Engine failure, Aircraft incident at Kajaani airport, Finland 1. October 1996

Micro-summary: **This McDonnell Douglas MD-83 experienced engine abnormalies during takeoff, resulting in an RTO.**

Event Date: **1996-10-01**

Investigative Body: **Finland Accident Investigation Board (AIB), Finland**

Investigative Body's Web Site: **http://www.onnettomuustutkinta.fi/**

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FINLAND

Aircraft Incident Report

B 11/1996 L

Translation of the Finnish original report

Aircraft incident at Kajaani airport, Finland 1. October 1996

TC-INC

DC-9-83 (MD-83)

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TABLE OF CONTENTS

ABBREVIATIONS

AD	Airworthiness Directive
AFIS	Aerodrome Flight Information Service
AIB	Accident Investigation Board
AOL	All Operational Letter
ATC	Air Traffic Control
ATS	Autothrottle System
CAA	Civil Aviation Administration (Finland), Flight Safety Authority
CAVOK	Clouds And Visibility OK (Visibility, cloud and weather better than prescribed values or conditions)
CL	Climb
CRM	Crew Resource Management
CVR	Cockpit Voice Recorder
DGCA	Directorate General of Civil Aviation
DO	Flight Operations Director
EGT	Exhaust Gas Temperature
EPR	Engine Pressure Ratio
FCOM	Flight Crew Operational Manual
FF	Fuel Flow
FMA	Flight Mode Annunciator
FOM	Flight Operations Manual
ft	Feet (1 ft = 0,3048 m)
hPa	Hectopascal
IATA	International Air Transport Association
ICAO	International Civil Aviation Organisation
LBA	Luftfahrt-Bundesamt (Germany)
MEL	Minimum Equipment List
N1	Low pressure compressor rotation speed
N2	High pressure compressor rotation speed
PIC	Pilot-In-Command
p/n	Part number
QNH	Corrected mean sea level pressure
SAFA	Safety Assessment of Foreign Aircraft
SB	Service Bulletin
s/n	Part number
TC	Technical Director
TOGA	Takeoff and go-around
UFDR	Universal Flight Data Recorder
UTC	Co-ordinated universal time

SYNOPSIS

On Monday September 30, 1996 an aircraft left engine damage took place during flight SWW 2721 from Dalaman, Turkey to Cologne/Bonn, Germany with a Douglas DC-9-83 (MD-83) aircraft, registered TC-INC, owned by Irish Aerospace Finance Ltd and operated by Turkish Intersun Sunways Havacilic A.S. A loud bang was heard in the cockpit from the left engine two to three minutes after reaching the cruising flight level. The engine continued to run but with increased Exhaus Gas Temperature (EGT), high pressure compressor rotation speed (N2) and fuel flow. The aircraft landed in Cologne/Bonn as planned. There were 129 passengers and seven crew members on board.

No qualified trouble shooting was performed in Cologne/Bonn and flight SWW 2722 departed for Kajaani, Finland with seven crew members on board but without passengers as planned. In the beginning of the takeoff the difference between the left and the right engine acceleration rates to 1,4 Engine Pressure Ratio (EPR) had increased significantly compared to the previous takeoff in Dalaman with the left engine being slower. During the flight to Kajaani the left engine surged when thrust was reduced from climb to cruise first at Flight Level (FL) 350 and later on at FL 330.

The serviceability of the left engine was not assured in Kajaani. A total of 137 passengers boarded the aircraft and the crew prepared for the flight SWW 2042 to Dalaman. The aircraft taxied out to the runway and the cockpit crew performed the normal procedures prior to takeoff. A loud banging noise was heard in the aircraft and at the terminal building when thrust was increased and the aircraft made a 180^{o} turn into takeoff position. When the throttles were advanced for takeoff, the left engine did not accelerate normally. The left engine EGT was fluctuating with high peaks and the loud ban ing noise was heard again. The cockpit crew waited for approximately 40 s for the left engine to accelerate. When the engine did not accelerate, takeoff was aborted.

The Accident Investigation Board (AIB), Finland was notified of this incident in the morning of October 1, 1996. The Finnish Ministry of Justice appointed on October 3, 1996 an investigation commission in accordance with the Investigation of Accidents Act (373/85) to investigate the chain of events described above, which was suspected having seriously endangered flight safety. Airline pilot (ret.) Mr Lars Westermarck was appointed investigator-in-charge. Chief air accident investigator Mr Seppo Hämäläinen from the AIB, Finland and inspection supervisor (ret.) Mr Pertti Nenonen were appointed members of the commission. The commission consulted airline pilot Mr Timo Uramaa as an expert on the MD-83. Student of technology and psychology Mr Tero Lybeck assisted in writing the report and in the investigation of the human factors aspects of this incident.

Westermarck, Hämäläinen, Nenonen and Uramaa arrived at Kajaani airport on Tuesday October 1, 1996 at 20.00 local time. The cockpit crew was interviewed

and the Universal Flight Data Recorder (UFDR) and the Cockpit Voice Recorder (CVR) removed from the aircraft. The data of the recorders was read out by SAS Flight Analysis in Copenhagen, Denmark.

The Directorate General of Civil Aviation (DGCA), Turkey was notified of this incident and the investigation on October 2, 1996. The DGCA, Turkey did not approve the investigation because it did not consider the case a "serious incident". The DGCA, Turkey did not nominate an accredited representative for the investigation according to the International Civil Aviation Organization (ICAO) Annex 13. Intersun Sunways nominated the company operations advisor as the company representative. The investigation was based on Finnish legislation, ICAO Annex 13 and the Council of the European Union directive 94/56/EC.

Intersun Sunways went into bankruptcy and ceased operations in October 1997. The commission sent the draft of this incident report to the DGCA, Turkey and Flugunfalluntersuchungsstelle beim Luftfahrt-Bundesamt (Accidents Investigation Bureau at the LBA, Germany) for comments according to ICAO Annex 13 on December 29, 1997. The German aviation authorities did not have any comments on the draft. No reply was received from the DWA, Turkey. The investigation was completed on March 26, 1998.

1 FACTUAL INFORMATION

1.1 Occurrences

1.1.1 Flight Dalaman - Cologne/Bonn

The aircraft TC-INC had flown the flights Dalaman - Kokkola - Dalaman on September 30, 1996 before the flight Dalaman - Cologne/Bonn. The aircraft took off from Dalaman for Cologne/Bonn at 14.40 Co-ordinated universal time (UTC). According to the UFDR the left engine had a sudden EPR and low pressure compressor rotation speed (N1) drop and EGT rise during climb through FL 272 just before the aircraft reached its initial cruising altitude of FL 280. According to the cockpit crew a loud bang (described as "bom" by captain B) was heard in the cockpit from the left engine two or three minutes after reaching the cruising flight level. One cabin attendant stated that she had heard a loud bang like an explosion when she was working in the cabin. The aircraft was at that time about 11.000-13.000 feet (ft) above clouds in clear air. The left engine continued to run but with increased EGT, N2 and fuel flow. The aircraft landed at Cologne/Bonn at 18.11 UTC.

1.1.2 The left engine inspection in Cologne/Bonn

Upon arrival in Cologne/Bonn the cockpit crew contacted their handling agent and requested technical assistance. The handling agent contacted an aircraft technical service company and told a company mechanic that the captain had requested technical assistance. The nature of the problem was not specified. The mechanic told the handling agent that he was not typerated for the MD-83 nor authorized to release the aircraft to service. He additionally stated that his company had no maintenance agreement with the carrier in question and that he therefore saw no reason to go to the aircraft. After another request from the handling agent the mechanic finally agreed to go to the aircraft and said that he would discuss the problem with the crew.

According to captain A the mechanic was briefed on the situation encountered at FL 280. According to the mechanic the captain told him that they had heard a strange noise from the left engine when increasing thrust. No entries about the observed abnormal left engine behaviour had been made into the aircraft documents. The mechanic told the captain that he was not licensed for maintenance activities on the MD-83 nor had he any experience on the type and that he therefore could not help. The captain, however, requested the mechanic to at least open the left engine cowlings and to take a look but the mechanic refused. He said anyway that he and the captain could together take a look into the engine inlet and exhaust pipe from a platform with a flashlight. This was done and the free movement of the fan was checked. The captain and the mechanic opened some service access doors on the left engine cowling and looked inside with a flashlight. Nothing abnormal was found.

The mechanic then told the captain that this was all he could do for him that he could not give the aircraft a release to service neither in writing nor verbally and that the captain alone would have to take the decision and responsibility to continue the flight. The left engine inspection was not noted in the aircraft documents. The transit check was signed by the first officer and the aircraft was signed airworthy by captain A.

1.1.3 Flight Cologne/Bonn - Kajaani

During taxiing out in Cologne/Bonn the idle N1 and N2 were approximately 3 % lower and EGT 40 ^{o}C higher in the left engine than in the right engine. In Dalaman these values had been approximately equal for both engines. When the throttles were manually advanced for spool-up in the beginning of the takeoff, the right engine accelerated normally to 1,6 EPR but the left engine responded slowly. When the throttles were further advanced, both engines accelerated to 1,75 EPR, which after the autothrottle was engaged. The left engine acceleration rate from idle to 1,4 EPR was approximately 8 s slower than the right engine acceleration rate. In Dalaman the difference had been only 2 s. The aircraft took off from Cologne/Bonn at 19.13 UTC.

When the aircraft was levelling off at cruising altitude of FL 350, an unusual noise was heard from the left engine (described as "prrrt" by the cockpit crew). A decision to descend to FL 310 was made. FL 310 was maintained for about 20 minutes which after the aircraft was cleared to FL 330. When the aircraft was levelling off at FL 330 the same noise was heard again. The cockpit crew decided to descend to FL 290 and the flight was continued to Kajaani. According to the cockpit crew everything was normal during the rest of the flight. The aircraft landed at Kajaani at 21.32 UTC (00.32 local time).

1.1.4 Ground events in Kajaani

1.1.4.1 The events on the apron

Intersun Sunways had an International Air Transport Association (IATA) standard ground handling agreement with Finnair excluding section 7.6, snow and ice removal, and 9, aircraft maintenance. According to the Intersun Sunways operations advisor the de-icing service was verbally agreed upon with Finnair.

The Finnair station manager went to the aircraft upon its arrival. When he entered the cockpit the pilot in the left seat (captain A) requested technical assistance and stated that they had a little problem with the left engine. The station manager left and returned shortly with the Finnair station mechanic. The cockpit crew told them that the left

engine instrument indications had dropped momentarily in association with the loud bang at FL 280 on the flight Dalaman - Cologne/Bonn. They also demonstrated this drop by hand movement. One cabin attendant told the station mechanic that she had heard one very loud bang like an explosion on the flight Dalaman - Cologne/Bonn when she was working in the cabin. She told that the engine had run rough after the bang and that she had heard unusual engine noise also during the flight Cologne/Bonn - Kajaani.

The mechanic told the cockpit crew that he could do nothing because Finnair had no maintenance agreement with Intersun Sunways. He suggested that he could contact Finnair Line Maintenance in Helsinki for further instructions upon which the cockpit crew agreed. The mechanic called Finnair Line Maintenance and informed the inspector-in-charge about the abnormal left engine behaviour. The mechanic told the inspector-in-charge that he assumed that the engine had stalled.

The inspector-in-charge gave the following instructions: perform a visual check on the engine inlet and exhaust areas, perform an engine test run including acceleration test and bleed valve check with aircraft into headwind, perform a boroscope check if engine behaviour during the test run is not normal. The station mechanic and station manager told the cockpit crew that Finnair Line Maintenance had suggested an engine test run. The mechanic relayed the initial instructions to the cockpit crew and told them that the aircraft should be moved to a suitable area for the test run. The cockpit crew discussed the proposal among themselves in Turkish which after they refused it. The abnormal left engine behaviour was not discussed thereafter with Finnair personnel. The cockpit crew did not check the left engine from a platform which is needed for a thorough visual inspection.

The weather in Kajaani was favourable for overwing ice and frost formation with temperature +4 ^{o}C, dewpoint +4 ^{o}C and light rain. The amount of cold soaked fuel remaining after the 2 h 25 min flight Cologne/Bonn - Kajaani was more than 20.000 lb (9072 kg). The station mechanic observed frost on the upper and lower wing surfaces. He left stairs next to the wing for the cockpit crew overwing ice check and suggested de-icing to captain B. Captain B and the mechanic then walked inside the aircraft to the overwing emergency exits. Captain B checked the wing by looking through the cabin windows. He stated to the mechanic that they would not take the de-icing and demonstrated his decision by hand movement. According to the mechanic it was not possible to determine the wing condition properly through the cabin windows due to darkness and poor lightning.

The station manager was told that there was oil leaking from the left engine. He relayed this information to the first officer who was monitoring the refueling. Upon request of the first officer the station manager asked the station mechanic to add oil into the left engine. The mechanic refused because Intersun Sunways had no maintenance agreement with Finnair but he provided the stairs needed to reach the engine. The first officer added two quarts of engine oil. It was, however, noted in the aircraft documents that no oil had been added.

The passengers boarded the aircraft. A Finnair station officer came to the aircraft after consulting a Finnair assistant vice-president in Helsinki about the need for de-icing. She told the cockpit crew that they should seriously consider the opinion of a professional (the station mechanic) on de-icing in order to maintain smooth co-operation also in the future. The cockpit crew finally agreed and the aircraft was de-iced.

1.1.4.2 The attempted takeoff

The first officer signed the transit check and captain A signed the aircraft airworthy. The cockpit crew requested engine start-up clearance at 23.21 UTC. Kajaani airport Aerodrome Flight Information Service (AFIS) officer relayed the ATC clearance from Rovaniemi Area Control Center to the cockpit crew. The flight guidance system was set for takeoff. Parking brake was released at 23.26 UTC. Flaps and slats were set for takeoff when the aircraft taxied out and backtracked to takeoff position runway 07. A loud banging noise was heard in the aircraft and at the terminal building when thrust was increased and the aircraft made a 180^{o} turn into takeoff position. Captain A then requested Kajaani AFIS for a mechanic to inspect the aircraft nose wheel:

"We would like to check nose tyre wheel and then we would like to departure."

The AFIS officer asked the cockpit crew to contact Finnair on the company frequency which the cockpit crew did not do. Captain B left the aircraft Via aft stairs and returned shortly during which the aircraft was kept stationary with brake pedals. Captain A contacted AFIS and said:

"Tower, Intersun 2042, we checked it, everything is ok, request takeoff."

The AFIS officer replied:

"Intersun 2042, roger and runway vacated, wind 140 degrees 11 knots."

When the throttles were advanced, the left engine did not accelerate but the right engine operated normally. The left engine EGT was fluctuating with high peaks and the loud banging noise was heard again. The cockpit crew waited for the left engine to accelerate for approximately 40 s. When the engine did not accelerate, takeoff was aborted. Captain A then reported to the A.FIS:

"Kajaani, Intersun 2042, we aborted and turning to parking area."

The aircraft taxied back to the apron. The passengers disembarked the aircraft and were guided to the terminal building.

1.2 Injuries to persons

There were no injuries. There were seven crew members and 137 passengers on board.

1.3 Damage to aircraft

One left engine 8th stage compressor rotor blade had fractured and caused serious damage to the high pressure compressor.

1.4 Other damage

There was no other damage.

1.5 Personnel information

Captain B was the pilot-in-command on the flight Dalaman - Cologne/Bonn and captain A on the flight Cologne/Bonn - Kajaani and on the interrupted flight Kajaani - Dalaman.

1.5.1 Captain A

Captain A:	Male, 49 years (born 1947)
Licences:	Airline transport pilot's licence 1992, renewed Nov 27, 1995, valid until Nov 26, 1996
Ratings:	Instrument rating 1992
Type ratings:	Boeing 737-300, MD-83
Last line check:	Apr 5, 1996 (no remarks)
Last proficiency check:	Jul 8, 1996 (no remarks)
Medical certificate:	Class one, issued Jun 17, 1996 with no restrictions, valid until Dec 17, 1996

Flying experience	**All types**	**On the type**
Last 24 h	4 h 20 min	4 h 20 min
Last 30 days	85 h 20 min	85 h 20 min
Total experience	6100 h	3200 h

Captain A got his basic flight training in the Turkish Air Force Aviation School and flew in the Turkish Air Force as a fighter pilot. During this time he flew 2100 h.

Captain A was hired as a co-pilot by Turkish Tur Avrupa Airways in 1992. He completed the type training for the MD-83 as a first officer in 1994. In 1994 he was hired as a first officer by Birgenair and completed the type training for the Boeing 737-300. In 1995 he was hired by Intersun Sunways as a MD-83 captain. MD-83 type training was given by Intersun Sunways instructors and was completed during April 1995. The theoretical and flight training were given in Turkey and the simulator training in Finland. Captain A thereafter got his captain's qualification for the MD-83. The annual recurrent ground and simulator training were given by Intersun Sunways.

1.5.2 Captain B

Captain B:	Male, 56 years (born 1940)
Licences:	Airline transport pilot's licence 1992, renewed Nov 29, 1995, valid until Nov 28, 1996
Ratings:	Instrument rating 1992
Type ratings:	Boeing 727, MD-83
Last line check:	Dec 4, 1995 (no remarks)
Last proficiency check:	May 16, 1996 (no remarks)
Medical certificate:	Class one, issued Jul 22, 1996 with no restrictions, valid until Jan 21, 1997

Flying experience	**All types**	**On the type**
Last 24 h	4 h 20 min	4 h 20 min
Last 30 days	95 h 55 min	95 h 55 min
Total experience	9600 h	1600 h

Captain B got his basic flight training in the Turkish Air Force Aviation School and flew as a transport pilot in the Turkish Air Force. During this time he flew 7000 h.

Captain B was hired as a co-pilot by Turkish Tur Avrupa Airways in 1993. He completed the type training for the Boeing 727 as a first officer in 1995. He was hired in the same year as a first officer by Intersun Sunways and he completed the type training for the MD-83. The theoretical and flight training were given in Turkey and the simulator training in Finland by Intersun Sunways instructors. In the same year he was hired as captain for the MD-83 by Intersun Sunways. The annual recurrent ground and simulator training were given by Intersun Sunways.

1.5.3 First officer

First officer:	Male, 39 years (born 1957)
Licences:	Commercial pilot's licence 1996, valid until Jan 24, 1997
Ratings:	Instrument rating 1996
Type ratings:	CN-235. MD-83
Last line check:	Apr 26, 1996 (no remarks)
Last proficiency check:	Jun 26, 1996 (no remarks)
Medical certificate:	Class one, issued Nov 28, 1995 with no restrictions, valid until Nov 27, 1996

Flying experience	**All types**	**On the type**
Last 24 h	4 h 20 min	4 h 20 min
Last 30 days	80 h 10 min	80 h 10 min
Total experience	6600 h	700 h

The first officer got his basic flight training in the Turkish Air Force Aviation School and flew as a transport pilot in the Turkish Air Force. During this time he flew 5900 h.

The first officer completed the type training for the MD-83 during May 1996 and was hired as a MD-83 first officer by Intersun Sunways. The theoretical and flight training were given in Turkey and the simulator training in Finland by Intersun Sunways instructors. The annual recurrent ground and simulator training were given by Intersun Sunways.

1.5.4 Cabin crew

There were four flight attendants who had all been qualified for their duties by Intersun Sunways. One flight attendant was a native Finn. Some differences in the cabin crew certificate markings made the certificate validity check difficult.

1.6 Aircraft information

The aircraft was a twin-engine commercial jet aircraft with a 167 passenger seat configuration.

Nationality and registration:	Turkish, TC-INC
Owner:	Irish Aerospace Finance Ltd.
Operator:	Intersun Sunways Havacilik A.S.
Manufacturer:	McDonnell Douglas Corporation, USA
Type and model:	Douglas DC-9-83 (MD-83)
Serial number:	49792
Year of manufacture:	1989
Aircraft total time	19961 h, 7279 cycles

Engines

Manufacturer:	Pratt & Whitney Ltd, USA
Type and model:	JT8D-219
Fuel used:	JET A-1

Left engine

Serial number:	725 492
Hours since manufacture:	18332, 6686 cycles
Hours since last overhaul:	10971

Right engine

Serial number:	725 485
Hours since manufacture:	17714, 6414 cycles
Hours since last overhaul:	3916

According to the Intersun Sunways engineering department aircraft status report dated 3.11.1996 the left engine had 29 flight hours and the right engine 7084 flight hours remaining before the next engine overhaul. The certification of airworthiness was valid until March 15, 1997 and it had been renewed on March 16, 1996.

1.7 Meteorological information

1.7.1 Meteorological conditions at the time of the loud bang on the flight Dalaman - Cologne/Bonn

According to the cockpit crew a loud bang was heard from the left engine during the flight Dalaman to Cologne/Bonn at FL 280, when the aircraft was approximately 11.000-13.000 ft above clouds in clear air.

1.7.2 Weather in Cologne/Bonn

- 17.50 UTC: wind 180°/7 kt, CAVOK, temperature +17°C, dewpoint +14 °C, QNH 1008 hPa

1.7.3 Weather in Kajaani

- 20.50 UTC: wind 140 °/11 kt variable 100°-210°, visibility more than 10 km, clouds 8/8 800 ft, temperature +4 °C, dewpoint +3 °C. QNH 992 hPa
- 21.50 UTC: wind 140 °/11 kt variable 100 ° -180 °, visibility more than 10 km, light rain, clouds 8/8 800 ft, temperature +4 °C, dewpoint +4 °C, QNH 991 hPa
- 22.50 UTC: wind 140 °/10 kt variable 100 ° -190 °, visibility more than 10 km, clouds 7/8 700 ft, temperature +4 °C, dewpoint +4 °C, QNH 990 hPa

The AFIS officer gave the cockpit crew the following weather information in Kajaani at engine start-up:

- 23.21 UTC: wind 150 ° /7 kt, temperature +4 °C, QNH 990 hPa

1.8 Aids to navigation

Not applicable.

1.9 Communications

The radio communications were listened to from the recordings of Kajaani AFIS and the CVR. Acoustic feedback noise disturbed the transmissions from the aircraft. This phenomenon is usually caused either by poor internal tuning of the communication radio(s) or too loud a volume set by the cockpit crew in the cockpit loudspeaker(s). Kajaani AFIS radio communications transcript is enclosed in Appendix 1.

1.10 Airport information

Aerodrome Flight Information Service (AFIS) is provided at Kajaani airport. The main runway 07/25 is 2500 m long and 45 m wide. The coordinates of the airport reference point are 64 ° 17'02" North, 27 ° 41'28" East and the elevation is 483 ft (147 m).

1.11 Flight recorders

The aircraft was equipped with a Sundstrand Universal Flight Data Recorder (UFDR, p/n 980-4100-DXUN, s/n 3521). The recorder runs when at least one fuel lever is on and the parking brake is released. The UFDR had functioned properly. The information was read out by SAS Flight Analysis in Copenhagen, Denmark. The UFDR did not record the use of engine anti-ice nor throttle lever angle, which would have been useful in this investigation.

The aircraft was equipped with a Sundstrand Cockpit Voice Recorder (CVR, p/n 980-6005-076, s/n 9011) which provided a continuous four channel recording for 30 minutes when the aircraft electrical power was on. In this case the electrical power had been on for more than 20 minutes after the crew had left the cockpit. The erase function of the CVR had malfunctioned and had not erased all the previous recordings properly. The cockpit crew conversations picked up by the cockpit area microphone were practically unreadable due to an interference noise. The radio communication channels were more readable. The CVR recordings were read out by SAS Flight Analysis and they were listened to by the DGCA, Turkey and the commission but neither of them was able to understand the discussions.

1.12 Wreckage information

Two left engine boroscope inspections and an inspection of the aircraft documents were performed at Kajaani airport.

1.13 Medical information

No tests were made.

1.14 Fire

There was no fire.

1.15 Survival aspects

Not applicable.

1.16 Tests and research

1.16.1 Boroscope inspections of the left engine

A Finnair Line Maintenance inspector performed a boroscope inspection on the left engine in the morning of October 1, 1996 upon Intersun Sunways' request. The inspection was performed through the compressor inspection ports at the 6/7th and the 13th stage. The inspection was performed with an optical boroscope according to the appropriate Finnair maintenance procedure, which was based on the McDonnell Douglas Corporation DC-9-82/83/87 Maintenance Manual.

Observations

One sharp strike was observed in the seventh stage stator vanes between the 7th and 8th compressor stage but there was no other visible damage. The 13th stage rotor blades had multiple nicks indicating something had passed through the compressor. One blade had a crack, which exceeded the acceptance limit. Due to this crack the left engine had to be changed before the next flight.

The second boroscope inspection was performed in Kajaani on October 3, 1996. The same areas, which had been checked already on October 1, 1996 and additionally the turbine second stage rotor blades were inspected. A videoboroscope was used and the inspection was recorded on videotape. The following observations were made:

1. The 6th and the 7th stage had all rotor blades remaining with no visible damage.
2. One 7th stage stator vane had a sharp nick in the tip area.
3. Approximately 15 of the 13th stage rotor blades had nicks and dents in the leading edges and tip bends (area A). Multiple damage was also found on blade area B. At least one strike in the leading edge was a sharp bottom crack which exceeded the 0,8 mm acceptance limit.
4. In the turbine the leading edges of the second stage rotor blades and trailing edges of the first stage rotor blades had suffered no visible damage.

1.16.2 Table inspection of left engine parts

The left engine (s/n 725492) was removed from the aircraft at Kajaani airport because the damages observed during the boroscope inspections prohibited flight before engine repair. Intersun Sunways transported the engine to Swissair engine maintenance shop in Zürich by truck. When the engine was completely disassembled for damage repair and overhaul the investigation commission had the opportunity to check the engine parts. No washing or any other action had been taken on the engine parts before the table inspection, which was performed on November 11 - 12, 1996.

Observations

The 7th stage compressor rotor blades were in good condition. Trailing edges of all stator vanes had severely tom in the tip area. Pieces of the vanes had separated but leading edges were in good condition.

One 8th stage compressor rotor blade (p/n 802 808) had fractured from the root and only the root piece was remaining in the disc. The liberated blade part had caused the compressor damage. The rotor blades were severely damaged in the leading and trailing edges. The blade tips had tom and pieces were missing. Several blade roots had rough surface which looked like corrosion (ref galling). All the 8th stage rotor blades were scrapped (58 pieces).

The 8th stage stator vane leading and trailing edges had strikes, nicks, deformations and fractures. Some vane material had separated. The damage was most severe at blade tips. The stator outer shroud had one deep dent, which was also visible on the outer skin of the outer shroud.

The most of the 9th stage compressor rotor blades were damaged in either the leading or trailing edge or on both. Blades had nicks and deformations and some material was missing from the blade tip corners. All the 9th stage rotor blades were scrapped (60 pieces).

The 10th stage was not available for inspection. The 11th and 12th compressor stages had damage to the earlier ones. 56 of the 70 11th stage and 64 of the 80 12th stage rotor blades were scraped. The leading and trailing edges of the 13th stage rotor blades had nicks, dents and deformations. There were some sharp bottom cracks in the areas A and B. 37 out of 74 blades were scraped.

1.16.3 Service bulletins

Several high pressure compressor 8th stage rotor blade fractures have occurred in the Pratt & Whitney JT8D-200 engines. Service Bulletins (SB) have been issued concerning the modification of the compressor blade.

Service Bulletin 5881 was issued on February 14, 1990. Two blade root fractures had occurred in the JT8D-200 engines. The reason for this Service Bulletin was to increase the blade durability by revising the natural frequency of the blade with a small airfoil squealer cut. As a result, engine testing demonstrated that the blade resonance was moved out of the engine operating range thus lowering the blade root stress. Blade resonance had earlier resulted in high root stress.

Service Bulletin 6044 was issued on September 11, 1991. Sixteen 8th stage high pressure compressor blade Z-plane root fractures had been observed. This Service Bulletin was issued in order to increase the area of squealer cut on the tip to lower the blade

root stress and to improve blade resonance. A larger squealer cut on the blade tip demonstrated a more favourable blade resonance and lowered root stress.

The 8th stage blade root fractures were also discussed in the Pratt & Whitney JT8D Technical Review of September, 1992. Blade root eddy current inspection was recommended for all JT8D and JT8D-200 blades at each refurbishment (all part numbers and models). Service bulletin 6044 was recommended to be incorporated for -219 engines at next module availability.

Service bulletin 5881 had been incorporated for the left engine. The recommendations of service bulletin 6044 had not yet been incorporated.

Figure 1. The failed 8th stage compressor rotor blade root

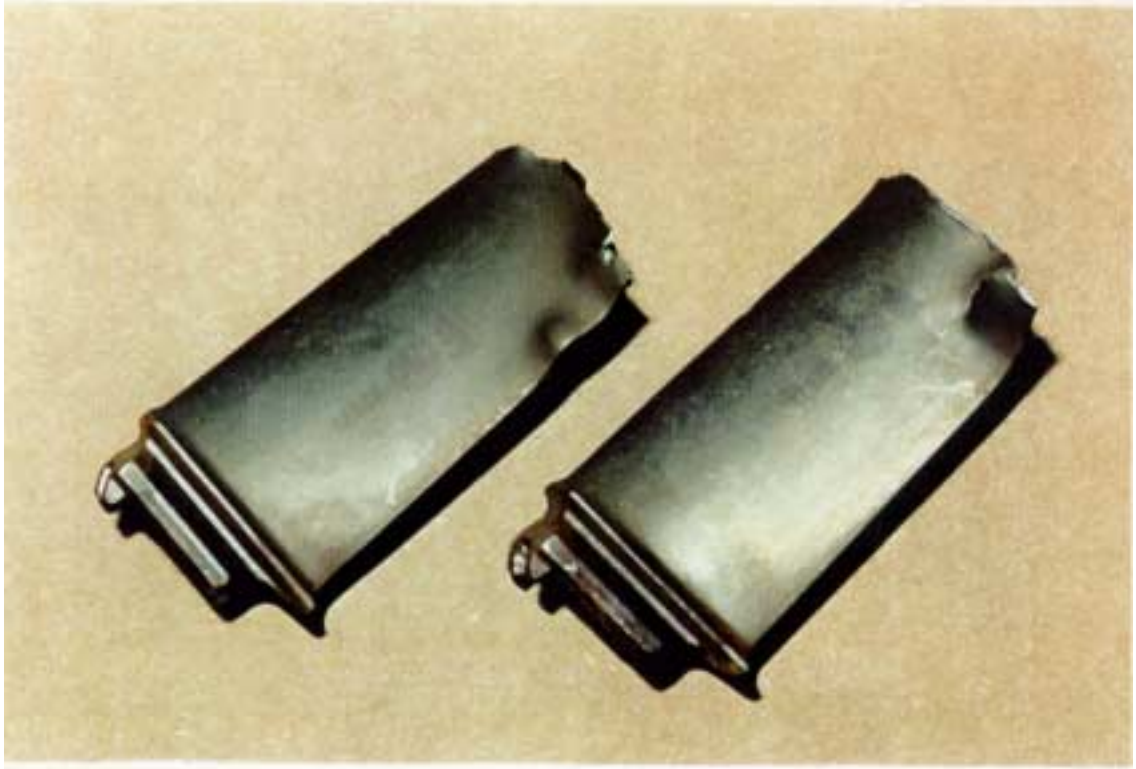

Figure 2. Two of the damaged 8th stage compressor rotor blades

Figure 3. Some of the compressor 7th stage stator trailing edge damages

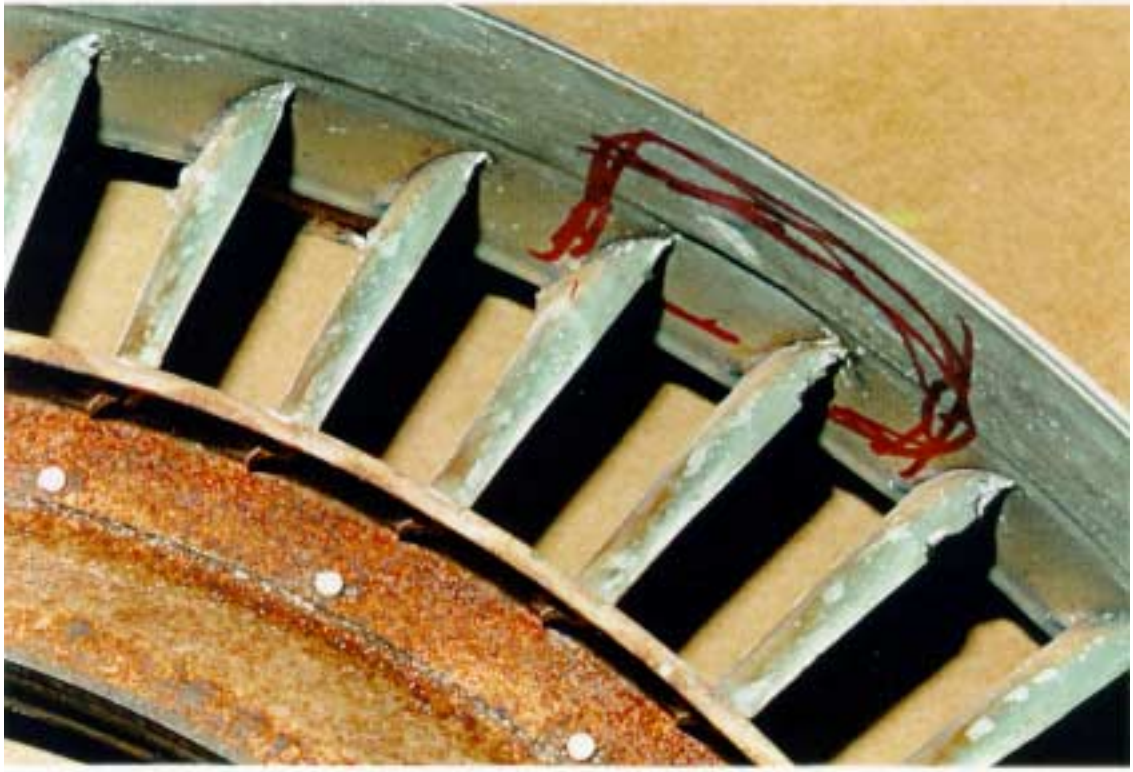

Figure 4. Some of the 8th stage stator leading edge damages

1.17 Organizational and management information

Intersun Sunways Havacilik A.S. was a charter airline based in Antalya, Turkey. The airline was an affiliated part of the Turkish Tursem group which had travel agencies in several countries, e.g. "Kymppimatkat" in Finland. Intersun Sunways begun its operations in April 1995 with three MD-83 aircraft and got the fourth in 1996.

The company had three departments: flight operations, technical department and ground operations. All departments worked under the corporate board and the accountable director. Chief pilot, training manager, flight safety manager, performance and documentation manager, cabin crew manager, chief stewardess, crew planning manager and chief dispatcher worked under the flight operations director (D0). The company had also hired a former Finnair executive as a flight operations advisor, member of the executive board as well as training and line captain (in this report referred to as the "operations advisor").

There were 20 captains and 20 first officers on Feb 16, 1996. The company pilots were mostly former Turkish Air Force pilots. The company used Finnair simulators for transition and recurrent training. Intersun Sunways training captains acted as instructors.

The quality manager and the engineering and maintenance manager worked under the technical director (TC) who had the responsibility for company aircraft maintenance. Intersun Sunways had its own licensed inspectors and mechanics. Daily inspections, A-checks and minor repairs were performed by the company. Preflight inspections and daily inspections were performed by the company's own mechanics in Antalya and Dalaman. Elsewhere the transit checks were usually performed by the pilots. An expanded daily check was performed once a week. More extensive checks were performed by foreign maintenance shops. Antalya was the company maintenance base.

Intersun Sunways went into bankruptcy and ceased operations in October 1997.

1.18 Other information

1.18.1 Autothrottle and speed control system

The autothrottle and speed control system, which is part of the digital flight guidance system, provides a full flight regime automatic throttle system that can control airspeed, Mach number and engine thrust from takeoff through landing. The AutothrottIe System (ATS) processes selected Mach/Airspeed inputs from the flight guidance glareshield control panel, EPR limit from the thrust rating system, throttle position, control surface position, angle of attack, airspeed, Mach number and altitude from the air data system as well as radio altitude and other airplane interface sources to generate the command signals for automatic thrust and speed control for the selected mode of operation.

The operating ATS unit is selected by the selector switch. The use of the autothrottle and speed control system is recommended from takeoff through the whole range of flight to the landing roll.

1.18.1.1 Takeoff

When the aircraft is ready for takeoff, the takeoff and go-around (TOGA) button is pressed to activate the roll and pitch function of the flight director. Takeoff will be displayed on the Flight Mode Annunciator (FMA) roll and pitch windows.

The throttles are manually advanced to a nearly vertical position to spool-up the engines for the initial target value of 1,4 EPR or approximately 80 % N2 and then adjusted so that the EPRs approximately match.

When the ATS switch is placed in AUTOTHRO ON position the throttles will advance to acquire and maintain the EPR limit for the selected takeoff thrust rating value. EPR TO will be displayed in the ATS window on the FMA.

The autothrottle clamp mode will engage at approximately 60 kt and the ATS FMA window will change from EPR TO to CLANT. When the ATS is engaged in the clamp mode, the power from the throttle servo is removed and the throttles remain clamped throughout the rest of the takeoff phase until another thrust rating mode is selected on the thrust rating indicator panel.

1.18.1.2 Climb

After takeoff when the aircraft is climbing through 1500 ft, the climb thrust mode is selected on the thrust rating panel. Power is then connected to the throttle servomotor and the throttle levers are controlled by the servomotor, which acquires and maintain s the selected climb thrust indicated on the thrust rating indicator panel during the climb phase.

The ATS will automatically revert from climb thrust to the preselected speed or Mach mode when the altitude or flight level capture occurs and maintain the preset speed/Mach during the cruise phase of the flight.

1.18.1.3 EPR synchronizer

The ATS monitors the EPR output of both engines and will control the throttle servo with reference to the engine displaying the highest EPR value to match the EPR for the selected ATS mode. As both throttle levers are driven by a common servomotor through the respective clutch assemblies, an additional synchronizing system is required to match both engines for the selected EPR limit, speed or Mach references.

1.18.2 Aerodrome Flight Information Service

Aerodrome Flight Information Service (AFIS) was provided at the time of the incident. The AFIS is a form of air traffic service provided at airports with low traffic density. It differs from the Air Traffic Control Service in many ways. The AFIS provides the air traffic in the manoeuvring area and in the Flight Information Zone (FIZ) with alerting services and information necessary for safe and efficient flight. The AFIS does not provide separation but only gives traffic information, using which the pilots themselves are responsible for the avoidance of aircraft collisions.

The AFIS does not issue clearances for aircraft, only information relevant to the flight, on grounds of which the pilots make the operational decisions by themselves. These decisions shall finally be made by the pilot-in-command (PIC) at ATC airports as well. The difference is that at AFIS airports the PICs themselves are responsible for the flexible traffic flow. At ATC airports this is left to the ATC officers.

2. ANALYSIS

2.1 Left engine deterioration

2.1.1 General

It was an Intersun Sunways policy to record engine performance data in the Maintenance and Performance logbook during the first flight of the day. The data from September 16-30, 1996 was reviewed in this investigation. During this time the left mean EGT had been approximately 10°C higher and the left fuel flow slightly higher than the right at the same EPR setting. The N1 and N2 indications had been approximately equal for both engines. This indicated that these engines made a good pair regarding engine rpm and resonance sounds.

The engine parameters for the flights Kokkola-Dalaman - Cologne/Bonn - Kajaani on September 30, 1996 were read out from the UFDR. The left and the right engine parameters were compared at the same EPR i.e. at the same engine thrust. It was then possible to compare the high pressure compressor rpms (N2) and exhaust gas temperatures (EGT). The fuel flow indications were compared also because this gave supporting evidence for the EGT indications. The low pressure compressor rpm (N1) does not give as clear a picture of the situation as the core engine N2 rpm. The low and high pressure assemblies are not mechanically interconnected.

Pratt & Whitney Operations Instructions, section 4 "Engine operating limits" states the maximum takeoff N2 as 102,5 % which equals to 12550 rpm (1 % N2 equals to 122,4 rpm) with JT8D-219 engines. The maximum takeoff N1 is 101,6 % which equals to 8350 rpm (1 % N1 equals to 82,2 rpm).

Samples of engine parameters are shown in the following tables. A frame is a UFDR time unit (one frame equals to four seconds). EGT is given in 'C and fuel flow (FF) in kg/h. The left and right engine parameters are separated with a slash (left parameter/right parameter).

2.1.2 Flight Kokkola-Dalaman

The aircraft had flown the flights Dalaman-Kokkola-Dalaman on October 30, 1996 before departing for the flight to Cologne/Bonn. During the filght from Kokkola to Dalaman the left mean EGT was 9,2 °C higher than the right and the left mean N2 0,3 % lower than the right at the same EPR. The mean fuel flow indications were approximately the same for both engines. This was observed with several different EPR values at several frames, which can be seen in the table below.

Frame [4 s]	EPR	EGT [°C]	N2 [%]	FF [kg/h]
11952	1,885/1,885	507/489	94,1/94,9	3171/3249
12113	1,791/1,791	405/397	87,9/87,9	1759/1802
12122	1,820/1,820	408/402	88,5/88,4	1788/1816
12181	1,804/1,804	404/396	87,7/87,9	1823/1731
12193	1,857/1,857	418/412	88,2/88,8	1894/1830

2.1.3 Flight Dalaman - Cologne/Bonn

The aircraft had left Dalaman and was climbing to FL 280 with autopilot and autothrottle engaged.

During climb with climb thrust before the frame 16131 the left mean EGT was 13,6 °C higher, the left mean N2 0,24 % lower and the left mean fuel flow 51 kg/h higher than the right.

Comparison between the left and the right engine parameters after the frame 16131 during cruise at FL 280 indicated that the left mean EGT was 19,5 °C higher, the left mean N2 1,4 % higher and the left mean fuel flow 117 kg/h higher than the right.

Comparison between the left engine parameters before and after the frame 16131 indicated that the left mean N2 had increased by 1,64 % i.e. approximately 200 rpm to reach the same EPR as the right engine. The left EGT had risen approximately 6 °C and the left fuel flow almost 70 kg/h.

Frame [4 s]	EPR	EGT [°C]	N2 [%]	FF [kg/h]
15888	1,969/1,969	575/561	97,1/97,0	5257/5349
15967	1,891/1,891	512/492	94,4/94,9	3590/3561
16001	1,946/1,948	513/500	94,5/94,8	3455/3341
16009	1,952/1,952	509/496	94,5/94,6	3320/3327
16101	2,041/2,041	489/481	93,5/93,9	2689/2682
16131	*A sudden change in the left engine parameters occurred at this frame.*			
16187	1,743/1,746	427/405	89,4/88,3	1852/1752
16254	1,706/1,706	416/397	89,7/87,8	1774/1696
16344	1,618/1,617	400/379	87,9/86,4	1596/1475
16364	1,757/1,757	429/414	89,6/88,3	1894/1759
16405	1,748/1,748	428/410	89,4/88,1	1887/1688
16429	1,752/1,752	427/405	89,6/88,3	1859/1759

2.1.4 Occurrence at frame 16131

During climb through FL 272 the left EPR suddenly dropped from 2,059 to 1,891. It then rose and stabilized to a value of 2,020 in 20 s. The left N1 dropped from 93,0 % to 85,4 % after which it rose and stabilized to 90 % in 10 s. The left EGT rose from 489 ^{o}C to 509 ^{o}C from where it stabilized to 483 ^{o}C in 10 s. The left N2 rose approximately 1 %. The left EPR stabilized to a value of 2,020 while the right EPR remained constant at 2,059. The fuel flow indicated a slight momentary drop, which was followed by a quick stabilization. In less than one minute the aircraft reached FL 280 and the ATS reduced thrust normally on both engines.

Based on the above UFDR data it is the opinion of the commission that the engine was initially damaged at frame 16131 during climb through FL 272.

2.1.5 Flight Cologne/Bonn - Kajaani

During cruise the left mean EGT was,22,3 ^{o}C higher, the left mean N2 1,65 % higher and the left mean fuel flow 68 kg/h higher than the right.

When comparing the left engine parameters before frame 16131 and during the flight Cologne/Bonn - Kajaani it can be seen that the left EGT had risen 8,7 ^{o}C and the left N2 1,89 % i.e. approximately 230 rpm. This indicates that the left engine condition had deteriorated further during the flight Cologne/Bonn - Kajaani, most probably during the takeoff.

Frame [4 s]	EPR	EGT [^{o}C]	N2 [%]	FF [kg/h]
19865	1,891/1,891	537/506	96,1/94,8	3639/3583
20160	1,824/1,824	403/379	88,5/86,9	1440/1412
20287	1,787/1,789	421/402	89,3/87,7	1717/1539
20398	1,702/1,702	403/384	88,0/86,4	1547/1461
20849	1,650/1,650	406/386	88,7/86,7	1582/1539
21302	1,669/1,669	408/387	88,4/86,6	1596/1575

2.2 Cockpit crew action after the left engine abnormal behaviour

2.2.1 Left engine damage on flight Dalaman - Cologne/Bonn

During climb through FL 272 just before the aircraft reached its initial cruising altitude of FL 280, the left engine had an unusual EPR and N1 drop and an EGT rise. According to the cockpit crew a loud bang was heard in the cockpit from the left engine two to three minutes after reaching the cruising flight level.

According to the Finnair station manager and station mechanic in Kajaani the cockpit crew stated to them that the left engine parameters had dropped momentarily in association with the loud bang. The cockpit crew demonstrated this drop by hand movement. Captain B, who had been the pilot in command on the flight Dalaman - Cologne/Bonn, stated during the cockpit crew interview in Kajaani:

"There was a noise, 'bom', we looked all the engine instruments right and left engine, the noise came from the left engine but all the indications are the same, there is nothing."

Captain A stated in his written report on the incident:

"After climb levelled at *FL 280 a 'bang' coming from left engine was heard, just 2 or 3 minutes after levelling. Left engine parameters were checked and no abnormal indications observed. Left engine parameters were equal to right engine parameters during the check."*

The commission is of the opinion that in an MD-83 with rear mounted engines it is difficult to determine in the cockpit from which engine the above mentioned sound is originated without an associated change in the engine instrument indications.

The left engine continued to run but with increased EGT, N2 and fuel flow. The abnormal and emergency check list was not consulted. The last engine performance data entry in the Maintenance and Performance logbook had been made on September 30, 1996 on the flight Dalaman-Kokkola. It is the opinion of the commission that a new entry should have been made after the bang. The deterioration of the left engine condition would have become obvious through data comparison. The data was available onboard for the previous two weeks but it was not taken advantage of It is the opinion of the commission that an introduction to the effective use of engine performance data should be included into the type training.

2.2.2 Ground events in Cologne/Bonn

The cockpit crew failed to note the abnormal left engine behaviour in the aircraft documents in Cologne/Bonn. According to the Intersun Sunways Flight Operations Manual (FOM) Section 1.2.10 part 1. GENERAL:

- *The Pilot in Command (PIC) is responsible for reporting all known and suspected defects of the aircraft to the maintenance agent at the termination of the flight. Where no technical services are available the Pilot in Command is responsible for carrying out inspections according to technical regulations.*
- *If in doubt regarding MEL serviceability or malfunction of systems and equipment and their effect on the aircrafts airworthiness, the PIC must contact TC/DO for instructions and guidance.*

A mechanic who was unqualified for the MD-83 was consulted in Cologne/Bonn. The mechanic told captain A that he was not authorized for maintenance activities on the MD-83 nor had he any experience on the type and that he therefore could not help. Captain A, however, requested the mechanic to provide assistance. The cockpit crew should have arranged a qualified mechanic to the aircraft in order to determine the serviceability of the left engine and therefore the airworthiness of the aircraft. Alternatively they should have contacted their home base (TC/DO) for instructions and guidance.

According to the mechanic's written statement to the Luftfahrt-Bundesamt the cockpit crew told him that

"they had heard strange noise from the left engine when increasing thrust."

According to the written statement of captain A

"the mechanic was informed about the situation encountered at FL 280."

The commission was unable to determine whether the mechanic was also informed about the loud bang and the associated drop in the left engine instrument indications. Technical personnel should always be provided with all available information about the observed abnormalities.

Captain A and the mechanic together looked into the engine inlet and exhaust pipe, checked the free movement of the fan and looked inside the engine cowlings through some service access doors. Nothing abnormal was found. According to the LBA investigation the mechanic stated to the captain after the above mentioned visual checks that

He could not give him a RELEASE TO SERVICE either in writing nor verbally and that he alone would have to take the decision and responsibility to continue the flight.

According to the written statement of captain A the mechanic stated that the left engine was normal and that the flight could continue. Captain A should have understood that the mechanic could not have given the aircraft a release to service.

According to an LBA order, German mechanics are not allowed to carry out technical assistance on aircraft unless the crew has made an entry about technical problems into the aircraft documents. In this case no entries had been made about the observed left engine abnormalities. The inspection, which the mechanic performed together with the captain was therefore against the LBA order.

The transit check in Cologne/Bonn was signed by the first officer. Captain A signed the aircraft airworthy. The aircraft was therefore signed airworthy without assuring the serviceability of the left engine. The performed left engine inspection was not noted in the aircraft documents.

2.2.3 Flight Cologne/Bonn - Kajaani

During taxiing out in Cologne/Bonn the idle N1 and N2 were approximately 3 % lower and EGT 40 ^{o}C higher in the left engine than in the right engine. In Dalaman these values had been approximately equal for both engines. When the throttles were manually advanced for spool-up in the beginning of the takeoff, the right engine accelerated to 1,6 EPR but the left engine responded slowly. When the throttles were further advanced, both engines accelerated to 1,75 EPR and the autothrottle was engaged. When thrust was increased for spool-up, the left engine accelerated from idle to 1,4 EPR approximately 8 s slower than the right. In Dalaman the difference had been only 2 s. According to the McDonnell Douglas Corporation All Operator Letter (AOL) FO-AOL-9-035, Aug 22, 1993 (also an enclosure of AOL-9-2355A, 2 June 1994):

> *Normally, when throttles of properly trimmed engines are smoothly and simultaneously advanced to approximately 1,4 EPR, the engines should achieve a stable, spooled-up condition within three seconds of each other. Differences between engine acceleration rates greater than three seconds are not normal, and should be written up for appropriate maintenance action.*

According to Intersun Sunways all AOLs had been given out to the company pilots. The cockpit crew stated during the interview in Kajaani that the engine acceleration had been normal during takeoff in Cologne/Bonn. The commission does not consider this statement reliable, because a difference of 8 s between engine acceleration rates is easily recognizable. This difference was not noted in the aircraft documents, according to AOL instructions. It was found out during the discussions with the Intersun Sunways operations advisor, who also acted as flight instructor that he neither knew the contents of the above mentioned AOL concerning the engine acceleration rates. Some engine parameters can be seen in the figures on the following page.

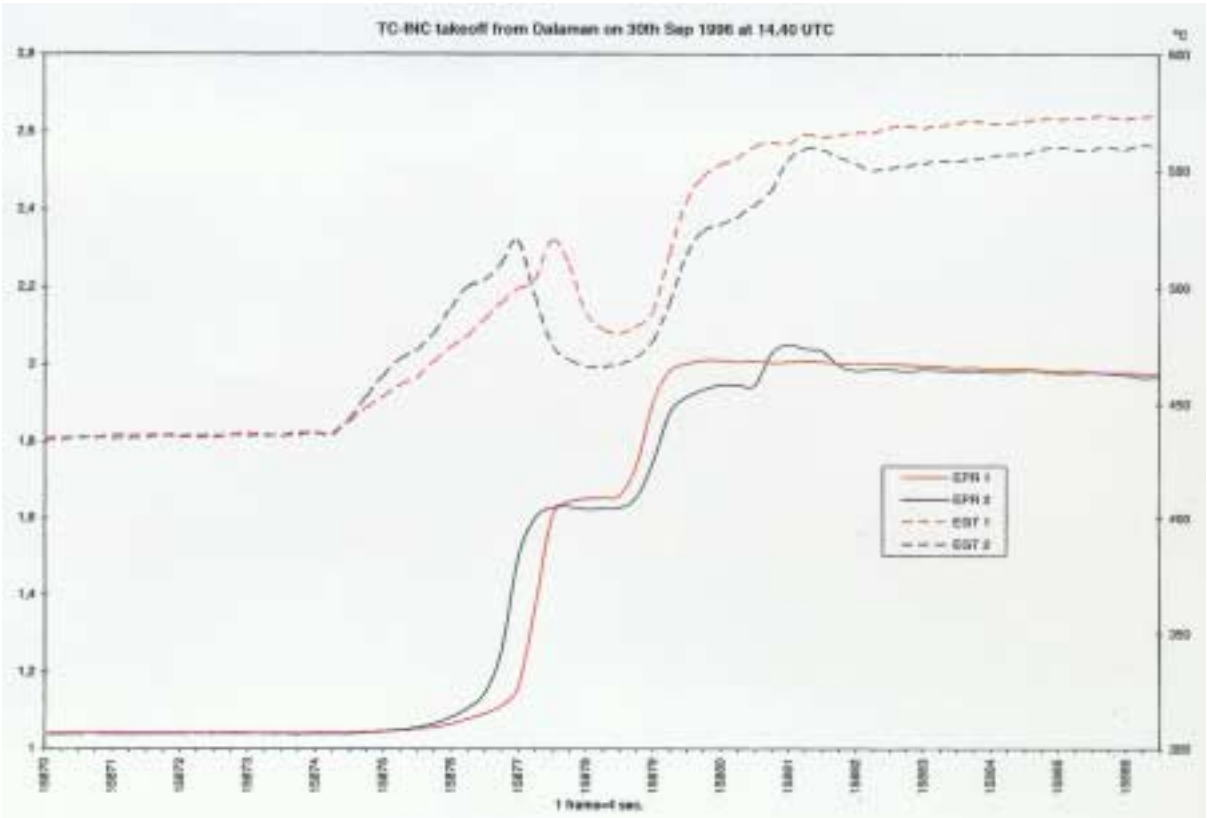

Figure 5. EPR and EGT during the takeoff in Dalaman

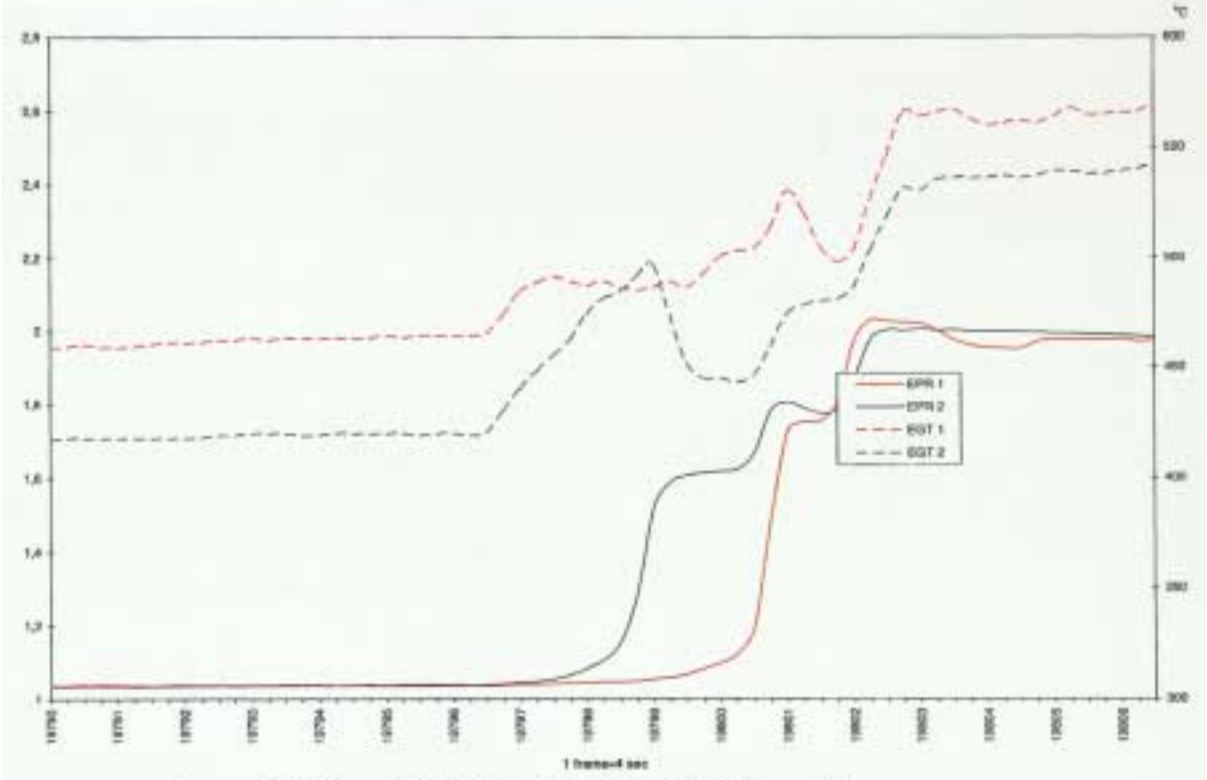

Figure 6. EPR and EGT during the takeoff in Cologne/Bonn

The left engine surged when thrust was being reduced from climb to cruise first at FL 350 and later on at FL 330. The cockpit crew described these sounds as "prrrt" and stated that they were distinctly different from the loud bang, which had been heard during the flight Dalaman - Cologne/Bonn. The abnormal and emergency check list was not consulted and no engine performance data entry was made. It is the opinion of the commission that a new engine performance data entry should have been made and compared with the previous data available on board in order to find out about the nature of the abnormal left engine behaviour. The observed engine abnormalities were not noted in the aircraft documents upon termination of the flight, i.e. in Kajaani.

The landing time at Kajaani was 21.38 UTC according to the flight log. The correct landing time was 21.32 UTC. According to the Intersun Sunways operations advisor Intersun Sunways pilots used the landing time registered by the Omega navigation system. If the Omega navigation system is used, the system time must be correct.

2.2.4 Ground events in Kajaani

2.2.4.1 Engine inspection on the apron

Intersun Sunways had an International Airline Transport Association (IATA) standard ground handling agreement with Finnair excluding section 7.6, snow and ice removal, and 9, aircraft maintenance. According to the Intersun Sunways operations advisor deicing service was verbally agreed upon with Finnair.

The cockpit crew explained the abnormal left engine behaviour to the Finnair station manager and station mechanic as explained in 1.1.4.1. The cockpit crew, however, did not mention the abnormal difference between the left and right engine acceleration rates, idle N1s, N2s and EGTs in Cologne/Bonn. They neither mentioned the strange noise from the left engine when increasing thrust during the flight Dalaman - Cologne/Bonn, which they had mentioned to the mechanic in Cologne/Bonn.

The Finnair station mechanic asked the cockpit crew whether they wanted him to contact Finnair Line Maintenance in Helsinki for instructions, upon which the cockpit crew agreed. At this point of time the cockpit crew should, at the latest, have provided the mechanic with all available information regarding the abnormal left engine behaviour. The station mechanic consulted Finnair Line Maintenance in Helsinki and relayed the initial suggested engine test run instructions to the cockpit crew. The cockpit crew discussed the suggestion among themselves in Turkish which after they refused it. They were therefore left without the complete engine test run instructions. The abnormal left engine behaviour was not discussed thereafter with Finnair personnel.

The complete test run would have included a bleed valve check and acceleration test. The bleed valve check is performed after engine warm up with the aircraft into headwind. The throttle shall be advanced slowly while monitoring the N1 indication. When the bleed valves close a rapid increase in N1 can be seen. Once the bleed valves are closed the check will be performed to the opposite direction by retarding the throttle from approximately 60 % N1. As bleed valves open a rapid drop in N1 can be seen.

The acceleration check can be performed under field conditions by advancing the throttle rapidly from approach-idle to takeoff power subtracted by 5 % takeoff N2. The engine acceleration rate shall be measured. The allowable limits are 4-6 s for 219 engines. The EGT shall also be recorded during the check.

Captain A wrote in his report on the incident on October 1, 1996:

> *"Later on, the technician conveyed the information that he got valve or fuel control unit may be defective, after runway alignment by advancing the left engine throttle to 50 % NI and reducing to the IDLE the engine can be checked. It test is OKEY continue to the flight, if not return to the parking area."*

The test run procedure described by captain A is incorrect and would not have given sufficient information in order to evaluate the serviceability of the left engine. Additionally, it is not a Finnair policy to perform engine test runs with passengers onboard. The commission considers it highly improbable that the mechanic would have given the above mentioned instructions to the cockpit crew.

The first officer signed the Transit check and captain A signed the aircraft airworthy before the aircraft left the apron. This was done prior to the left engine test run, which the cockpit crew claimed they were intending to do in the takeoff position in order to confirm the serviceability of the left engine. The commission considers the action taken by the cockpit crew completely wrong and dangerous for flight safety.

2.2.4.2 De-icing

The weather and the remaining cold soaked fuel in the wing tanks were favourable for wing ice and frost formation. The station mechanic observed frost on the upper and lower wing surfaces and suggested de-icing to captain B. Captain B and the mechanic walked to the overwing emergency exits inside the aircraft. Captain B checked the wing by looking through the cabin windows and stated to the mechanic that de-icing would not be taken. According to the mechanic it was not possible to determine the wing condition properly through the cabin windows due to darkness and poor lightning.

The transit check card for cockplt crew and pre flight check card for technical personnel written in Turkish and without effective dates were located in the cockpit during the initial investigation. The English translations were provided by Intersun Sunways on October 22, 1996. It was written under item wings

"Because of clear ice problem on connection parte between upper wing surface and fuselage, this region must be controlled by help of telescopic bar of cockpit and the stairs. (It must be seen that the red-colored Tufte have free movement ability) AD 92-03-02."

The cockpit crew did not mention the telescopic bar during the interview nor was the bar used during the intermediate stop in Kajaani. The above mentioned transit check procedure was not followed.

Captain B stated during the interview that de-icing had not been necessary. He also stated twice that when the ambient temperature is above +4 ^{o}C icing does not occur. This is not true for ice and frost formation due to cold soaked fuel in the wing tanks. The clear ice and frost formation phenomenon has been observed to occur at upper surface wing root area of the DC-9 series aircraft at ambient temperatures up to +14 ^{o}C.

On December 4, 1996 the commission requested information from Intersun Sunways about the pilots' transit check training. Intersun Sunways provided the "MD-83 preflight check" procedure dated May 11, 1996, which, according to Intersun Sunways, was also used for the transit checks performed by the cockpit crew. According to the pre-flight check item 7:

"From cabin carry out visual inspection of wings upper surfaces for general condition and obvious damage and ensure that clear ice formation is not present.

Note: Tempereatures below +15 ^{o}C, ensure that clear ice formation is not present by hands on inspection."

The temperature in Kajaani was +4 ^{o}C at the time of the incident, but no hands-on inspection was performed. It is the opinion of the commission that the cockpit crew did not fully understand the wing ice and frost phenomenon which is caused by cold soaked fuel in the wing tanks. This led to the inappropriate decision of not taking de-lcing. According to Intersun Sunways the pilots had been trained for ice formation phenomena and de-icing procedures. The Intersun Sunways FOM and MD-80 Flight Crew Operating Manual (FCOM) specified that care must be exercised to ascertain that no frost or ice is present on top surface of the wing or other lifting/control surfaces before dispatch. The cockpit crew training had not been sufficient or fully understood.

The poor understanding among Intersun Sunways pilots of ice formation on the wings and the need for de-iclng had already previously compelled Finnish Civil

Aviation Administration Flight Safety Authority (CAA) to send several requests for action to the DGCA, Turkey. The Intersun Sunways operations advisor told the commission in 1997 that Intersun Sunways had taken action in order to eliminate the de-icing problems with additional training.

Intersun Sunways replied to a telefax from the CAA, Finland dated 4.10.1996 regarding "incident on flight SWW 2042 on Intersun Havacilik A.S. in Finland 1.10.1996" as follows:

> *"...it seems to be the case that the mechanic concerned directed his suggestions/demands to the augmented crew aboard the aircraft…*
>
> *The mechanic failed to address himself to the Captain of de-icing issues...*
>
> *The captain ordered de-icing when directly addressed by the mechanic on the subject."*

The commission is of the opinion that co-operation with ground personnel must be the concern of the whole flight crew. If ground personnel address themselves to a "wrong" flight crew member they must be shown to the appropriate one. In this case the mechanic suggested de-icing to captain B, who did not tell the mechanic that he was not the pilot-in-command for the next flight. Captain B inspected the wing through cabin windows and told the mechanic that de-icing would not be taken. After this the mechanic had no way of knowing that he had addressed himself to the "wrong" captain. According to Intersun Sunways FOM Section 3.2.8 "6. Co-operation with ground":

> *"The closest co-operation shall always be established between the PIC, or crew member delegated by him, and the responsible ground personnel to execute smooth and efficient handling of all flight and ground operational matters."*

The commission considers the position expressed by Intersun completely wrong and conflicting with the company flight operations manual.

Later on, a Finnair station officer strongly recommended de-icing to the cockpit crew after consulting a Finnair assistant vice-president in Helsinki by telephone. The cockpit crew finally agreed and the de-icing was performed.

2.2.4.3 The attempted takeoff in Kajaani

It is the opinion of the commission that the serviceability of the left engine should have been determined properly prior to the attempted takeoff. Captain A wrote in his report on the incident that the test run was performed after runway alignment. The test run was, however, not mentioned to Kajaani AFIS in the radio communications. When the throttles were advanced for takeoff, the left engine surged several times and the loud

banging noise occurred again. The right engine accelerated normally. The left engine EGT was fluctuating with high peaks. The cockpit crew waited for the left engine acceleration for approximately 40 s before retarding the throttles. The commission considers it unprofessional that the cockpit crew did not retard the left throttle immediately after the left engine malfunction occurred again and that they tried to apply thrust in the left engine even when they taxied back to the apron.

The commission is of the opinion that the cockpit crew would have begun the takeoff run, if the left engine had accelerated. This is supported by the facts that the cockpit crew had performed all normal procedures prior to takeoff and route clearance had been received and confirmed. The alleged left engine test run was not mentioned to Kajaani AFIS. When the aircraft was in takeoff position, the cockpit crew requested takeoff clearance. The AFIS officer answered that the runway was vacated and gave the actual wind. Thereafter both throttle levers were advanced simultaneously. If the pilots had intended to perform a left engine test run, only the left throttle lever would have been advanced.

Neither the alleged left engine test run nor the aborted takeoff were written up in the aircraft documents after the aircraft returned to the apron. The first officer wrote the entry about the observed left engine abnormalities in the Maintenance and Performance logbook only after the boroscope check, which was performed in the morning. This was the first entry about the left engine abnormalities observed during the flights Dalaman - Cologne/]Bonn - Kajaani but the alleged left engine test run was not noted. The commission considers the cockpit crew action completely wrong and hazardous to flight safety.

Some engine parameters during the attempted takeoff in Kajaani can be seen in the figures on the next page.

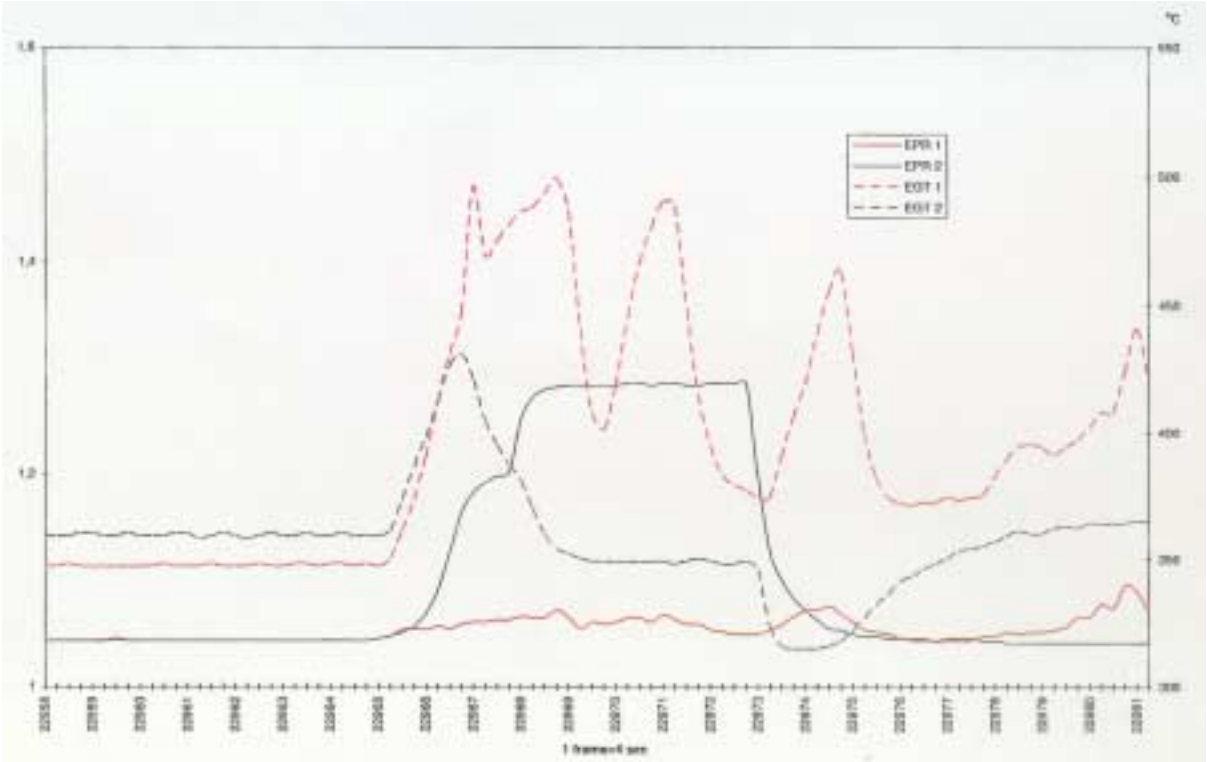

Figure 7. EPR and EGT during the attempted takeoff in Kajaani

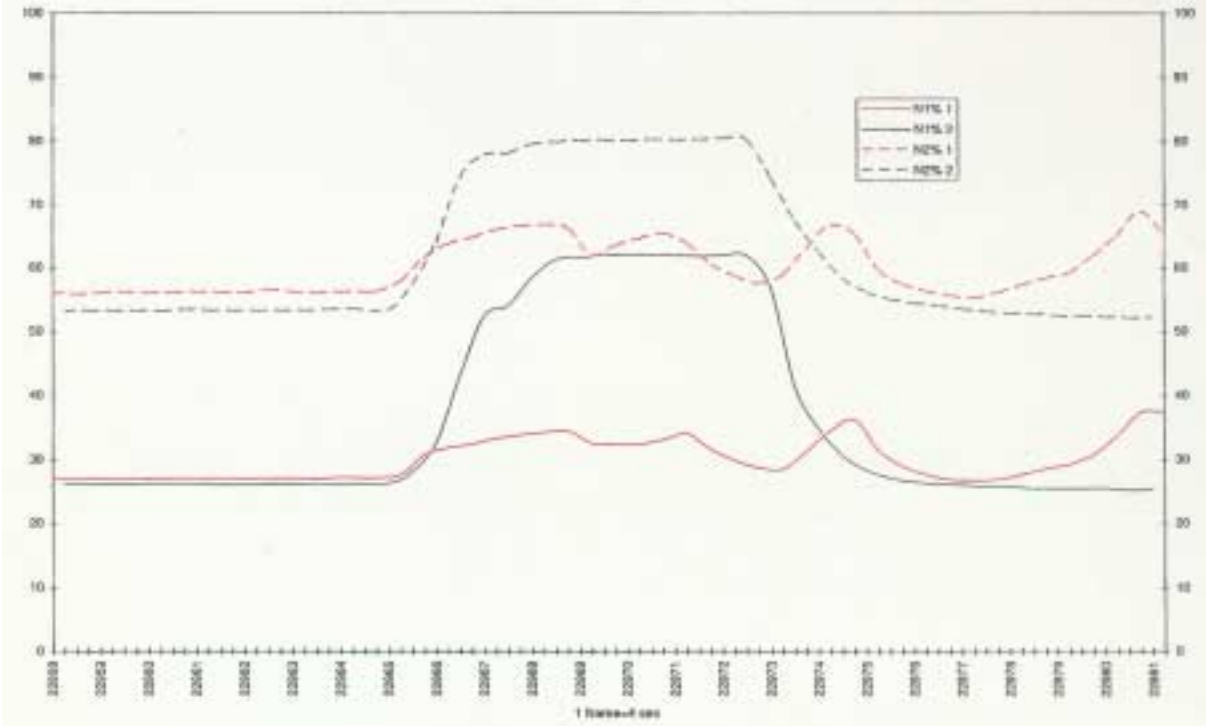

Figure 8. N1 and N2 during the attempted takeoff in Kajaani

2.3 The initial investigation in Kajaani

Intersun Sunways Maintenance department requested technical assistance from Finnair Line Maintenance in Helsinki on October 1, 1996 at 05.00 local time in order to find out the causes of the abnormal left engine behaviour. A Finnair inspector from Helsinki arrived in Kajaani after a few hours. The first officer also arrived at the airport from hotel and told the inspector that the left engine had stalled several times but all engine instrument indications had been normal and no abnormal vibrations had occurred (the aircraft was not equipped with engine vibration monitoring system). The inspector said that a boroscope inspection was necessary under these circumstances because the engine might have internal damage. The boroscope inspection was performed and it was concluded that the left engine had to be changed before the next flight.

Chief air accident investigator Mr Seppo Hämäläinen from the AIB, Finland, discussed the CVR and UFDR removal with the Intersun Sunways operations advisor in the morning of October 1, 1996. The operations advisor gave the permission to remove the recorders after consulting Intersun Sunways. Mr Hämäläinen called the Finnair station manager in Kajaani and requested recorder removal. The inspector who had performed the boroscope inspection was requested to remove the recorders and he informed the first officer about this. The first officer called his captain in the hotel and stated thereafter that nothing may be removed from the aircraft. When the inspector asked the first officer whether the aircraft documents had entries about the observed left engine abnormalities, the first officer stated that no entries had been made. He then wrote in the Maintenance and Performance logbook:

"After departed from Dalaman at 28.000 feet we heard nose from left engine. Instruments information was normal about left engine.

After landing to Cologne a tecknician controled the left engine and said: 'Every think is normal about this engine. You can fly!!'

During flying from Cologne to Kajaani at 35000 feet and 33000 feet we have seen stall information again on this engine but the engine instruments information was normal.

At Kajaani after entring runway for departure we have seen the same stall information and then we rejected flight and turned parking area."

The first officer needed some assistance from Finnair station manager in writing the entry in English. He then asked the inspector to write his statement about the boroscope inspection. The inspector wrote about his observations and concluded that the left engine had to be changed before the next flight.

The inspector phoned the Finnair quality control engineer in Helsinki and discussed the flight recorder removal. He was instructed not to remove the recorders without Intersun Sunways' permission. He then discussed the recorder removal with the first officer again. The first officer referred to his discussion with his captain and stated that the crew saw no reason to remove the recorders. The recorders were removed as ordered by Mr Hämäläinen after the cockpit crew interview in Kajaani in the evening of October 1, 1996.

2.4 Organizational factors

2.4.1 The Directorate General of Civil Aviation, Turkey

The DGCA, Turkey and Intersun Sunways initially strongly opposed this incident investigation which the Accident Investigation Board, Finland started on the events of Intersun Sunways flights Dalaman - Cologne/Bonn - Kajaani - Dalaman on September 30, 1996. The DGCA, Turkey did not nominate an accredited representative for the investigation, which it could have done according to ICAO Annex 13. It became apparent during the investigation that the DGCA, Turkey had initially had a lot of incomplete and incorrect information about the incident.

The initial position taken by the DGCA, Turkey was revealed in a telefax which the DGCA, Turkey sent to the CAA, Finland on October 12, 1996. The telefax was a response to a telefax sent by the CAA, Finland to the DGCA, Turkey on October 4, 1996 in which the CAA, Finland expressed its concerns about this incident and Intersun Sunways operations in general. The DGCA, Turkey provided the following incorrect or incomplete information, which was obviously taken as factual.

> *"The technical checks made after landing at COLOGNE Airport disclosed no significant deficiencies and the aircraft was cleared to takeoff for Kajaani."*

According to the LBA investigation the German mechanic in Cologne/Bonn had clearly stated to the cockpit crew that he was not licensed for maintenance activities on the MD-83 nor had he any experience on the type and that he therefore could not give the aircraft any kind of release to service. Captain A signed the aircraft airworthy without first properly finding out the true cause of the abnormal left engine behaviour.

The DGCA, Turkey wrote about the left engine trouble shooting in Kajaani:

> "... *upon request of the flight crew the problem was communicated to Finnair Helsinki technical department with whom Intersun has a technical agreement by the local technical team."*

Finnair had no technical service agreement with Intersun Sunways at the time of .the incident except a verbal agreement about de-icing.

The DGCA, Turkey continued about the events in Kajaani:

> *"As a result of technical work/troubleshooting by Finnair it was estimated that this might have stemmed from a defect of the fuel control unit or bleed valve but in order to come to firm finding the flight crew suggested that the engine be tested at the runway threshold with a power of 50 % N1."*

The Finnair station mechanic only relayed the information provided by the cockpit crew about the abnormal left engine behaviour to Finnair line maintenance in Helsinki. He then relayed the initial suggested engine test run instructions from Helsinki to the cockpit crew and stated that the aircraft should be moved to a suitable area and turned into headwind or the test run. It was therefore the mechanic who suggested the engine test run to the cockpit crew but not in the takeoff position with passengers on board nor with the thrust setting of 50 % N1.

The DGCA, Turkey continued about the events in Kajaani:

> *"The permit (clearance) to run the engine and enter into the runway was given despite this condition."*

The commission was unable to determine what the DGCA, Turkey wanted to point out with the above statement. At AFIS airports like Kajaani there is no permission required for entering the runway. With regard to the serviceability of the left engine it was solely the responsibility of the captain.

The DGCA, Turkey wrote about the alleged left engine test run:

> *"The test was carried out while the aircraft was standing at the runway threshold under the control of the parking brake."*

It was found out from the UFDR data that parking brake was not used on the runway. The aircraft was kept stationary with brake pedals. The DGCA, Turkey was obviously also unaware of the fact that all cockpit crew action was aimed at takeoff - not an engine test run.

The DGCA, TURKEY stated that if the UFDR and CVR have to be removed from the aircraft, such work must be carried out with the participation of the civil aviation authority of the state of registry. The reason behind the quick removal of the UFDR and CVR was that the commission wanted to return the recorders to the aircraft as soon as possible in order to return the aircraft to service in respect of the recorders. The aircraft, however, remained in Kajaani for more than one month without the left engine. Intersun Sunways was informed about the recorder removal on October 1, 1996 and it was later provided with the requested recorder readouts.

The DGCA, Turkey stated about the investigation:

> "*We kindly ask you to reverse your decision to consider the incident as 'serious' or otherwise I am sorry to inform you that this decision shall be challenged legally in Finland or institutions elsewhere as appropriate."*

It seems that the request of the DGCA, Turkey was based on incomplete information about the circumstances surrounding this incident. The commission considers it strange that the DGCA, Turkey took the position above without first considering all available information e.g. aircraft documents, UFDR data and Kajaani AFIS radio communications.

The DGCA, Turkey finally stated:

> *"In the event that you might agree, I am looking forward to hear that the file is closed at your end whereby our administration will continue the investigation of the incident."*

The DGCA, Turkey was obviously not aware of the Finnish aviation accident and incident investigation procedures and legislation. The DGCA, Turkey was asking the CAA, Finland to close the investigation even though it was the Finnish Ministry of Justice, which had appointed an investigation commission according to Finnish legislation. The Ministry of Justice, AIB, Finland and all the appointed investigation commissions are independent of the CAA, Finland.

Two representatives of the DGCA, Turkey, Head of air navigation bureau and Safety Assessment of Foreign Aircraft (SAFA) National Coordinator, visited AIB, Finland on November 20, 1996 in order to discuss the right of the Finnish authorities to investigate this incident. The Turkish representatives were of the opinion that the case under investigation was not a "serious incident" and should therefore have been investigated by the Turkish authorities. The Turkish representatives thought that it was the engine malfunction that was being investigated when it was actually the cockpit crew action upon the observed left engine abnormalities. The Turkish representatives wanted to focus the investigation on the engine in order to make it more reliable and to avoid similar incidents in the future. In addition, they stated that it was not prohibited to perform an engine test run with passengers on board.

The radio transcripts of Kajaani AFIS and the CVR were listened to and the Turkish representatives were provided with copies of them. The Turkish representatives stated that they would translate the CVR tapes and send transcripts to the AIB, Finland. After an inquiry a reply was received on February 5, 1997 stating that the poor sound quality of the CVR made understanding of the discussions impossible and that a translation could therefore not be made.

2.4.2 Intersun Sunways

2.4.2.1 Co-operation during the investigation

Upon Intersun Sunways' request the Tursem Group chairman of the board, a Finnish lawyer and a representative of the Finnish travel agency Kymppimatkat, visited AIB, Finland on October 14, 1996 and listened to the CVR tapes of the incident aircraft.

A delegation formed by the Tursem Group chairman of the board, Intersun Sunways technical manager, deputy of flight operations director, quality manager, operations advisor, media and marketing director, an English attorney of law, a Finnish lawyer and the Chief Executive Officer of the Finnish travel agency Kymppimatkat visited AIIB, Finland on October 16, 1996 upon Intersun Sunways' request. Intersun Sunways suggested that the case under investigation should not be handled as a serious incident but as a contained engine failure, which according to ICAO Annex 13 should not be investigated by the Finnish authorities. The AIB, Finland informed the DGCA, Turkey and Intersun Sunways that an investigation had been started on the events, which occurred during the Intersun Sunways flights Dalaman - Cologne/Bonn - Kajaani - Dalaman on September 30, 1996.

It was characteristic to this investigation that whenever Intersun Sunways representatives stated that they would send the commission some requested documents for investigational purposes, they were not received in reasonable time or not at all. The requests were most often sent to the operations advisor who was nominated by the company chairman of the board as the company representative. The following documents were delayed or not received at all despite the commission's requests:

- The captain's written report was requested several times, first time on December 4,1996. On some occasions Intersun Sunways stated that the report had already been sent and on other occasions that it would be sent soon. The commission sent a final request for certain essential documents to Intersun Sunways on March 21, 1997. The report in English was received after this request on April 3, 1997.
- Swissair engine overhaul report on the damaged engine was not received at all even though Intersun Sunways fiight operations director and the quality manager stated that it would be sent immediately once it arrived in Turkey. The flight operations director stated in his telefax dated March 12, 1997 that the final engine overhaul report had not yet been received. The commission learned during the investigation that the report had been written in January 1997.
- The Intersun Sunways Training Manual which had been valid during the type training of the first officer (December 1995) was not received at all. A more recent Training Manual (Operations Manual Part D Training) dated 01.01.1997 was received on March 3, 1997. After further requests a Training Manual dated February 16, 1996 was received on April 3, 1997 containing only training syllabi.

- Intersun Sunways provided the pilots' training histories upon request of the commission. The first officer's transition training test results were not dated. Upon further request Intersun Sunways provided the dated test results and informed the commission that the Crew Resource Management (CRM) and the Safety and Emergency Training tests had been held in Turkey just after the completion of the courses. The training had been given at Finnair training center on January 16, 1996. When the information was received on March 24, 1997 it was noted that the first officer's test results had been changed and were dated December 27, 1995 i.e. before the training was given.

2.4.2.2 Shortcomings in the operational documentation and its use

The commission found several shortcomings in Intersun Sunways' operational documentation and its use. The aircraft certificate of insurance was not found onboard the aircraft in Kajaani. Only a special insurance certificate required by the German authorities was found. According to Intersun Sunways FOM section 7.1.3 the certificate of insurance should have been included in the aircraft documents. Intersun Sunways provided a copy of this document later upon request of the commission.

The ranks of Capt. in Command, Captain and Pilot were listed in the flight log. The ranks of Pilot in command and Co-pilot were listed in company FOM section 3.1.1 Crew Composition - Cockpit and Cabin Crew. The operations advisor told the commission that the rank of Captain in command was equal to Commander.

The flights Dalaman - Cologne/Bonn - Kajaani - Dalaman on September 30, 1996 had all been marked on the same flight log page. Captain A and captain B had both been marked as Captain in command for all flight legs. Captain A had been marked as the captain in the Maintenance and Performance logbook. It was found out during the cockpit crew interview in Kajaani that captain B had been the pilot in command on the flight Dalaman - Cologne/Bonn and captain A on the flight Cologne/Bonn - Kajaani and the intended flight Kajaani - Dalaman. The flight log had not been signed for these flights. The first officer wrote the name of captain A with block letters in the flight log field titled Captain in command's signature.

The Maintenance and Performance logbook was used as a technical log but it was not mentioned in the Flight Operations Manual. The FOM required the technical malfunctions to be written in the flight log. According to the FOM the flight log pages should have had preprinted page numbers and space reserved for operational remarks but this was not the case.

The commission is of the opinion that there were inconsistencies between the flight operations manual and the flight log page and that the flight log had been filled in incorrectly on behalf of the cockpit crewmembers.

According to Intersun Sunways FOM Section 3.2,8, Page 3 of 6, Eff 96-02-16 by signing the load sheet the PIC certifies on behalf of the company for example that the aircraft is airworthy and that the maintenance work at line station has been completed satisfactorily. The commission does not consider this procedure good because no detailed information about the technical status of the aircraft is left on ground at intermediate stops.

The commission is of the opinion that Intersun Sunways flight operations management had failed to arrange proper operational documentation for the cockpit crews. The DGCA, Turkey had failed to oversee the operational documentation of Intersun Sunways.

2.4.2.3 Intersun Sunways pilot training

Intersun Sunways mostly recruited pilots with a military background. The pilots of the incident aircraft were all former Turkish Air Force pilots. Captain A had flown 2100 h as a fighter pilot, captain B 7000 h as a transport pilot and the first officer 5900 h as a transport pilot in the Turkish Air Force. Captain A had about four years, captain B three years and the first officer about six months of airline flying experience.

The candidates for military flying generally go through a careful selection process. The military pilots are usually rather standardized group as far as performance is concerned. They have passed through a standardized training and gained their flying experience within a well-standardized operational environment. The training is generally of high quality and it is often performed with high performance aircraft. The military pilots' abilities vary depending on their background as a fighter or transport pilot. The transport aircraft cockpit systems and the nature of operations are quite similar to airline operations. It is noted that there may be cultural differences between countries, armed services and streams within the same training programs. The commission does not know the cultures of Turkey and the Turkish Air Force well enough in order to draw conclusions in this particular case.

The commission is of the opinion that the transition training for airline operations given to the pilots by Intersun Sunways was not sufficient. When an ex-military pilot is in transition to airline operations, he should be given enough properly targeted training. The differences between the military and airline operations should be highlighted. A special emphasis should be laid on cockpit crew co-operation with all personnel involved in the operations, for example in the form of CRM training. When training is given for international operations, cultural differences, which the pilots might face at work should be highlighted as well. In this case the first officer had only been given 4 h of introductory CRM training. The commission does not consider this sufficient.

According to the type training course syllabus the first officers simulator training should have included ten simulator sessions but only seven were given. Each simulator

session consisted of 4 h of simulator time (2 h as piloting pilot and 2 h as monitoring pilot) and 2 h of briefing time. All simulator training was given during subsequent nights by the same instructor. Introduction to Crew Resource Management (4 h) and Emergency and Safety Training (4 h) were given during a single day between the simulator sessions. The commission is of the opinion that the rest periods were not sufficient. Training efficiency is usually not optimum when the training is too intensive and given at night time.

The commission learned during the cockpit crew interview in Kajaani that the pilots' proficiency in the English language was rather limited. The commission had difficulties in communicating with the pilots in English. The first officer needed some assistance in writing the entry in the Maintenance and Performance logbook about the observed abnormal left engine behaviour. He received assistance from the Finnair station manager. The company operations advisor informed the commission during the investigation that Intersun Sunways was planning to give its pilots a course in English in the near future.

3 Conclusions

3.1 Findings

1. The cockpit crew had valid licences and they were qualified for the flight.
2. The airworthiness certificate of the aircraft was valid.
3. The insurance certificate was not onboard the aircraft in Kajaani but the insurance was valid.
4. Some differences in the cabin crew certificate markings made the validity checks difficult.
5. According to the UFDR the left engine had an unusual EPR and N1 drop and an EGT rise when the aircraft was climbing through FL 272 on the flight Dalaman - Cologne/Bonn. The engine continued to run but with increased EGT, N2 and fuel flow.
6. During the cockpit crew interview in Kajaani the pilots stated that a loud bang had been heard from the left engine two or three minutes after reaching FL 280 on the flight Dalaman - Cologne/Bonn but that the left engine instrument indications had been normal. According to the Finnair station manager and station mechanic the cockpit crew told them in Kajaani that the left engine instrument indications had dropped momentarily in association with a loud bang at FL 280. According to the written report of captain A and the maintenance and performance logbook entry by the first officer the left engine instrument indications had been normal. There were no sudden changes in the UFDR data two or three minutes after the aircraft reached FL 280.
7. The commission is of the opinion that in the cockpit of an MD-83 with rear mounted engines it is difficult to determine from which engine the bang mentioned in finding # 6 is originated without an associated change in the engine instrument indications.
8. One left engine 8th stage compressor rotor blade fractured from the root and caused extensive damage to the high pressure compressor.
9. Based on the UFDR data the left engine was initially damaged during climb through FL 272 on the flight Dalaman - Cologne/Bonn.
10. The left engine had only 29 flight hours remaining before the next overhaul.
11. Several high pressure compressor eight stage rotor blade fractures have occurred in the Pratt & Whitney JT8D-200 engines. Service Bulletins have been issued concerning the modification of the compressor blade.
12. A mechanic who was unqualified for the MD-83 was consulted in Cologne/Bonn. The mechanic told captain A that he was not authorized for maintenance activities nor had he any experience on the MD-83 and that he therefore could not help. Captain A, however, requested the mechanic to provide assistance.

13. According to the written statement of the mechanic to the LBA, the cockpit crew told him that they had heard strange noise from the left engine when increasing thrust. The mechanic did not mention the loud bang in his statement. According to the written statement of captain A the situation encountered at FL 280 was explained to the mechanic. The cockpit crew had not made an entry about the observed abnormal left engine behaviour into the aircraft documents.

14. Captain A and the mechanic together performed an external check on the left engine but nothing abnormal was found. According to the LBA investigation the mechanic then told the captain that he could not give the aircraft a release to service neither in writing nor verbally and that the captain alone would have to take the decision and responsibility to continue the flight. According to the written statement of captain A and the maintenance and performance logbook entry by the first officer in Kajaani the mechanic stated that the left engine was normal and the flight could continue. The performed left engine check was not noted in the aircraft documents.

15. According to a LBA order, German mechanics are not allowed to carry out technical help on aircraft unless the crew has made an entry about technical problems into the technical/flight logbook. The inspection, which the mechanic performed together with the captain was therefore against the LBA order.

16. Captain A signed the aircraft airworthy in Cologne/Bonn without first assuring the serviceability of the left engine. The first officer signed the transit check.

17. During taxiing out in Cologne/Bonn the left engine idle N1 and N2 were approximately 3 % lower and EGT 40 ^{o}C higher than the right. In Dalaman these values had been approximately equal for both engines.

18. It was found out from the UFDR data that when throttles were manually advanced for spool-up in the beginning of the takeoff in Cologne/Bonn, the right engine accelerated normally to 1,6 EPR but the left engine responded slowly. When the throttles were further advanced, both engines accelerated to 1,75 EPR which after the autothrottle was engaged. The left engine accelerated from idle to 1,4 EPR approximately 8 s slower than the right. In Dalaman this difference had been only 2 s. According to the written statement of captain A no abnormalities in the left engine instrument indications were observed during the takeoff, departure and climb from Cologne/Bonn. During the interview in Kajaani the cockpit crew stated that the engine acceleration had been normal during the takeoff in Cologne/Bonn. A difference of 8 s between engine acceleration rates is easily recognizable.

19. The left engine surged when thrust was reduced from climb to cruise first at FL 350 and later on at FL 330. The cockpit crew stated during the interview in Kajaani that the sounds of surging were distinctly different from the loud bang, which had been heard during the flight Dalaman - Cologne/Bonn.

20. The cockpit crew contacted Finnair for technical assistance in Kajaani and explained the situation as in finding 4 6. The Finnair station mechanic told the cockpit crew that he could do nothing because Finnair had no maintenance

agreement with Intersun Sunways. He asked the cockpit crew if they wanted him to contact Finnair Line Maintenance in Helsinki for instructions upon which the cockpit crew agreed.

21. The cockpit crew did not tell the Finnair station mechanic about the abnormal left engine acceleration rate during takeoff in Cologne/Bonn nor about the strange noise when increasing thrust, which they had mentioned to the German mechanic in Cologne/Bonn.

22. According to the instructions provided by Finnair Line Maintenance the mechanic suggested the cockpit crew a trouble shooting procedure including an engine test run. The cockpit crew discussed the proposal among them selves in Turkish and then refused. The abnormal left engine behaviour was not discussed any more with Finnair personnel.

23. The weather and the remaining cold soaked fuel in the wing tanks were favourable for wing ice and frost formation. The Finnair station mechanic observed frost on the upper and lower wing surfaces and suggested de-icing to captain B. Captain B checked the wing by looking through the cabin windows and refused to take de-icing. According to the station mechanic it was not possible to determine the wing condition properly through the cabin windows due to darkness. The cockpit crew accepted de-icing later on only after persuasion.

24. The cockpit crew did not fully understand the ice and frost formation phenomenon, which is caused by cold soaked fuel in the wing tanks. Captain B stated during the cockpit crew interview in Kajaani that when the ambient temperature is above $+4^{o}C$ icing does not occur. This is not true for ice and frost formation due to cold soaked fuel in the wing tanks, which has been observed to occur at upper surface wing root area of the DC-9 series aircraft at ambient temperatures up to $+14\ ^{o}C$.

25. Intersun Sunways procedure for wing ice contamination check was confusing. According to the transit check training syllabus the wing should have been checked by hands on inspection whereas according to the transit and preflight check cards the wing should have been checked with the help of a telescopic bar in order to confirm the free movement of the red colored tuftes on the upper wing surface. Neither check was performed in Kajaani.

26. A total of 137 passengers boarded the aircraft for the flight to Dalaman.

27. The first officer signed the transit check and captain A signed the aircraft airworthy. This was done before assuring the serviceability of the left engine.

28. The cockpit crew performed all normal procedures prior to takeoff and received and acknowledged their ATC clearance. The aircraft taxied out and backtracked to takeoff position runway 07. A loud banging noise was heard in the aircraft and at the terminal building when thrust was increased during the 180' turn into takeoff position.

29. When the aircraft was in the takeoff position runway 07, captain A requested Kajaani AFIS for a mechanic to inspect the aicraft nose wheel. AFIS officer

asked captain A to contact Finnair on the company frequency but the pilots did not do this. Captain B, however, left the aircraft via the aft stairs and returned shortly. The aircraft was kept stationary with brake pedals. The cockpit crew then reported to the AFIS that everything was ok and requested takeoff. They were given the appropriate traffic and actual wind information (AFIS does not give clearances as explained in 1.18.2).

30. When the throttles were manually advanced for spool-up in the beginning of the takeoff in Kajaani, the left engine surged several times and the loud banging noise was heard again. The left engine EGT fluctuated with high peaks. The cockpit crew waited for the left engine spool-up for approximately 40 s before the throttles were retarded. Takeoff was aborted and the aircraft taxied back to the apron.

31. During the interview the cockpit crew claimed that they had performed the left engine test run in the takeoff position and aborted, when the left engine did not accelerate normally. The cockpit crew did not mention the test run in the radio communications with Kajaani AFIS but requested takeoff. The test run was not noted in the aircraft documents. The first officer only wrote in the Maintenance and performance logbook that they had entered the runway for departure and rejected the flight when the left engine stalled again. According to the written report of captain A the left engine was checked after runway alignment and when engine stall was observed the crew decided to return to the apron.

32. The cockpit crew did not have the proper engine test run instructions. The engine test run procedure, which captain A described in his written report, would not have given sufficient information for the evaluation of the serviceability of the left engine.

33. It is the opinion of the commission that the cockpit crew would have begun the takeoff roll in Kajaani if the left engine had accelerated. This would have caused significant hazard to flight safety.

34. Thrust was applied in the malfunctioning left engine even when the aircraft was taxied back to the apron.

35. The erase function of the CVR had malfunctioned and had not erased all previous recordings properly. The recording had an unusual amount of interference noise, which made the cockpit crew conversations picked up by the cockpit area microphone practically unreadable.

36. The training for airline operations which was given to the first officer by Intersun Sunways was not sufficient.

37. According to the Intersun Sunways simulator training syllabus the first officer should have had ten simulator sessions during the type training for the NM-83 but only seven were given.

38. The commission initially obtained the first officer's undated CRM and emergency and safety training test results. When the requested dated results

were obtained, it was noted that they had been changed. According to the dated results the tests had been held before training was given.

39. The pilots' English skills were modest.

40. Based on the radio communications with Kajaani AFIS and the cockpit crew interview in Kajaani, the cockpit crew did not fully understand the AFIS procedures and operations in uncontrolled airspace.

41. Intersun Sunways flight operations management had failed to arrange proper operational documentation for the cockpit crews. The most significant problem was that the technical abnormalities were not noted in the aircraft documents upon termination of the flight.

42. Intersun Sunways did not provide the commission with all the requested documents in reasonable time or not at all.

43. The DGCA, Turkey failed to properly oversee the operations of Intersun Sunways A. S. as a new start-up charter operator.

44. Intersun Sunways and the DGCA, Turkey strongly opposed this investigation. They alleged that the case was not a serious incident and should therefore not be investigated by the Finnish authorities. According to Intersun Sunways and the DGCA, Turkey the investigation should have been conducted by the DGCA, Turkey.

45. The DGCA, Turkey did not nominate an accredited representative for the investigation.

3.2 Probable cause

- The knowledge and skills of the cockpit crew were insufficient and their attitudes were unprofessional in the handling of the engine malfunction. This was manifested most clearly when the pilots refused to perform the left engine test run in Kajaani according to given instructions and attempted to depart without first determining the serviceability of the left engine.

- The flight operations management of Intersun Sunways A.S. failed to ensure the competency of the cockpit crews.

- The DGCA, Turkey failed to properly oversee the operations of Intersun Sunways A.S. as a new start-up charter operator.

4 Recommendations

Intersun Sunways went into bankruptcy and ceased operations in October 1997. Therefore, there are no recommendations for the operator.

The DGCA, Turkey

- should ensure that those cockpit crews who fly international operations and/or have manuals in English, have sufficient language skills to manage normal and non-normal situations encountered during flight operations

- should more closely monitor that the training given to cockpit 'crews is in accordance with the operator's training manual requirements

- should more closely monitor and direct the operations of new start-up operators.

Helsinki, Finland, March 26, 1998

Lars Westermarck Seppo Hämäläinen

Pertti Nenonen

APPENDIX 1

Radio communications on Kajaani AFIS frequency 118,1 MHz

Intersun Sunways A.S. flight SWW 2722/2042
Kajaani AFIS, 118,1 MHz

From	To	Time (local)	Transmission
SWW 2722	EFKI AFIS	21.16	Kajaani, Intersun 2722, good evening, descending 110
EFKI AFIS	SWW 2722	21.17	Good evening Sunway 2722, Kajaani AFIS, we have no other reported traffic. Kajaani met report wind 150 degrees 10 knots, minimum 6, maximum 15 knots, visibility 10 kilometres, light rain, clouds 8 octas 800 ft, temperature 4, dewpoint 3, QNH 991, transition level 60
SWW 2722	EFKI AFIS		Thank you, all information copied
SWW 2722	EFKI AFIS		Runway 07, confirm
EFKI AFIS	SWW 2722		Sunway... correction, Intersun 2722, wind actually 140 degrees 10 knots and if you prefer runway 07 it's OK
SWW 2722	EFKI AFIS	21.18	(unreadable) zero, we prefer 07
EFKI AFIS	SWW 2722		Roger, and QNH 991
SWW 2722	EFKI AFIS		991
SWW 2722	EFKI AFIS	21.19	Two two, maintaining 110, request further descent
EFKI AFIS	SWW 2722		Intersun 2722, you may descend at your own discretion, no other traffic below
SWW 2722	EFKI AFIS		OK, thank you
EFKI AFIS	SWW 2722	21.27	Intersun 2722, request your distance and level
SWW 2722	EFKI AFIS		Now 8 miles and 2100
EFKI AFIS	SWW 2722		Roger, next report KAJ inbound
SWW 2722	EFKI AFIS		Now on the localizer runway 07, Intersun 2... 2722
EFKI AFIS	SWW 2722	21.28	Intersun 2722
EFKI AFIS	SWW 2722	21.31	Intersun 2722, runway vacated, wind 140 degrees 10 knots maximum 14 knots
SWW 2722	EFKI AFIS		Cleared to land
SWW 2722	EFKI AFIS	21.32	Intersun 2722, it will be 180 degrees turn back, confirm
EFKI AFIS	SWW 2722		Intersun 2722 landed at time 32 and you may backtrack

			to apron
SWW 2722	EFKI AFIS		(unreadable) backtrack, 2722
EFKI AFIS	SWW 2722	21.33	Intersun 2722, for your information, fuel station is southpart of the apron and you should taxi right wing towards the tank
SWW 2722	EFKI AFIS		Roger, 2722
SWW 2042	EFKI AFIS	23.21	Kajaani tower, good morning, Intersun 2042
EFKI AFIS	SWW 2042		Good morning Intersun 2042, Kajaani AFIS, go ahead
SWW 2042	EFKI AFIS		2042, parking, ready for start-up, destination will be LTBS
EFKI AFIS	SWW 2042		Intersun 2042, no start-up restrictions, wind 150 degrees 7 knots, temperature 4, QNH 990, correct time 22
SWW 2042	EFKI AFIS		All copied, QNH 990
SWW 2042	EFKI AFIS	23.25	Tower, Intersun 202... 42, ready for taxi
EFKI AFIS	SWW 2042		Intersun 2042, no other traffic and your clearance ready
SWW 2042	EFKI AFIS	23.26	Go ahead for ATC
EFKI AFIS	SWW 2042		Rovaniemi control clears Intersun 2042 to your destination via flight planned route, flight level 290, squawk 2013
SWW 2042	EFKI AFIS		Rovaniemi control clears Intersun 2042 to destination at flight level 290, squawk 2013
EFKI AFIS	SWW 2042	23.26	Clearance correct
SWW 2042	EFKI AFIS		Ready for taxi 2042
EFKI AFIS	SWW 2042		No other traffic and runway vacated
SWW 2042	EFKI AFIS		Thank you, 2042
SWW 2042	EFKI AFIS	23.27	Tower, Intersun 2042, lining up for runway 07
EFKI AFIS	SWW 2042		Intersun 2042, roger
SWW 2042	EFKI AFIS	23.31	(unreadable) Intersun 2042
EFKI AFIS	SWW 2042		Intersun 2042, runway vacated, wind 150 degrees 9 knots
SWW 2042	EFKI AFIS		We would like to check nose tyre wheel and then... aaa... like to departure
EFKI AFIS	SWW 2042		Intersun 2042, roger, are you going to taxi to apron?
SWW 2042	EFKI AFIS		We stop... aaa in the runway... aaa could you send me a mechanic?
EFKI AFIS	SWW 2042	23.32	You are asking mechanic to the runway?
SWW 2042	EFKI AFIS		Okay

EFKI AFIS	SWW 2042		Stand by
SWW 2042	EFKI AFIS		Standing by
EFKI AFIS	SWW 2042	23.33	Intersun 2042 do you have company frequency?
SWW 2042	EFKI AFIS		Okay
EFKI AFIS	SWW 2042		131.50, call mechanic
SWW 2042	EFKI AFIS		131?
SWW 2042	EFKI AFIS		131.40
EFKI AFIS	SWW 2042		131.50
SWW 2042	EFKI AFIS	23.34	50, thanks
SWW 2042	EFKI AFIS		Tower, Intersun 2042, we checked it, everything is OK... aaa... request takeoff
EFKI AFIS	SWW 2042		Intersun 2042, roger and runway vacated, wind 140 degrees 11 knots
SWW 2042	EFKI AFIS	23.35	(unreadable)
SWW 2042	EFKI AFIS		SWW 2042 Kajaani, Intersun 2042, aaa... we aborted and (unreadable) turning parking area
EFKI AFIS	SWW 2042	23.36	aaa... you are taxiing to apron?
EFKI AFIS	SWW 2042		2042, confirm you are taxiing to the apron
SWW 2042	EFKI AFIS		Affirmative
EFKI AFIS	SWW 2042		Roger
EFKI AFIS	SWW 2042	23.46	Intersun 2042, Kajaani AFIS
SWW 2042	EFKI AFIS		aaa... sir?
EFKI AFIS	SWW 2042		There is telephone call in Finnair office to you
SWW 2042	EFKI AFIS		OK