C O N C L U S I V E R E P O R T

ON THE CAUSE OF ACCIDENT

T F - F L A

ON APPROACH TO KATUNAYAKE INTERNATIONAL AIRPORT

ON NOVEMBER 15, 1978

Submitted by

The Icelandic Delegation to the Inquiry

held in Colombo, Sri Lanka,
March 12 through April 6, 1979

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1. INTRODUCTION

1.1 In accordance with ICAO Annex 13 (Aircraft Accident Investigation) the Icelandic Directorate of Civil Aviation appointed [redacted] as the accredited representative of Iceland in the investigation of the accident to the Loftleidir DC-8-63 aircraft, TF-FLA, which crashed on approach to the Katunayake International Airport, Sri Lanka, on 15th November 1978.

1.2 During the preliminary investigation he was assisted by the following representatives of Loftleidir:

[redacted] Manager Flight Procedures,
Capt. [redacted] DC-8 Check Captain,
(appointed Loftleidir Chief Pilot effective 22 Jan. 1979),
[redacted] Loftleidir Chief Flight Engineer.

1.3 During the inquiry phase of the investigation the following representatives of Loftleidir have participated:

[redacted] Manager Flight Procedures,
Capt. [redacted] DC-8 captain,
[redacted] Lead Mechanic.

1.4 On the 12th of March 1979 the Icelandic delegation submitted a statement to the inquiry regarding its findings. This was based on evaluation of all existing and available information and facts. The circumstances of the accident have now been discussed back and forth during four weeks and a number of witnesses have been questioned.

In our opinion nothing has been presented that has changed our previous statement. On the contrary we have learned more about the deplorable status of the principal navigational aids at Katunayake Airport as it was on the night of 15th November 1978.

On the following pages we will evaluate every subject that was discussed and considered being a possible causal factor in the accident.

2. EVALUATION OF CAUSAL FACTORS

2.1 Instrument Landing System (ILS)

2.1.1 ATC- Clearance and Type of Approach

After [redacted] last appearance at the inquiry there remains no doubt whatsoever as to which type of approach the aircraft was cleared for, namely "ILS approach for runway 22". This was further confirmed by the Area Controller [redacted] Neither is there any doubt what instrument approach aid the captain was using for guidance to the runway. It was confirmed that both pilots had tuned in the BIS-ILS, and according to [redacted] the Localizer was followed accurately from the time the aircraft was established on the beam until the very end, when, according to the radar, the aircraft drifted slightly to the left. Referring to the flight path cross-section (evidence marked AC-3/6) it is also proven, in-so-far as possible, that the Glide-Path was also being followed. Flaps were selected full down almost exactly at the time when the aircraft intercepted the nominal glide path from below, which is in complete accordance with the prescribed company procedure. The captain's Course Indicator, found in the wreck, indicates that it was receiving ILS signals at the time of the crash. According to this instrument the aircraft was slightly to the right of the localizer, which also coincides with where the aircraft crashed, and only slightly low on the glide path (app.1/2 "dot"). It was produced in evidence that it is a prescribed company procedure for the pilot to remain on instruments from the Decision Height (DH) to the point of crossing the runway threshold at 50 feet. (Capt. [redacted] statement marked AC-18 and Loftleidir Operating Manual, Evidence marked X-25, page 4-4-20).

2.1.2 Status of the ILS on November 15, 1978

2.1.2.1 According to the international Standard in ICAO Annex 10, Vol. I. Part I, para. 3.1.2., an ILS shall be comprised of the three major components Localizer, Glide Path and Marker Beacons. Each of these components shall have an associated monitor system, remote control, and indicator equipment.

2.1.2.2 The status of the BIS-ILS on 15 Nov. was as follows:

a) The Outer Marker Beacon was not monitored, and it is confirmed that when the facility was visited by the Radio Inspectors it was sometimes found not to be working at all. (Ref. [redacted]

b) The Remote Control Was neither connected to the Marker Beacons nor to the Glide Path Equipment (Ref. [redacted] and [redacted].

c) The Indicator Equipment for the Glide Path Equipment and Marker Beacons was not working satisfactorily, as it was either not connected at all or faulty [redacted] and others).

According to the ATC Log Book (evidence marked X-10) the audio warning signal sounded frequently on the night of the accident, indicating that the localizer was "tripping". The ATC Tower Tape (Inter-Tower-Channel) confirms that this warning sounded 7 times in an 8 minute period ending 4 minutes 48 seconds prior to the accident, and again a few minutes after the accident. The Localizer was the only component connected to the Indicator Equipment, whereas six navaid components should have been connected, namely DME/VOR/OM/IM/Glide Path/Localizer (Ref. [redacted].

2.1.2.3 ICAO Annex 10, Vol. I. Part I, para. 2.9 contains the following international Standard for Secondary Power Supplies for radio navigation aids and communication system:

"Radio navigation aids and ground elements of communication systems of the type specified in Volume I, Part I of Annex 10 shall be provided with suitable power supplies and means to ensure continuity of service appropriate to the needs of the service provided.

Note. - Guidance material on this subject is contained in Section 8 of Attachment C to Part I."

Standby power was available for the Glide Path and the Localizer, but reportedly not reliable (Ref. ATC Log Book, evidence X-10, date 13.11.2300 Hrs. prior to the accident, and ref. evidence X-13, date 29.11.0043 Hrs. after the accident). The Marker Beacons did not have a stand-by power source (Ref. [redacted]

2.1.2.4 ICAO Annex 10, Vol. I, Part I, para. 2.7 contains the following international Standard for Ground and Flight Testing:

"Radio navigation aids of the types covered by the specifications in Part I, Chapter 3, of this Annex and available for use by aircraft engaged in international air navigation shall be the subject of periodic ground and flight tests.

Note. - Guidance on the ground and flight testing of some ICAO standard facilities is contained in Attachment C to Part I and in Doc 8071."

ICAO Doc. 8071 (Manual on Testing of Radio Navigation Aids, Vol. II, ILS) specifies that a routine flight inspection be performed at ninety-day intervals, plus or minus fifteen days. The attention of Provider States is furthermore drawn to the

fact that "routine inspections at lesser intervals than ninety days may be needed if there are doubts about equipment performance at a given site". Para. 7.2.1.2 in the same ICAO Document states: "ILS signals are used during a very critical phase of aircraft operations i.e. approach and landing. The safety of the aircraft is directly dependent on the accuracy and integrity of the ILS signals. It is essential therefore to examine the structure of the ILS signal in space when they are used".

At the time of the accident the Katunayake ILS had not been flight tested since 6 December 1977, or for a total of 344 days.

Considering the above references the facility at Katunayake Airport was not an Instrument Landing System on the night of the accident. Consequently, the air traffic controller should not have, and indeed had no right to inform the pilot of TF-FLA that "The ILS is working now", and subsequently clear the aircraft for an ILS-approach to the airport.

2.1.3. Erroneuous Glide Path Structure

2.1.3.1 During this inquiry certain evidence has been produced substantiating that the Glide Path was bending downwards approximately 3.5 nautical miles from the Touchdown Zone. The evidence referred to is the following:

a) Flight Path Cross Section, evidence marked AC-3/6, (wind component: plus 10),

b) Memo of a meeting with [redacted] U.S.FAA) marked AC-1.

c) "ILS Glide Slope Change Reversal", marked AC-7.

d) Certain entries in the ATC Log Book, evidence marked X-13 and the extract from same marked AC-11.

The above evidence, as well as that obtained from witnesses at the inquiry, substantiate that such bending, e.g. due to change reversal, is possible [redacted], Captain [redacted] and Flight Engineer [redacted]

2.1.3.2 [redacted] expressed the following opinion when asked about possible beam bends at KIA: "I would not expect any beam bends, because two flight checks have been done within one year. If there was any deterioration it would have been noticed at the second testing. Aircraft have been flying into KIA and if anything seriously adverse had been noticed, they would have reported it." Referring to Attachment A to this report, which contains a list of reports made by pilots, as noted in the ATC Log Books, we consider such notices most certainly to be at hand. [redacted] therefore must be considered to agree with the strong propability of a bending of the Glide Path at KIA.

2.1.4 Evidence of Glide Path bending as the main causal factor of the accident.

2.1.4.1 Based on information retained by the Cockpit Voice Recorder (evidence marked X-2A), as well as that obtained from the Flight Data Recorder (evidence marked X-19), it is confirmed that the captain was making an ILS approach [redacted] with steady Indicated Airspeed and normal heading changes (Flight Engineer [redacted]), until about 25 seconds prior to impact, when the aircraft departed from the nominal ILS Glide Path, and the rate of sink increases (Ref. AC-3/6, wind component plus 10 knots).

2.1.3.2 Considering additionally the information retained by the Course Indicator, and the fact that the Ground Proximity Warning System did not alert the pilots that the aircraft was below the Glide Path, it is furthermore proven that from the pilot's point of view, the approach continued to be normal, and he was not alerted of any abnormalities until 5 seconds prior to impact

and at about the Decision Height, when the copilot suddenly saw the "all-red" VASI lights. Within 2 seconds the captain applied maximum power, as he then had two kinds of glide path information, which did not agree, namely the 1/2 "dot" ILS up-demand on the Flight Director Indicator and the "all-red" on the VASIS. However, due to the fact that the aircraft was farther away from the threshold than it should have been, according to the nominal Glide Path, recovery was unsuccessful and the aircraft impaced with a hill, which at that altitude on the nominal Glide Path the aircraft should already have had crossed.

Bending of the Glide Path is thus considered to be the main causal factor of the accident.

2.1.4.3 Referring to the ATC Log Books, and confirmed by many witnesses, it can be established that this bending of the Glide Path does not exist every day. There are days, even weeks, that no reports of bendings are filed, and the Glide Path apparently is quite normal. The reason or reasons for this bending was not established during the inquiry. However, evidence was produced that such bending could result from improper operation and/or maintenance of the system (Ref. [redacted] report, evidence marked AC-1).

2.2 RADAR

2.2.1 Radar Procedures:

It was established in evidence that the Sri Lanka AIP (Aeronautical Information Publication) contains no procedure for the use of the Surveillance Radar at KIA [redacted] Neither do the Jeppesen approach charts, which were available to the pilots, contain any information in this regard. The captain therefore had no information available to him regarding radar procedures for Katunayake International Airport.

2.2.2 Erroneous information provided by the Radar Controller

Referring to the Flight Path Cross-Section (Evidence marked AC-3/6, wind component plus 10), it is confirmed that the radar distances reported to the pilot were incorrect. In fact the aircraft was always farther away from the runway touch-down point than specified by the radar controller. Consequently during the approach the aircraft was always higher than recommended by the radar controller.

When radar reported the aircraft 4 nautical miles from touch-down and that the altitude should be 1300 feet, the aircraft was actually at about 4.5 nm and at 1530 feet. When radar reported 3 nm and altitude should be 1000 feet, the aircraft was about 3.7 nm and at 1200 feet, and when reported by radar 2 nm and the altitude should be 650 feet, it was in fact at 2.8 nm and 870 feet altitude. The reason for this distance error was not conclusively established during the inquiry. However, the possibility of such an error was agreed to [redacted] and evidence marked AC-15).

As previously mentioned the captain was flying the instrument approach using the ILS. However, considering the fact that during the approach the radar controller was constantly advising him to fly lower, it must have subconciously affected his decision to follow the downwards bending of the Glide Path at approximately 3.5 nm, although this required a higher sink rate of the aircraft.

Thus erroneous distance and altitude information provided by the radar controller was a significant contributing factor to the accident.

2.3 WEATHER

2.3.1 Downdraft and Tailwind

It was established in evidence (Meteorologist [redacted] and evidence marked X-18) that strong vertical downdrafts in the approach area were quite probable due to heavy precipitation from the CumuloNimbus clouds. This is further substantiated by [redacted] (evidence marked AC-2). Furthermore a tailwind component in the approach pattern was likely, in spite of the calm wind conditions reported at the airport.

The presence of this tailwind component, and the resulting higher ground speed, made higher-sink rates necessary to maintain the Glide Path. In consequence when the sink rate became even higher, due to the down-bending of the Glide Path, the Captain was less concerned than he otherwise would have been.

A downdraft would have made recovery from the higher sink rate more difficult, even though full power was immediately applied.

Therefore, weather (downdraft and tailwind) must be considered a contributing factor to the accident.

2.3.2 Wind Shear

It is a well known fact that when an aircraft flies into an area where the direction of the horizontal wind changes abrubtly, the indicated airspeed will change with the relative wind. Referring to the Flight Data Recorder (evidence marked X-19 and X-19A) no abnormal changes were registered in the airspeed. It is also a known fact that wind shear is always accompanied by some turbulence. The absence of turbulence, as confirmed by survivors' statements (e.g. [redacted] further substantiates that the presence of horizontal wind shear can be ruled out.

2.4 NOTAMS (Notices to Airmen)

2.4.1 In ICAO Annex 15 (Aeronautical Information Services) certain Standards pertain to the issuance of NOTAMs (Notices to Airmen). Para. 5.1.1.1 specifies that a NOTAM be originated and issued whenever certain information "is of direct operational significance". Amongst these criteria is "irregularity or unreliability of operation of any electronic aid to air navigation". According to the Supplement to ICAO Annex 15, Sri Lanka has formally notified ICAO that no differences exist between its national regulations and practices and the International Standards and Recommendations of Annex 15, sixth edition.

2.4.2 It is established in evidence that the NOTAM service in general for the approach and landing aids at Katunayake did not meet the Standards referred to [redacted] Considering the very serious status of the ILS, as discussed in chapter 2.1. of this report this system should by any standard have been NOTAMed unreliable long before the accident. If such a NOTAM had been issued by Sri Lanka the captain of TF-FLA would not have based his planned landing minima on the use of such an ILS.

Consequently improper NOTAM service was a contributing factor in the accident.

2.5 PILOT PROCEDURES

2.5.1 Approach "Call-Outs"

It was established at the inquiry that the final approach call-outs of Altitude/V-ref/Sink-rate were not all accomplished in full accordance with the Loftleidir Operating Manual. The reason was found to be the very heavy workload on the pilots, and other more important tasks were being attended to by the co-pilot at such times, when call-outs would normally have been made [redacted] report marked in evidence AC-9, presented April 4th).

The pilot witnesses at the inquiry disagreed as to the importance of these call-outs. [redacted] maintained that had all the call-outs been made, the accident perhaps would not have happened, whereas [redacted] stated in reply to the importance of these call-outs that he could not find fault with the copilot for not calling out. Flight Engineer [redacted] said, that under the circumstances it was understandable that all of the call-outs were not accomplished, but maintained that the Flight Engineer should have made these if the copilot was preoccupied with other pressing tasks. However in the DC-8-63 this is not possible, as the Flight Engineer is so located in the aircraft that he can not read the necessary pilot's instruments.

The lack of some call-outs in the final phases of the approach may have had an indirect bearing on the accident.

2.5.2 Decision Height

It was not established at the inquiry whether the captain, during his approach, willingly descended below the decision height, as set forth by the company on the "ILS 22 Jeppesen Approach Chart". The reason why this could not be established is that the indication-lag in the altimeter was not known, and the Cockpit Voice Recorder is timed only to the nearest second. These two factors combined could make such a difference as to prove that the aircraft was exactly at the Decision Height, when the copilot called-out "You are in the red on the VASIS", at which time the captain had visual contact and, according to normal procedures, could continue his approach [redacted]

In the absence of relevant evidence it can not be established that the Decision Height had any bearing on the accident.

2.6 FLIGHT AND DUTY TIME

It was established in evidence that the flight and duty time limitations for the crew, according to Icelandic regulations, were not exceeded (Ref. evidence marked AC-10).

2.7 AIRCRAFT MAINTENANCE

It was established in evidence that the aircraft had been properly maintained in accordance with approved standards, and the aircraft maintenance had no bearing on the accident.

3. PROBABLE CAUSE OF THE ACCIDENT

3.1 As determined from the previously listed findings the probable main cause of the accident, was erratic structure of the ILS Glide Path beam caused by bending or change reversal.

3.2 Contributing factors were:

1. Erroneous distance and altitude information provided by the radar controller.
2. Presence of downdraft and tailwind in the final approach area.
3. Improper NOTAM service.

3.3 The lack of some "call-outs" in the final approach may have had an indirect bearing on the accident.

Reykjavik, 11 April 1979

[redacted]

Chief Investigator of Accidents,
Directorate of Civil Aviation,
Aeronautical Inspection Div.

Accredited Representative of
Iceland to the Investigation.

ATTACHMENT A List of specific abnormalities recorded in the Katunayake ATC Log Books.

Abnormality	day/month/time
"Glide Path unreliable"	21/1/1245, 24/3/-
"Glide Path useless"	20/11/0239
"Glide Path unusable"	16/11/1332
"Glide Slope unservicable"	28/10/0045, 28/10/0545, 28/10/1128, 29/10/0810, 30/10/0600, 31/10/0500, 3/11/0335, 3/11/0700, 4/11/0832/1611, 5/11/1545, 6/11/0755/0800
"ILS faulty"	2/12/2210
"ILS power loss"	26/10/1318, 4/11/1821/2200, 5/11/0752 on 30 occasions/1440, 10/11/1730, 13/11/2300/2355 29/11/0043, 22/2/0800 (alarm) 16/11/1540
"ILS unservicable"	22/10/1035, 26/10/0929, 28/10/1900, 29/10/1900, 30/10/0600/0815, 4/11/1850, 5/11/0830, 10/11/0145/0600/0627, 11/11/0810 13/11/2300 14/1030, 20/11/1615, 3/12/0130, 14/11/0605/0800.
"ILS tripping"	22/10/2300, 26/10/1930/2345, 31/10/0220, 10/11/1605, 12/11/0010 frequent/1609 now and then. 13/11/2106, 14/11/2010/2330, 15/11/0200/2310/2326 (crash) 16/11/1656 very minute17/11/0031/0033/0829/1130/1310/1444, 22/11/many times, 14/12/1758/1915 every often 25/12/1400.
"ILS off the air"	19/10/0545
"ILS misleading"	28/10/0545
"Up and Down"	14/2/0810, 19/2/0015
"Status not known"	28/10/0054, 3/11/1607, 4/11/0635, 7/11/0800/ 16/11/1340/1600, 11/11/1040.
"Misleading"	28/10/0054, 28/10/0545
"Never picked up"	28/10/0054, 31/10/0220, 16/11/1126, 3/11/040
"Tripping"	1/12/1751 four times/1752, 5/12 (all the tim 7.8.9.10.11-frequent trippings, 13/12/1242-1 9 times. 15/12/1823 12 times. 24/12/1852, 25/12 continously, 9/2/2010 (too often)

"Dip"	2/2/1510, 14/2/0810
"Erratic"	6/11/1430, 10/2/1824
"Low"	2/12/2010/2205
"Fluctuating"	28/11/occiliates. 6/12/0050, 6/2/0850.
"Unsteady"	16/11/1332, 30/12/1430, 23/1/1150 (unstable) 19/2/0015, 14/2/0810
"Fly low"	28/12/1140, 12/1-79/0730/2100, 10/2/1842, 12/2/
"Fly down"	12/1/2100, 12/1/1245, 10/2/0810, 14/2/0810
"Abrupt change"	6/2/0850, 12/2/0830
" 2 1/2 - 3 dots fly down"	10/2/0810
"Outermarker u/s"	19/10/0600, 26/10/2345, 29/10/0810, 12/11/0010, 16/11/1120/1540
"Localizer u/s"	4/11/0635/0950/1611, 14/2/0810
"Did not pick up VASIS"	12/11/2325
"VASIS u/s"	13/11/2106
"Negative indication"	23/10/1607, 16/11/0800, 13/11/1600
"Markers never picked up"	28/11/ 2/12/2010, 6/12/0050 ofsett localiz 2/12/1010, 2/2/1510, 19/2/0015, 2/12/2205 ILS on test 3/2/0800

Note: The recording of the above abnormalities was prompted by one or more of the following:

a) Reports from pilots or other flight crew members.

b) Reports from radio technical staff.

c) Observations of the air traffic controllers.