exceptionally good condition outside and inside. The aircraft was not, however, inspected specifically the day it was registered. The CAA has never had the technical facility, e.g. maintenance station, nor sufficient personnel with specialised knowledge to scrutinise whether a specific activity or repair job has been discharged in the required manner. This technical aspect is directed to approved maintenance stations and the CAA relies on the conclusions thereof. The CAA thereupon investigates at regular intervals whether work methods and maintenance control of such parties meet the requirements to which such activities are subjected. – There were sufficient documents and information available to issue an airworthiness certificate for the aircraft (cf. items 8-9 in the report).

In spite of this lack of facilities, it is the opinion of the Ad Hoc Investigation Committee that due to the long unclear period in the aircraft's history it would have been correct for the CAA to check more thoroughly the documents presented by the maintenance station on the aircraft's condition, especially since they were not well prepared as previously described.

A further confirmation thereof is in the Analysis Report of CAA Director General to the Minister of Transport, of 4 October 2002, where it says:

> The statement [of Forward and Taylor] that the certificate of airworthiness should not have been issued was strongly embraced by the ICAA in light of the facts that had emerged in the detailed investigation by the AAIB in the wake of the accident. However all necessary documentation was in place when the certificate was issued. ICAA could only have refused to issue this certificate by reasonably drawing these data into question at the time of application. Such reasoned opinion was not on hand at that time. In chapter 6 the authors [Forward and Taylor] acknowledge that in retrospect it is easy to say that the certificate should not have been issued. Furthermore it is clear that if the issuance of the certificate had been turned down this would have delayed such issuance until a new data plate had been obtained from the engine manufacturer. (Cf. the report's conclusive chapter)

The CAA Analysis Paper of 25 January 2005 says, furthermore, that a signed list of airworthiness directives accompanied the application. It then says:

> This list had been prepared by the JAR-145 maintenance station that had performed an annual inspection of the aircraft. It was compared with the list available from the FAA on published AD notes

> for this type of aircraft. The ICAA inspector consequently had no reason to anticipate that the inspection by the JAR-145 repair station had been incomplete and that the AD directives had not been carried out in an appropriate manner. An investigation after the accident revealed that the markings on the wing regarding refueling of the aircraft were in all probability missing and that the inspection by the repair station was lacking in this respect. No other impairment appeared in AAIB's investigation concerning implementation of airworthiness directives for the aircraft (cf. p. 3).[1]

It is admitted here that it would have been preferable to consider documents more closely before issuing an airworthiness certificate even though there are ample extenuating circumstances justifying issue of an airworthiness certificate for the aircraft to the operator.

2.3 Lack of placards

The Memo, dated 24 January 2005, Appendix B, cites the following words from the Ad Hoc Investigation Committee Report:

> 6. "The engine lacked markings and the maintenance records lacked information on cylinder compression tests."

These are the subject of the following comment:

> It is unclear what *that the engine lacked markings* means. It will be discussed below under the heading "Engine". The engine had a normal data plate. Concerning the cylinder compression check, the implication appears to be the lack of documentation of the actual figures that resulted from the compression check, the documentation only stating that the result was in order and within prescribed limits. It is agreed, that the procedure to write down the actual pressure values is preferable (cf. pp. 6-7, item 6).

In a report dated 22 Oct. 2001 to the CAA Director General, the Director of CAA Flight Safety Division replies to the Chief of Police on placards:

> a) It should be pointed out here that the same person is the operator's Technical Director and the responsible Managing Director of the JAR-145 approved maintenance station. Maintenance certification in the maintenance manual is done by a certifying staff member at an approved maintenance station but not by the operator's Technical Director.
>
> The maintenance station that carried out the annual inspection was obliged to check that all placards according to a type certificate and additions, if any, were in place before issuing a maintenance certificate for the annual inspection. A maintenance schedule for the aircraft includes that an annual inspection shall involve checking of all placards, whether they belong to an original type certificate or a supplement to it (STC). JAR-145, cf. notice No. 477/1994, states in Article JAR 145.50 that certifying staff members with the relevant authorisations issue a maintenance certificate when they have checked that all maintenance of an aircraft and its components has been correctly performed by the maintenance station. The maintenance station seems to have violated this rule as it was not made certain that the placards were in place.
>
> b) The aircraft would not have received an airworthiness certificate if it had been known that it had been wrongly confirmed that the placards were in place (cf. item 6 of the report).

The last part is reiterated in the Ad Hoc Investigation Committee final report, cf. Section 4.2.3.

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[1] Ad Hoc Investigation Committee translator's comment: The last sentence of the quotation is missing in the English translation of the CAA's document. This rendering is the work of the translator of the Ad Hoc Investigation Committee.

This should clarify what is meant by lack of placards.

<u>2.4 Older log books</u>

The Chapter on older log books and an incomplete list says the following in the Memo dated 24 January 2005, Appendix B:

> The ICAA could have, without any doubt, demanded the presentation of another tidier application and a list of all items that the JAR-145 organisation checked or accomplished. It would, however, have been in contradiction with general practice and equality to demand such a list unless there was a motive. With this in mind and that the aircraft appeared to be in good order, all required documentation was at hand, and in addition to that – had a valid Certificate of Airworthiness when the aircraft was flown from the United States of America to Iceland. It is difficult to determine why the ICAA should have called for further documentation (cf. p. 7).

This calls for a reminder of the rule of investigation in Article 10 of the Administrative Procedures Act. Twenty one years of the aircraft's history were unclear, giving special cause for deviating from general practices and demanding more complete information from the maintenance station. In addition to this the data plate had been altered, cf. Sections 5.4 and 5.5 of the Ad Hoc Investigation Committee final report. Such a request would not have violated any rule of equality, only been the performance of a legally required obligation to investigate.

The Memo finally refers to the explanatory report with the Aviation Act No. 34/1964, which says:

> It is not required by law to conduct an inspection of an aircraft, prior to issuance of an Airworthiness Certificate, if airworthiness can be positively proven in another manner, f.ex. by the certification of an inspection that has been validated by a foreign body (Authority) (cf. p. 7).

It should therefore be considered that the type certificate and the FAA airworthiness certificate guarantee general technical airworthiness, and that an annual inspection according to an approved maintenance plan, performed at a JAR-145 approved maintenance organisation, ensures conformity with Icelandic regulations on commercial air transport.

The CAA conclusion is therefore that it cannot be assumed from the above that an airworthiness certificate should "never" have been issued for the aircraft. All documents were available and no cause for demanding further documents. It would have been questionable, according to accepted public administration practices, for the CAA to doubt the competence of the JAR-145 station and the Technical Director of L.Í.O. ehf./Air Charter Iceland in this particular case and deny the issuance of an airworthiness certificate.

The conclusion is further emphasised in these words:

> **It is clear, that the moment it had been confirmed that the label had been put in place, the Airworthiness Certificate would have been issued. The ICAA could not refuse to issue the Airworthiness Certificate after it had been certified by an authorised person, that all items of an Annual Inspection had been performed, as is required by a JAR-145 Maintenance Organisation. Therefore there is no logic in the statement, that a Certificate of Airworthiness should never have been issued for the aircraft.** (Memo dated 24 January 2005, Appendix B, p. 8, bold lettered there.)

The above is incorrect in that the competence of the JAR-145 station and Technical Director of L.Í.O. ehf./Air Charter Iceland is not being questioned, even though there is reason to call for further documents and information, nor is it a violation of good public administration practices. As previously stated this is a common and quite normal occurrence.

The final report of the Ad Hoc Investigation Committee says the following on the issuance of an airworthiness certificate in item 4 of Chapter 15:

> The CAA should neither have registered the aircraft TF-GTI nor issued an airworthiness certificate for it because of its unclear history and insufficient documents that came with it, cf. Chapter 4.

As stated earlier in the CAA's report it is implied that an airworthiness certificate should "never" have been issued for the aircraft TF-GTI, because there were no arguments to support it. It is self-evident that a party instructed to provide more documents and hand in more thorough information can make amends and, if necessary, renew the application and then receive an airworthiness certificate.

<u>2.5 From the AAIB report of 23 March 2001</u>

On account of what has been stated, a reminder is in order of what the AAIB report of 23 March 2001, Section 1.18.3. says, among other things:

> 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 simple inspection, the ADs should have been implemented specifically and attested to in the log books.
>
> JULR259K, issued a maintenance certificate following an annual inspection on 15 February 1999. In the engine log book a maintenance certificate for overhaul of the engine was pasted on 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.[2]
>
> 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 C1 had been implemented.
> 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
The main points of the abovementioned Chapter are the following:

The latest books should have shown that they were new and that the older ones were lost. "According to generally accepted procedures in the aviation industry (AC-43-9C)" it should have been stated: *that* it had been confirmed by inspection, *that* all major repairs and modifications of the aircraft had been done according to accepted procedures, *that* all

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[2] For further information see Section 1.18.4 on timing, and the chapters of Ad Hoc Investigation Committee final report indicated below,

airworthiness directives for the aircraft and its components had been implemented, *that* airworthiness directives, the implementation of which could not be confirmed with a simple inspection, should have been implemented specially and confirmed in the books.

The abovementioned Section, 1.18.3, of the AAIB can be summarised as follows:

There was no indication in the log books that these were new log books, nor was there confirmation or mention of the aircraft having been inspected specifically in light of the fact that the original log books were missing and there was no confirmation in the log books of airworthiness directives having been implemented.

The first entry in the aircraft's log book, which is in fact also stated in the Ad Hoc Investigation Committee final report, was a maintenance certificate that JAS Inc. issued on 15 February 1999, cf. Section 5.4.2.1 in the Ad Hoc Investigation Committee final report.

In the engine log book there was a maintenance certificate pasted at the front of the book, along with a sign-out from JAS Inc. after a 100-hour inspection. This is reiterated in the Ad Hoc Investigation Committee final report, cf. Section 5.4.2.2.

The propeller log book contained a maintenance certificate on overhaul by Precision Propeller Service Inc. This is reiterated in the Ad Hoc Investigation Committee final report, cf. Section 5.4.2.3.

The aircraft documents included a list of airworthiness directives, prepared and signed by JAS Inc. There were signatures attesting to implementation of only a part of the airworthiness directives which applied to this aircraft and its components.

It is clear from the above that US companies were in charge of renewing the documents. The Ad Hoc Investigation Committee agrees with the AAIB that the FAA Advisory Circular (AC 43-9C Maintenance Records) with directions on how to keep maintenance records should have been observed. The directions neither instruct nor set rules. They begin with:

> 1. **PURPOSE.** This advisory circular (AC) describes methods, procedures and practices that have been determined to be acceptable means of showing compliance with the general aviation maintenance record making and record keeping requirements of Title14 of the Code of Federal Regulations (14 CFR) parts 43 and 91. This material is not mandatory, nor is it regulatory and acknowledges that the Federal Aviation Administration (FAA) will consider other methods that may be presented. It is issued for guidance purposes and outlines several methods of compliance with the regulations.

Chapter 12 of the guidelines discusses how to react in the event of lost or damaged documents. It says among other things:

> **LOST OR DESTROYED RECORDS**. Occasionally, the records for an aircraft are lost or destroyed. In order to re-construct them, it is necessary to establish the total time-in-service of the airframe. This can be done by reference to other records that reflect the time-in-service; research of records maintained by repair facilities; and reference to records maintained by individual mechanics, etc. When these things have been done and the record is still incomplete, the owner/operator may take a notarized statement in the new record describing the loss and establishing the time-in-service based on the research and the best estimate of time-in-service.
>
> a. The current status of applicable ADs may present a more formidable problem. This may require a detailed inspection by maintenance personnel to establish that the applicable ADs have been complied

> with. It can readily be seen that this could entail considerable time, expense, and in some instances, might require recompliance with the AD.
>
> b. Other items required by section 91.417(a)(2), such as the current status of life-limited parts, time since last overhaul, current inspection status, and current list of major alterations, may present difficult problems. Some items may be easier to re-establish than others, but all are problems. Losing maintenance records can be troublesome, costly and time consuming. Safekeeping of the records is an integral part of a good record keeping system.

Furthermore, regulation No. 443/1976 on inspections, maintenance and repair of aircraft says, cf. Article 4:

> Aircraft shall be maintained and repaired according to maintenance and repair books approved for the relevant aircraft type and/or according to generally accepted methods of the aviation industry. The Civil Aviation Administration decides on debatable issues.
>
> Attn: Examples of generally accepted methods of the aviation industry are:
>
> FAA – Advisory circular No. 43. 13-1, Acceptable Methods, Techniques and Practices. Aircraft Inspection and Repair.
> No 43. 13-2, Acceptable Methods, Techniques and Practices. Aircraft Alteration.[3]
>
> BCAA – Inspection Procedures.

The aircraft's airworthiness certificate was for commercial flights in Iceland and its maintenance should therefore have been subject to the rules of the Joint Aviation Authorities of certain European countries, including Iceland.
The guidelines IEM 145.55 (a), cf. maintenance record requirements according to JAR 145.55[4] say the following on the renewal of maintenance records:

> Reconstruction of lost or destroyed records can be done by reference to other records which reflect the time in service, research of records maintained by repair facilities and reference to records maintained by individual mechanics etc. When these things have been done and the record is still incomplete, the owner/operator may make statement in the new record describing the loss and establishing the time in service based on the research and the best estimate of time in service. The reconstructed records should be submitted to the JAA [**full member Authority**] for acceptance.

2.6 On the aircraft's engine

The CAA Analysis Paper from 24 January 2005 says that the engine was an H type as stated in the type certificate. That it was overhauled at a recognised maintenance facility in the USA and set to zero. Information on engine and propeller total hours were then irrelevant to its airworthiness and there were no indications of the engine components not being original ones. It must be pointed out here that the TF-GTI data plate said ECH which means that an E-type had been changed to an H-type which is an indication to the contrary, see further Section 5.4.4-5.4.5 in the Ad Hoc Investigation Committee final report.

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[3] This refers to a manual or circular with the following name: AC 43. 13-1A. Change Three. Acceptable Methods, Techniques And Practices. AC 43. 13-2A. Aircraft Alterations. Publisher IAP Inc.

[4] IEM is an abbreviation of Interpretative Explanatory Material, which contains data and material for further explanation of JAR rules (Joint Aviation Requirements), who contain joint requirements of the countries that are parties to JAA, Joint Aviation Authorities, cf. advertisement No. 477/1994 on changes of requirements for maintenance stations recognised for maintenance of aircraft and their components.

The previously mentioned FAA guidelines on keeping maintenance records (AC 43-9C) say among other things on maintenance records for rebuilt engines in Chapter 7 (Rebuilt Engine Maintenance Records):

> a. Section 91.421 provides that zero time may be granted to an engine that has been rebuilt by a manufacturer or an agency approved by the manufacturer. When this is done, the owner/operator may use a new maintenance record without regard to previous operating history.
>
> b. The manufacturer or an agency approved by the manufacturer that rebuilds and grant zero time to an engine is required by section 91.421 to provide signed statement containing: 1) the date the engine was rebuilt; 2) each change made, as required by an AD; and 3) each change made in compliance with service bulletins, when the service bulletin specifically requests an entry to be made.

In other respects regarding this issue, please refer to the discussion of the aircraft registration above, cf. the Ad Hoc Investigation Committee final report, Section 5.3.4 where the report of the Director General of Civil Aviation of 4 October 2002 is cited about the CAA having changed its working methods for registering aircraft with an engine without an original data plate, cf. Chapter 6 of the report.

2.7 Transfer from a US environment

The aircraft was entering a different regulation environment than that of the US. For those reasons these requirements were made:

1) That a specific maintenance schedule be recognised by the CAA according to regulations on air transport.
2) That the aircraft be maintained at a JAR-145 maintenance station.
3) That the aircraft's maintenance status be compared to a recognised maintenance schedule of a JAR-145 maintenance station.

This was done, thereby bridging the gap from US private aviation into the transport aviation environment. Therefore the CAA had to issue an Icelandic airworthiness certificate for the aircraft. (CAA Analysis Paper, dated 25 January 2005, p. 4).

The CAA conclusion is as follows:

> *The IAAIB's and the Special Investigating Committee's Report's reference to a more detailed "Conformity Inspection" that should have been carried out, over and above the annual inspection, is unfounded, and it is difficult to establish what that inspection would consist of. The JAA has neither defined the term "conformity inspection" in its Regulations nor described any special inspection as a "conformity inspection".* (Memo dated 24 January 2005, Appendix B, p. 5, italicised there.)

The Ad Hoc Investigation Committee considers it right to refer here to the AAIB final report of 23 March 2001, where it says in Section 1.18.4:

> 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.

Attention must therefore be paid to the reference to an inspection "which is commonly referred to as "Conformity Inspection" of aircraft [...]." As far as the Ad Hoc Committee knows there is no definition of this wording in FAA or JAA documents which probably explains the usage of "commonly". This usage is, nevertheless, used on FAA application forms for airworthiness certificates.[5] In aviation circles, "Conformity Inspection" is the colloquial term for inspections confirmed by aviation authorities following an inspection, thereby confirming that an aircraft meets, i.a. requirements of the type certificate, of minimum equipment and of maintenance.
Such an inspection process is more thorough than a normal annual inspection.

TF-GTI was transported to Iceland from the USA, where it had an airworthiness certificate for private aviation. More stringent requirements are made on aircraft in commercial aviation than in private aviation. As stated in the Ad Hoc Investigation Committee final report the aircraft's history is unclear and in some respect suspicious. From what is revealed about the communication between the aircraft's owner and the maintenance station on the one hand, and the CAA on the other hand, which is detailed in the Ad Hoc Investigation Committee final report, it appears that confidence was lacking between the parties. The Ad Hoc Investigation Committee agrees with the assessment of the AAIB report of 23 March 2001, that it would have been right for a special inspection of conformity or coordination to have taken place in order to verify that the aircraft met requirements for aircraft in commercial aviation in Iceland. Once again it must be reiterated that nothing suggests that the registration process or issuance of an airworthiness certificate had any part in the accident of 7 August 2000.

3.0 On the CAA surveillance of the operation of L.Í.O. ehf./Air Charter Iceland

3.1 Overview of comments on the operation of L.Í.O. ehf./Air Charter Iceland

The CAA Analysis Paper dated 25 January 2005 with comments on the Ad Hoc Investigation Committee draft final report, discusses surveillance of the operation of L.Í.O. ehf./Air Charter Iceland. It says among other things that CAA communication with smaller operators was unusually extensive in 2000 and surveillance of the operations was in fact much greater than can be deduced from the AAIB final report. The CAA was continuously working on reforms. The CAA measures were badly received and the organisation suffered a lack of instruments to enforce its demands.

For further emphasis a reference is made to the following summary from the Flight Safety Division's memo concerning the CAA's surveillance of L.Í.O. ehf./Air Charter Iceland flight

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[5] US Department of Transportation. Federal Aviation Administration. Information for Applicant.. Application for U.S. Airworthiness Certificate. FAA Form 8130-6 (10-04). See also Statement of Conformity. FAA Form 8130-9 (4-03).

operation, dated 31 January 2005 (Appendix C), cf. also CAA Analysis Paper dated 25 January 2005, pp. 5-6, which shows:

1. That there were many inadequacies in the flight operations of L.Í.O. ehf./Air Charter Iceland.

2. That surveillance and auditing documents show, however, that CAA surveillance of the company's flight operation was both greater and more formal than stated in the AAIB report.

3. That a comprehensive audit at the company's headquarters was carried out in January 1998 and again in September 2000.

4. That the CAA had formally dealt eleven times with the operations, addressing separate operational factors through reviewing of documents, comments and surveillance, from the time of the headquarter audit in January 1998 until the accident on 7 August 2000.

5. That there was correspondence regarding registration of aircraft on the company's Air Operator Certificate and revision of the company's new flight operations manual.

6. That a comprehensive audit which would have been preferable in the first half of 2000 was delayed because L.Í.O. ehf./Air Charter Iceland was adopting a new system of operations to meet JAR-OPS 1 and also because a review of a new operational manual was being completed.

7. That the comprehensive audit of September 2000 and examination of flight documents a few days after the accident revealed that for the main part the company's operation was in a reasonable state, although there were some irregularities.

8. That the most important irregularities were indeed the ones that the Flight Operation Section had repeatedly demanded correction of.

9. That operation of TF-GTI had, however, not been according to the company's operating license and that there were many different irregularities in its operation on the day of the accident.

10. That no irregularities had appeared in the operator's operations in a comprehensive audit in September 2000, or been of a nature justifying that the operation be placed under a specific surveillance, even though a comprehensive audit at the company headquarters would have been preferable in the first half of 2000.

11. That the aforementioned comprehensive audit did not "reveal any signs of general deterioration of the operation since the previous audit although the discrepancies in updating various documents that had been previously observed were again detected" (cf. CAA Analysis Paper of 25 January 2005, p. 5, item 2).

12. That it had repeatedly been requested formally that certain irregularities be corrected, such as the chapter in the flight operations manual on flight and duty time

limitations for flight crews which had not been added to the manual, yet the operator had been in possession of a regulation thereon; and this indicates that the CAA had limited means of enforcement.

13. That the only means were to withdraw the air operator license and thereby halting the operations, which would hardly have been considered proper public administrative practice.

14. That the CAA audit of the flight operations in September 2000 included previous documentation such as passenger lists and flight-duty records and that it confirmed informally the results of a document inspection, undertaken by an inspector three days before the accident, of mass and balance records, flight plans and passenger lists for several flights. That these documents proved in order.

15. That the AAIB did not consider on 17 August 2000 that the accident investigation had revealed anything indicating that specific action was required.

16. That there were no flight incidents related to L.Í.O. ehf./Air Charter Iceland from 1995 to August of 2000 which the AAIB considered necessary to investigate.

17. That there were no serious flight incidents related to the company until the accident, calling for extreme measures.

18. That there is every indication that the flight operations of L.Í.O. ehf./Air Charter Iceland were in general well within limits from the beginning of the year until the accident. That it is, however, clear that TF-GTI was not operated in the same way as other parts of the company's operations during its short service time. That it is also clear that there had been deficiencies in the company operations on the day of the accident.

The summary above shows that the CAA objected to several aspects of the L.Í.O. ehf./Air Charter Iceland operations, which the operator did little or nothing to remedy.

It is in particular worth drawing attention here to the fact that the CAA had dealt formally eleven times with the company's operations from January 1998 until 7 August 2000, or over a period of two and a half years. There were flaws in updating the aircraft flight manual, among other things on flight crew and duty time limitations. In this respect it may be pointed out that the pilot exceeded considerably authorised flight duty limitations on the day of the accident, which is further described in Chapter 10 of the Ad Hoc Investigation Committee final report. The CAA Analysis Report to the Minister of Transport, on the report by Forward and Taylor of 4 October 2002, states that rules on a 10 hour maximum flight duty are not as inflexible as may appear at first, even though violations of rules on flight duty are treated seriously. Even though the pilot exceeded the authorised flight duty by more than 3 hours on the day of the accident, thereby violating the rules, it is an unlikely cause of the accident, cf. Chapters 2 and 8 of the report.

It appears from the summary above that registration documents were in order according to the CAA inspector, cf. item 14 above. This contradicts, however, the CAA Analysis Paper, dated 25 January 2005, where it says that there were flaws in documents and updates thereof (cf. p. 3). The Director General of Aviation points out, for further emphasis, in his letter to the Ad

Hoc Investigation Committee, dated 26 January 2005, that for a number of years it has been a weakness in the operation of smaller air operators that updating of all kinds of documents intended to provide operation transparency and traceability were not as they should. That the CAA was continuously working on correcting this situation. Pressure applied for reform was not always welcomed, some considered that the CAA put too much pressure on them and the Administration lacked legal means to enforce its requirements.

It is clear that passenger lists were not made on 7 August 2000 as stipulated by law and no fuel or oil record was presented to the AAIB when investigating the accident, cf. Section 11.1.2.1 of the Ad Hoc Investigation Committee final report.

The Ad Hoc Investigation Committee now considers the most likely cause of the accident, by far, that fuel starvation caused the aircraft's engine to stop and that the pilot did not adequately monitor the fuel quantity. That he did not react correctly when the engine stopped, tired after a long and busy day of work. The pilot is of course responsible, but the operator's supervision and control is necessary in order to secure utmost safety and the CAA plays an important role in securing this even further.

This does not mean, and it is emphasised specifically, that the abovementioned faults in CAA's surveillance were factors in the accident. Even though the utmost surveillance is secured it will never be possible to ensure that an operator or pilot does not deviate from rules in individual instances, such as was the case on 7 August 2000. This is only pointed out to ensure utmost aviation safety in the future.

<u>3.2 On lack of legal means</u>

It is of interest that the CAA seems not to have followed up suggestions and criticisms of L.Í.O. ehf./Air Charter Iceland as it should have. Article 86 of the Aviation Act No. 34/1964 provided, for the period in question, for means available to the CAA, which are as follows:

> If a license holder [operating license holder] in the licensed operation violates in a serious manner the law, license conditions, other instructions on the operation, or if he proves unable to run the operation, it is justifiable to take away his license.

The current Aviation Act No. 60/1998 which substituted the previous one, stipulated in Article 84 as follows, before it was amended by Act No. 21/2002:

> If a license holder violates in a serious manner the law, other instructions on the operation, license conditions, or if he proves unable to run the operation the license shall be withdrawn.

The CAA must have considered that it lacked means to follow up measures and states the following on this point:

> The fact that ICAA had repeatedly and in a formal manner requested that certain non-conformities, e.g. the chapter that deals with the flight and duty time in the Flight Operations Manual were corrected, indicates that the ICAA's legal strength of enforcement was extremely limited. ICAA's only option at the time would have been to initiate the process to withdraw the Air Operator's Certificate and thereby bringing the operation to a complete halt. Considering the fact that the company already possessed the regulation regarding flight and duty time, [even though it had not been entered in the Flight Operations

> Manual[6]] it is doubtful that withdrawing the Air Operator's Certificate could qualify as proper public administrative practices, considering the nature of the non-conformity concerned. ICAA's lack of enforcement power in such cases has since been acknowledged in practice with the changes of articles 28, 82 and article 136 to the Aviation Act in the year 2002. These changes provided the ICAA with more comprehensive measures and power to gather information and to enforce corrective actions than previously. (Memo dated 25 January 2005, Appendix C, pp. 2-3).

The CAA conclusion is then the following:

> **It can be agreed that the ICAA's surveillance was not sufficiently effective as is stated in the report of the Special Investigation Committee, page 131. First and foremost the reason is, that the necessary enforcement measures were not available to the ICAA at the time.** (Memo dated 31 January 2005, Appendix C, p. 3, in bold type there).

The text above makes it clear that the CAA felt that it lacked legal authority to remove the operator's Air Operator Certificate due to flaws in updating the flight operations manual, since the operator had access to the necessary information as further described in the aforementioned text. It would hardly have been considered proper public administrative practice to let such flaws cause a loss of license. Such a measure would only have been authorised by the current law if there had been serious faults in the operations of the operator concerned.

This may in fact be true, but according to the summary above this was not the only flaw in the operation, even though the CAA report is not reliable in this respect.

The provisions above are quite explicit, but they could obviously have been reminded of, even threaten to use them, all the while respecting proportionality, equality and the right to objection, cf. the Administrative Procedures Act No. 73/1993, since the abovementioned rules were generally acknowledged before the Administrative Procedures Act took effect. It must be specifically kept in mind here that aviation safety must always come first, when considering CAA legal authorities to enforce its directions against the interest and rights of flight operators.

The Act No. 21/2002 changed, among other things, Articles 28, 84, and 136 of the Aviation Act, stipulating further on instruments for the CAA to enforce its demands of reform. These provisions are certainly for the better and strengthen the CAA position for control and supervision, but they are of no consequence for assessing the CAA instruments before the Act took effect, therefore there is no reason to discuss them further.

4.0 Conclusion

It has not been questioned herewith that legally stipulated documents for registration and issuance of an airworthiness certificate were available, only that there was reason to review them more closely. The CAA was not obliged to register the aircraft according to the documents presented without any delay as has been maintained. It could, with reference to the rule of investigation in Article 10 of the Administrative Procedures Act, have taken a suitable time to review the documents more closely and requested further information.

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[6] Comment by Ad Hoc Investigation Committee translator: This sentence is missing in CAA's translation of its memo.

The same applies to the issuance of an airworthiness certificate, where there was even greater cause to scrutinise the documents presented. It has not been maintained anywhere that an airworthiness certificate should "never" have been issued as, indeed, there was a way to make amends.

Even though additional documents and further information had been demanded, nobody's competence would have been questioned. This is a common procedure when necessary for all kinds of applications and granting of licenses.

The lack of legal measures has been mentioned as the main reason why demands to L.Í.O. ehf./Air Charter Iceland for improvements were not followed up more firmly. The Ad Hoc Investigation Committee does not accept this, even though the CAA means of control have been clarified. The CAA was authorised to halt operations, the operator could have been reminded of this, even been set an ultimatum in case of non-compliance. Of course operators have an operating interest that is legally protected in their constitutional freedom of occupation and employment rights. That freedom may, however, be limited in the interest of aviation safety and the CAA powers must be considered in light thereof, thus taking precedence over the operator's interest, as previously stated.

It is the opinion of the Ad Hoc Investigation Committee that the CAA comments on the final draft of its report, discussing registration of TF-GTI and issuance of an airworthiness certificate, do not call for a review of Chapters 3-5 of the draft final report. The same applies to the CAA comments on the surveillance of L.Í.O. ehf./Air Charter Iceland. According to the Ad Hoc Investigation Committee it does not call for revision of Chapter 11 of its draft final report.

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Birger Andreas Bull has mainly contributed in the Ad Hoc Investigating Committee regarding fuel calculations and investigation of possible fuel starvation. He finished his report 10 August 2003.