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M-00602/AIG-02

AIRCRAFT INCIDENT REPORT

Report by the Norwegian Accident Investigation Board into the incident to Boeing 757-200, TF-FIO at Oslo Gardermoen Airport, Norway on 22 January 2002

TF-FIO
Boeing 757-200
Oslo Gardermoen Airport
22 January 2002

REPORT ON THE SERIOUS INCIDENT TO ICELANDAIR BOEING 757-200 AT OSLO AIRPORT GARDERMOEN NORWAY 22 JANUARY 2002

Aircraft type:	Boeing 757-208
Registration:	TF-FIO
Owner:	Flugleidir h/f, 101 Reykjavik airport, Reykjavik
Operator:	Flugleidir h/f, 101 Reykjavik airport, Reykjavik
Crew:	2/5
Passengers:	75
Incident site:	Over RWY 01L at Oslo airport Gardermoen
Date and time of incident:	22 January 2002 at time 1049 hrs.

All times given in this report are local times (UTC +1), if not otherwise stated.

NOTIFICATION

The incident was not notified to AAIB/N after the landing at Oslo airport Gardermoen (ENGM). The Commander of TF-FIO was not conscious of the fact that the aircraft could have been overstressed during the rough manoeuvre following the unstabilized approach at ENGM. At Stockholm airport Arlanda (ESSA), the next scheduled stop, the Commander by phone gave the company's chief pilot a non-specific notification that there had been abnormal manoeuvring before landing at ENGM. He would like to report details from the incident directly to him upon arriving Keflavik in the afternoon. When the aircraft was returned to Keflavik airport Iceland, the chief pilot of the company met the crew of TF-FIO at Reykjavik.

Details of the manoeuvring of the aircraft were given. The Flight Data Recorder (FDR) was removed from the aircraft. The morning after the incident, January 23, Icelandair informed AAIB Iceland, describing the occurrence as an "upset" after an interrupted approach to runway 01L at Gardermoen. AAIB Iceland informed AAIB/N the same morning that an occurrence had taken place at Gardermoen January 22. The seriousness of the incident was not evident, and AAIB/N did not start an investigation at that time. On the 31st of January AAIB/N received information about the incident indicating the necessity to start an investigation.

AAIB/N also received letters from concerned passengers requesting the incident to be investigated. When the details from the FDR were known regarding high load factors, excessive speed and

different warnings given, the Boeing Aircraft Company was also informed, and the aircraft was grounded for inspections.

In accordance with ICAO Annex 13, Aircraft Accident Investigation Board, (AAIB) Iceland appointed Thormodur Thormodsson as an accredited representative. National Transportation Safety Board (NTSB) of USA designated Gregory Phillips as U. S. accredited representative.

SUMMARY

On the 22nd of January 2002 a Boeing 757-208, TF-FIO, on Icelandair flight number 315, made an approach to Oslo airport Gardermoen. The descent and approach was made in strong tailwind. The unstabilized final approach was abandoned at low altitude, and during the go-around the aircraft entered an extreme manoeuvre with high positive and negative pitch attitudes, and the aircraft exceeded maximum negative and positive g-values. The speed limits were exceeded. After the "upset", the aircraft was flown for another approach and landed at the airport 1102. The aircraft structure appeared not to be damaged. At the time of landing no report of the incident was made to the authorities. The aircraft continued on the scheduled flight without a proper technical inspection.

AAIB/N has made 4 safety recommendations.

1. FACTUAL INFORMATION

1.1 History of the flight

1.1.1 TF-FIO, a Boeing 757-208 from Icelandair with the call sign of FI-315, was on a scheduled flight from Keflavik Iceland (BIKF) to ENGM. The flight departed BIKF 0735 UTC. The flying time to Oslo was planned to be 2:10 hours.

1.1.2 The flight was dispatched with the following equipment inoperative: Right ILS, right GPS and center autopilot (A/P).

1.1.3 The take-off and landing weights were within normal limitations.

1.1.4 The scheduled flight was uneventful until the descent and approach to ENGM. The Commander was the pilot flying (PF) and the First Officer performed the duties of the non-flying pilot (PNF). The aircraft was flown by the autopilots (AP).

1.1.5 At a distance of approx. 200 NM from ENGM the First Officer received and noted down the 0920 UTC Automatic Terminal Information Service (ATIS) for ENGM, which stated RWY 01R was in use and that the weather was satisfactory for an approach to this RWY. The Commander planned for a practice CAT II approach.

Instruments and navigation aids were set and the approach was briefed according to Icelandair Standard Operating Procedures (SOP).

1.1.6 From ATC, the crew received descent instructions and SIG 2E arrival. (See Appendix no. 1: AIP NORGE/NORWAY AD 2 ENGM 4-16 and 4-15.) The descent was started at time 0930 UTC, approx. 117 NM (track miles) from ENGM. During the descend TF-FIO was cleared direct to SONER with free speed below FL 100. Later the crew was informed that the runway in use at ENGM was changed to runway 01L. The reason for the runway change was snow clearing in progress on runway 01R. The whole descent and approach was made in strong tailwind. ATC did not give any information regarding the wind. The crew was initially aware of the strong tailwind, but they also knew there was a light northerly wind at the airport and due to the high workload in the approach they failed to notice that the tailwind was much stronger than forecasted. Wind information was available through the flight deck instrument equipment. Later TF-FIO was cleared direct to Non Directional Beacon (NDB) Solberg (SLB). (See Appendix no. 2: AIP NORGE/NORWAY AD 2 ENGM 5-1.) The change of runway, the strong tail wind and the shortened approach path resulted in the aircraft becoming high on the approach profile.

1.1.7 The aircraft was flown on the autopilot flight director system (AFDS). As the aircraft was high on the descent profile, the Commander extended speed brakes at times, trying to maintain proper descent profile. During the descent the aircraft's speed was slowed down to approx. 240 kt. There is no CAT II approach onto RWY 01L and the crew performed a new approach briefing because of the change of runway. Instrument and navigation aids were correctly set and identified for a CAT I approach to RWY 01L.

1.1.8 At distance 10 NM from SLB, the crew of TF-FIO was cleared to descent to 3 000 ft and were told they could expect inbound turn on the localizer (LLZ) in 8 NM. The aircraft was slowed down to approx. 220 kt and flaps were extended. Close to overhead the NDB SLB, the crew received the clearance to intercept the LLZ at time 0945 UTC. Approach mode was selected on the Mode Control Panel (MCP). The autopilot flight director system captured the LLZ almost immediately, but the aircraft overshot the centreline. After crossing the LLZ centreline due to the limitations of the AFDS, an interception was made from the right side of the LLZ. The aircraft was at this time above on the Glide Path (GP). The AFDS corrected to the left to intercept. At 3 000 ft, the tailwind velocity was approx. 45 kt. The FDR data indicate the winds at 2 000 ft AGL were not constant, reducing from 30 to 20 kt from an approximate heading of 200^{o}. As altitude decreased to 500 ft AGL the FDR winds shifted to a heading of approximately 60^{o} to 70^{o} and decreased to approximately 8 kt. (On the ground the wind was light from the north).

1.1.9 At the time, 0946 UTC, the aircraft was cleared by ATC down to 2 500 ft, and this altitude was set on the MCP. This setting was maintained through the aborted approach. The gear was selected down. When the aircraft finally was established on the LLZ, it was at least 1 dot high on the GP. Flaps 20^{o} had been set with appropriate speed selection.

1.1.10 As the Commander doubted that the AP in AUTO mode could capture the GP, he disconnected both AP's and the Auto Throttle (AT) with the thumb-switches in order to manually capture the GP from above. The aircraft was flown manually the remainder of the approach, and the throttles were also operated manually until TOGA was initiated. Shortly there after, the Commander noticed that raw data information of the ILS on his ADI and HSI were lost. No flag warnings were observed. The Commander reduced the rate of descent because of the uncertaincy. The raw data signals on his instrument panel appeared and disappeared again. The First Officer was informed, but on his instruments all indications were normal. The crew did not consider a change of controls at this time.

1.1.11 The aircraft descended through 1 000 ft AAL (Above Aerodrome Level) in an unstabilized mode without the mandatory "call out".

1.1.12 At an altitude of approx. 580 ft AAL (Flight Data Recorder (FDR) radio altimeter reading) the Commander decided that he discontinued the unstabilized approach and initiated a missed approach. The time was 09:49:11 UTC. He announced his decision to the First Officer and started a "Go-Around" (GA).

1.1.13 The status of the flight was as follows: The aircraft was above the GP, and the SOP calls for the GA altitude to be set when stabilized on GP, therefore the GA altitude was not set on the MCP. Flaps were not in landing configuration, because landing Check List was not completed. The Commander's instrument panel indicated intermittent ILS failures of raw data without any flag warnings. The lowest altitude AAL indicated on the FDR was approx 460 ft.

1.1.14 The "pitch over" incident is here described mainly based on the FDR information with the Commander's and First Officer's reports incorporated:

1.1.14.1 When the go-around manoeuvre was started by the use of the auto go-around system, the speed was 182 kt. The aircraft was flown manually. The aircraft pitch was increased to approx. 20^{o} and the aircraft started to climb. Upon initiating the go-around, the A/T automatically engaged and increased the thrust to the EPR (Engine Pressure Ratio) limit. In addition, the application of the under wing engine power also gave pitch up movement. During the climb the landing gear was retracted. The flight director pitch initially targeted a pitch attitude of 15^{o}. The airspeed reached a maximum of 198 kt before it started to decrease.

1.1.14.2 Because of the aircrafts proximity to the MCP selected altitude of 2 500 ft when the go-around was started; the AFDS transitioned to Altitude Capture almost immediately after a positive rate of climb was achieved. At time 09:49:19 UTC the aircraft climbed rapidly through the MCP altitude of 2 500 ft, The FD continued to give commands targeting the MCP selected altitude. The A/T changed from go-around mode to targeting the MCP selected speed (150 kt). The maximum aircraft pitch (21^{o}) was reached. The thrust remained near maximum because the Commander held the throttles forward. The speed was decelerating and quickly dropped below MCP speed. The pitch flight director continued to give command to lead the pilot back to the MCP altitude.

1.1.14.3 At time 09:49:34 UTC the aircraft reached a peak altitude of 2895 ft (FDR QNH corrected altitude) and the speed had decreased to 137 kt. (The reference speed for flaps 20^{o} is 131 kt.) Nose down was applied manually by the control column. The First Officer called for "bug up" (for the flap up manoeuvring speed) to set the airspeed indicator, and the Commander pushed on the Flight Level Change Switch (FLCH) button to break the flight director altitude lock on. The speed selected on MCP was changed from 150 kt to 210 kt. During the next seconds, a full nose down input on the control column was made manually. The aircraft pitched over to an attitude of approx. –30^{o}, and for a period of approx. 5 seconds the FDR indicates negative g-values with a maximum load factor of –0.6 g.

1.1.14.4 The control column was briefly returned to near neutral, and then another abrupt large nose down column input was made. The aircraft pitched over rapidly with the speed increasing excessively. The FDR data show that the Ground Proximity Warning System (GWPS) aural warning of "Pull up" was activated. The aircraft was now in a steep dive and rapidly descending. During the dive the flight director pitch bar gave pitch up commands relative to the pitch attitude. The A/T reduced the trust from 98% N1 to 45% N1. At time 09:49:44 UTC the aircraft pitch attitude had peaked at -49^{o} and was beginning to increase positively.

1.1.14.5 At this time the First Officer called out "PULL UP!" - "PULL UP!". The GPWS aural warnings of "TERRAIN" and then "TOO LOW TERRAIN" were activated. Both pilots were active at the control columns and a maximum "up" input was made. A split between left and right elevator was indicated at this time. It appears the split occurred due to both pilots being active at the controls. The pilots did not register the aural warnings. During the dive the airspeed increased to 251 kt and the lowest altitude in the recovery was 321 ft radio altitude with a peaked load factor of +3.59 g's.

1.1.14.6 The recovery continued with the aircraft pitch attitude increasing to about 40^{o}, and a positive rate of climb was established. The AT increased the thrust back to around 98% N1. Eventually a normal trimmed flight was established, after a short level off around 3 000 ft, finally at 4 000 ft, after several abrupt control inputs.

1.1.15 Reports from the chief cabin attendant and some of the passengers on the status during the "pitch-over" can be summarized:

> The movement of the aircraft resulted in water being expelled from toilets and all loose articles started to move around. Bags stored from underneath seats became loose, newspapers moved out of paper racks, magazines and books out of seat pockets, mobile phones and spectacles were lifted from pockets of personal clothing. In some cases, articles belonging to passengers sitting in front of the wing section ended up in the aft galley. Fortunately, everybody, with one exception, had their seatbelts fastened. He did not know whether he had fastened it or if it had become unfastened. He was in shock and demonstrated several signs of distress.

> The passengers felt the positive and negative g-forces as extreme and very uncomfortable. It led to chaos in the cabin. The manoeuvres were very scaring, some were screaming and others were praying to God.

1.1.16 When established at 4 000 ft the appropriate selections were made on the MCP. The AP was engaged. The First Officer reported the missed approach to the Approach Control, which gave TF-FIO vectors for a new approach. No information about the incident was given, and ATC was not made aware of the abnormal manoeuvre.

1.1.17 The whole "pitch-over" manoeuvre was made in clouds. Some of the passengers had a brief view of the ground when the aircraft was at the lowest point. For the flight deck crew, the incident took place in IMC.

1.1.18 The Commander gave a short announcement to the passengers and cabin attendants stating the approach had not been successful. A new approach had been started, and a landing could be expected within 10 minutes. When established on final the Commanders ILS raw data disappeared again. He handed over the control of the aircraft to the First Officer who landed the aircraft at time 1102.

1.1.19 Because of the negative and positive load factors, the chaos in the cockpit was identical to that in the cabin. Flight bags and papers had been thrown about. During the taxiing-in the pilots made a short review (debriefing) between themselves of the "pitch-over" manoeuvre without coming to a conclusion of what really had happened.

1.1.20 After parking at the gate the passengers with destination Oslo left the aircraft without any orientation/briefing of the missed approach and the following manoeuvres. The passengers were confused and many were shocked and frightened.

1.1.21 When the aircraft was parked, the pilots cleaned up the cockpit. The Commander gave a short initial briefing to the cabin attendants. He requested contact with a technician. The First Officer had requested through Scandinavian Airlines System (SAS), the ground-handling agent, a technician to report to the aircraft. SAS contacted the Braathens airline company and a technician arrived, informing the Commander that his licence on B757 had expired, and as far as he knew there were at present no maintenance contract between Icelandair and Braathens. The technician also informed the Commander that by contacting Icelandair the validity of his licence could be extended. This would probably take some 30 minutes. (A valid contract was in force between Icelandair and the company Britannia of Sweden which operates B757's. However this company did not operate at Gardermoen airport at the time of the incident. It has later been confirmed that Britannia technical personnel were available at the time of the incident.) The Commander was not aware of this fact.

1.1.22 At the time the Braathens' technician arrived, the Commander was in the telephone with the Icelandair Maintenance Control at Keflavik. He informed the company of

the failures of the basic ILS data, the lack of flag warnings, and thereafter handed the phone over to the technician. In agreement with the Maintenance Control in Iceland, the Braathens' technician made BITE tests of the instrument system. When the tests were completed, he checked the raw data for normal indications and informed the Commander about the results. No information of load or speed exceedances was given to the technician.

1.1.23 The technician was finally asked by the Commander to check the flaps operation. The flaps were extended and retracted. A normal operation was indicated.

1.1.24 The Commander took time to give a thorough briefing of what he thought had taken place to the stunned cabin attendants. He also asked them if they wanted to continue onwards on the scheduled flight. All five of them agreed to continue their duties.

1.1.25 After a discussion with the First Officer who was concerned of possible exceedance of maximum flaps 20^{o} speed, the Commander decided to continue the flight according to schedule. The First Officer agreed to the continuation of the flight. The flight crew were not at the time aware of the fact that the aircraft had been overstressed. Possible exeedances of load factors were not discussed. When the continuing passengers for Stockholm boarded, they also received a briefing of the missed approach and the following "pitch-up".

1.1.26 The flight continued to ESSA and later on to Iceland. The flights were uneventful, and all systems worked normally.

1.1.27 During the stop at ESSA, a phone call to the company chief pilot was made. The Commander requested a meeting for a debriefing of the aborted approach at Oslo airport Gardermoen upon arrival Iceland.

1.1.28 After landing at Keflavik airport Iceland, the chief pilot of the Icelandair met the crew of TF-FIO at Reykjavik. Details from the manoeuvring of the aircraft were given. The FDR was removed from the aircraft upon order from the chief pilot.

1.1.29 The aircraft continued operating until 25th of January when a C-check was performed. The aircraft was released on the 7th of February, and was flying on scheduled flights until 13th of March when the Boeing Company recommended further inspections after evaluating data of the incident from the FDR.

1.2 Injuries to persons

INJURIES	CREW	PASSENGERS	OTHERS
FATAL			
SERIOUS			
MINOR/NONE	7	75	

1.3 Damage to aircraft

None

1.4 Other damage

None

1.5 Personnel information

1.5.1 The Commander

1.5.1.1 The Commander, a male aged 43, possessed an ATPL-A (Airline Transport Pilot Licence (Aircraft)) valid for Boeing 757/767 type rating. The licence was valid until the 23rd of August 2006. His last Class 1 medical examination was carried out on the 21st of August 2001 and was valid until 21st of February 2002. The Commander's Proficiency Check was valid until the end of March 2002.

1.5.1.2 The Commander began his flying career in April 1986.

1.5.1.3 In June 1975 the Commander started work for Icelandair as a baggage handler and worked as such on his school vacations for some years. He started working for the company as an aircraft maintenance technician and in April 1986 he started his career as a First Officer flying the Fokker F-27.

1.5.1.4 The Commander had 581 flying hours the previous year and had accumulated a total of 8 034 hours of flying time.

1.5.1.5

FLYING EXPERIENCE	TOTAL	ON TYPE
LAST 24 HOURS	2:40	2:40
LAST 3 DAYS	2:40	2:40
LAST 30 DAYS	34:35	34:35
LAST 90 DAYS	126:20	126:20

1.5.1.6 The Commander was off duty the last four days before the incident. The incident took place on the first of three scheduled flight sectors that day.

1.5.2 The First Officer

1.5.2.1 The First Officer, a 26-year old male, possessed a CPL-A (Commercial Pilot Licence (Aircraft)) valid for Boeing 757/767. The licence was valid until 23rd of August 2006. His last Class 1 medical examination had been carried out on the 21st of

August 2001 and was valid until 23rd of August 2002. The First Officer's Company Proficiency Check was valid until the end of March 2002.

1.5.2.2 The First Officer started to work with Icelandair as a dispatcher. 1st April 1999 he began his flying career as First Officer flying the Fokker 50.

1.5.2.3 The First Officer had 495 flying hours during the previous year and had accumulated a total of 2 485 hours of flying time.

1.5.2.4

FLYING EXPERIENCE	TOTAL	ON TYPE
LAST 24 HOURS	7:19	7:19
LAST 3 DAYS	14:27	14:27
LAST 30 DAYS	30:53	30:53
LAST 90 DAYS	107:45	107:45

1.5.2.5 The First Officer was on the first sector of three, on the second day of a two-day schedule. His flight duty period on the previous day was 9:29 hours. He had a rest period of 13 hours before returning to work on the 22nd of January.

1.6 Aircraft information

1.6.1 Boeing 757-208, registered TF-FIO, is a medium range twin turbofan airliner. It is powered by two 178,4 kN (40,100 lb st) Rolls-Royce RB211-535-E4 turbofans. The aircraft was manufactured in 1999.

The aircraft was dispatched from Keflavik with the following equipment inoperative: Right ILS, Right GPS and Center autopilot. These dispatch deviations were allowed according to the Minimum Equipment List (MEL) and accepted by the Commander of the flight.

1.6.2 In February 2002, after the incident, the aircraft went through a C-check. When Boeing became aware of the seriousness of the incident, the company requested Icelandair to perform a very extensive structural inspection on the airplane. The inspection was focused on the fuselage, wings, empennage and the engine strut connection. The inspection asked to look for distortion, flaked paint, cracks, and buckled structure and for fasteners that have pulled out or "are not there". The inspection was very detailed, and required many of the inspection tasks that already had been accomplished during the above-mentioned C-check. The Boeing Company sent a wing structure engineer specialist to assist with determining possible damage, and to determine if further inspection would be required. It turned out that a re-inspection of the parts that had been inspected during the C-check was not necessary. As a result of this, the extent of the inspection decreased. It was apparent that the

airplane's structure had not been damaged. As a precaution, the following parts were exchanged:

1. Six fuse bolts in the engine strut connection
2. The forward bolts on the flap track to wing connection
3. The two bolts that run through the two main rollers, on each flap track.

The engine manufacturer, Rolls Royce, decided after contact with Icelandair that no special inspection would be necessary on the engines. Rolls Royce did, however, recommend that the engines mount connection points should be inspected next time the engines were removed.

1.7 Meteorological information

1.7.1 The flight en route was made in VMC and in strong tailwind.

1.7.2 The missed approach and the following manoeuvre were made in IMC (in clouds).

1.7.3 The forecast for ENGM at 0500 UTC for the period 06 –15: Wind: Variable 05 kt. Visibility 2 000 m in snow. Clouds: Scattered at 500 ft, broken at 1 000 ft. Temporary 06 – 15: Visibility 1 000 m in snow, vertical visibility 400 ft.

1.7.4 The actual weather at ENGM 0620 UTC: Wind: 020^{o} 5 kt. Visibility: 1 500 m in snow. Vertical visibility: 600 ft. Temperature and dew point: -4 ^{o}C / -5 ^{o}C. QNH: 990 hPa. Temporary: Visibility 1 000 m in snow.

1.7.5 Automatic Terminal Information System (ATIS):

Information OSCAR at 0920 UTC:
Braking Action at time 0810, 43-43-46. Runway 01R in use. W/V 010/3. Visibility 3 000 m, light freezing drizzle. Few clouds at 200 ft, scattered clouds at 300 ft, broken cloud base at 500 ft. TEMPO visibility 1 000 m, freezing drizzle and mist, vertical visibility 400 ft. Tailwind reported 20 kt down to 200 ft.

1.7.6 Actual weather at 0950 UTC: Wind: 360^{o} 2 kt. Visibility: 2 700 m.
Weather: Freezing drizzle, mist. Clouds: Few at 100, scattered at 200, broken at 300. Temperature and dew point: -4^{o} C / -4^{o} C. QNH: 985 hPa.
Temporary: Visibility: 1 000 m, freezing drizzle, mist, vertical visibility 200 ft.

1.7.7 January 22 at 0850 an "Aerodrome warning" was issued by AIS/MET Department ENGM:

2.	Crosswind:	Wind 2 000 ft 170^{o} / 10 kt Wind 3 000 ft 245^{o} / 40 kt Wind 4 000 ft 240^{o} / 45 kt
3.	Freezing: Rain/Drizzle:	Icing condition due to intermittent freezing drizzle

1.8 Aids to navigation

Ground based aids to navigation had no effect on the incident.

1.9 Aerodrome information

1.9.1 Oslo airport Gardermoen (ENGM) is equipped with modern communication- and navigation equipment. There are several area radio navigation- and approach-aids. These consists of NDB's, DME's and DME/VOR's. There are installed ILS to all runways. Runway 01R has a ILS of CAT II standard, while runway 01L's ILS is of CAT I standard. The aerodrome is furnished with both approach- and ground radar. All aids worked normally at the time of the incident.

1.10 Communications

1.10.1 The radio communications between TF-FIO and the different ATC controllers functioned normally. Judging from the recordings, radio reception was good and there was no interference on the frequency. The phraseology used was mainly in accordance with the instructions.

1.11 Flight recorders

1.11.1 The aircraft was equipped with a Honeywell flight data recorder, P/N 980-4700-042, S/N 3979. The FDR was removed from the airplane January 22th 2002. The data has been of great use for this investigation.

1.11.2 A cockpit voice recorder (CVR), type L3 Communication (Fairchild) type 2100-1020-00 was installed. As the flight continued after the incident with electrical power on the system, no information from the CVR has been available to AAIB/N.

1.12 Wreckage and impact information

Not relevant.

1.13 Medical and pathological information

There were no medical cause factors in this incident.

1.14 Fire

Not relevant

1.15 Survival aspects

Not applicable.

1.16 Test and research

Not relevant.

1.17 Organizational and management information

1.17.1 The airline

1.17.1.1 Icelandair as an airline traces its roots to the year 1937 when a fledging airline, Flugfelag Akureyrar, was founded at Akureyri on the north coast of Iceland. In 1943 the company moved its headquarters to the capital city, Reykjavik, and changed its name to Flufelag Íslands. The airline later assumed the international trade name of Icelandair.

1.17.1.2 Another important milestone was passed in 1944, when three young Icelandic pilots, returning from their flight training in Canada, founded Loftleidir, which later became known as Icelandic Airlines. Initially both companies concentrated on Icelandic domestic air services. However, in 1945 Flugfelag Íslands made its first international flights to Scotland and Denmark. Loftleidir started international operations in 1947. It's pioneering low-fare services across the North-Atlantic commenced in 1953.

1.17.1.3 In 1973 it was agreed to merge Flugfelag Íslands and Loftleidir under a new holding company, Flugleidir. In October 1979 Flugleidir assumed all operating responsibilities of its two "parents", and decided to use Icelandair as its international

trade name, only retaining the Flugleidir name in the Icelandic domestic market.

1.17.1.4 The company is 100% privately owned by 4517 Icelandic shareholders. It is the largest private company in Iceland, employing over 2 000 people.

1.17.1.5 Icelandair has been a member of IATA (International Air Transport Association) since 1950, a member of AEA (Association of European Airlines) since 1957, and a member of the Flight Safety Foundation since 1966.

1.17.2 Organization

1.17.2.1 Icelandair operated scheduled passenger, cargo and charter flights primarily between Iceland, Europe and North America. It is one of the largest aviation operators in Iceland and has a long and distinguished operational record. In 1990 the airline started to expand and restructure its aircraft fleet. It is presently operating a fleet of 11 Boeing 757-200 and 757-300 aircraft.

1.17.2.2 Authority for operation is by an Air Operators Certificate (AOC) issued by the CAA of Iceland. Iceland is a member of the JOINT AVIATION AUTHORITIES, and Icelandair operates according to JAR-OPS 1 requirements.

1.17.2.3 An Accountable Manager has the overall responsibility for all aspects of aircraft operation and Nominated Post Holders are responsible for:

- Flight Operation
- Maintenance Systems
- Crew training
- Ground Operations

At the time of the incident one person is Nominated Post Holder for Flight Operation, Crew Training and Ground Operation.
One other person is Nominated Post Holder for Maintenance Systems.

1.17.2.4 A comprehensive Flight Operations Manual (FOM), supplemented by Aeroplane Operating Manual (AOM), Route Manual (RM) and Training Manual (TM) controls the different aspects of Flight Operations. A Manual System described by a “manual tree” places the different manuals in relation to each other.

1.17.2.5 Crew selection, initial technical- and flight training and recurrent training satisfy the requirements from the authorities. The training is organized in a series of modules given at different times and at different locations. Crew Resource Management (CRM) is one such module. The modular system places increased workload on Flight Operations management in the areas of checking and supervision in order to assure that all safety critical items and procedures are adequately addressed. The new training facility in Reykjavik was opened in December 2001 before the incident

occurred. After the incident Icelandair has started using the new in-house training facility utilizing the latest state-of-the-art training aids.

1.17.2.6 Icelandair was not at the time of the incident utilizing a systematic analysis of flight recorder data of all flights for supervision, control and monitoring of the company's operational standard. The present aircraft fleet is equipped with Quick Access Recorders making such analysis possible.

1.17.2.7 Icelandair has a philosophy and a set of policies as well as procedures and practices in order to maximize the safety of all flights.

1.17.3 Training and selection

1.17.3.1 In order to be accepted as a pilot candidate for Icelandair, the flying experience required is either:

1) having previously received type rating on an aircraft requiring two pilots or
2) having accumulated at least 1 500 flight hours, or
3) having accumulated at least 500 flight hours and completed specific training courses approved by ICAA in preparation for training on turbo-jet airplanes.

1.17.3.2 The pilot candidates to Icelandair must in addition pass an extensive selection process before being accepted for pilot training in the company.

1.17.3.3 The candidates have to undergo several psychological tests like MMPI (Minnesota Multiphasic Personality Inventory). (MMPI is a method for measurement of traits of personality, such as those having to do with interests, attitudes, emotional adjustment and social relations, all-important aspects of a pilot's personality and abilities). In addition the pilot candidates are checked for psycho-technical abilities, communication skills, leadership potential, stress tolerance and inductive intelligence. Further the candidates have to demonstrate basic flying and CRM (in this connection Cockpit Resource Management) skills in a flight-training device where two applicants are tested at the same time.

1.17.3.4 Being accepted as a pilot in Icelandair the pilots undergo an initial course including type rating, and a four weeks ground course followed by two weeks of simulator training. Finally landing and line flying under supervision is given for 1 – 3 weeks. Both flight crewmembers had undergone this flight training.

1.18 Additional information

1.18.1 From Icelandair Standard Operating Procedure (SOP):

1.18.1.1 2.1 Checklists

---------. The pilot assigned to read the checklist will not initiate a checklist but he will remind the PF when he feels the call for the checklist is becoming overdue. ----------.

1.18.1.2 2.4 FCM/CDU

---------. In-flight: FMC/CDU route and approach modifications should be inserted by the PNF and executed only after confirmation by the PF. --------.

1.18.1.3 2.9 Approach considerations

---------. Crews can reduce risk with planning and vigilance. --------. Plan to abandon the approach if company standards for a stabilized approach are not met.

After commencement of an approach, a missed approach should be conducted when:

- Confusion exists or crew coordination breaks down;
- There is uncertainty about situational awareness;
- Checklists are being conducted late or the crew is task overloaded;
- Any malfunction threatens the successful completion of the approach;
- The approach becomes unstable in altitude, airspeed, glide path, course or configuration;
- ---------.

1.18.1.4 2.10 Stabilized approach

An approach is stabilized when the airplane is flown:

- Along the desired flight path in landing configuration;
- With a heading needing only small corrections to maintain the desired flight path;
- At the correct approach speed including relevant and agreed upon corrections; maintaining an acceptable rate of descent; and
- At a thrust setting needing only small corrections to maintain the desired flight path.

In IMC the approach should be stabilised no later than 1 000 ft AAL.

1.18.1.5 2.12 Flight deck Discipline

Both pilots should be aware of altitude, aeroplane position and situation. If any doubt, investigate.
----------. Use standard callouts at all times. The pilot not flying should accomplish callouts based on instrument indications or observations for the appropriate condition. -------- If the PNF fails to make the required callout the PF should make it. -------. Pilots are expected to give all commands, challenges and responses in a command tone (clearly).

1.18.1.6 Descent/Approach Procedures

In these procedures it is stated that PNF shall call out at 1 000 ft AAL (QNH): **"One thousand"** and the PF shall confirm.
It is also stated: "Accomplish landing checklist to flaps at glide slope intercept. When landing flaps are set, complete landing checklist.

1.18.1.7 7.7 Missed Approach Procedure. ILS Approach

The SOP has a detailed procedure of what PF's and PNF's duties. It starts with the PF shall announce go-around, he shall push the GA switch and order "FLAPS TWENTY". Both pilots shall verify rotation to go-around attitude and thrust increase, and verify flight mode annunciation on ADI for proper mode. The PNF shall verify go-around thrust and adjust if necessary. He shall call out "POSITIVE CLIMB". The procedure continuous with gear retraction and the setting of climb power.

1.19 Useful or effective investigation techniques

1.19.1 Nothing other than routine investigative methods have been used in this investigation.

2. ANALYSIS

2.1 The descent and the unstabilized approach:

2.1.1 The descent was started at normal time and distance from the planned landing runway. After the descent had been initiated, there was a change of runway; but this made only a minor shortening of the distance. Later the descent distance was shortened twice by ATC. This, together with the strong tailwind, caused the aircraft to become high on the approach profile. Contributing to this incident was also the air traffic controller's vectoring of the airplane. To compensate, the Commander was

using speed brakes. In spite of this, the aircraft was still high when approaching the point of the glide path capture for runway 01L. The Commander did not contact ATC in order to extend the descent distance. To get rid of the high energy of the aircraft became a problem. A stabilized approach is critical for a safe landing. Everyone involved in the system has an important role to play. When the last turns were made to intercept the LLZ, they were made too late with the result that the aircraft overshot. A new intercept from the opposite side had to be made. During the hearing of this report AAIB/N received the following from CAA Iceland:

> "We think that there should be more emphasis on the captains responsibility to plan his approach in such a way that a stable approach can be made, to follow standard operating procedures and to follow and see to it that CRM procedures are followed. If the captain fails in his duties, the first officer should of course draw the captains attention to the irregularity."

AAIB/N are in agreement with this statement.

2.1.2 When, finally, the aircraft was stabilized on the LLZ, it was high on the glide path, the correct flap setting was not made, and the approach speed was varying, being too high. The final landing checklist could not be completed according to SOP, as the completion of this checklist depended on being stabilized on the glide path. The Commander analysed the situation during the continued approach, and finally, when he also lost raw data from the ILS on his instruments, he correctly decided – late in the sequence - to abandon the approach and to perform a go-around.

2.1.3 AAIB/N consider that the Commander entered into a situation of mental overload. The overload started when he did not comprehend the problem being high on the descent profile. The aircraft ended being unstabilized on the final approach. According to SOP, the aircraft should be in landing configuration and only very small corrections to speed, power and attitude should be rendered at this final stage of approach.

2.1.4 In an approach in marginal weather, there should normally be a high degree of cooperation between the crewmembers. AAIB/N have reached the opinion that sufficient cooperation did not take place. The SOP and the flight crew training, especially the CRM-training, should have lead to a more active crew cooperation. The hesitant attitude of the First Officer during the approach is considered an important factor for the unstabilized approach and the Commander's mental overload situation. It is of no less importance the obligation of the Commander to remind the Co-pilot of his duties as Pilot Not Flying. The lack of call-outs regarding altitudes and speeds reinforced the difficult situation that eventually developed. The decent and approach were not performed according to the company SOP.

2.2 The go-around:

2.2.1 It is difficult to fully understand why the crew unintentionally entered the extreme manoeuvres following the abortion of the approach. This part of the flight was performed in IMC. In trying to understand why it happened, it is necessary to look into details of the "upset".

2.2.2 When the Commander finally, too late in the sequence in the opinion of AAIB/N, decided to discontinue the unstabilized approach, he was flying the aircraft manually. When initiating the auto "Go-around", the auto throttle became engaged, and increased automatically the engine trust to the EPR limit. The application of the under wing engine power also gave a pitch up movement. The flight director pitch bar commanded a pitch attitude of 15^{o}. (The AFDS commanded a level off at 2 500 ft (the last assigned altitude by ATC). The AFDS calculates the high closure rate to 2 500 ft and captures that altitude almost immediately; causing the A/T to change from Go-around mode to retard power to MCP selected speed (150 kt)). The aircraft therefore climbed very rapidly through the MCP selected altitude of 2 500 ft and with the aircraft pitch increasing to 21^{o}. AAIB/N considers that the Commander at this time had lost situational awareness (being "behind the aircraft").

2.2.3 As the Commander noticed the speed to be rapidly decreasing, he pushed the control column forward. This was in order to follow the command of level off at 2 500 ft. Pushing the control column forward is also an elementary flying procedure to increase the speed and to prevent the aircraft from entering a stall.

2.2.4 The First Officer at this time called for "Bug up". The Commander reached for and resat the MCP speed. This was contrary to company Standard Operation Procedure. Simultaneously the Commander continued to push the control column even more forward. The aircraft reached a maximum altitude of 2 895 ft and the load factor reached a negative g-value of –0.6.

2.2.5 The aircraft then entered a rapid dive, and the speed increased. Different warnings were given of ground proximity and the command of pull up by the aircraft systems, but not registered by the crew. The A/T reduced the trust from 98% N1 (full power) to 45% N1 (idle power). The negative pitch reached a maximum value nose down of 49^{o}. Up to this time the First Officer had been somewhat passive and confused. Now he acted as an active and co-operative crew member and asked: "What are you doing" and next, he called out: "Pull up!" - "Pull up!". Both pilots pulled back on their control columns, and the aircraft, after reaching a maximum speed of 251 kt, recovered from the dive with a clearance of 321 ft (radio height) over the north end of the runway 01L. During the pull-up the load factor increased to positive G-value of 3.59.

To the hearing of this report the Commander gave AAIB/N the following statement:

> "I believe my First Officer acted as an active and co-operative crewmember throughout the flight, but in the final approach, due to the abnormally high workload, both of us became occupied handling details instead of looking at the

whole picture. And when we suddenly got the altitude capture commands from our FDS, when both of us were mindset for a go-around, we became confused and later on the unbelievable nose down pitch attitude, we became even more confused."

2.2.6 The aircraft pitch then increased to about 40° nose up, and after several abrupt control inputs, the aircraft was levelled off at 4 000 ft. Pitch upsets are defined as pitch in excess of 25° up and 10° down. As the pitch values were outside these limits, the artificial horizon indication became all brown as registered by the Commander when the aircraft descended. This baffled the Commander even more. (There is at least 0.25 inches of blue visible on the HSI during this situation on the accident airplane as delivered.)

2.2.7 The importance of crew cooperation is imperative. In this case, AAIB/N is of the opinion there was a complete breakdown of crew management and a lack of interaction at an early stage. When the confusion started, the combination of one pilot manually operating the controls partly in opposition to the automatic throttle movement made this "upset" understandable. This can be referred to as an "automation trap". When "bug-up" is selected to target speed, this command gets cancelled by selection of "Flight Level Change" or by altitude capture. The speed then becomes "present speed". This caused the aircraft to act differently than the pilots had anticipated. This resulted in confusion and was probably a factor in causing the incident to occur. In the opinion of AAIB/N it is not satisfactory that a seemingly properly trained and qualified airline crew should end up loosing control of a modern airliner and cause an incident like this one.

2.3 Background - training

2.3.1 Selection of individual crewmembers, initial training, type training and recurrent training in Icelandair confirms to the traditional pattern found in most airlines. The training is organized in modules and subcontractors may present the different modules individually in different locations. Each module in itself can be fully satisfactory as far as contents and presentation is concerned, but the challenge for the airlines operational management is to assure that the total training program, with all its interfaces, fulfils the goal of the operator as well as the requirements of the aviation authorities. A Quality Assurance System with the necessary oversight- and supervision systems are required to monitor the complete training process to detect possible "glitches" in the interfaces between modules in order to prevent latent failures in the system.

2.3.2 CRM training could be used as an integration tool in order to identify problem areas and at the same time prepare crewmembers for better cooperation when handling unusual and unexpected occurrences during flight.

2.3.3 A system utilizing Flight Recorder Data for continuous monitoring of the flight operational standard and the effectiveness of company procedures and regulations

were not in use in Icelandair at the time of the incident. Such a system, based on data from the QAR (Quick Access Recorder), and used to collect statistical data, has been found by many operators to give valuable early warnings about problems not easily detected by other means. The technical equipment needed for the collection of such data is already installed in Icelandair's Boeing 757 fleet.

2.4 Crew Resource Management (CRM)

2.4.1 CRM training is required for JAR OPS 1 operations. The application of CRM concepts can approve crew performance through enhanced communication training, problem solving, decision-making and workload management. In the present situation the crew demonstrated omission of action: ie. insufficient approach briefings, failure to administer high workload and a lack of risk assessment - recognize failure from standard procedures. Failures in CRM may be associated with complacency or overconfidence.

2.4.1.1 An important part of pilot training today is CRM training. CRM is not a universal recipe for safety, but a highly effective and essential aspect of flight crew training. CRM has passed through a number of generations during its lifetime of less than 20 years. The original CRM was a response to human errors, especially those associated with ineffective teamwork and decision-making. The fifth generation is based on the fact that there will always be human errors and that they are inevitable. To be effective, the training must therefore credibly communicate the limits of human factor performance with regard to mental capacity to function under stress, and thus make the crew more aware of personal limits and capabilities.

2.4.1.2 In addition the effect of CRM training is dependent of different cultures under which it is performed. In Icelandair one would presume that all the crew have the same national culture thus simplifying many aspects of the training. However, one must realise that crew behaviour is shaped by three additional cultures: professional culture, organizational culture and the company’s safety culture.

2.4.1.3 Professional culture reflects the attitudes and values associated with an occupation. For pilots this often means unrealistic denial of vulnerability to the multiple stressors of the occupation. Such attitudes may reduce the acceptance of CRM training. Further we have organizational culture, which is manifested in the openness between management and employees or in the attitudes and behaviour of critical role models such as air check men. Finally a negative organizational culture can result in CRM being viewed as yet another square filling exercise rather than the reflection of the organizations standards.

2.4.1.4 Last but not least will the company’s safety culture be manifested in knowing channels to communicate safety concerns and a sense that these should be addressed. It is essential that training and evaluation not only focus on the avoidance of error, but also on the management of error. In accordance with this view the last generation of CRM training is trying to get rid of the term “pilot flying and pilot not

flying" and substitute it with "pilot flying and pilot monitoring". In the present situation the crew did not function as a crew, but rather as two individuals in the same cockpit without a common plan for the flight and landing. The CRM training they had received prior to the incident had not been integrated in their behaviour the way it was supposed to: "CRM is the utilization of all available resources to achieve safe and efficient operation to enhance the communication and the management skills of the flight crewmember concerned". Lack of planning left the pilots in a stressed state where they no longer were able to communicate their doubts or actions. Rather than hiding errors or shortcomings, the open sharing of error and the effective management of error provide reinforcement of CRM practice.

2.4.1.5 Lack of joint CRM training with the rest of the crew was obvious in the way the crew managed the situation immediately after landing: It took some minutes before the cabin crew got any information from the cockpit about the incident, therefore they were not able to inform the passengers properly about the situation or make sure the passengers got a psychological debriefing immediately after leaving the plane. The way the situation was handled gave the passengers unnecessary problems, which may take them some time to solve.

2.4.2 Icelandair should consider its plans for a colleague support program in connection with accidents and incidents. Such programs have proven to be helpful to pilots and cabin attendants after stressful situations, reducing the time away from active duty and fewer reports on delayed emotional reactions caused by stressful experiences.

2.5 Organization and management

2.5.1 Icelandair is organized and managed in accordance with the requirements of JAR-OPS 1 and the Icelandic CAA. Rapid expansion and recent re-organization has resulted in "growing pains" in the organization. And the management, being aware of the situation, is monitoring the process closely.

2.5.2 An investigation of Icelandair's Organization and Management along the vertical line: Philosophies, Policies, Procedures, Practices and along the horizontal line of the modules: Crew Recruitment, Initial Training, Technical Training, Flight Training, CRM training, Commanders Training and Recurrent Training demonstrated certain weak points: Philosophies and policies were not sufficiently documented in the manuals to assure that all personnel respond in the required and correct manner during operation of aircraft.

2.5.3 Icelandair has a philosophy and a set of policies as well as procedures and practices in order to maximize the safety of all flights. A more clear documentation of the philosophy and the policies in the different manuals would be of advantage to personnel at all levels of the Company.

2.6 Dispatch of aircraft from Keflavik with inoperative equipment

AAIB/N is of the opinion that the inoperative equipment according to MEL: Right ILS, right GPS and center autopilot did not in any way affect the operation or performance of the aircraft with regard to the incident over Gardermoen airport. However, the inoperative equipment may have been a distracting factor for the Commander.

2.7 The Commander's analysing of the situation after landing ENGM, and his decision to continue the flight

2.7.1 After the parking of the aircraft, the crew became organized. They had been overwhelmed, stunned and surprised of what had taken place. Between them they discussed the incident. They were not aware of the problems with the high load factors. The crew did not register these values. But they were concerned about a possible exceedence of airspeed limits. However, they were not aware of the gross exceedence that had taken place.

2.7.2 The Commander's primary concern was the failure of the basic ILS data, and when this was remedied by the BITE test, the remaining problem was the overspeed. When the technician could confirm normal operation of the flaps, the Commander decided in co-operation with the First Officer, that the flight could proceed according to schedule. AAIB/N is of the opinion there should be clear, updated instructions available for the Commander whom to contact at an outside station in case of technical problems. AAIB/N questions the Commander's decision to continue the flight without a more thorough inspection made on the aircraft. Detailed information of the serious incident should have been given to a responsible operative leader i.e. chief pilot or operational manager before the flight was continued to Stockholm.

2.8 The situation in cabin

2.8.1 It is the opinion of AAIB/N that cabin crew and passengers could have been better taken care of. It is understandable that the lack of time and the technical problems present put a heavy load on the Commander. It is also possible that he was not aware of the strain they had been through. According to cabin- and passenger reports the situation in the cabin was rather dramatic. The heavy positive and negative load factors together with the loose items being thrown around in the cabin were for them a scaring experience. Many passengers have fear of flying. An incident as this one increases the fear and uncertainty for such passengers. A quick debriefing before the departing passengers left the aircraft would have been a great relief for the concerned passengers. According to letters AAIB/N has received, many of them were scared and as they didn't receive any information from the crew or from station personnel after disembarkation, it has taken a long

time for some of these passengers to treat the personal problems related to this flight. The company should consider reviewing its procedures of informing the passengers after unwanted occurrences.

2.9 The crew procedures/performance in relation to Standard Operating Procedures (SOP)

The SOP covers in detail the handling of the aircraft in normal and abnormal situations. AAIB/N is of the opinion that had the company's basic procedures been adhered to by the crew, this incident would not have happened. Thus the planning of the final stage of this flight in marginal weather was not thorough enough. The Commander let the flight become unstabilised in speed and attitude. Correct call-outs were not made. A detailed plan for a possible go-around was not made. The final check list could not be completed since the final flap setting had not been made. The approach was aborted late on final in spite of the flight not being stabilized in correct configuration in IMC at 1 000 ft AAL. It is possible that the airport's relatively high elevation may have been of importance in this case. Most of the airports which are used by Icelandair crew are situated at or close to sea level. Gardermoen's elevation is 681 ft. When finally the go-around was started, the Commander let the airplane fly away from him, and the crew cooperation broke down. All these details are covered in the SOP.

3. CONCLUSION

3.1.1 General

a. The flight from Keflavik airport to Oslo airport Gardermoen was uneventful until the descent was started.
b. The descent and approach was made in strong tailwind.
c. The aircraft overshot of the LLZ initially.
d. The aircraft descended on the LLZ unstabilized in height and speed.
e. After the Commander started the missed approach, the aircraft entered a dramatic manoeuvre with exceedences in pitch, speed and load factors.
f. After the landing, the Commander was concerned primarily regarding the ILS raw data failures and not so much regarding the exceedences.
g. The flight continued to Stockholm airport Arlanda and back to Keflavik airport without a thorough technical inspection to be performed.

3.1.2 The aircraft

a. The aircraft had been maintained and was serviceable with no significant defects. The equipment not being operative upon departure Keflavik did not have any effect regarding this incident.

b. The raw data information of the ILS on the Commander's flight instruments disappeared intermittently at times during the approach to Gardermoen.
c. The mass and balance of the aircraft were within the normal operating limits at the time of the incident.
d. The aircraft did not receive any damage during the "upset" in spite of the exceedences of both speed and load factors. As a precaution some components were later replaced.

3.1.3 Flight Operations

a. A comprehensive Flight Operations Manual, supplemented by Aeroplane Operating Manual, Route Manual and Training Manual controls the different aspects of Flight Operations.
b. Crew selection, initial technical- and flight training and recurrent training satisfy the requirements from the authorities.
c. The Company was at the time of the incident not utilizing a systematic analysis of flight recorder data of all flights for supervision, control and monitoring of the Company's operational standard.
d. A more clear documentation of the philosophy and the policies in the different manuals would be of advantage to personnel at all levels of the Company.

3.1.4 The crew

a. The crewmembers were properly licensed.
b. Working hours and rest periods prior to the incident were within the limits prescribed by regulations.
c. The proficiency checks for both pilots were valid.
d. Both pilots had gone through the company's technical and operational flight training without waivers.
e. Both pilots had received the planned CRM company training.

3.1.5 Organisation and management

a. Icelandair is organized and managed in accordance with the requirements of JAR-OPS 1 and the Icelandic CAA.
b. A more clear documentation of the philosophy and the policies would be of advantage to personnel in the company.

4. SAFETY RECOMMENDATIONS

AAIB/N recommends:

4.1.1 That the aviation community should review the operational procedure regarding discontinued approaches. The company should also review the flight crew training regarding an unstabilized approach followed by a go-around (Recommendation no 4/2003).

4.1.2 That the company should consider its plans for colleague support in relation to accident and incidents (Recommendation no 5/2003).

4.1.3 That the company should consider utilizing the quick access recorders for continuous monitoring of flight operations standards (Recommendation no 6/2003).

4.1.4 That CAA/N should consider the effect of ATC shortening the approaches in IMC for airline-crew with possible limited experience of the Oslo area, and the effect it has on the crew's ability to manage the aircraft energy and to stabilize the approach (Recommendation no 7/2003).

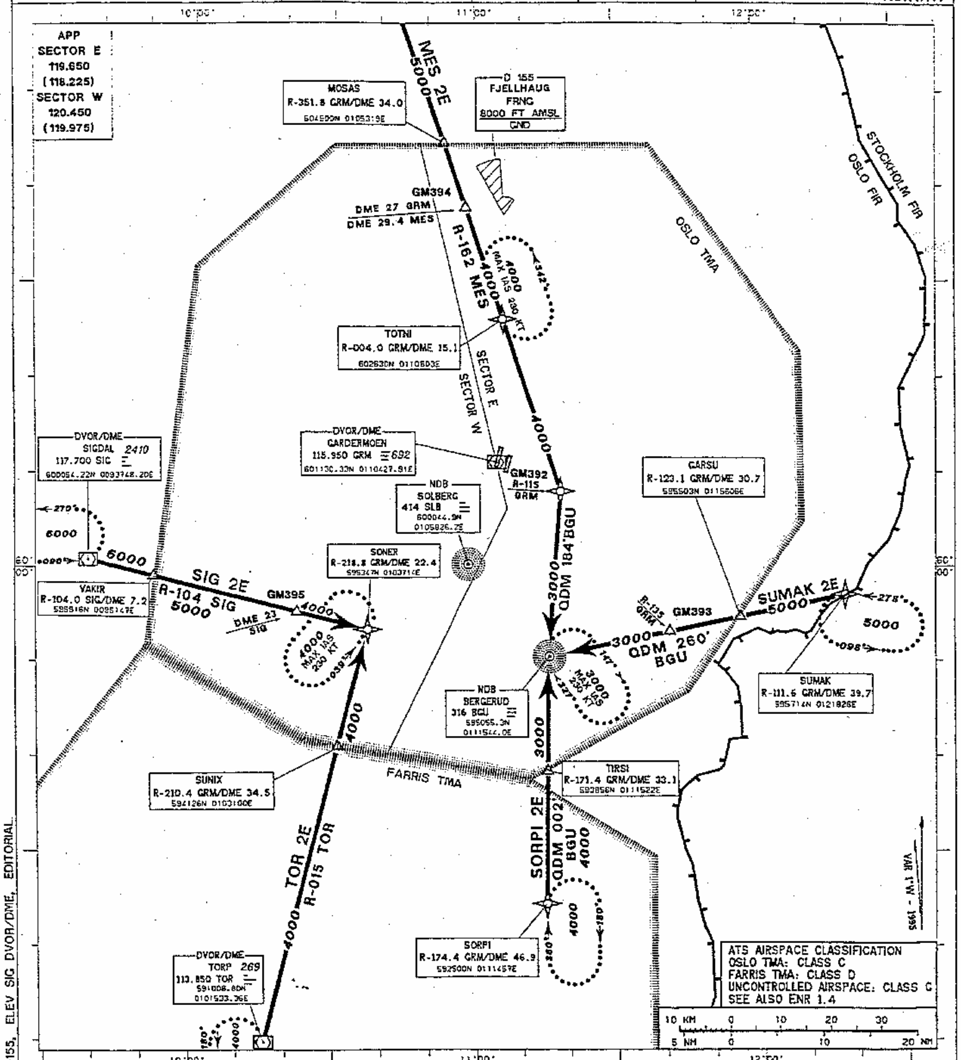
5. APPENDICES

1. AIP NORGE7NORWAY AD2 ENGM 4-16 and 4-15
2. AIP NORGE/NORWAY AD 2 ENGM 5-1
3. Glossary of abbreviations

ACCIDENT INVESTIGATION BOARD, NORWAY (AIB/N)
Lillestrøm, January 2003

Appendix no. 1 a

STANDARD ARRIVAL CHART INSTRUMENT (STAR) - ICAO	MNM SECT ALT 3800 GRM 2400 3000	BRG, TR AND RDL ARE MAGNETIC ALT AND ELEV ARE IN FEET DIST IN NAUTICAL MILES	TWR 118.300 120.100 DIR 131.350	ATIS 126.125 GND -	RWY 01L/R OSLO/GARDERMOEN NORWAY
		1:1000000 — TA 7000			


APP
SECTOR E
119.650
(118.225)
SECTOR W
120.450
(119.975)
MES 2E
5000
MOSAS
R-351.8 GRM/DME 34.0
D 155
FJELLHAUG
FRNG
8000 FT AMSL
GND
STOCKHOLM FIR
OSLO FIR
GM394
DME 27 GRM
DME 29.4 MES
R-162 MES
4000
OSLO TMA
MAX IAS 230 KT
TOTNI
R-004.0 GRM/DME 15.1
SECTOR E
SECTOR W
DVOR/DME
GARDERMOEN
115.950 GRM 692
DVOR/DME
SIGDAL 2410
117.700 SIG
GARSU
R-123.1 GRM/DME 30.7
GM392
R-115
GRM
NDB
SOLBERG
414 SLB
QDM 184° BGU
3000
SONER
R-218.8 GRM/DME 22.4
VAKIR
R-104.0 SIG/DME 7.2
SIG 2E
R-104 SIG
5000
6000
GM395
DME 23 SIG
SUMAK 2E
5000
GM393
R-135 GRM
QDM 260° BGU
NDB
BERGERUD
316 BGU
SUMAK
R-111.6 GRM/DME 39.7
SUNIX
R-210.4 GRM/DME 34.5
FARRIS TMA
TIRSI
R-171.4 GRM/DME 33.1
TOR 2E
R-015 TOR
SORPI 2E
QDM 002° BGU
4000
SORPI
R-174.4 GRM/DME 46.9
DVOR/DME
TORP 269
113.850 TOR
VAR 1°W - 1995
ATS AIRSPACE CLASSIFICATION
OSLO TMA: CLASS C
FARRIS TMA: CLASS D
UNCONTROLLED AIRSPACE: CLASS G
SEE ALSO ENR 1.4
10 KM 0 10 20 30
5 NM 0 10 20 NM
10°00'
11°00'
12°00'
60°00'

GARSU	595503N	0115606E	R-123.1 GRM DME 30.7
MOSAS	604500N	0105319E	R-351.8 GRM DME 34.0/R-162.0 MES DME 22.2
SONER	595347N	0103714E	R-104.0 SIG DME 30.7/R-015.0 TOR DME 45.1/R-218.8 GRM DME 22.4
SORPI	592500N	0111457E	R-174.4 GRM DME 46.9
SUMAK	595714N	0121826E	R-111.6 GRM DME 39.7
SUNIX	594126N	0103100E	R-210.4 GRM DME 34.5/R-015.0 TOR DME 32.3
TIRSI	593856N	0111522E	R-171.4 GRM DME 33.1
TOTNI	602630N	0110603E	R-004.0 GRM DME 15.1/R-162.0 MES DME 41.8
VAKIR	595916N	0095147E	R-104.0 SIG DME 7.2/R-252.9 GRM DME 38.4
GM392	600826N	0111814E	R-115.0 GRM DME 7.5/R-162.0 MES DME 60.9
GM393	595333N	0114117E	R-135.0 GRM DME 25.8
GM394	603815N	0105800E	R-162.0 MES DME 29.4/R-354.2 GRM DME 27.0
GM395	595537N	0102220E	R-104.0 SIG DME 23.0/R-234.3 GRM DME 26.5

STAR DESCRIPTION OVERLEAF.

CHANGES: SONER HLDG, D-155, ELEV SIG DVOR/DME, EDITORIAL.

STANDARD ARRIVAL ROUTES - (STAR)

OSLO/GARDERMOEN RWY 01L/R

SPEED RESTRICTION: Advise ATC if/when reducing below instructed speed.

RADAR VECTORING: Expect radar vectoring for sequencing to final.

NOTE: RNAV based on VOR/DME
REF FAC Gardermoen DVOR/DME GRM FREQ 115.950 MHZ/CH 106Y
PSN: 601130.33N 0110427.91E
Altitudes shown on this chart are minimum obstacle clearance altitudes only.
PIC must strictly follow instructions from ATC concerning altitudes and flight levels.

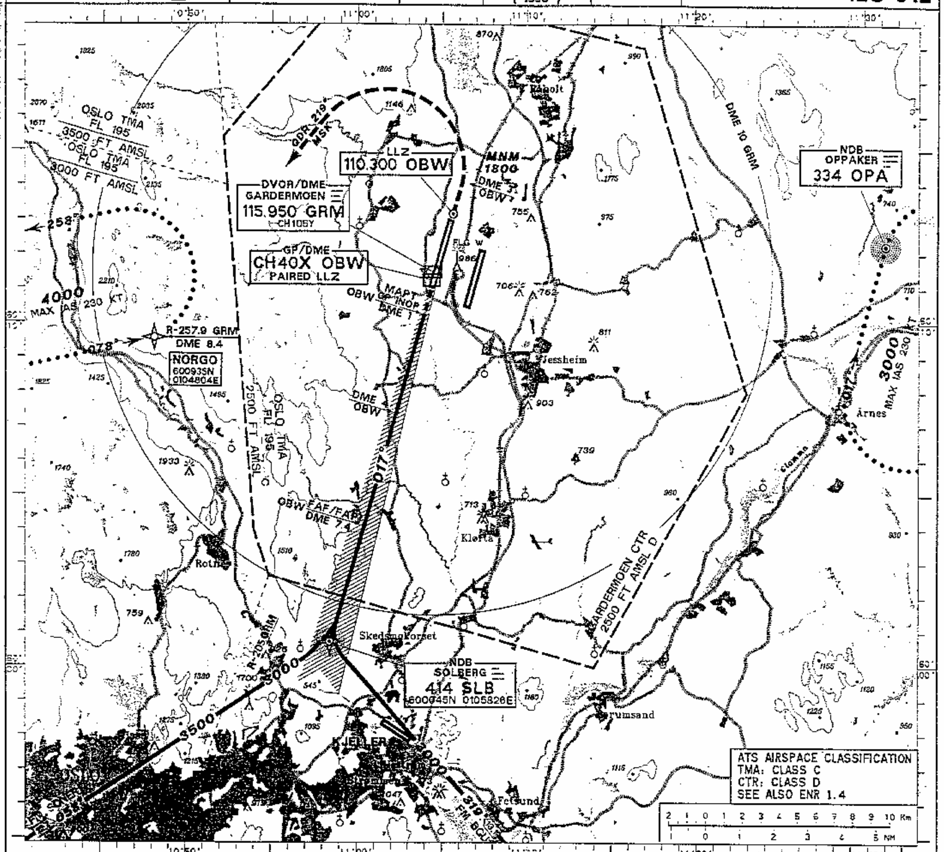
DESCEND: As cleared by ATC.

DESIGNATOR	ROUTE	RESTRICTIONS
MESNALI TWO ECHO ARRIVAL (MES 2E)	From MES proceed on R-162 MES via MOSAS and TOTNI. On passing R-115 GRM turn right DCT BGU. RNAV: MES – MOSAS – GM394 – TOTNI – GM392 – BGU.	Cross MOSAS FL 190 or below and max speed 250KIAS or as instructed by ATC.
SIGDAL TWO ECHO ARRIVAL (SIG 2E)	From SIG proceed on R-104 SIG via VAKIR to SONER. RNAV: SIG – VAKIR – GM395 – SONER.	Cross VAKIR FL 190 or below and max speed 250KIAS or as instructed by ATC.
SORPI TWO ECHO ARRIVAL (SORPI 2E)	From SORPI proceed on QDM 002° BGU via TIRSI to BGU. (RNAV required for SORPI HLDG) RNAV: SORPI – TIRSI – BGU.	Cross TIRSI FL 190 or below and max speed 250KIAS or as instructed by ATC.
SUMAK TWO ECHO ARRIVAL (SUMAK 2E)	From SUMAK proceed on QDM 260° BGU via GARSU to BGU. (RNAV required for SUMAK HLDG) RNAV: SUMAK – GARSU – GM393 – BGU.	Cross GARSU FL 190 or below and max speed 250KIAS or as instructed by ATC.
TORP TWO ECHO ARRIVAL (TOR 2E)	From TOR proceed on R-015 TOR via SUNIX to SONER. RNAV: TOR – SUNIX – SONER.	Cross SUNIX FL 190 or below and max speed 250KIAS or as instructed by ATC.

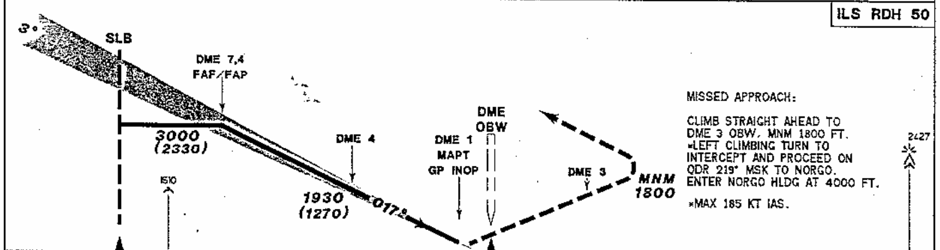
WAY-POINT LIST:

Ident	LAT/LONG	Definition	MIN ALT (FT)	RMK
BGU	595055.3N 0111544.0E	BGU NDB	3000 FT	
GARSU	595503N 0115606E	R-123.1 GRM DME 30.7	5000 FT	
GM392	600826N 0111814E	R-115.0 GRM DME 7.5 R-162.0 MES DME 60.9	4000 FT	Turn and step-down fix
GM393	595333N 0114117E	R-135.0 GRM DME 25.8 QDM 260° BGU	5000 FT	Step-down fix
GM394	603815N 0105800E	R-162.0 MES DME 29.4 DME 27 GRM	5000 FT	Step-down fix
GM395	595537N 0102220E	R-104.0 SIG DME 23.0	5000 FT	Step-down fix
MES	610559.26N 0103834.02E	MES DVOR/DME	5000 FT	
MOSAS	604500N 0105319E	R-351.8 GRM DME 34.0 R-162.0 MES DME 22.2	5000 FT	
SIG	600054.22N 0093748.20E	SIG DVOR/DME	6000 FT	
SONER	595347N 0103714E	R-218.8 GRM DME 22.4 R-104.0 SIG DME 30.7 R-015.0 TOR DME 45.1	4000 FT	
SORPI	592500N 0111457E	R-174.4 GRM DME 46.9	4000 FT	
SUMAK	595714N 0121826E	R-111.6 GRM DME 39.7	5000 FT	
SUNIX	594126N 0103100E	R-210.4 GRM DME 34.5 R-015.0 TOR DME 32.3	4000 FT	
TIRSI	593856N 0111522E	R-171.4 GRM DME 33.1	4000 FT	
TOR	591008.80N 0101533.36E	TOR DVOR/DME	4000 FT	
TOTNI	602630N 0110603E	R-004.0 GRM DME 15.1 R-162.0 MES DME 41.8	4000 FT	
VAKIR	595916N 0095147E	R-104.0 SIG DME 7.2	6000 FT	

INSTRUMENT APPROACH CHART-ICAO 1:275000	MNM SECT ALT 3800 270° GRM 090° 3400 180° 3000	HGT RELATED TO THR 01L ELEV 656 FT. CIRCLING HGT RELATED TO AD ELEV 681 FT. ALTITUDE, ELEVATION AND HGT IN FT. BEARINGS ARE MAG.	TWR 118.300 (123.325)	APP 119.650 120.450	DIR 131.350	ATIS 126.125 CLR 121.600 GND 121.675	OSLO GARDERMOEN NORWAY
			TA 7000	VAR 1° W (1995)			ILS-01L


OSLO TMA FL 195
3500 FT AMSL
OSLO TMA FL 195
3000 FT AMSL
QDR 219° MSK
LLZ 110.300 OBW
DVOR/DME GARDERMOEN 115.950 GRM CH105Y
GP/DME CH40X OBW PAIRED LLZ
MNM 1800
DME 3 OBW
MAPT GP INOP DME 1
4000 MAX IAS 230 KT
R-257.9 GRM DME 8.4
NORGO 600935N 0104804E
078
258
Jessheim
DME 10 GRM
NDB OPPAKER 334 OPA
3000 MAX IAS 230 KT
017
Årnes
OSLO TMA FL 195 2500 FT AMSL
017
OBW FAF/FAP DME 7.4
Kløfta
Rotnes
GARDERMOEN CTR 2500 FT AMSL
Skedsmokorset
NDB SOLBERG 414 SLB 600045N 0105826E
3000
3500
KJELLER
Fetsund
Årnsand
ATS AIRSPACE CLASSIFICATION
TMA: CLASS C
CTR: CLASS D
SEE ALSO ENR 1.4

ILS RDH 50



MISSED APPROACH:

CLIMB STRAIGHT AHEAD TO DME 3 OBW, MNM 1800 FT.
*LEFT CLIMBING TURN TO INTERCEPT AND PROCEED ON QDR 219° MSK TO NORGO.
ENTER NORGO HLDG AT 4000 FT.

*MAX 185 KT IAS.

CHANGES: MINIMUM GP INOP.

CAT OF ACFT		A	B	C	D
OCA (H) STRAIGHT-IN	CAT I	795(140)	804(149)	815(160)	827(172)
	GP INOP	930(270)			
CIRCLING		1090(400)	1190(500)	2040(1360)	2250(1570)
NOTE: CIRCLING W OF RWY ONLY.					

FINAL APPROACH	DISTANCE FM DME 4 TO MAPT: 3.0 NM					
SPEED	KT	80	90	120	150	180
TIME	MIN:SEC	3:00	2:00	1:30	1:12	1:00
RATE OF DESCENT	FT/MIN	320	480	640	800	960
DIST DME		6	5	4	3	2
ALT (HGT)		2570(1960)	2250(1590)	1930(1270)	1610(960)	1290(640)

Glossary of abbreviations used in this report

AAIB/N	-	Aircraft Accident Investigation Board/Norway
AAL	-	Above Aerodrome Level
ACC	-	Area Control Center
ADI	-	Attitude Direction Indicator
AGL	-	Above Ground Level
AIP	-	Aeronautical Information Publication
AIS	-	Aeronautical Information Service
A/T	-	Auto Throttle
ATC	-	Air Traffic Control
CAA	-	Civil Aviation Administration
CAT	-	Category
CVR	-	Cockpit Voice Recorder
DME	-	Distance Measuring Equipment
FD	-	Flight Director
FL	-	Flight Level
FRD	-	Flight Data Recorder
ft	-	feet
g	-	Unit of acceleration due to gravity
GP	-	Glide Path
GPWS	-	Ground Proximity Warning System
GPS	-	Global Positioning System
hPa	-	Hectopascal
HSI	-	Horizontal Situation Indicator

ICAO	-	International Civil Aviation Organization
IFR	-	Instrument Flight Rules
ILS	-	Instrument Landing System
IMC	-	Instrument Meteorological Conditions
JAA	-	Joint Aviation Authorities
JAR	-	Joint Aviation Requirements
kt	-	knots
LLZ	-	Localizer
MCP	-	Mode Control Panel
METAR	-	Meteorological Aerodrome Report
NFP	-	Non flying pilot
NM	-	Nautical miles
NTSB	-	National Transportation Safety Board (USA)
PF	-	Pilot flying
RWY	-	Runway
TAF	-	Terminal Aerodrome Forecast
UTC	-	Universal Time coordinated
VMC	-	Visual Meterological Conditions
VOR	-	Very high frequency Omnidirectional radio Range