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Report of the Commission of Inquiry appointed by His Excellency the President to inquire into the causes and circumstances in which Loftleider Icelandic Airways Aircraft DC - 8 - 63F TF - FLA met with an accident in the vicinity of the Katunayake Airport on 15th November, 1978

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REPORT OF THE COMMISSION OF INQUIRY APPOINTED BY HIS EXCELLENCY THE PRESIDENT TO INQUIRE INTO THE CAUSES AND CIRCUMSTANCES IN WHICH LOFTLEIDER ICELANDIC AIRWAYS AIRCRAFT DC–8–63F TF-FLA MET WITH AN ACCIDENT IN THE VICINITY OF THE KATUNAYAKE AIRPORT ON 15TH NOVEMBER, 1978

The inquiries of the Commission commenced on 25.11.1978 and was completed on 28.06.1979

COMMISSIONER :

V. SIVA SUPRAMANIAM

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PARTICULARS OF ANNEXURES

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1. Terms of Reference of the Commission

HIS EXCELLENCY J. R. JAYEWARDENE
PRESIDENT OF SRI LANKA

YOUR EXCELLENCY,

ON November 25, 1978, Your Excellency issued to me a Commission in pursuance of the provisions of Section 2 of the Commissions of Inquiry Act (Chapter 393), with the following terms of reference :—

(1) To inquire into and report on the causes and circumstances in which the aircraft bearing registration No. TF-FLA and belonging to Loftleider Icelandic Airways met with an accident in the vicinity of Katunayake Airport at about 23.30 hours local time on November 15, 1978 ;

(2) To consider whether any degree of responsibility for the aforesaid accident may be attributed to any person ; and

(3) To recommend what steps, if any, should be taken to ensure the avoidance of similar accidents in the future.

SECTION I

2. Synopsis

2.1. On November 15, 1978, Icelandic Airlines Flight LL 001 a DC-8 63 CF (TF-FLA) which was being operated as a charter passenger flight, took-off from Jeddah Airport, Saudi Arabia, at approximately 12.58.03 z to proceed to Surabaya, Indonesia, with a programmed technical stop at Colombo Airport, Katunayake (CAK), Sri Lanka, for fuel and crew change. The aircraft had been chartered by GARUDA Indonesian Airways to carry Indonesian "Haj" pilgrims from Indonesia to Mecca and return. The aircraft contacted Area Control, Ratmalana, at 22.53.24 local time and was informed that the runway in use at Colombo Airport, Katunayake, was 04. The aircraft requested runway 22 and accordingly was cleared for a radar vectored Instrument Landing System (ILS) approach to runway 22. Area Control who was in contact with the aircraft initially descended the aircraft from FL (flight level) 330 to FL 220 approximately 90 miles out of Colombo Airport, Katunayake. The aircraft was then handed over at 23.06.32 to the Radar Control (CAK) under whose instructions it descended to FL 20 to make an ILS approach to runway 22. The aircraft followed the Controller's instructions and, to all appearances, was making a normal ILS approach to runway 22. The Radar Controller also requested the aircraft to report when it was established on the Localizer, but, though the request was acknowledged, no confirmation was received. The Radar Controller continued to give advisory information on the aircraft's distance and height, the last advisory call being at 23.27.26 when the aircraft was informed thus :

"Lima, Lima 001, slightly to the left of centre line, very slightly to the left of centre line, two miles from touch-down, height 650 feet, cleared to land-off this approach."

This transmission was acknowledged by the aircraft at 23.27.37 in the manner "Roger". There was no further communication from the aircraft.

2.2. Shortly thereafter, the Approach Controller (CAK) sighted the aircraft very low on the approach and called out twice "Lima, Lima 001, you are undershooting". However, this transmission was not received by the aircraft as the Approach Controller spoke on the approach frequency 119.7 MHz whereas the aircraft was still tuned to the Radar Controller on 119.1 MHz. The Approach Controller observed the aircraft disappearing from sight followed by what appeared to be a ball of fire around the area where it passed out of sight. The aircraft had crashed into a rubber and coconut plantation at a point 1.1589 n.m. from runway 22 threshold, 103.15 feet to the right of the extended centre line of the runway. The aircraft was destroyed by impact and fire.

2.3. The Approach Controller on duty was the first to observe the crash, and the Radar Controller, Area Controller and others were immediately notified of the accident by him.

3. Rescue Activities

3.1. Rescue activities commenced within half an hour of the accident and fire-fighting units were in attendance from this time onwards. Around 5 fire-fighting units were in attendance and the whole operation was co-ordinated satisfactorily. The main section of the fuselage that was intact was under intense fire and considerable effort was required to bring the fire under control by which time all occupants of this section of the aircraft had succumbed due to fire. Fire-fighting activity was hampered as ready access to the site of the crash was not possible due to the large number of coconut trees that prevented large units from getting closer to the wreckage.

3.2. The Acting Director of Civil Aviation was personally present with the members of his staff and participated in the rescue operations along with the police and airport staff. The rescue operations were subsequently highly commended by the representatives of the Indonsian and Icelandic Governments.

3.3. All cockpit instruments found among the wreckage were photographed before being handled by anyone and were taken charge of by the Acting

Director of Civil Aviation who handed them over to the office of the Defence Ministry to be kept under security. The seals of the packages were broken in my presence at the inquiry.

SECTION II

4. Injuries to Persons

4.1. The injuries to persons were as follows :

Injuries	*Crew*	*Passengers*	*Others*
Fatal	8	175	0
Non-fatal	4	28	0
None	1	46	0

5. Notifications to Interested Parties

5.1. The State of Registry of the aircraft, namely, Iceland, the State of Manufacture of the aircraft, namely, the United States of America, the State of maximum number of fatalities, namely, Indonesia, were all informed of the accident. They sent their accredited representatives who made their own preliminary fact-finding investigations and returned to their respective States. The Department of Civil Aviation gave them its full co-operation in the conduct of such investigations.

6. Read-out of Recordings

6.1. At the time of my appointment as Commissioner, only the Icelandic team was still in this country and I had several informal discussions with them in regard to the investigation. Before formal sittings could be held for the recording of evidence of witnesses, it was necessary to send three instruments recovered from the wreckage of the aircraft, namely, the Flight Data Recorder (FDR) (commonly called the Black Box), the Cockpit Voice Recorder (CVR) and the Kifis Box (KB), to appropriate centres abroad for a read-out of the recordings as there are no facilities locally for that purpose. The FDR and CVR were sent to the Air Safety Investigation Branch of the Department of Transport in Melbourne, Australia, and the Kifis Box to the manufacturers in the United States of America.

7. Formal Sittings

7.1. Fifteen formal sittings were held during the period 12th March to 6th April. The records of the proceedings are forwarded separately.

7.2. All the interested parties were given due notice of the formal sittings.

7.3. Mr. Skuli Jon Sigurdarson was present throughout the sittings as the accredited representative of Iceland and participated in the proceedings assisted by Mr. Jon Oltarr Olafsson, Capt. Skuli Br. Steinthorsson and Mr. Johannes Jonsson representing the Icelandic Airlines.

Mr. I. R. Soepartolo was the accredited representative of Indonesia and was assisted by Mr. Soewardi. He was present at most of the sittings and participated in the proceedings.

Mr. D. H. Athulathmudali, Acting Director of Civil Aviation of Sri Lanka, was present throughout the sittings and participated in the proceedings.

The State of Manufacture of the aircraft, namely, USA, was not represented at the inquiry though due notice was given.

Mr. V. C. Gunatilaka, Solicitor-General, assisted the Commission as Legal Adviser and Mr. D. J. Rosa, Assistant Director of Civil Aviation (Aeronautical Inspections), as Technical Adviser.

Mr. G. P. S. U. de Silva, Senior Assistant Secretary of the Ministry of Defence, functioned as Secretary to the Commission.

8. Public Representations

8.1. Newspaper advertisements calling for public representations were inserted in the leading local newspapers. A number of letters were received in response to these advertisements but none of them merited consideration. The writers of those letters were not called to give evidence.

SECTION III

9. Navigational Aids

The navigational aids installed at Katunyakaye Airport and their status at the time of the accident are as follows :—

9.1. Visual Aids :

(a) *Visual Approach Slope Indicator* (VASI).—VASI is a very useful pilot aid. It is of various types. In the type fitted at Katunayake airfield, bars of red and white lights on each side of the runway are so beamed by reflectors that when a pilot is too low he sees all red lights ; when he is too high he sees all white lights ; and when he is on the correct approach path he sees red and white bars one above the other.

The VASI was in satisfactory working order on the night of the accident.

(b) *Approach Lighting*.—The Approach Lighting System gives guidance to aircrafts in the landing phase assisting them in aligning correctly with the runway centre line.

This system had been unserviceable for some months prior to the date of the accident and this fact had been brought to the notice of all airmen by the issuance of a "notam" in accordance with the international practice.

The pilot of flight LL 001 would have been aware of the non-availability of the approach lights. At the time of the accident he was correctly aligned on the centre line by other means and as he was already in sight of the runway lights and of the VASI, the non-availability of the Approach lighting System had no bearing on the accident.

(c) *Runway Lights*.—The Runway Lighting System was in operation at the time of the accident. The cockpit voice recording indicates that two different voices had mentioned on four occasions that Capt./Co-Pilot "had been visual". This term implies that the Capt./Co-Pilot had seen the runway lights while making the approach to land.

9.2. Radio Navigational Aids :

(a) *Very High Frequency Omni-directional Radio Range* (VOR).—This was in operation at the time of the accident and there was a remote indicator at the Control Tower to indicate the serviceability of the unit. This aid is of little importance other than to get some rough guidance to align the aircraft with the runway centre line. In the instant case, however, this had been done by the use of the radar.

(b) *Distance Measuring Equipment* (DME).—At the time of the accident this had been unserviceable for over two months and had been "notamed" to that effect. At Katunayake the DME is co-located with the VOR which is not on the extended centre line of the runway. It is useful as a landing aid only if it is co-located with the Glide Path Equipment as is sometimes done in some countries. The function of the DME is for en route navigation purposes. Its unserviceability on the night of November 15 had no bearing on the accident.

(c) *Non-Directional Beacon*.—The Non-Directional Beacon installed at the airport (NBD-KAT) was in operation at the time of the accident. As the aircraft was correctly aligned on the extended centreline of the runway it was of no further importance to the landing of the aircraft.

(d) *Non-Directional Beacon at Yakwila* (NDB-YKW).—The Non-Directional Beacon at Yakwila is located on the extended centre line of the runway and was in working condition at the time of the accident. The location of this NDB is approximately 17 miles from the end of the runway. As the aircraft was correctly aligned on the extended centre line by other means, it was of little importance to the landing phase of the aircraft.

(e) *Instrument Landing System* (ILS).—This is by far the most important radio navigational aid associated with the landing phase of an aircraft. It was available to aircraft making an approach to runway 22.

9.3. The ILS comprises the following basic components :

(i) VHF Localizer Equipment (LOC), associated monitor system, remote control and indicator equipment,

(ii) VHF Glide Slope or Glide Path Equipment (GS), associated monitor system, remote control and indicator equipment ;

(iii) Two VHF Marker Beacons, namely, the Outer Marker and Middle Marker (OM and MM), associated monitor systems, remote control and indicator equipment.

The system is operated electronically. The Localizer is a thin beam in the vertical plane and provides correct guidance to align the aircraft on the extended centre line of the runway. The beam comes from a very high frequency (VHF) transmitter at the far end of the runway on the centre line. The pilot sees it as a vertical needle on his ILS instrument.

The Glide Slope (or Glide Path) is a thin beam in the horizontal plane. It provides electronic guidance defining a 3° glide angle and keeps the pilot on the correct descent path. The pilot sees it as a horizontal needle on his ILS instrument.

By flying the aircraft so that the needles are exactly crossed—" locked on "—the pilot keeps the aircraft on the correct landing approach.

The Marker Beacons located on the extended centre line and away from the airport at a distance of 5 n.m. and 3,500 feet respectively from the threshold of the runway 22, provide vertically generated information which can be picked up in the aircraft only when it is overhead of the respective beacons.

9.4. In the Control Tower is situated the remote control and indicator equipment of each of the components which would indicate to the Controller the operational status of the respective components at any time. The indicator would show a green light if the particular component was functioning properly and a red light if it was not. On the night of the accident only the indicator in respect of the Localizer was serviceable. The cable connecting the Glide Slope to the indicator unit was broken and, therefore, the signal that should be received from the monitor of the Glide Slope was not received in the indicator unit. The indicator of the Glide Slope, therefore, constantly showed a red light irrespective of whether the Glide Slope was properly functioning or not. According to the evidence led before me, information as to whether the Glide Slope was functioning properly or not was furnished to the Controller at the tower by a radio technician who was in charge of an ILS portable receiver in a room on the lower floor of the building. It was the duty of that technician to monitor the portable receiver and to communicate immediately to the Tower Controller if the glide slope equipment had shut down or was malfunctioning.

9.5. The cables connecting the two Marker Beacons were also missing (as they were being constantly stolen) and the Controller at the tower had no means of knowing whether they were functioning or not.

On the night of November 15, the aircraft crashed after passing the Outer Marker and before reaching the Middle Marker. Consequently, the status of the Marker Beacons that night had no bearing on the accident.

9.6. One of the matters that requires consideration and which became controversial during the course of the inquiry is whether the Glide Slope was working properly on the night of November 15, or whether it was the malfunctioning of the Glide Slope that was the cause or one of the causes of the accident. I shall deal with this matter later on in this report.

SECTION IV

10. Course of the Flight

10.1. The aircraft contacted Area Control Centre, Colombo, at 22.53.24 local time and was informed that the runway in use at Colombo Airport, Katunayake (CAK) was 04 and was also given particulars of the weather. The aircraft inquired whether runway 22 was available. (Runway 22 is the one on which the use of the ILS was available). Area Control confirmed the availability of runway 22 and immediately afterwards at 23.00.48 the pilot confirmed his decision to use runway 22.

10.2. At 23.01.51 meteorological information regarding the cloud base was passed on to the aircraft subsequent to which the aircraft requested the Madras weather. Some time later, Area Control obtained the Madras weather from Madras and furnished it to the aircraft at 23.18.40.

10.3. At 23.03.47 the aircraft reported " standing by for descent " upon which Area Control cleared it for descent to FL 290. At 23.06.09 it was descended further to FL 220.

10.4. Colombo radar took over control of the aircraft around 23.07.00 when it was 90 n.m. out. At 23.10.17 clearance to descend to 7,000 feet was given to the aircraft, and at 23.11.21 a distance call of 60 n.m. was given by the Radar Controller.

10.5. The next radar call was at 23.10.13 when the aircraft was informed by the Radar Controller that it would be a radar vectoring to the ILS on runway 22 and that there was a " bit of weather " on the approach but that visibility was reported to be 6,000 metres. A further clearance to descend to 5,000′ was given to the aircraft at 23.17.30 and to 3,000′ at 23.22.08. At 23.23.41 it was recleared to 2,000′ and a heading of 180 was given.

10.6. In response to an inquiry from the aircraft " Is the ILS working now ? " around 23.24.00 the R/C replied " affirmative " and went on to inform the aircraft " You are closing the localizer from the right, 12 miles from touch-down, recleared to 2,000′.

10.7. Whilst lining up on finals at 23.25.23 the aircraft was informed that it was 8 m. from touch-down and was given a heading change of 220. Seventeen seconds later it was instructed to commence a descent to maintain a 3° glide path with the information that it was 7½ miles from touch-down. At 23.25.55 the Radar Controller requested the aircraft to report when it was established on the localizer or when runway was in sight and this call was acknowledged by the aircraft as " Roger ".

10.8. The next call from Radar was at 23.26.15 after the aircraft had lined up with the centre line of runway 22 when the Radar Controller advised, " You will approach the outer marker in 25 seconds ". This call was acknowledged by the aircraft as " Roger " at 23.26.28.

10.9. At 23.26.52 the aircraft was informed by Radar that it was 4 miles from touch-down and at a height of 1,300′, being cleared to land off the approach to runway 22. This clearance was acknowledged by the aircraft at 23.27.00.

10.10. The next advisory call was given by Radar at 3 miles with height particulars of 1,000′ at 23.27.10.

10.11. Radar gave the next call at two miles at 23.27.26 in the following manner, " Lima, Lima 001, slightly to the left of centre line, very slightly to the left of centre line, two miles from touch-down, height 650′, cleared to land off this approach." This was acknowledged by the aircraft at 23.27.37 as " Roger ".

10.12. A further final call to the aircraft by Radar " Slightly to the left of centre line " at 23.27.49 went unacknowledged.

10.13. At 23.28.03 the aircraft crashed 1.1589 n.m. from the threshold of runway 22.

11. Impact Sequence and Wreckage

11.1. The impact occurred in an area along the extended centre line of runway 22, the initial contact with coconut trees being at a height of 163′ above mean sea level, 103.15′ to the right of the centre line of runway 22. This area was planted with coconut trees, the aircraft brushing the tops of five

coconut trees whilst traversing the last 99 feet of the coconut plantation. On leaving the coconut plantation the aircraft entered the rubber plantation almost in a level altitude and passed through the rubber tree tops without an appreciable change in elevation but progressively banking to the Port, the bank angle on leaving the rubber plantation being approximately 20 degrees. Whilst traversing the rubber plantation the aircraft cut a path through the trees approximately 429 feet long and 112 feet wide at the widest point. The Port wing-tip and area immediately after it progressively disintegrated whilst passing through the rubber trees. The aircraft then entered the second coconut plantation and travelled in a slightly descending altitude, the bank to Port increasing progressively up to around 40 degrees over a distance of approximately 396 feet at which point the ground impact marks commenced. The marks on the ground extended to almost 360 feet around which point the aircraft cart-wheeled to the starboard. Whilst cart-wheeling, the Port engines were shed, and the fuselage section from around 12 feet forward of the centre section up to the cockpit sheared away and continued along the path of travel, progressively breaking up into six sections and piling up in one heap approximately 478 feet from the point of initial contact with ground of the aircraft. The remainder of the fuselage, port and starboard wings of the empennage continued to move in a sweeping motion, the tail section approximately 30 feet above ground finally coming to rest almost on the centre line of the runway on a heading 070/290 facing the east. The tail section of the rear galley broke off at this stage and the starboard engines were shed immediately prior to the final resting of the fuselage. A fire ensued in the main fuselage section.

11.2. The port wing-tip and the wing-tip attachment areas were demolished at the initial impact within the rubber plantation. The port wing continued to break down progressively as the aircraft traversed through the rubber and coconut trees up to the point of impact with ground. Other than the port wing, the rest of the aircraft did not suffer any damage up to this point. The breaking up of the fuselage and empennage occurred after the ground impact. During the examination of the wreckage, all flying controls and components were identified ruling out the possibility of any pre-crash failure of the structure. The fire that engulfed the main fuselage section burnt down the fuselage up to window level. There was no fire in the forward area which accounted for most of the survivors being from the forward section.

SECTION V

12. Instruments Recovered and Readings

Although the cockpit area was broken up into sections certain instruments were located and taken charge of, the principal ones being the following :—

12.1 *Flight Data Recorder* (FDR).—The Flight Data Recorder was recovered in an undamaged condition on the morning after the accident from the wreckage strewn around the tail area of the aircraft.

12.2. *Cockpit Voice Recorder* (CVR).—The Cockpit Voice Recorder was recovered in a slightly damaged condition on the morning after the accident from the undergrowth around the area where the wreckage of the tail section of the fuselage was scattered. The unit was in a relatively undamaged state.

12.3. *Course Indicator* (Captain's Panel).—This instrument showed the following readings :—

(*a*) Course Indicator—210 degrees ;

(*b*) Course Bug set at 220 degrees ;

(*c*) Deviation Needle .75 dots to the left ;

(*d*) Glide Path Needle .5 dots above aircraft position ;

(*e*) Glide Slope Flag out of view ;

(*f*) LOC Flag out of view ;

(*g*) Compass Flag in view.

12.4. *Flight Director Display* (Captain's Panel).—The readings were as follows :—

(*a*) V-Command Bars—showing marked fly-up ;

(*b*) Rising Runway—almost in contact with aircraft.

12.5. *Radio Altimeter* (Captain's Panel).—This instrument showed the following readings :—

(*a*) Flag-out ;

(*b*) Bug set at 150′ ;

(*c*) Altitude Indicator—120′.

12.6. *Pressure Altimeter* (Captain's Panel).—This was set at 1014 mbs. reading 250′.

12.7. *VHF NAV*—Captain — 116.30Hz
Co-Pilot — 110.30Hz
VHF COM—Captain — 118.97
Co-Pilot — 131.50

12.8. *Flight Director Control Panel*
Mode Switch—GA
Altitude Control Switch—off
Pilot Control—0 degrees

13. Read-out of Instruments

13.1. The Flight Data Recorder was taken to the Air Safety Investigation Branch of the Department of Transport, Melbourne, Australia, where a satisfactory read-out was obtained (*vide* Annex I).

13.2. *Cockpit Voice Recorder*.—This was also sent to the Air Safety Investigation Branch of the Department of Transport, Melbourne, Australia, for a read-out. The cartridge of the Voice Recorder was found in an undamaged condition and was played back on the special equipment available at the ASIB. A copy of the report of the Board is annexed (Annex II). Of the half hour recording available on the CVR a large percentage of the conversation was in Icelandic. Recordings of the four channels on the cartridge were made individually and collectively and given over to the Icelandic delegation for translation. A certified translation in English of the read-out as furnished by the Icelandic delegation is Annex III. Certain amendments to this certified translation were effected by the delegation in March 1979 during the course of the proceedings. The amended version is Annex IV.

13.3. *Control Tower Tapes*.—A recording of the VHF communications between Area Control, Radar Control and the aircraft was available and an accurately timed transcript of this was made out, extracts of which were superimposed on the Final Approach Profile Diagram.

13.4.1. *Reconstructed Approach Profile* (Annex V).—The Reconstructed Approach Profile was drawn using data computed from the FDR read-outs. The FDR is an old type giving only five parameters and the ground speed cannot be obtained directly. The computation of the Distance Axis (Axis X) on the Approach Profile graph is dependent on accurately knowing the ground speed, which is the vector sum of the indicated air speed (IAS) and the speed of the wind relative to ground (or air speed).

13.4.2. The wind component used was zero as the wind, according to the meteorological report at the time of accident, was " 120 degrees 07 " which meant a 7 kt wind was prevalent from direction 120 degrees. As the approach heading was 220 degrees the component of this wind along the approach path was reckoned to be almost zero.

13.4.3. The nominal glide slope is 3 degrees and the lower broken line on the drawing is the worst assumed glide slope at 1.48 degrees to the horizon. The curve at the top of the drawing is the descent rate. The text appearing above the nominal glide slope in cages is from the CVR transcript and the text below the glide slope in cages is from the Control Tower tapes. The figure in the cages alongside the conversation is local time.

13.4.4. The impact point 'x' is at 163′ above mean sea level.

13.5. A cross section of the Approach Profile prepared by the Icelandic delegation with a wind component of 0, is Annex VI.

14. Superimposed Transcript

A superimposed transcript was made combining the Control Tower tapes transcription and the CVR transcripts. This appears as Annex VII to this report. The contents of the transcript provided valuable information for the analysis:

SECTION VI

15. Approach Procedures

The more important of the procedures laid down in the Loftleider Icelandic Operations Manual for Approach and Landing as appearing at pages 4.3.27, 4.3.28, 4.4.18 and 4.4.19 are set out below. The ILS at Katunayake being only of Category I, the approach procedures set out for automatic approaches under Section P at pages 4.4.19 and 4.4.20 are not applicable.

(*a*) After passing through 18,000′ or transition altitude, select the P.T.C. to " override " and maintain 2,000 setting on the Radio Altimeter until passing 2,000′ above the ground and observing the light ON at which time the minimum descent altitude or decision height may be set.

(*b*) The Co-Pilot will set the Altitude Alerting System to indicate clearance limit altitude throughout the descent and clearance to landing.

(*c*) The Co-Pilot will note and announce altitude 1,000′ prior to reaching the clearance limit altitude.

(*d*) Use positive, not excessive rate of descent right down to the minimum descent altitude.

(*e*) At the outer marker and at 500′ above the runway threshold altitude the Pilot not flying the aircraft will cross-check both sets of flight instruments for proper comparison and ascertain that no warning flags are in view.

(*f*) If the flying instruments are normal, he will announce 'no flags'. He will also announce the airspeed in relation to Vref (Threshold Speed) and the rate of sink. Example :

Outer Marker	*500 ft.*
No flags	No flags
Ref + 10	Ref +10
Sink 900	Sink 600

(*g*) Notification will also be made when—

(1) passing through 1,000′,

(2) leaving 500′,

(3) passing through 100′ above minima,

(4) at minima, and

(5) approach lights in sight.

Only the altitude need be called out, unless deviation from desired speed, track or glide path is noted.

SECTION VII

16. Failure of the Crew to Adhere to Laid Down Procedures

16.1. A perusal of the Control communication/CVR transcript and the Approach Profile (Annexes V and VII) indicates that the crew in command failed in many respects to adhere to the procedures laid down.

16.2. The Co-Pilot had not announced the altitude 1,000′ prior to reaching the clearance limit altitude (*vide* 15 (*c*) above).

16.3. The call-out of altitudes when passing through 1,000′, leaving 500′, passing through 100′ above MDH and at MDH (*vide* 15 (*g*) above) had not been made.

The call at MDH is a most important call as this height is the lowest altitude that the pilot descends to if he cannot see the runway and he must stay at this altitude, not lower, until he has visual contact with the runway and, if not visual, he should go around (overshoot) and make another approach.

16.4. At the outer marker and at 500′ the standard announcements that had to be made regarding—

(i) the indication from his scan for warning flags,

(ii) the speed in relation to desired threshold speed, and

(iii) the sink rate (*vide* 15 (*f*))

were not called.

The failure to monitor the sink rate was a grave lapse which was a contributory factor to the accident. Considering the average ground speed of the aircraft and its gross weight during descent, the appropriate rate of descent would have been 850/900′ per minute. The rate of descent appearing on the top of the Approach Profile (Annex VII) indicates that the rate of descent whilst being on the high side for most of the approach has been well above 1,000′/min. on five peak value excursions, the maximum rate of descent being as high as 2,000′/min. and 1,800′/min. in the final phase of descent.

16.5. The rates of descent of 1,800′ to 2,000′/min. are excessive especially at such a late stage on the final approach when the crew had lost visual contact with the runway and were approaching the minima for that runway. This situation could have been avoided if the crew had adhered to the laid down procedures (*vide* 15 (*d*)).

16.6. The Icelandic team sought to find an excuse for the failure of the crew to call out the altitudes, the sink rates and Vref deviations by stating that the Co-Pilot was busy complying with the Captain's instructions and had no time to make the aforesaid vital call-outs. An efficient crew member will never miss important calls at critical stages of any approach, however, heavy his work-load may be, as he should know that non-compliance may result in the aircraft and the passengers being placed in jeopardy. It is not clear why the Company procedure does not provide for the Flight Engineer being utilized to monitor important procedures and call-outs during approach when the Co-Pilot is busy otherwise. In any event, if the procedures had been strictly followed, there should have been no clash between the Co-Pilot's carrying out the Captain's orders and making the call-outs expected of him.

SECTION VIII

17. Information Furnished by the Radar Controller

17.1. The point was raised that there was discrepancy in the position data passed on to the aircraft by the Radar Controller ; that when the R/C gave the call " 4 miles out at 1,300′ " the position of the aircraft according to the Approach Profile (Annex VII) was 4.2 miles out at 1,640′ ; similarly, when the call was " 3 miles out at 1,000′ " the position of the aircraft was 3.7 miles out at 1,290′ ; and when the call was " 2 miles from touch-down at 650′ " the position of the aircraft was 2.77 miles out at 1,020′ ; and that the Captain's excessive rates of descent at those points were probably due to his anxiety to conform to the calls given by the R/C. It was thus sought to lay the blame on the R/C for the excessive sink rates at those points. It should be noted that the excessive sink rates were not confined to those points alone. Apart from that, one may consider whether the blame for the excessive sink rates can be reasonably passed on to the R/C.

17.2. The aircraft was cleared for an ILS approach to runway 22 by the R/C at 23.16.13 and the R/C informed the aircraft that it was a " radar vectoring to ILS ". The principle of a radar vector to the ILS is " to provide radar vectoring of arriving traffic on to pilot-interpreted final approach aids " (ICAO DOC 4444 Rules of Air Traffic Services, p. 10). The radar vector to ILS positively terminates once an aircraft is established on the ILS. The Captain, therefore, once he was established on the ILS should and would have known that further radar vectoring was unnecessary and superfluous ; that he was no longer under the control of the R/C and that he was not obliged to take note of any advisory information given to him by the R/C.

17.3. The R/C had at 23.25.25 instructed the aircraft to report when it was established on the localizer or when runway was in sight. The crew had, however, failed to report at any stage that they were established on the localizer or that runway was in sight and consequently the R/C appears to have continued to give advisory heights. This subsequent advisory information was definitely not a part of the radar vectoring to the ILS as the aircraft was already established on the localizer. Had the aircraft reported established on the localizer or had the runway in sight the R/C would have terminated the vectoring and handed over the aircraft to the Tower Approach Controller for the final

approach and touch-down. It was primarily the Captain's failure to report that he was established on the localizer that was responsible for the aircraft not being handed over to the Tower Approach Controller at the proper time. Apart from the fact that he was not under any obligation to take note of the superfluous advisory information that was continuing to be furnished to him by the R/C, the Captain could have checked his own altimeters before accepting the heights furnished by the R/C and acting on them. The Pilot should have known that it was not a Surveillance Radar Approach (SRA) that he was following. If the readings on his altimeter did not tally with the information furnished by the R/C, the R/C's information should have been ignored. It was also open to the Captain to bring to the notice of the R/C that the altitudes furnished by him did not tally with the readings on his altimeters and to have asked for confirmation. In all the circumstances, I do not think it reasonable to pass on to the R/C the blame for the excessive sink rates of the aircraft.

17.4. The Icelandic team marked in evidence a Flight Path cross section (with wind component + 10) (*vide* Annex VIII) and submitted that the aircraft was always farther away from the runway touch-down point than specified by the Radar Controller. According to them, when the Radar reported the aircraft to be 4 n.m. from touch-down and the altitude to be 1,300′ the aircraft was actually at 4.5 n.m. and at an altitude of 1,530′ ; when Radar reported 3 n.m. and an altitude of 1,000′ the aircraft was about 3.7 n.m. at 1,200′ ; and when Radar reported 2 n.m. and the altitude to be 650' it was in fact at 2.8 n.m. and 870′ altitude. It will be noted that the figures given by the Icelandic team on the basis of Annex VIII differ from the figures on the basis of the Approach Profile (Annex VII), perhaps due to the difference in the wind component. There is no reliable data in regard to the wind component at the relevant times and the accuracy of the distances on the approach profiles that are reconstructed cannot therefore be completely depended upon.

17.5. The Icelandic team, however, submitted that the erroneous distance and altitude information provided by the Radar Controller was a significant contributing factor to the accident.

17.6. On his last call the Radar Controller had indicated that the aircraft should be at a height of 650′ and 2 n.m. from the runway. Even assuming that the heights and distances furnished were not accurate, the pilot's descent below the last call was on his own responsibility. If he had descended from the altitude at which he was at a normal sink rate and at the decision height of 250′ (or 228′) had initiated an overshoot if the runway was not visible, the accident would not have taken place. Any wrong advisory information given earlier by the Radar Controller could not, therefore, have been a contributory cause of the accident.

SECTION IX

18. Radio Altimeter

18.1. The obstruction clearance limit (OCL) for an ILS approach to runway 22 at Katunayake is 200′ (*vide* Annex IX). Consistent with this height was the instruction of the Captain to set the Radio Altimeter bug at 250′ as seen at 23.26.45 on the transcript (Annex VII). Whilst no call-outs had been made approaching the MDH, the Radio Altimeter (RA) found on the Captain's panel of instruments recovered from the wreckage showed the bug set at 150′ —*vide* the photograph, Annex X. It is not possible to determine at what stage the bug on the RA had been set to 150′.

18.2. The Icelandic team submitted that since the Captain had at 23.26.45 instructed the Co-Pilot to set the Radio Altimeter at 250′, he would have set his own too at 250′ ; that the knob with which the bug has to be set is very easily moved ; that turning the knob half a turn will change the setting by one hundred feet ; and that, normally only a slight touch of the knob is enough to turn it. For these reasons they were of the opinion that the bug had moved during or after the crash.

18.3. In view of the above submissions, I have carefully re-examined the Radio Altimeter and tested the knob and the bug. The knob is undamaged and is turned by a rotary movement. In order to change the setting of the bug by one hundred feet, the knob has to be turned one full turn and not half a turn. A half turn changes the setting by only fifty feet. The bug cannot be moved except by a deliberate manipulation of the knob, unlike the other instrumentation on the panel which have spring loaded indicator needles where the tendency is for the needles to return to the zero position on power cut-off or the possibility exists that they may be shaken round due to forces of impact, thus settling in a completely different position from that indicated while it was functioning properly. It is not correct that a slight touch is sufficient to turn the knob. In my opinion, it is highly improbable that a full turn of the knob to change the setting from 250′ to 150′ could have taken place as a result of the impact during the crash. It seems to be much more likely that the Captain had, by error, set the bug at 150' instead of at 250′, though he intended to set it at 250′.

18.4. On the other hand, if the Captain had correctly set his radio altimeter bug at 250′, the warning light would have come on when the aircraft came down to that height. If he was scanning his instruments, he could not have failed to notice that fact. In that event, one cannot understand why he did not overshoot if the runway was not within view.

18.5. None of the instruments on the Co-Pilot's panel were recovered as they were all badly smashed up. It is possible that the Co-Pilot's radio altimeter had been set at 250′ but, perhaps, the Co-Pilot was too pre-occupied with looking out, watching for the runway lights, that he failed to take note of the warning light on his panel when the plane descended to 250′.

18.6. An erroneous misreading of the altimeter by the crew is not unknown. For example, in the aircraft crash that took place at Escambia Bay in Florida on May 8, 1978, the Captain and the First Officer both admitted at the hearing that they had misread the altimeter reading. In that case too there had been no altitude call-outs. The report of the said air accident by the National Transportation Safety Board (NTSB) dated November 9, 1978, states at page 19 :

> " The Captain and First Officer testified that they misread their barometric altimeters during the latter stages of the descent after they were cleared to descend from 1,700′ . . . . The Captain said that he misread his altimeter at 500' and believed he saw 1,500′ . . . . The First Officer said that he failed to make the required altitude call-outs because he was never aware of the fact that the aircraft was 1,000′ until just before the impact."

J. N. Ramsden in his book " The Safe Airline " (MacDonald and Jane's London, 1976, page 207) says :

> " Altitude awareness is perhaps the professional pilot's most highly developed facility instilled into him from the first hour of training. But in the first half of the 1970s there were more than 80 fatal approach accidents to public transport aircraft, with the loss of over 2,600 lives. Most of these accidents were caused by the crew's unawareness, until too late, of their proximity to the ground."

18.7. According to the evidence, the decision height at Katunayake in terms of the procedure laid down by the Icelandic Airlines is 228′. The Captain appears to have been cautious and decided to fix it at 250′ for the landing, taking into account, perhaps, the stormy weather. (It was stated in evidence that Air Ceylon pilots usually fix 300′ as the Decision Height especially in bad weather). If the altimeter bug had been erroneously set at 150' the warning lights would not have come on at 250′ to warn the Captain that he was at the Decision Height. In the absence of altitude call-outs and of the warning lights the Captain was probably not aware of the altitude when he allowed the aircraft to go down below the Decision Height and to reach a dangerous level so as to hit a tree which was 163′ above mean sea level. This would also confirm that there had been no proper cross-check of the flight instruments by the crew.

18.8. It was also stated that the Icelandic crew during Category One approaches utilize the Radio Altimeter only for guidance and cross-check of the Barometric Altimeter and it is the Barometric Altimeter that is used by the pilot to establish his Decision Height. The Barometric Altimeter, however, does not have a warning light on the Captain's panel and it is only the Radio Altimeter that would have given him the warning in the absence of call-outs by the Co-Pilot.

18.9. Since all altitudes of the Ground Proximity Warning System (GPWS) mode IV are computed from the aircraft radio altimeter (*Vide* Ramsden : *Ibid*, p. 210), the GPWS too would not have given any warning until the aircraft came down to the altitude of 150′.

18.10. It seems clear that both the Captain and the Co-Pilot became aware of the dangerously low altitude to which the aircraft had descended only when the Co-Pilot saw and announced that the VASI lights were red.

SECTION X

19. Decision Height

19.1. According to ICAO, Decision Height is the height below which an aircraft on an electronic glide slope may not descend, and at which an overshoot must be initiated if there is no visual reference. (*vide* Ramsden : *Ibid*, p. 208) In the instant case the Pilot at the height of 250′ (which he appears to have fixed as the Decision Height) or at least at a height of 228′ (which, according to the Icelandic Airlines' laid down procedure was the Decision Height for Katunayake) should have initiated an overshoot if the runway was not visual at that stage. Had he done so, whether he was flying a glide slope or not, he would have avoided a crash. The fact that he was flying the glide slope was no justification at all for him to descend the aircraft to a level below 228′. It was stated by the Icelandic team that according to the laid down procedure of the Icelandic Airlines the Pilot was strongly recommended " to remain on instruments " until he reached the altitude of 50′ over the threshold of the runway. It was submitted that the Captain therefore acted in conformity with instructions in flying the glide slope even below the Decision Height level. An examination of the provisions of the Icelandic Airlines' Operations Manual for DC–8–63 aircraft at p. 4.4.19 shows that the recommendation referred to is applicable only to automatic approaches. Category 1 ILS is not meant for automatic approaches and a pilot should not rely on the ILS below Decision Height.

19.2. In any event, the expression " remaining on instruments " would mean a scan of all the instruments on the Captain's panel in the cockpit and not merely ' flying the ILS '. Had the Captain had a proper scan of all instruments he could not have failed to detect the low altitude to which the aircraft was descending. The ILS at Katunayake falls under Category I and is not meant for an ILS descent below the Decision Height. The Glide Slope cannot be used as a touch-down guidance aid. (*vide* Avionics Navigation Systems by Myson Kayton and Walter R. Fried, p. 532).

19.3. Captain S. R. Wickramanayake, a Pilot of considerable experience in flying all types of aircraft and who is at present Chairman of Air Lanka, stated in evidence that the ILS category I is not designed to bring the aircraft down to the threshold and that at the Decision Height, if the runway was not visual, the Pilot had to initiate an overshoot. To a question put by Captain Steinthorsson of the Icelandic team, " Do you agree with me that if you initiated a missed approach at Decision Height, you can very well slip about a few feet ? " he gave the answer, " Forty to fifty feet is allowed ". So that, if the Pilot had initiated missed approach procedure at the height of 250′ (which he appears to have set for himself as the break-off point) he should still have been able to avoid the crash which took place at an altitude of 163'.

SECTION XI

20. Was a Bent Glide Slope the Cause of the Accident ?

20.1. The Icelandic delegation produced in evidence a flight path cross section (Annex VIII) prepared by them and pointed out that according to that cross section the aircraft had followed the glide slope at the time of the accident. They submitted that the Captain's course indicator found in the wreck indicated that at the time of the crash the aircraft was receiving ILS signals and was slightly to the right of the localizer which coincided with the spot where the crash took place and only slightly low on the glide path (approximately ½ "dot"). According to them, the glide path was bending downwards approximately 3·5 n.m. from the touch-down zone and it was by following that bent glide slope that the Pilot came down to a dangerously low altitude and crashed.

20.2. In support of their submission they relied on the following :

(*a*) The flight path cross section referred to above ;

(*b*) Memo of a meeting with a Mr. Heyn (AC 1) ;

(*c*) ILS glide slope change reversal (AC 7) ;

(*d*) Certain entries in the ATC Log Book (X 13) and the extracts from the same (AC 11) ;

(*e*) The Ground Proximity Warning System did not alert the Pilots that the aircraft was below the glide path and that from the Pilot's point of view the approach continued to be normal until he was alerted by the Co-Pilot's call that the VASI lights were red.

20.3. As regards the memo of a meeting with Mr. Heyn it was stated that Mr.Heyn is attached to the Flight Inspection Branch of the FAA and that he had expressed certain views in regard to the formation of bends in a glide slope when a team from Iceland met him in the U.S.A. for consultations. Mr. Heyn was, however, not called as a witness before me and I informed the Icelandic delegation in the course of the proceedings that opinions expressed to them by any person, however eminent he may be, would not be relevant evidence and cannot be acted on by me unless that person was called to testify personally at the proceedings before me or his opinions were supported by any competent witness who gave evidence before me.

The document marked AC 7 is also one based on the opinion expressed by Mr. Heyn and cannot be availed of as relevant evidence.

20.4. Mr. Heyn appears to have expressed the opinion that significant deviations can occur in ILS glide slope and localizer beams as a result of " improper maintenance procedures " and that those deviations can be aggravated during inclement weather, such as heavy rainfall. On the evidence placed before me it is not possible to come to the conclusion that the ILS at Katunayake had been improperly maintained.

20.5. But the Icelandic team relied on certain entries in the Log Book of the Tower Controllers to show that the ILS had not been working satisfactorily. The principal officer in charge of maintaining airport equipment and all navigational aids at Katunayake is Mr. Somasiri who has been attached to the Department of Civil Aviation for 20 years. He had had training at the Air Services Training School in Canada on radar fundamentals, VOR equipment and test equipment. He had also had practical training at Halifax International Airport. In 1972–73 he had attended the Federal Aviation Administration Academy in Oklahoma City, USA, and had had training on navigational aids for 7½ months. He had also had a period of training in Manila where an ILS identical to the one in use at Katunayake is in operation. He testified to the fact that the ILS equipment at Katunayake had been properly maintained throughout the period in accordance with the specified standards laid down by the manufacturers. The meter readings of the GP station taken on 3rd November, 1978 (Annex XI) and those taken on 18th November, 1978 (Annex XII) when compared with the readings of the last flight calibration indicate that there has not been any noticeable deterioration of the equipment. The Maintenance Log Book was also produced in evidence. It showed that maintenance work on the ILS had been regularly attended to. The theory, therefore, that on the night in question there had been a marked glide slope bend as a result of " improper maintenance procedure " of the ILS does not find support in the evidence led before me.

20.6.1. Reliance was also placed on the following passage at page 532 of Kayton and Fried's " Avionics Navigation Systems " :

" Because the glide slope transmissions are of continuous-wave type, reflections to the aircraft from surface irregularities, hills, vegetation and other aircraft will cause bends in the glide path. (The received signal is the vector sum of all energy arriving at the aircraft's antenna, including the given reflections.) "

The development of such a bend is illustrated by a diagram (not drawn to scale) in which a hill is sited in close proximity to the glide slope antennae.

20.6.2. It may be noted however, that what is described as a ' bend ' is a slight deviation from the normal path and not an abnormal downward course of the glide beam. At Katunayake there have admittedly been no changes in the surface area since the time of commissioning of the ILS or of the last flight calibration. The evidence does not show that there was any aircraft or other external object, reflections from which could have conduced to the developing of bends. Deviations, if any, arising from reflections from wet foliage of the trees in the area would not be of any substantial nature.

21. Evidence of Mr. Krishna Prasaad, Project Manager, ICAO

21.1. The evidence of Mr. Krishna Prasad given before me shows that the theory that the aircraft crashed as a result of following a bent glide slope is not tenable. Mr. Prasad is an Electronics Engineer who has been functioning as the ICAO Project Manager for Telecommunication Facilities and Navigational Aids in Sri Lanka since September 1975. He had earlier been an expert attached to the UNDP for about two years and had in that capacity visited various countries such as Indonesia, Nepal, Bangladesh, Burma, Cambodia, Malaysia and Sierra Leone. He had had training in ILS with the FAA at the Training Centre in Oklahoma. He stated that from 1955 onwards he had been associated with ILS in various countries in the form of flight checks, site evaluation, installation of ILS and supervision of ILS installations. He had been in Sri Lanka when the ILS was installed at Katunayake. He stated that he had been consulted by the Department of Civil Aviation, Sri Lanka, regarding the suitability of the site, particularly the glide path at the time of installation, and in his opinion the site was very good. It is his opinion that a substantial bend in the glide beam which can lead to a deviation of an aircraft from its course to a dangerously low level is not possible at Katunayake since, in the event of any malfunctioning of the system, the monitor will shut it down. It would appear from his evidence that the site selected for the ILS being almost an ideal one the conditions referred to by Kayton and Fried for the development of substantial glide slope bends do not exist at Katunayake.

21.2. Some of the questions put to him and his answers which are quoted below make the position clear:

" *Q.* Once you select that particular glide path which is optimum for this purpose could beam bends occur after that ?

A. There is an initial flight check. You do a very extensive and very involved examination. Every parameter is gone into in detail and the facility is certified fit for operation only if the variations are well within the permitted tolerance. It was done at Katunayake.

Q. Could there be temporary bends after installation of ILS due to very heavy rain, for instance ?

A. . . . . Once the facility is flight-checked and it has been established that everything is within tolerance it is expected and known that the system is suitable. Of course, in the critical area there could be accumulation of snow or an aircraft parked. Then a beam bend could suddenly occur. . . . .

Q. As a result of poor maintenance of that equipment, is it possible that there may be bends ?

A. You have a monitor right in front of the glide path which is adjusted very precisely. It takes care of variations in any parameter. To the best of my knowledge the equipment is very good.

Q. I understand that poor maintenance can affect the glide slope of the ILS. That would cause fly-down in landing or irregularities in the system ?

A. Beam bends would occur if there was any major change in the critical area. If there was no change in the critical area, as long as the antennae remain in the correct place, there is no possibility of beam bends taking place. . . . .

Q. Is it possible that due to a defective monitor system of the glide slope a faulty glide slope can go undetected and the system will not trip ?

A. The monitors are built by manufacturers with what is called Fail Safe Feature, that is, if any monitor circuit fails, the monitor automatically shuts down the equipment. . . . .

Q. Does heavy accumulation of water in the critical area cause a bend in the glide slope ?

A. It could cause a shift in the glide path. When there is a change in the glide angle from 3 degrees, it may be 2·99 degrees or 2·9 degrees. But it will be very small. It will be there with accumulation of water. It must be an enormous accumulation like a pond or a lake.

Q. Is it your view that it would not be a bend ?

A. It will not create a bend. It will definitely have an effect on the glide path, that is, the position of the glide path. . . . .

Q. Could there be a bend in the glide slope when such an accident takes place ?

A. If there are vehicles obstructing in the critical area. It will show a bend in the glide path in the critical area if you introduce external objects or trees or a big mound. . . . .

Q. If the glide slope was functioning at that time could it have caused a bend to give a wrong direction ?

A. Only if there was a very big obstacle.

Q. If the glide path was functioning at that time could a bend have occurred to mislead the Pilot ?

A. No abnormal bend. . . . .

When you talk of bends, that would be a course which can be followed but excursions or fluctuations will always be there, even in the most ideal site. . . . .

MR. OLAFSSON :

Q. You have been in the Aviation Industry for a number of years. Have you not heard or read a report by ICAO on accidents, of accidents that would probably have been caused by what is called bending in the glide slope ?

A. No.

MR. OLAFSSON :

Q. But if you are a specialist on ILS you would definitely get reports ?

COMMISSIONER TO MR. OLAFSSON :

Q. Have you any reports ?

A. No, I do not have reports.

MR. SIGURDARSON :

We may get some major information. We reserve the right to call Mr. Prasad again. . . . .

Q. . . . . How many feet in front of the glide slope antenna, in your opinion, should be free of any obstacle to have a perfect glide slope ?

A. The position of the monitor depends upon the glide angle. For 3 degrees it is about 200′. The area between the glide path mast and the monitor is critical. Whatever point you have which is in that area is very critical.

Q. The most critical point is between the antenna and the monitor ?

A. Up to threshold also.

Q. In the case of Katunayake ILS the antenna is 1,000′. Would you agree that this 1,000′ is the most critical ?

A. Yes.

Q. The monitor being coupled to the glide path, in case there was some doubt, would you conclusively say that what is radiated is continuously sampled by the monitor and therefore the monitor would ensure the equipment is shut down ?

A. Yes. . . . .

Q. There was some mention about bad maintenance ; improper maintenance causing beam bends. Would it not be correct to say that the monitor would detect incorrect settings and therefore shut down ?

A. Yes, that is correct. . . . .

Q. Other than power failure, any power fluctuations or voltage changes, that is line surges, could that cause equipment to trip ?

A. That is right.

Q. In your experience have you ever found after the commissioning flight check done on an ILS where the site had remained substantially the same, under any circumstances, has given rise to large unacceptable and dangerous beam bends ? I am not referring to minor fluctuations but to large and dangerous fly-down indications.

A. When you say large and dangerous bends, of what magnitude ?

Q. I mean a situation where the beam will cause an aircraft to be placed in a dangerous position.

A. In fact, the first part, no. The second part, to give you an idea of what is 1 dot deviation, when the sector is very narrow it is 0·04 degrees ; when the sector is wide it is .08 degrees.

That is the magnitude. That is, it has shifted so much.

Q. Fly-down under worst conditions, would it not be .24 degrees ?

A. Yes.

Q. Suppose it is ·25 degrees which is 1/4 of a degree. From a 3-degree angle it will be 2·75 degrees. Would you say that an aircraft following a 2·75 degrees angle will still be above any obstruction at Katunayake ?

A. It will be. "

21.3.1. In the course of his further evidence Mr. Prasad said " I would not expect any beam bend because two flight checks had been done within one year.. If there was any deterioration it would have been noticed at the second test. Aircrafts have been flying into Katunayake and if anything seriously adverse had been noticed they would have reported it. ".

21.3.2. The Icelandic delegation submitted that in view of the large number of adverse pilots' reports that had been received and entered in the ATC Log Book, both before and after the date of the accident, Mr. Prasad " must be considered to agree with the strong probability of a bending of the glide path at KIA ". But Mr. Prasad's evidence under further questioning clearly indicated that he did not regard the pilots' reports which had been received, however numerous they may be, as of much value since they were generalized, loose statements without the necessary data being furnished. According to him any reasonable inference in regard to the ILS can be drawn from pilots' reports only if the report is substantiated with full information.

22. Log Book Entries regarding the ILS

22.1. The Icelandic delegation submitted an analysis of the Log Book entries of pilots' reports relating to the ILS covering a period of about one month before the accident and about 2½ months thereafter. Subsequent to the accident the Competent Authority of the Airport had called for reports from pilots in regard to the working of the navigational aids and these log entries referred to the reports of those pilots. According to that analysis (Annex XIII) a large majority of the complaints fall under the following heads:—

" Glide path unreliable "	" Status not known "
" Glide path useless "	" Never picked up "
" Glide path unusable "	" Tripping "
" Glide slope unserviceable "	" Unsteady "
" ILS power loss "	" Outer Marker unserviceable "
" ILS unserviceable "	" Localizer unserviceable "
" ILS tripping "	" Erratic "
" ILS off the air "	" Fluctuative "

Some of the entries have been repeated under different heads. Out of the period of 3½ months only on 7 days, namely, on 2.12.78, 28.12.78, 12.1.79. 2.2.79, 10.2.79, 12.2.79 and 14.2.79, did the pilots' reports refer to the glide slope having shown fly-down or erroneous indications.

22.2. As stated by Mr. Prasad, most of the pilots' reports were vague and did not furnish relevant data to enable one to draw correct inferences from them. Some were clearly inaccurate. For example, the entry under 28.10.78 reads :

" BA 034 on ground says Area Control advised him that ILS was O.K. and he never picked up glide slope. He also says it is misleading."

To say that the glide slope which he did not pick up was misleading does not make sense. On 12.1.79 at 21·00 the entry reads :

" AE 223 GS indicating 'fly low' while VASI showed correct. At YKW, GS needle shows full fly-down all the way."

Yakwila is at a distance of 17 n.m. from the threshold of runway 22 and, according to the evidence, glide slope beam signals would not be received at that distance. It is difficult to understand how the glide slope could have shown " full fly-down " at that distance.

22.3. It is in evidence that electric power to the ILS and the other navigational aids at Katunayake is supplied by the Ceylon Electricity Board. The supply of power during the relevant period appears to have been most erratic and undependable. Fluctuations of power as well as its complete stoppage were a common occurrence. These power supply problems resulted in frequent Navaid outages.

22.4. According to the evidence the Aviation Authorities have no control over the power supply. This appears to be a matter on which the Central Government should intervene and see that the Ceylon Electricity Board takes remedial measures to ensure a steady supply of power. The maintenance of a steady and adequate power supply to the navigational aids is linked with aircraft safety and should be dealt with as a matter of urgency if Katunayake is to function efficiently as an international airport.

22.5. Most of the complaints relating to the ILS which have been listed in Annex XIII are directly referable to erratic power supply or complete failure of power supply. Mr. Prasad's evidence was that they did not necessarily indicate that there was anything wrong with the ILS instruments. It would appear that faulty fly-down indications of the glide slope can seldom lead a pilot into dangerous situations provided he has adequate scan of the instruments on his panel which would give him the altitude and sink rate and other relevant information at any particular point of time.

22.6. In the course of his evidence Captain Wickramanayake stated as follows :

" *Q*. There have been various log entries produced here relating to sudden fly-down conditions reported by captains of aircrafts. Could you explain to the Commission what these fly-down conditions are and what relevance they have ?

A. I have never experienced a fly-down condition yet, but if I did experience a fly-down condition, as a professional pilot, if I was following the glide slope correctly and then I was given a fly-down indication by the instrument I would certainly disregard it. I would not follow it, in other words.

Q. You disregard the glide slope from that point ?

A. That is right.

Q. How would you know that you had to disregard it ?

A. Because we have a little needle that is moving up and down. Now, if you are flying the glide slope correctly, the needle remains in its centre position. If the needle moves down it is telling you to go down. If the needle should move up it is telling you to go up. If you are correctly set in the slot, as we call it, and you are coming down, the needle remains in the centre position. If there is a bend in the glide slope, the needle will suddenly tell you to go down at a fairly fast rate of descent. I would not follow it. I would know then that there is something wrong with that.

Q. The Pilot should know ?

A. He should know."

22.7. Ramsden (*Ibid*) says at p. 213 :

" The problem still remains with ILS that there is one part of the system which has relatively low integrity, namely, the transmission path, partly because it is a single path, ... Even in the best ILS installations the integrity of the transmission path cannot be completely guaranteed."

A proper continuous scan of all the instruments will, of course, enable the pilot to avoid getting into dangerous situations.

22.8. Captain Wickramanayake was also questioned about the readings found on the Flight Director of the Captain's panel which was recovered from the wreckage. He stated that the Flight Director was type 109 and that he had himself used Flight Directors of that type.

" *Q*. Taking into account that the aircraft was on the approach mode, using ILS, I would like to know your observations of what you see there (on the Flight Director) taking into account the command bars, rising runway and the aircraft indicator.

A. Well, it shows the pilot below the glide slope.

Q. Can you in any way say that at that time he was following the glide slope or was he below the glide slope ?

A. I would say he was below the glide slope."

22.9. As against the indications given by the Flight Director, the glide slope pointer on the Course Indicator recovered from the wreckage showed only half a dot variation. The glide slope pointer on the Flight Director gave a different reading. The glass of the Flight Director had been completely smashed and the sky-line had turned directions. None of the needles had got embedded at the time of the crash and they were all movable. I do not, therefore, consider it safe to draw any inference from the readings on the Flight Director after the crash. It is not unlikely that the various needles had altered their positions by the force of the impact.

22.10. The glass of the Course Indicator was only partly broken but there were small pebbles and mud under the glass. The Glide Slope Pointer was not embedded but was movable. In these circumstances, it is not possible to state with any reasonable degree of certainty that the position of the Glide Slope Pointer as shown in the photograph (Annex XIV) was the self-same position at the time of the crash. The position may well have altered as a result of the force of the impact and, in considering the evidence, therefore, much importance cannot be attached to the fact that the photograph shows the indicator to be only about half a dot above.

22.11. As regards the submission that the Ground Proximity Warning System did not alert the Pilot that the aircraft was below the glide path, one has to consider the fact that, although according to the statement of Flight Lt. Jonsson of the Icelandic team, all five modes of the GPWS were in operation, the CVR recordings do not show that there had been any warning on any one of the modes. On mode 4 there should have been a warning of 'Too near the ground' when the aircraft was descending below the altitude of 200′, but the CVR has not recorded any warning at all. It is therefore difficult to draw any definite conclusion from the absence of any warning on mode 5 which relates to the glide slope. One cannot overrule the possibility that the system was not functioning.

22.12. Captain Mawalagedara who was Assistant General Manager (Operations) at Air Ceylon for a period of ten years until 20th February 1979, stated in evidence that on 17.11.78 he carried out 4 ILS approaches and found that the ILS was working satisfactorily. On 21st November too during certain test flights he carried out some ILS approaches and found that the system was working satisfactorily. He had carried out about 6 approaches on the "Trident" and about 4 on the "Avro". He further stated that after the ILS had been calibrated in December 1977 he had used it quite regularly but had never found it giving wrong information. When it was working it worked well; when it was not working it was completely off. Mr. Olafsson of the Icleandic team cross-examined Captain Mawalagedara with reference to the flights on 17th November and the Tower Controller's Log Book entries on that date. He stated that the ILS had tripped five times on that day. But Captain Mawalagedara stated that during the period when he did the ILS approaches the ILS was functioning. It should be noted that according to the log entries cited there had been no tripping during the period Captain Mawalagedara did his approaches.

22.13. The Icelandic team also pointed out that about four minutes prior to the crash according to the tower tapes there had been several audio-alarms indicating trippings. According to Mr. Somasiri, those audio-alarms were from the localizer and not from the glide slope. He stated that when there was heavy lightning, transients were picked up on the lines and tended to give an audio-alarm in the tower without the localizer actually tripping. As far as the glide slope was concerned, in view of the absence of the connecting cable it was only information received from the Radio Technician who monitored a portable receiver that would have enabled the Tower Controller to know whether the glide slope was functioning properly or not. If the glide slope tripped then the Technician had to go to the site to reset it as the resetting could not be done from the tower.

23. The ILS at Katunayake

23.1. According to the recommendations of ICAO, the ILS should be flight calibrated once in three months or at least four months. In the case of the instrument at Katunayake, however, no flight calibration had been done for a period of nearly 11 months. Although the recommendation is not mandatory it is essential that flight calibration of such a sensitive instrument as the ILS should be done at regular intervals as all aberrations and deviations can be detected and set right only by a flight calibration. Since the safety of the aircraft and its passengers may depend on the efficient working of the Instrument Landing System it is important that every one of the components of the system should be in perfect condition. The Icelandic team were justified in their criticism of the ILS equipment in view of the absence of remote control facilities in the tower in respect of the glide slope and the two markers on the night in question and the frequent unserviceability of the system owing to defective or erratic power supply.

24. Defective ILS as a Factor in Accidents

24.1. When, in the course of the cross-examination of Mr. Prasad by the Icelandic team, he was questioned on reports of accidents caused by bending glide slopes and Mr. Prasad replied that he had not seen any reports but if there were any findings after any investigation that any accident had been caused by the mal-functioning of a glide slope he would not question that report, I enquired from Mr. Sigurdarson whether he had any report in his possession. He said he had none with him but expected some "major information" on the matter. No report was, however, produced at any stage.

24.2. After the recording of evidence at the enquiry had been concluded, I requested Mr. D. H. Athulathmudali, the Acting Director of Civil Aviation of Sri Lanka, to obtain from ICAO any available information in regard to any previous accident due to the bending of a glide slope. Since Mr. Prasad is the local representative of ICAO, Mr. Athulathmudali appears to have requested him to obtain that information from Headquarters. Mr. Prasad had addressed a letter (*vide* copy—Annex XV) in which he had asked for information on the following points :—

(1) Has any aircraft accident taken place as a result of a beam bend on the glide path system ?

(2) Is there any report on the occurrence of dangerous beam bends on the glide path system (ICAO standard) ? If so, the conditions under which such bending has been known to have taken place and gone undetected by the automatic monitoring system associated with the glide path.

He also asked for any information of any accident reports wherein it had been clearly established that the aircraft accident was due to a defective ILS ground equipment.

24.3. In answer to the said queries the following telex message had been received (*vide* Annex XVI).

"ICAO AIG Section has searched its accident/incident data bank and the records of Chief/Com. From both sources response to both your questions is negative, i.e., there are no accident reports supporting the situation posed in your letter. Furthermore, no reports establishing clearly accident due to defective ILS ground equipment."

24.4. The cross-examination of Mr. Prasad on the basis that there were reported cases of accidents due to bends in glide slopes would therefore appear to have been unjustified. The case at Houston to which reference appears to have been made by Mr. Heyn in his discussions with the Icelandic team was one where the monitoring system of the ILS was out of order. Mr. Prasad's evidence was that the monitor is a fail safe instrument and would shut down the system in the event of any malfunctioning.

25. ILS Approaches Before and After the Accident

25.1 Evidence was also led that the ILS at Katunayake had been used by several aircrafts for approaches both before and after the accident until the Competent Autority placed it " on test " pending a flight calibration of the system. The details for a period of one week preceding and one week succeeding the accident are contained in Annex XVII. On 9th November there were 4 ILS approaches ; 10th November—2 approaches ; 11th November—3 approaches ; 12th November—2 approaches ; 15th November—2 approaches (at 08.05 and 08.24 respectively) ; 16th November—3 approaches ; 17th November —1 approach ; 21st November—1 approach.

SECTION XII

26. Weather

26.1. The evidence of Mr. Sumanasekera, Meteorological Officer, showed that there had been thunderstorms that night both before and about the time of the accident and an accumulation of Cumulo Nimbus clouds. His evidence about the significance of Cumulo Nimbus clouds was as follows :

" *Q*. Associated with Aviation what is the significance of CBs ?

A. Particularly in the lower levels below 5,000′ to the ground they cause heavy down draughts, up draughts and also in the horizontal plane they cause very strong down draughts. These are local ones over a

Q. Dangerous for aircrafts ?

A. Yes, very dangerous because of the wind-shear that it causes. CBs are dangerous to aviation mainly because of the strong vertical and horizontal currents of air that are set in motion. There have been instances where winds of 70 to 80 knots existed in CBs.

Q. Can aircraft entering such weather experience head winds or tail winds ?

A. If the path of the aircraft is through the thunderstorm there could be strong down draughts."

26.2. Having regard to the air speed shown by the Flight Data Recorder read-outs, the possibility of wind-shear being a contributory cause of the accident can be ruled out. It is possible, however, that there were vertical down draughts in the approach area which made recovery from the excessive sink rate more difficult.

SECTION XIII

27. Pathological Examinations

27.1. Post-mortem examinations were carried out on all remains recovered of the Cockpit and Cabin crew. There were no indications of any illness or exposure to toxic vapours on any of them.

SECTION XIV

28. Summary of Findings

(1) The aircraft crew and controllers were certificated and qualified.

(2) The Captain asked for and was given an ILS approach to runway 22.

(3) The Captain of the aircraft failed to comply with the Radar Controller's instruction to report when established on the Localizer or when he was visual.

(4) Owing to the Captain's failure to report that he was established on the Localizer, the Radar Controller continued to give advisory heights and distances, the last call being that the aircraft was at a height of 650′ and two miles from touch-down.

(5) Contrary to the procedure laid down by the Icelandic Airlines, the Co-Pilot failed to make the altitude and sink rate call-outs at 1,000′, 500′, 100′ above Decision Height and at Decision Height.

(6) The Captain and the Co-Pilot had not effectively monitored the Flight Instruments during the final phase of the approach and had consequently deprived themselves of vital altitude and sink rate information.

(7) The accident could have been averted if at the altitude of 250′ or at 228′ the Pilot had initiated a missed approach.

(8) The accident was not the result of a bending glide slope. Even if there was a bend in the glide slope, the accident would have been avoided if the Pilot and Co-Pilot had followed the laid down procedures.

(9) The Pilot should have discontinued the use of the glide slope at the altitude of 200′, if not earlier.

(10) The recommendation contained in the Icelandic DC-8-63 Operations Manual at page 4.4.20 for the Captain to " remain on instruments " from the Decision Height to the point of crossing the runway threshold at 50′, applies only to automatic approaches and had no application to landings at Katunayake Airport which is equipped only with a Category 1 ILS.

(11) The altitude and distance call-outs by the Radar Controller, even if erroneous, were not a contributing factor to the accident as no calls were given after the aircraft had descended to the altitude of 650′.

(12) There is a probability that the Radio Altimeter on the Captain's panel had been erroneously set at 150′ instead of at 250′ .

(13) If the Radio Altimeter had been erroneously set at 150′, the light on the Captain's panel and the Ground Proximity Warning System would not have given the warning when the aircraft was descending below the height of 250′.

SECTION XV

29. Probable Cause of the Accident

29.1. The probable cause of the accident was the flight crew's failure to conform to the laid down approach procedures.

29.2. They failed to check and utilize all instruments available for altitude and descent rate awareness.

29.3. The Co-Pilot failed to provide the Captain with the required altitude and sink rate call-outs at the various levels.

29.4. The sink rate was very excessive during most part of the descent.

29.6. There is a probability that the Radio Altimeter Bug on the Captain's panel had been erroneously set at 150′ which resulted in the Captain being deprived of the warning light of the altimeter and of the audiovisual warnings of the GPWS at the break-off altitude of 250′ which he had intended to set.

29.7. Contributing to the accident was the fact that there was a down draught of the wind which probably rendered recovery more difficult when the Captain realized that the aircraft had descended too low and called for maximum power to overshoot.

SECTION XVI

30. Recommendations

30.1. Early steps should be taken to ensure that a regular, uninterrupted supply of electric power is made available at Katunayake for the proper functioning of the navigational aids.

30.2. The Instrument Landing System at Katunayake should be flight calibrated at an early date and such calibrations should be repeated at regular intervals in terms of the recommendation of ICAO.

30.3. Steps should be taken to ensure that all the components of the ILS are connected to the remote control unit at the Control Tower and the display unit functions properly so that the Aircraft Controller may have prompt and accurate information at all times in regard to the status of each of the components.

30.4. The Approach Lighting System should be restored without delay and should always be available for the use of in-coming aircraft.

30.5. All navigational aids, both visual and radio navigational, should be maintained at the highest pitch of efficiency.

30.6. The radar should never be left unmanned.

On two unscheduled visits to the Radar Control Room, I found on one occasion that the place was deserted and the radar was unmanned and on the other that the room was locked and no one appeared to be inside.

SECTION XVII

31. Conclusion / Acknowledgments

31.1. In concluding my report I wish to place on record my deep appreciation of the advice and assistance which I received from my Legal Adviser, Mr. V. C. Gunatilaka, Solicitor-General, and my Technical Adviser, Mr. D. J. Rosa,

Mr. Gunatilaka's specialised knowledge of Aviation law and procedure was of considerable assistance to me at various stages of the enquiry.

Mr. Rosa took great pains and prepared the reconstructed Flight Approach Profile (Annex V) as well as the superimposed transcript combining the recordings on the tower tapes and the CVR transcripts (Annex VII). Both these documents provided valuable information for the enquiry. I am also obliged to him for his assistance in analysing the factual information and for his advice in regard to the technical aspects of the investigation, although I could not agree with his conclusions on various matters where such conclusions were unsupported by the evidence placed before me or were inconsistent with that evidence.

31.2. I am also deeply indebted to Captain S. R. Wickremanayake who was my technical adviser during the early stages of the investigation for his very valuable advice and assistance on many aspects of the investigation.

31.3. I should record my very sincere thanks to the members of the Icelandic team who participated in the enquiry for their considerable assistance in elucidating many of the difficult problems that arose for consideration, although, on the material before me, I could not agree with their conclusions in regard to the probable cause or causes of the accident.

31.4. I am grateful to Mr. Douglas Dreifus, the U.S. accredited representative for his statement of Factual Information which he very kindly forwarded to me and for his offer of assistance, if needed. His statement was of great value.

31.5. I will be failing in my duty if I did not record my sincere thanks to Mr. J. Diandas, F.C.A., who very kindly furnished me with reports of several aircraft accidents published by the National Transportation Safety Board of the U.S. Government. These reports were of great assistance to me.

31.6. Finally, I must place on record my deep appreciation of the very valuable assistance rendered to me by Mr. G. P. S. U. de Silva, the Secretary to this Commission. His duties were, at times, very exacting but he discharged them with great efficiency and cheerfulness.

I submit the above Report for Your Excellency's consideration.

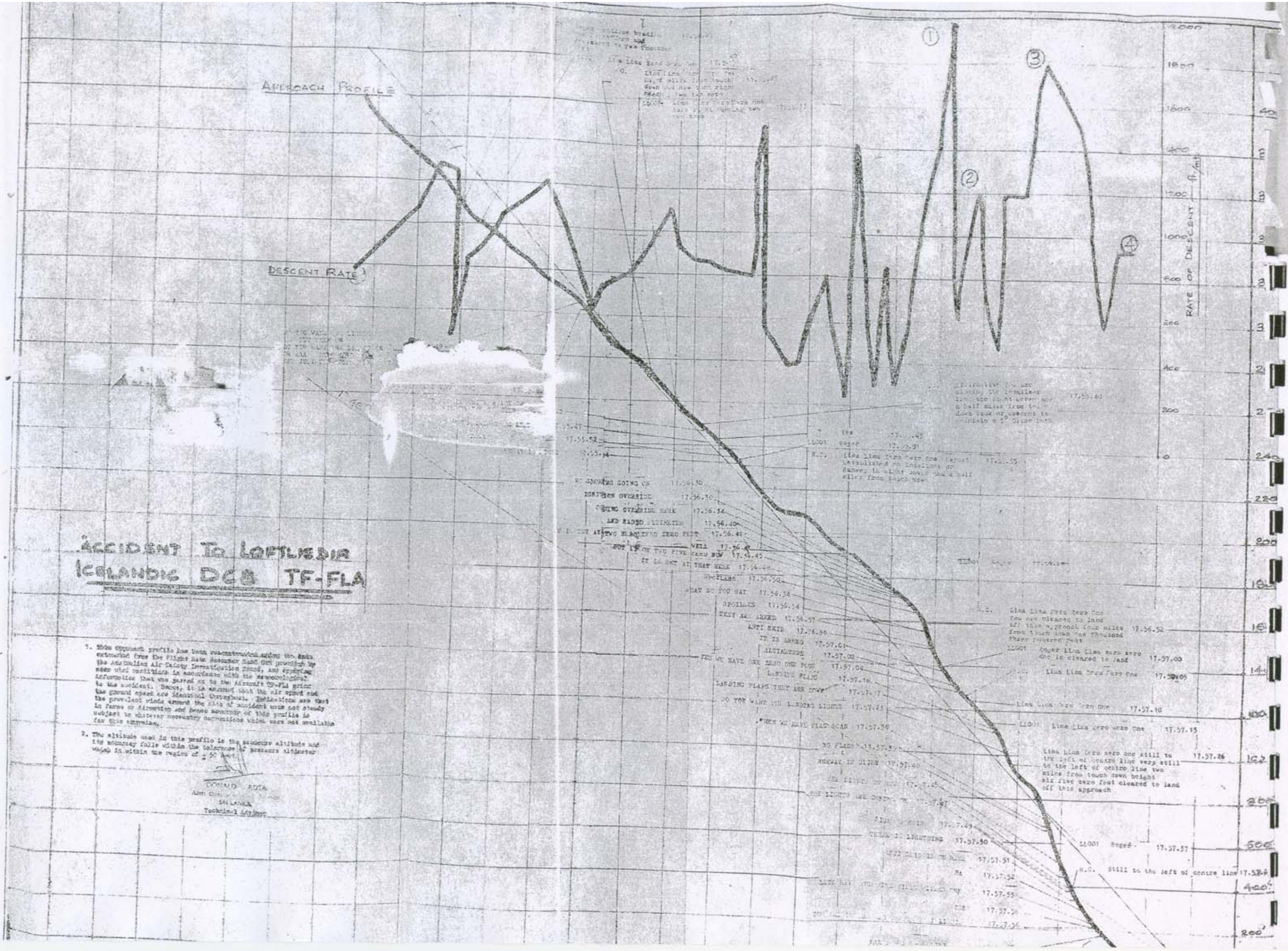
I remain, Sir,
Your obedient servant,

V. Siva Supramaniam,
Commissioner.

Colombo, June 28, 1979.

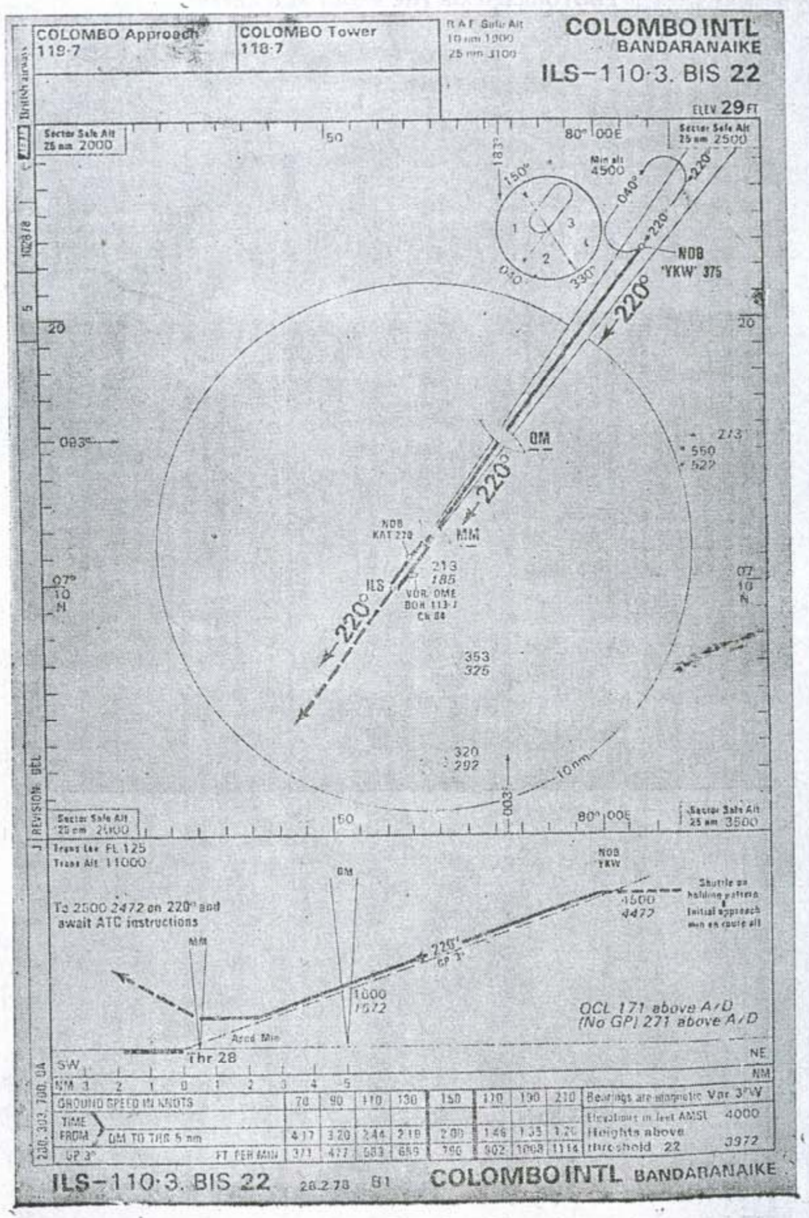
LIST OF PERSONS WHO GAVE EVIDENCE BEFORE THE COMMISSION OF INQUIRY

Mr. T. N. Ramachandra	Air Traffic Controller, Colombo International Airport
Mr. B. Somasiri	Senior Radio Inspector, Colombo International Airport
Capt. Mawalagedera	Former Assistant General Manager, Air Ceylon
Mr. H. D. K. Prasad	ICAO Project Manager for Telecommunication Facilities and Navigational Aids in Sri Lanka
Mr. Nihal Lakshman de Silva	Air Traffic Controller, Ratmalana Airport
Mr. D. N. Hewapathirana	Air Traffic Controller, Colombo International Airport
Mr. B. D. W. Karunaratne	Assistant Director, Air Traffic Services, Department of Civil Aviation
Mr. Ranjit Mahinda de Silva	Air Traffic Controller, Colombo International Airport
Mr. P. Sumanasekara	Meteorologist
Mr. D. A. B. Visidagama	Radio Instructor, Colombo International Airport
Capt. Santha Rakkitha Wickramanayake	Chairman, Air Lanka
Mr. W. Artingstall	Flight Engineer, Singapore Airlines
Mr. S. R. de S. Amangilihewa	Radar Engineer, Colombo International Airport


APPROACH PROFILE
DESCENT RATE
ACCIDENT TO LOFTLEIDIR
ICELANDIC DC8 TF-FLA
RATE OF DESCENT ft/min
2000
1800
1600
1400
1200
1000
800
600
400
200
0
1
2
3
4
Lima Lima Zero Zero One still to the left of centre line very still to the left of centre line two miles from touch down height six five zero feet cleared to land off this approach
17.57.26
LL001 Roger 17.57.37
Still to the left of centre line

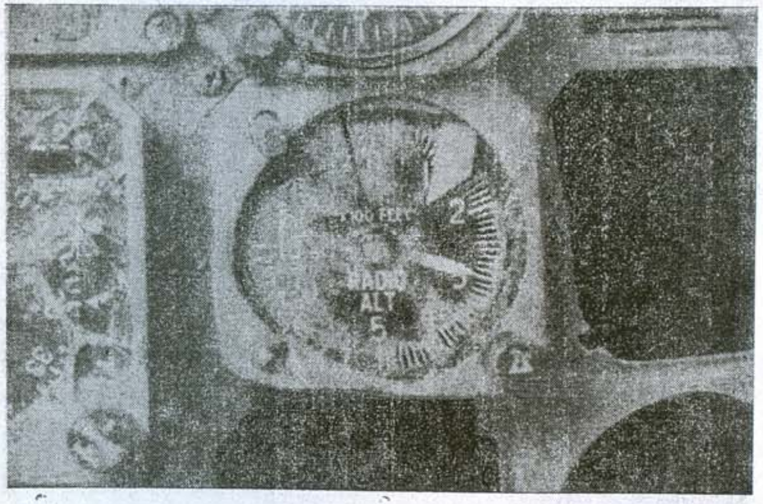
COLOMBO APPROACH DIAGRAM

ANNEXE IX



ANNEXE X

PHOTOGRAPH OF THE RADIO ALTIMETER



ANNEXE XI

RADIO ENGINEERING DIVISION, B. I. A.

Daily Meter Readings—Instrument Landing System

	Localizer Course/Clearance Equipment			
	No. 1		No. 2	
	Course	Clearance	Course	Clearance
Transmitter :				
Oscillator	4.4	5.1	4.5	5.0
1st Doubler	7.0	6.2	7 0	6 0
2nd Doubler	8.2	9.0	8.0	5.5
1st RF Amp.	4.0	3.5	3.0	4.5
2nd RF Amp.	14.0	14.0	14.0	13.0
Driver	16.1	17	17.0	16.5
Power Amp.	8.0	8.5	7.0	8.0
RF Output	4.5	12.5	10.0	10.5
Power Supply	14.2	13.0	13.0	12.5
Monitor :				
Off Course Sens.	Lo	Lo	Lo	Lo
Off Course Meter DDM	0/+	6.	-01	+04
Off Course DDM Indicator	165/150	158/150	160/150	160/150
On Course Sens.	Lo	Lo	Lo	Lo
On Course DDM Meter	+01	18/150	-04	-04
On Course DDM Indicator	025/90	90	24/90	17/150
Pos. Volts	85	87	90	85
Off Course Path Level	95	100	105	105
On Course Path Level	100	100	90	110
Meg. Volts.	105	100	100	105
RF Level	110	105	105	110
Modulator :				
Sideband Phaser	52	30	40	16
Sideband Amplitude	41	20	50	37
Modulation Balance	20	21	27	26
Modulation Percentage	24.	.91	13.	14.0

Ant. Changeover :

Power Output Forward
CSB Reverse
SB Forward
Reverse
A/C Voltage Unregulated
Regulated

Aircond. Telephone Tools

Date 3.11.78 Name Signature

" Erratic "	6/11/1430, 10/2/1824
" Low "	2/12/2010/2205
" Fluctuating "	28/11/oscillates. 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, 12/2/0830
" Fly down "	12/1/2100, 12/1/1245, 10/2/0810, 14/2/0810
" Abrupt change "	6/2/0850, 12/2/ 0830
" 2½-3 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 off set localizer 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 followings :—

(*a*) Reports from pilots or other flight crew members ;

(*b*) Reports from radio technical staff ;

(*c*) Observations of the air traffic controllers.

ANNEXE XIV

PHOTOGRAPH OF THE PILOTS INSTRUMENT PANEL RECOVERED FROM THE WRECKAGE