

AIRCRAFT ACCIDENT report 1/78

**CHIEF INSPECTOR OF ACCIDENTS
CIVIL AVIATION DEPARTMENT
MALAYSIA**

**BOEING 737 9M-MBD—REPORT 1/78
ACCIDENT NEAR GELANG PATAH, NEGERI JOHOR**

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Perpustakaan
Jabatan Penerbangan Awam
Malaysia

BOEING 737 9M-MBD—REPORT 1/78
ACCIDENT NEAR GELANG PATAH, NEGERI JOHOR
ON 4th DECEMBER, 1977

Identity	Narrative/Aural Warnings	Remarks
?	Altitude Alert "Still won't come up"	Not voice of either pilot
?	It still won't come up"	Not voice of either pilot
?	V _{MO} Warning Starts To Run "It won't come up"	Not voice of either pilot
	Aerodynamic Noise Has Increased To Approximately This Point, Now Diminishes	075 seconds
	Altitude Alert And Crew Call Together	
	Knock	
	Knock	
?	Unintelligible	Two persons, possibly involved in a struggle
?	Unintelligible	
?	Unintelligible	
	Knocking Noise And Sounds As of Someone Moving About	
	V _{MO} Warning Stops	
	Altitude Alert. Horizontal Stabilizer Trim Running (Possibly)	
	Altitude Alert Aerodynamic Noise At A Low Level Knocking Noises Sounds As Of Someone Moving About	
?	Altitude Alert Unintelligible but considered to be in a foreign language Altitude Alert V _{MO} Warning Starts To Run Rapid Increase In Aerodynamic Noise To End Of Tape	

END OF PART 2

**BOEING 737 9M-MBD
REPORT ON THE ACCIDENT AT TANJUNG KUPANG,
GELANG PATAH JOHOR BAHRU,
ON 04 DECEMBER, 1977**

Aircraft Accident Investigation Team,
Civil Aviation Department, Malaysia.

Aircraft Accident Report No: 1/78

Aircraft : Boeing 737-2H6 Registration 9M-MBD
Engines : Two Pratt & Whitney JT8D-15
Owner and Operator : Malaysian Airline System
Flight Crew : 2 Fatal
Cabin Crew : 5 Fatal
Passengers : 93 Fatal
Place of Accident : Tanjung Kupang, Gelang Patah near
Johor Bahru
Latitude : 01 deg 21 North
Longitude : 103 deg 37 East
Date : 04 December, 1977 at 2016 hours

All Times in this Report are Local

SUMMARY

The aircraft was operating a scheduled internal domestic flight from Penang to Kuala Lumpur on the evening of 04 December, 1977. The departure from Penang and the flight to Kuala Lumpur progressed uneventfully until the aircraft was making preparations for landing. At this point, some 4 miles north of Kuala Lumpur, the aircraft was taken over by a hijacker or hijackers. There was some confusion initially as to whether the aircraft was to land at Kuala Lumpur or to proceed elsewhere. Subsequently, the aircraft was cleared to and proceeded towards Singapore. Singapore ATC identified the aircraft on radar and progressively cleared it to descend from flight level

210 to 11,000 feet to 7,000 feet. During the descent, whilst passing approximately 14,000 feet, the crew were shot by the hijacker or hijackers. The aircraft then carried out some unusual, pitch up and pitch down terminal manoeuvres before finally impacting into swampy ground at some 450 knots. The report concludes that the accident was caused by the crews being fatally incapacitated by a hijacker or hijackers leaving the aircraft professionally uncontrolled until it impacted with the ground.

Following the accident, the Civil Aviation Department was informed and two representatives from the UK Accident Investigation Branch were invited to advise and assist in the investigation.

1. INVESTIGATION

NOTE: It has not been possible to determine with any degree of certainty the number of hijackers on board the aircraft. Subsequent references in this report to hijackers should be interpreted as one person or more.

1.1 History of The Flight

The aircraft was operating Malaysian Airline System (MAS) Flight MH653 on 04 December, 1977. It was a scheduled, internal domestic, passenger flight from Kuala Lumpur to Penang to Kuala Lumpur and then to Singapore. The flight from Kuala Lumpur to Penang and departure from Penang to Kuala Lumpur was normal. The aircraft departed Penang at 1921 hours. It climbed to and maintained flight level 190 for Kuala Lumpur. The aircraft was identified on radar and at 1943:50 hours, it was cleared to descend through 4,000 feet. At 1946:20 hours, the aircraft reported it was at Batu Arang inbound for Kuala Lumpur. Very soon after this, hijackers entered the cockpit and took over control of the flight.

The hijackers immediately ordered the crew to cut all radio contact. The crew attempted to convince the hijackers that it was essential that radio contact be maintained for flight safety reasons especially since they were already approaching the Kuala Lumpur circuit traffic pattern; attempts were made to establish where the hijackers wanted to go; made the necessary standard operating radio calls and advised Lumpur Tower that they had an emergency on board in the form of hijackers. It was established that the hijackers had no intention of landing at Kuala Lumpur. The crew explained that they had sufficient fuel only to proceed as far as Singapore. There was no other option but to proceed to Singapore for fuel reserve reasons.

At 1950:00 hours, air traffic clearance was given for the aircraft to climb to flight level 140 initially and then to flight level 210 for Singapore via Malacca and Batu Pahat. The crew were regularly questioned on the progress of the flight and on what was transmitted

PART 2—LAST TRANSMISSION FROM AIRCRAFT TO CRASH.
TIMES GIVEN ARE SECONDS FROM IMPACT,
TAKEN FROM VOICEPRINT OF CVR TAPE.

Identity	Narrative/Aural Warnings	Remarks
F/O	"Cleared to 7000"	218 seconds
F/O	Unintelligible	
	First Shot	187 seconds
?	Soft groan	
CAPT	"No, please don't"	Agitated
	Second Shot	183 seconds
CAPT	"No, please, no"	Distressed
	Third Shot	181 seconds
CAPT	"Please, oh, oh." Sound tapers off into groaning which gradually diminishes to nothing. Interrupted by sound of something falling	
	Sound of Metallic Object Falling	
	Knock	
	High Speed (V _{MO}) Warning Starts To Run	
	Knock	
	Altitude Alert Sounds. Horizontal Stabilizer Trim Running (Possibly)	
	Aerodynamic Noise Has Increased To This Point, Now Diminishes	135 seconds
	Variety of Knocking Noises (Possibly On Cockpit Door)	
	V _{MO} Warning Stops	
	Variety Of Knocking Noises - Possibly Some On Cockpit Door	
	Sound, Possibly Of Arm Or Sleeve Being Brushed Across Area Microphone, Repeated Several Times	
	"It won't come up"	Not voice of either pilot

Identity	Narrative/Aural Warnings	Remarks
CAPT	"Number 1 on Sinjohn, Number 2 Kong Kong"	
?	"Where have you put the er" Unintelligible	
?	Unintelligible "background light" Unintelligible	
F/O	"Put off the background light"	
?	"Yeah"	
CAPT	"What does he want"	
CAPT	"Normally, we want just the background light"	
?	"OK"	
F/O ?	"Yeah"	
F/O	(Unintelligible)	
F/O	"Cleared to 7000 Malaysian 653"	
END OF PART 1		

between the crew and ground control. The hijackers appeared to be highly suspicious and edgy about the explanations given and actions taken by the crew. Their desire to enforce complete radio silence could not be satisfied and was not met. Throughout the flight, the crew behaved co-operatively and took care to explain the progress of the flight at every opportunity to the hijackers. Refreshments were offered and permission was first obtained before any action was taken. The cockpit door was locked to prevent unnecessary access and in accordance with the hijackers wishes.

At 2005:30 hours, the aircraft was handed over to Singapore Radar control abeam Batu Pahat. Permission was requested to communicate with Singapore and this was granted. When the crew asked the hijackers whether they might wish to convey any message to Singapore, the reply was very faint and unintelligible. The crew ended up having to reassure the hijackers that they (the crew) would do exactly what they were told and they would certainly not attempt anything foolish. Refreshments were again offered and the hijackers were invited to partake of some.

At 2007:40 hours, Singapore ATC identified the aircraft on radar and cleared it to descend progressively from flight level 210 to 11,000 to 10,000 and then 7,000 feet. The aircraft called leaving flight level 210 for one one thousand at 2009:10 hours. At 2012:50 hours, the aircraft acknowledged the clearance for descent to 7,000 feet. This was the last transmission made by the aircraft. Singapore ATC then made several unsuccessful attempts to communicate with the aircraft.

From the ATC, aircraft CVR and FDR data, it is established that at 2013:09 hours the crew were incapacitated by the hijackers as the aircraft was descending through 14,000 feet altitude.

The aircraft continued its descend below 14,000 feet without either pilot in control and reached a speed of 400 kts at 8,000 feet. It then pitched up sharply to 9,500 feet/300 knots; dived to 5,000 feet/380 knots; pitched up again to 9,000 feet at 160 knots before diving finally to impact with the ground at 450 knots. During the final pitch up and down to impact, the aircraft altered heading from 124 degs. to 054 degs. i.e. a change in heading of some 70 degs. The aircraft was seen to disappear off Singapore Radar's screen at 2014:50 hours and crashed at 2016:20 hours, 55 minutes after being airborne from Penang. There were no survivors.

The accident was observed by some eye-witnesses on the ground at the crash site. Three eye-witnesses were located together some 5,000 metres north of the crash site. Two of these witnesses reported seeing the aircraft in normal flight initially and then developing a weave or wing-rock. They reported that as the aircraft came nearer to them, there were sounds of the aircraft engine power being increased very sharply before the aircraft went into a steep climb and then nosing

down very quickly and steeply with some bank. Both these witnesses reported the aircraft was on fire in flight before impact. On impact, there was a loud explosion simultaneous with a fireball, a column of smoke and then silence. The third witness gave the same account except that he did not see any fire on the aircraft in flight.

Another witness who saw the accident through a window of his dining-hall was located on high ground 1 Km, west-north-west of the crash site. He reported the aircraft was already at low-level and burning furiously with some break-up. Just before reaching the tree-tops, there was a loud explosion and then another on impact. He described the first explosion as so violent that it almost ripped the aircraft into two.

A fifth witness located 4,000 metres south-east of the crash site reported he was fishing using a carbide lamp along the mangrove-shore tree-line at the time of the accident. He first heard the aircraft fly normally behind him. He then looked over his shoulder at the aircraft because of two sudden soft explosions coming from it immediately accompanied by the wild scream of the engines. He did not (and could not have) see the aircraft again because of the tree-line but saw and heard the explosion on impact. He thought that the time lapse from first hearing the soft explosions on the aircraft to impact was no more than 5 to 8 seconds.

Several other witnesses confirmed the same engine power increase followed by a sudden pitch up and down manoeuvre by the aircraft in the flight before impact. Most witnesses described the aircraft as on fire before impact. The aircraft was seen to pitch up to about 45 degrees, down some 40 degrees nose-down with 20/30 degrees bank to impact.

Investigations into the accident confirm that the flight path, impact angle, aircraft pitch up and pitch down manoeuvres in the last stages of its flight, as described by the ground eye-witnesses were reasonably correct and accurate. CVR and FDR data confirm that the witnesses probably saw only the second and final pitch up manoeuvre to impact. No evidence could be found to substantiate that the aircraft was on fire or there was an explosion in flight before impact. What evidence of fire was found was that caused by post-impact combustion.

1.2 Injuries To Persons

Injuries	Crew	Passengers	Others
Fatal	7	93	Nil
Serious	Nil	Nil	Nil
Minor/None	Nil	Nil	Nil

Identity	Narrative/Aural Warnings	Remarks
F/O	"Er — one zero is set"	
F/O	"Two zero"	
CAPT	"Zero nine"	
F/O	"Zero nine"	
F/O	"Cleared to one zero thousand, Malaysian 653"	
F/O	"Zero zero niner"	
CAPT	"You relax Sir, we'll do exactly what you — you order us to do, alright"	
	Knock On Cockpit Door	
CAPT	"It's alright. May I open? May I"	
?	(Unintelligible)	
MIXED VOICES	"Yeah — very cold — oh, I see — er, can I have a glass of drink please — may I have a glass of water also — have you stated what you want — tomato juice — glass of water please no ice — er alright"	
?	(Unintelligible)	
CAPT	"Just give us please quickly a glass of water and what he wants and then we'll lock it again OK"	
?	(Unintelligible)	
CAPT	"Whatever you say Sir. (Interruption). Everything is alright Sir, you don't er we're not going to do anything funny, no, never"	
F/O	"One zero, zero"	
CAPT	"Nine, nine"	
HJ	"What is this"	
HJ	"You bluff us"	
CAPT	"You must" Unintelligible	
HJ	Unintelligible "don't need it here"	

Identity	Narrative/Aural Warnings	Remarks
CAPT	"I beg your pardon"	
F/O	"Let me talk with Singapore tower"	
CAPT	"Er, it's alright, whatever" Unintelligible	
?	(Unintelligible)	
CAPT	"Sorry Sir, I have this bad habit of chewing sireh"	
	(Several Passages — Probably Hand-Off From Kuala Lumpur ATC To Singapore Airways)	
HJ	"How many miles more?"	
CAPT	"About 70 miles, that's Singapore"	
HJ	"Are we travelling over land?"	
CAPT	"Well, we're almost near Batu Pahat — are you familiar with this Batu Pahat? Now we are going in for Singapore landing"	
CAPT	"What are we cleared down to?"	
F/O	"One one thousand"	
	Altitude Alert	
CAPT	"Cleared down"	
F/O	"Yes"	
F/O & CAPT	"Anti-ice off — starter switches low — EPR 2.07 — one hundred" Unintelligible	Descent Check List
F/O	Unintelligible "two one zero" Unintelligible	
CAPT	"Tell them we are leaving now two one zero"	
CAPT	"Would you like to convey any message?"	
F/O	"Out of two zero zero"	
CAPT	"Two zero zero"	
CAPT	"QNH"	

1.3 **Damage To Aircraft**

The aircraft was destroyed.

1.4 **Other Damage**

There was no other significant damage.

1.5 **Flight Crew Information**

The aircraft carried an operating crew of two pilots and five cabin crew.

(a) **COMMANDER**

Age : 43 years
 Licence : Airline Transport Pilots' Licence, valid until 31 May, 1978
 Aircraft Ratings : Fokker F27-500 and Boeing 737-200
 Instrument Rating : Valid until 27 August, 1978
 Medical Certificate : Valid until 31 May, 1978 with no restrictions
 Last Competency Check : 27 July, 1977
 Last Route Check : 28 July, 1977

FLYING EXPERIENCE

Total Pilot Hours : 15,500 hours
 Total Flying Hours in Command of Boeing 737 Aircraft : 3,218 hours
 Total Flying Hours in Last 30 Days : 50 hours

His rest and duty periods in the 7 days prior to the accident were examined and found satisfactory. He had been off duty for 3 days and had completed a flight duty period of 3 hours 05 minutes on the day prior to the accident.

(b) **CO-PILOT**

Age : 25 years and 6 months
 Licence : Commercial Pilots' Licence valid until 31 December, 1977

Aircraft Ratings : Beechcraft Musketeer, Fokker F27-500 and Boeing 737-200
 Instrument Rating : Valid until 11 August, 1978
 Medical Certificate : Valid until 31 December, 1978 with no restrictions
 Last Competency Check : 11 July, 1977
 Last Route Check : 29 October, 1977

FLYING EXPERIENCE

Total Pilot Hours : 1,866 hours
 Total Flying Hours as Co-pilot of Boeing 737 Aircraft : 498 hours
 Total Flying Hours in Last 30 Days : 51 hours

His rest and duty periods in the 7 days prior to the accident were examined and found satisfactory. He had been off duty for 2 days and had completed a flight duty period of 5 hours 35 minutes on the day prior to the accident.

1.6 Aircraft Information

Boeing 737-2H6 Registration 9M-MBD.

1.6.1 Manufacturer : Boeing Commercial Airplane Co., Seattle, Washington, USA
 Year of Manufacture : 1972
 Owner : Malaysian Airline System
 Certificate of Airworthiness (C of A) : Malaysian Certificate of Airworthiness valid in the Transport Category (Passenger) until 20 November, 1978. Certificate initially issued on 21 September, 1972 on basis of United States Export Certificate of Airworthiness No: E110052 dated 21 September, 1972
 Last Maintenance : 'C' Check carried out between 20.10.77 and 22.10.77

Identity	Narrative/Aural Warnings	Remarks
CAPT	"Number 2 on JB"	
F/O	"406"	
HJ	"Do the airport know that the plane is diverting and what is the reason"	
CAPT	"We've just told them that we have to divert to Singapore and er it was alright, have to give them clearance. We just told them that we have to divert to Singapore requesting diversion flight level" — Unintelligible. "They might be wondering, I don't know, because the weather here was alright but since you told us not to tell them they might be wondering on their own"	
CAPT	"But er we can't go after Singapore anywhere" Unintelligible. "Where would you like us to go, Sir? Anywhere you want. You could even ask for" Unintelligible	
?	"We have to" Unintelligible	
?	"Er" Unintelligible	
?	(Unintelligible)	
CAPT	"Do you mind Sir if I have one of my sirehs? Thank you"	
CAPT	"Sit there relax"	
?	(Unintelligible)	
HJ	Unintelligible — "What mike is that? What is it? May I have a look in the hand"	
CAPT	"What is it you — you can't talk to er cabin crew for whatever you want"	
?	(Unintelligible)	
?	(Unintelligible)	
?	(Unintelligible)	
F/O	"Can we talk with Singapore tower eh"	

Identity	Narrative/Aural Warnings	Remarks
CAPT	"Shall I put the light on please. Er, down there. Normally we check it here. Er 1009, runway 02, wind zero two zero 8 knots 10 km., visibility, 25 degrees Celsius. Alright"	
CAPT	"Can I put the light off please"	
CAPT & F/O	"1000 to go" Unintelligible "fuel left 15, 152" Unintelligible "200 to go"	
F/O	"We've got eleven thousand" Unintelligible	
HJ	"You are landing now"	This passage is mixed together
F/O	"Eleven thousand"	
CAPT	"No Sir, we are now er we have climbed to 21000 and then we are er —"	
HJ	"We are serious"	Ref: to SJ VOR Beacon
CAPT	" — about er Malacca, we are still about Malacca"	
F/O	"Sinjohn on one one three five"	
CAPT	"Sinjohn. Yeah. One one three five"	
CAPT	"We are about 120 miles still for er Singapore"	
HJ	Unintelligible "aircraft" Unintelligible	
CAPT	"We are coming up over Malacca now"	
CAPT	"Find time of arrival and can we arrive?"	
F/O	"OK"	
F/O	"Lumpur 653 is over Malacca now"	
HJ	"I think the two of you are getting out of hand"	
?	(Unintelligible)	
?	(Unintelligible)	
?	(Unintelligible)	

Hours Flown Since Last Maintenance	: 346 hours 47 minutes
Hours Flown Since New	: 12,684 hours 44 minutes
Maximum Regulated Landing Weight	: 103,000 lbs
Estimated Weight at the Time of Accident	: 91,770 lbs
Estimated Centre of Gravity (C of G) at Time of Accident	: 24:05% Mean Aerodynamic Chord (MAC)
Estimated Fuel Remaining at Time of Accident	: 10,000 lbs
Type of Fuel	: Jet A.1
Defects	: No significant defects were being deferred for action or had been reported at Penang
Maintenance History	: The aircraft had been satisfactorily maintained to a Maintenance Schedule approved by the Department of Civil Aviation. All relevant Airworthiness Directives had been complied with. The Certificate of Maintenance was valid until 21.1.78 or the completion of 12,712 hours 57 minutes total flying time.

1.7 Meteorological Information

The weather on the day and at the time of the accident was reported to be good. The winds were light and normal for the time of the year. At the lower levels, there were no thunderstorms, lightning or extensive cloud cover. Visibility was 10 Kms or more. There was no rain. It can therefore be concluded that weather was not a significant factor in this accident.

1.8 Aids To Navigation

The aircraft was fitted with sufficient navigation aids to comply with legislative requirements and satisfied current airline standards. CVR, FDR and ATC data indicate there was no malfunction or unreliability in the aircraft or reported unserviceability in ground installed navigational aids. All aids were fully utilised as far as can be gathered from evidence to date.

1.9 **Communications And Air Traffic Control**

Communications were good. CVR, FDR and ATC data indicate that all radio and air traffic communications were functioning normally. The crew made standard ATC calls throughout the flight in accordance with established procedures.

Analysis of the ATC tapes indicate the aircraft, MH653, first contacted Lumpur Control after departure from Penang when climbing through 9,500 feet at 1925:50 hours. It was progressively cleared to flight level 190 and identified on radar at 1930:00 hours. Closely following behind was another aircraft MH825, which had also taken off from Penang bound for Kuala Lumpur. This aircraft was cleared to flight level 170 and identified in turn on radar at 1931:30 hours. MH825 requested details on the weather at Kuala Lumpur which was given as at 1200 GMT (1930 hours LT) as calm, visibility 15 Kms, lightning west to north, 1 Okta CB 1700 west to north, 3 Okta 2,000, temperature 26, dew point 25, QNH 1008 mb, runway 33.

Both aircraft were given descent clearances in turn at 1935:00 hours with MH653 in the lead. At 1942:20 hours, MH653 was given clearance for a straight-in approach for runway 15 to report inbound from the VBA VOR beacon and to report passing 5,000 and 3,000 feet altitude respectively. MH825 was in turn cleared as No:2 behind MH653 with no delay. MH653 called passing 5,000 feet at 1943:20 hours and passing 4,000 feet at 1943:50 hours. At 1945:10 hours, the aircraft reported its position as 4½ nms north of the VBA VOR. At 1946:20 hours, it called at the VBA VOR inbound and was requested by Lumpur ATC to report at the North Marker NDB beacon. The ATC tape indicates there was a short, unintelligible, distorted transmission at 1947:10 hours, some 50 seconds after the instruction was passed to the aircraft. Ten seconds after this distorted transmission at 1947:20 hours, MH653 advised "going round" in a normal calm manner. Lumpur Tower responded by clearing the aircraft to land and reporting the surface wind as calm. This was immediately followed by MH653 reporting that it was "overshooting" in an urgent voice. The aircraft was immediately cleared to climb to 2,500 feet to the KL NDB beacon. Immediately after this transmission, a query as to what problems MH653 was facing was made. This transmission was most likely made by MH825 who was then descending through 5,000 feet approaching the VBA VOR beacon inbound. MH825 was cleared for a straight-in approach at 1948:00 hours and informed that the preceding aircraft (MH653) was overshooting climbing to 2,500 feet proceeding to the KL beacon. At 1948:10 hours, MH653 reported they had an emergency on board. MH653's intention was requested but before any reply was received. MH825 reported descending through 4,000 feet inbound. MH825 was recleared to the KL beacon to maintain 4,000 feet due to the reported emergency on board MH653.

Identity	Narrative/Aural Warnings	Remarks
CAPT	"Standby for further climb"	
F/O	"Yeah. One four zero"	
CAPT	"One four zero is quite low er fuel would be low"	
	Altitude Alert	
F/O	"653 is 43 DME from VBA"	
CAPT	"Cleared to level two one zero"	
F/O	"Two one zero cleared"	
F/O	(Unintelligible)	
CAPT	"Find Singapore weather on two one zero zero"	
F/O	(Unintelligible)	
?	(Unintelligible)	
HJ	(Unintelligible)	
?	(Unintelligible)	
HJ	(Unintelligible)	
?	(Unintelligible)	
CAPT	"Twenty, twenty one thousand OK"	
F/O	"Roger"	
F/O	"Twenty one"	
CAPT	"Set it up and Singapore have been informed"	
CAPT	"Do you want us to convey any message to Singapore"	
HJ	"Unintelligible, you just land there"	
CAPT	"123 knots and" Unintelligible	
CAPT	"Weather OK" Unintelligible (Unintelligible)	
F/O	(Unintelligible)	
HJ	"May I have a look at it"	
CAPT	"I beg your pardon"	
HJ	"May I have a look"	

Identity	Narrative/Aural Warnings	Remarks
CAPT	"No, we don't have a er just don't, don't worry — it's alright, everything is there. We'll do whatever you feel like"	
CAPT	Knock On Cockpit Door. Sound of Door Bolt "Yeah, OK, come in"	
CAPT & Others	"Now er don't say anything to the passengers OK, and I er don't want any nonsense from passengers OK, and er OK, merely tell them that we are diverting to Singapore er due to weather or whatever OK, tell them nothing, it's alright and we'll leave the door locked. Just close it now — relax — serve the passengers if you want"	
?	(Unintelligible)	
CAPT	"Half a glass of tea"	
STEW	"Half a glass"	
CAPT	Altitude Alert "Fourteen thousand"	
F/O	"Six five three approaching one four zero"	
CAPT	"OK, now, forget about the tea, you'll kindly allow us to"	
HJ	"OK"	
CAPT	"You just go out, I'll keep it locked"	
CAPT	"Well, have told them one four zero zero flight level" (Unintelligible) (Unintelligible) (Unintelligible) (Unintelligible)	
CAPT	"I don't have any" Unintelligible	
F/O	"Standby"	

At 1949:00 hours, MH825 requested Lumpur Tower to confirm the intentions of MH653. MH653 responded at 1949:20 hours that they had a hijacker on board. MH825 was subsequently cleared to land. At 1949:40 hours, MH653 reported maintaining 3,000 feet to be over KL beacon in 2 minutes with a hijacker on board. Lumpur Tower cleared the aircraft to land on runway 33 with no delay. The aircraft responded by informing the Tower that it was proceeding to Singapore and requested a flight level clearance. It reported its position then as over the South Marker (SM) beacon.

At 1950:00 hours, Lumpur Tower advised it had visual contact with the aircraft and cleared it to proceed to Singapore at flight level 140 initially via airway Amber 64. This call was acknowledged by the aircraft who also requested confirmation that their message had been received and understood. The Tower acknowledged having received and understood its message.

At 1951:50 hours, at the request of Lumpur Tower, the aircraft reported it was passing 6,500 feet and had an endurance of one hour and 40 minutes.

At 1953:30 hours, the aircraft called approaching flight level 140 and then requested clearance to continue the climb. It was cleared to climb to flight level 210. At 1954:30 hours, some 30 miles from Kuala Lumpur en-route to Singapore, the aircraft was identified on radar and cleared to maintain flight level 210 for Singapore. This call was acknowledged and the aircraft was handed over to Singapore Airways at 2005:30 hours.

At 2007:40 hours, the aircraft contacted Singapore Airways and reported its position as maintaining flight level 210 and 73 miles from SJ VOR beacon. It was identified by Singapore Radar and cleared to track direct for SJ beacon. The aircraft was then cleared to descend to 11,000 feet when ready.

At 2009:10 hours, the aircraft called leaving level 210 for 11,000 feet. Singapore Radar cleared the aircraft to descend to 10,000 feet. This call was acknowledged by the aircraft.

At 2012:10 hours, Singapore Radar cleared the aircraft for further descent to 7,000 feet. This call was also acknowledged. Analysis of the Singapore Radar tape indicates that there was then a short, involuntary transmission made at 2013:20 hours. Analysis of the CVR and FDR data confirm that this involuntary transmission was from aircraft MH653, made immediately after the crew were incapacitated.

At 2013:30 hours, Singapore Radar gave instructions for the aircraft to hold at SJ beacon with an expected approach time of 2045:00 hours. There was no response. Attempts were then made to re-establish contact with the aircraft, including the VHF distress

frequency, without success. At 2014:50 hours, the aircraft was seen to disappear off the Singapore Radar screen. It crashed at 2016:20 hours and search and rescue operations began by 2018:20 hours.

1.10 **Aerodrome And Group Facilities**

Not applicable.

1.11 **Flight Recorders**

1.11.1 **Flight Data Recorder (FDR)**

The aircraft carried a Sundstrand Model FA542 Flight Data Recorder (FDR) mounted in the ceiling of the aft end of the economy class cabin. It records airspeed, pressure altitude, magnetic heading, vertical acceleration and duration of aircraft radio transmissions against a time base. The recorder was recovered in a badly damaged condition. The foil was cleaned up and the corrected data plotted for analysis. See Appendix A.

Analysis of the FDR read-out confirms that the aircraft took-off from Penang and cruised at flight level 190 for Kuala Lumpur. The flight progressed smoothly with the aircraft progressively descending and then levelling off at 3,000 feet. The FDR indicates that the aircraft began a descent from 3,000 feet to 2,500 feet inbound for Kuala Lumpur.

The aircraft overshot the airfield at 2,500 feet and climbed sharply to 5,000 feet. It descended quickly to 4,000 feet and then established a smooth climb-out to flight level 140.

The FDR then indicates that the aircraft levelled off at flight level 140 for a short while before climbing to flight level 210.

The FDR trace then indicates that the aircraft descended normally at 300 knots on a heading of 123 degrees. A 0.7 second transmission was made in the descent at 19,000 feet. This transmission could not be traced on the CVR or ATC tapes. The FDR trace indicates a further transmission was made of 1.4 seconds duration some 200 seconds before the datum point used as a reference in the terminal event marks on the foil (1-200). (See Appendix A for location of this point). It has been possible to confirm that this was the involuntary transmission made from the aircraft and which was evident on the CVR and Singapore Radar tapes.

The FDR read-out indicates that the aircraft's heading, speed and rate of descent from 21,000 feet was constant to 12,500 feet altitude. At that point, the aircraft's rate of descent increased significantly, with a corresponding increase in speed from 310 kts to 400 kts and acceleration from +1.0g to -0.6g. The increased speed in the descent exceeded the aircraft's manoeuvring speed limit (V_{MO}) of 350 kts.

Identity	Narrative/Aural Warnings	Remarks
CAPT	"6500 and we have endurance of 1 hour and 40 minutes"	
CAPT	"They are asking us what level we are passing and what is our endurance because this is unusual"	
CAPT	"You would like, Sir, to go to Singapore? PAUSE. We tell you that because between Singapore and KL there are lots of airlines which keep on flying both ways so that we have to maintain flight plan otherwise — "	
CAPT & F/O	"We can't go anywhere at the moment" Unintelligible	
CAPT	"This is a very busy sector Kuala Lumpur Singapore Kuala Lumpur, very busy"	
CAPT	"We should be in Singapore in approximately 27, 28 minutes"	
CAPT	(Unintelligible)	
CAPT	"Try (Unintelligible) weather"	
CAPT	"One zero thousand"	
F/O	"One zero thousand"	
CAPT	"QNH"	
F/O	"1013 decimal 2"	
CAPT	(Unintelligible)	
?	(Unintelligible)	
F/O	Unintelligible "is off"	
?	"Better contact the stewards not to alert the passengers"	
CAPT	"Yeah, I'll tell them"	
CAPT	"May I call them in"	
HJ	"OK"	
HJ	"Just tell them through the intercom"	

Identity	Narrative/Aural Warnings	Remarks
HJ	"Can you please lock the door"	
?	"Just a minute, just a minute"	
?	(Unintelligible "level 140" Unintelligible "Amber 64" Unintelligible) Altitude Alert	
?	(Unintelligible)	
?	(Unintelligible)	
?	"225 Mike Charlie on Number 2"	
CAPT	"146 on the window"	
F/O	"146 roger"	
CAPT	"140 initially"	
F/O	"140 initially"	
F/O	"Thank you"	
	Knock On Door & Lock Operating	
? Mix	"Ah, you want to lock, lock the door, we are locked"	
HJ	"Lock the door"	
CAPT	"We just have barely enough fuel for er Singapore. Because when we start from er Penang this is up to Kuala Lumpur and then up to Singapore"	
F/O	"Passing 5000 and I want Mike Charlie on Number 2"	
CAPT	"Mike Charlie on Number 2"	
CAPT	"Number 1 on er Batu Pahat"	
F/O	"Roger"	
F/O	(Unintelligible "contact" Unintelligible)	
HJ	"No"	
F/O	(Unintelligible "contact" Unintelligible)	
HJ	"No"	

The aircraft descended to an altitude of 8,000 feet at 1-120 seconds before it began its first pitch up manoeuvre to an altitude of 9,500 feet at 1-85 seconds. The FDR acceleration and airspeed traces indicate an acceleration of -0.6g to a maximum of +1.6g was applied for the manoeuvre. The airspeed reduced from 400 kts at the bottom of the descent to 300 kts at the top of the pitch up.

The aircraft then pitched down from 9,500 feet at 1-85 seconds to an altitude of 5,000 feet at 1-30 seconds. An acceleration of from -0.3g to +1.3g was recorded with the airspeed increasing from 300 kts at the top of the initial pitch down to 380 kts at the bottom of the descent. Up to this point from 1-200 seconds to 1-30 seconds, the aircraft's heading remained substantially constant at 122/124 degrees.

At 1-30 seconds at 5,000 feet altitude, the FDR indicates the aircraft executed its second and final pitch up manoeuvre to 9,000 feet altitude at 1-15 seconds. The acceleration trace indicates forces varying from +1.3g to +2.4g were applied to execute the pitch up. The speed trace shows a fall-off of from 380 kts to 160 kts at the top of the pitch up. The heading trace simultaneously indicates an aircraft heading change from 124 degrees to 110 degrees.

The aircraft finally pitched down from 9,000 feet altitude at 1-15 seconds at 160 kts to impact with the ground at 450 kts. The acceleration trace shows a force varying from -1.0g to +2.3g was applied to carry out the final pitch down manoeuvre. At the same time, the FDR heading trace shows a continuous and fairly constant rate of change of heading from 5,000 feet/124 degrees at 1-30 seconds to 9,000 feet/110 degrees at 1-15 seconds to impact with the ground at sea-level/054 degrees. The heading change would be at the rate of 2.33 degrees/seconds on average which would be close to a standard rate one turn of 3 degrees/second.

The aircraft's terminal manoeuvres from the time the crew were incapacitated suggested that some person or persons unknown interfered with the aircraft's flying controls or attempted to fly the aircraft until the aircraft became irrecoverable.

The assistance of Boeing Commercial Airplane Company, the aircraft's manufacturers, was requested for a further opinion on the FDR analysis and their conclusions on the extent to which the controls might have been manipulated by an intruder. Their report is included under "Tests and Research".

1.11.2 Cockpit Voice Recorder (CVR)

The aircraft carried a Fairchild Model A100 four track Cockpit Voice Recorder (CVR) mounted in the rear freight hold. It was supplied from one area microphone mounted in the overhead switch

panel between the two pilots and from the pilots microphones only when the radio transmission switch was operated. Thus the conversation between the two pilots was only recorded by the area microphone, which is of much poorer quality than from comparable systems where the pilots microphones are electronically connected in such a manner that the CVR will record intercommunication between the crew as well as radio transmissions. The fourth track of the CVR tape was utilised to record transmissions by an extra crew member when carried. No extra crew member was carried on the flight. Therefore this track is not relevant to the investigation.

The tape was recovered in a badly damaged condition and sent to the UK AIB for cleaning, re-splicing and partial electronic filtering before an analysis of its contents could be attempted. It had been lying in mud, soaked with aviation fuel, Skydrol hydraulic fluid and salt water for seventeen days at a depth of some 12 feet in the ground. The CVR tape runs for 32 minutes and the complete hijack episode is contained on it. (See Appendix 'B')

Analysis of the CVR tape reveals the following evidence. The tape commences when the aircraft is making its approach to Kuala Lumpur airport. Whilst the landing checks are being carried out, the cabin-to-crew call chime is heard repeatedly, followed by a knocking on the cockpit door. The crew call out "It's open, and the hijackers then enter the cockpit. The crew are immediately ordered to "cut all radio contact" and this order is repeated three times. The cockpit door is then shut.

The Captain establishes that the hijackers do not want the aircraft to land at Kuala Lumpur, then executes a missed approach, the Captain takes control of the aircraft, and explains that there is insufficient fuel to go anywhere except Singapore. The aircraft is then cleaned up, the "After Take-off" checks are called and the Captain then patiently explains that he will do anything the hijackers wish but that they must maintain contact with ATC especially since the Kuala Lumpur-Singapore sector is a very busy one with "lots of airlines" flying the route. Permission is finally given and the flight is cleared to Singapore, initially at flight level 140. The cockpit door is then locked.

On passing 10,000 feet altitude en-route for Singapore, the hijackers order the crew to direct the cabin staff not to alert the passengers. The Captain requests permission to call them in but is ordered to contact the cabin crew via the intercom. He assures the hijackers that there is nothing to worry about, everything would be alright and they would do what the hijackers wished.

Next, a steward knocks on the cockpit door and is admitted. The Captain briefs the steward not to give a hint of any hijacking to any of the passengers but to inform them that they are diverting to

Identity	Narrative/Aural Warnings	Remarks
CAPT	"Anything you want us to do Sir"	
F/O & CAPT	"Check the — roger, after take-off check list — start switches — landing light — on — landing gear is up and locked"	
HJ	"Sorry, it's time to put you two out. You are landing now"	
CAPT	"No Sir — er, you want us to land"	
HJ	"No, no"	
CAPT & F/O	"Then er you have to because there is a lot of traffic here. You have to — whatever you want us to do — wherever you want us to go you have to contact them and tell them — because we are not out of traffic area — and there might be an accident Sir. If you don't mind —"	
CAPT	"We'll do whatever you feel like"	
?	(Unintelligible)	
CAPT	"I have to tell them because this is traffic area. Lots of aircraft coming from Singapore, there's one behind us from Penang. So you've got to tell them"	
CAPT	"Can we contact them, tell them"	
F/O	"— where you want to go, eh"	
	Altitude Alert	
CAPT	"Beg you pardon Sir"	
HJ	"Contact them say you are going to Singapore"	
CAPT	"May I call"	
?	(Unintelligible)	
CAPT	"Just a minute"	
CAPT	"MH653 we now are proceeding to Singapore requesting flight level, we are passing South Marker now"	

Identity	Narrative/Aural Warnings	Remarks
CAPT	"Ask him to come in"	
	Knock On Cockpit Door	
HJ	"Out!"	
CAPT	"We are, er, you don't want us to land"	
HJ	"Yes"	
HJ	"Out"	
HJ	"Cut all radio contact"	
CAPT	"I beg your pardon"	
HJ	"Cut radio contact now"	
F/O	"653 going round"	
CAPT	"Take the gear up"	
CAPT	"Where do you want us to go Sir"	
F/O	"653 overshooting"	
CAPT	"Flap, er"	
CAPT	"Flap one now"	
F/O	"Roger"	
	Altitude Alert	
HJ	Where are we now"	
CAPT & F/O	"We are over, er over Kuala Lumpur"	
HJ	"Cut all radio contact huh"	
CAPT	"Yes, but we don't have much fuel sir to go anywhere. We — just enough up to Singapore, whatever you want"	
	Altitude Alert	
F/O	"Flaps"	
CAPT	"Flaps are zero now"	
CAPT	"OK. I have control"	
F/O	"Roger"	
	Altitude Alert	
CAPT	"OK"	

Singapore because of the weather. The steward was also told to lock the door after him and to serve the passengers if they wished. Some refreshments for the cockpit are ordered and the cockpit door is then locked once again.

The aircraft is then further cleared up to, and reaches, flight level 210. CVR evidence up to now indicates that the Captain was always polite and clears any movement, switch selections or ATC calls he has to make with the hijackers before carrying them out. Singapore weather is obtained on the ATIS and the Captain continues to advise the hijackers of the aircraft's position as the flight progresses. "Overhead Malacca" is heard, and the Captain explains that after the aircraft reaches Singapore, there would not be sufficient fuel to proceed anywhere else and then asks the hijackers where they would like to be taken, anywhere that they wished, but no reply could be ascertained.

On nearing Batu Pahat, the crew requests permission to communicate with Singapore ATC and informs the hijackers of their position. The hijackers are asked if they are familiar with Batu Pahat to which there was no reply. Shortly after passing Batu Pahat, the descent checks are called and the aircraft leaves flight level 210 as directed by Singapore Radar for 11,000 feet when ready and the Captain asks the hijackers if they would like to send a message. The offer is not accepted and results in the crew having to reassure the hijackers that they would do exactly as they were ordered to do.

Whilst in the descent, there is a knock on the door and the Captain requests permission to open it. Someone asks for a glass of water and the Captain instructs the steward to get one quickly. The Captain then assures the hijackers that everything is alright and that the crew are "Not going to do anything funny-no-never". There is some conversation to confirm the altimeter QNH setting and some reference to the cockpit background lights and then a single shot. The Captain is then heard to implore the hijackers not to shoot. There are then two further shots in rapid succession and sounds of distress from the Captain who appears to finally lose consciousness.

Following this, several sounds are heard some of which it has not been possible to interpret with certainty. Whilst this is going on, the aerodynamic noise is heard to increase and then to decrease. There are the sounds of the stabiliser trim running, high speed warning, altitude alert warning and cabin-to-crew call chime in operation. Mixed with these sounds are other sounds like a sleeve or arm brushing the CVR microphone. There are low voices which are unintelligible, and "It won't come up" repeated three times, followed by sounds of the shuffling of feet or some other movement as if indicative of a struggle. Thereafter, the aerodynamic noise is again heard to increase to a very high level, with the high speed

warning operating before terminating in the end of the recording which denotes the impact. Just prior to impact, a voice is heard clearly in a language which it has not been possible to identify.

The CVR recording recovered from the accident aircraft is seriously affected by electronic background noise. There are several parts of the recording where the conversation is unintelligible. The further assistance of the CVR Division of the UK AIB was therefore requested to refine the tape recording to the best they could as well as to produce analogue traces of the CVR and Singapore ATC tapes, including a separate recording of the aircraft Captain and Co-pilots tracks in stereo. These refined tapes and traces were produced and correlated. Further analysis and correlation of these tapes and traces failed to produce any further evidence to significantly alter the initial findings. It is considered unlikely that even if those parts of the recording which are still unintelligible are finally deciphered, they will add any further new and significant evidence to that which has been already established.

The analogue traces of the CVR and Singapore ATC tapes confirm that only three shots were fired by the hijackers followed by an involuntary transmission from the co-pilot's microphone. The involuntary transmission event which occurred at 2013:20 hours aligns clearly with the one second exclamation heard on the Singapore Radar ATC tape and the radio incident mark on the aircraft's FDR tape. The time at which the first shot was fired is established as at 2013:09 hours. It has not been possible to ascertain the exact cause or nature of the involuntary transmission or the reason for the sudden incapacitation of the crew. Neither has it been possible to identify the intruders or to determine whether there was one or more hijackers who entered the cockpit. Analysis of the last voices on the CVR tape and analogue traces appear to indicate that someone also made attempts to fly the aircraft after the crew were incapacitated. They certainly interfered with the aircraft flying controls and this has since been confirmed by further tests and research, the details of which are recorded elsewhere in this report.

Some 98% of the conversation that took place in the cockpit and was recorded on the CVR area microphone has been deciphered. Whilst the recording was noisy, it did reveal a great deal of information and positively determines the cause of the accident. Regrettably, it leaves many other questions unanswered, such as who were the hijackers; what were their intentions or cause; where did they wish to go. These are unresolved questions outside the scope of this investigation.

Other conclusions drawn from the CVR recording together with the FDR and ATC tapes are as follows:-

- (a) There is no evidence of an explosion, explosive decompression or a structural failure in flight.

CVR TRANSCRIPT OF LAST 32 MINUTES OF FLIGHT MH653—
PREPARED FROM FIRST AND SECOND VERSIONS OF TAPES
PRODUCED BY UK AIB.

PART 1 — BEGINNING OF TAPE TO LAST TRANSMISSION

Identity	Narrative/Aural Warnings	Remarks
MH825	"653 your DME please"	
F/O	"653 is four and a half north"	
CAPT	"Flap one"	
F/O	"Flap one"	
	Landing Gear Warning	
CAPT	"Flap five"	
F/O	"Flap five"	
CAPT	"Gear down"	
F/O	"Er"	
	Chime	
CAPT	"Aircraft is finally cleared to (interruption by chime) for 170 knots"	
	Two Chimes	
F/O	"653 Batu Arang inbound"	
F/O	"Abeam North Marker"	
CAPT	"What the hell is that"	
	Five Chimes	
?	"Let him call"	
CAPT	"What is going on by there"	
F/O	"I don't know"	
CAPT & F/O	"Uhl. The er — yeah, I know, yeah"	
	Knocks On Cockpit Door	
CAPT	"Open, it's open"	
CAPT	"Say again"	
	Altitude Alert	

Landing Gear Warning	Indicates aircraft is in landing configuration but landing gear is up.
Altitude Alert	Warning system which enables flight crew to pre-select a desired flight altitude and receive aural warning of approaching, or deviating from, selected altitude.

ABBREVIATIONS

"146 on the window"	Digital presentation of a VOR radial on the flight crew Horizontal Situation Indicators selected with the course selector, in this case 146°.
QNH	Altimeter sub-scale reference setting in millibars to allow for ambient pressure conditions. Altimeter will read true elevation at origin of reference.
EPR	Engine pressure ratio. Ratio of engine inlet and exhaust pressures which is an indication of engine thrust.

- (b) There is no evidence of fire or smoke in flight.
- (c) One or both engines were operating up to the moment of impact because electrical power supplies were available to the whole aircraft since both the CVR and FDR were fully functioning without interruption up to the time of impact.
- (d) There is no audio or other warning in the CVR/ATC recording or FDR data to indicate any significant aircraft system malfunction.

1.12 Wreckage Information

1.12.1 Accident Site

The accident site was in a flat area at a height of approximately 10 feet above mean sea level. Boundaries of the site, including the wreckage trail down-track of the initial impact were delineated by a coconut grove on the north-western side and a drainage channel/bund on the south-east (which exists as a barrier to prevent tidal ingress from the adjacent mangrove swamp). The vegetation included numerous trees (typically 30 feet in height) and the ground structure was a somewhat unstable clay with a surface layer of a more friable soil, associated with a water-table only a short distance below the surface.

The initial impact produced a roughly circular area of smashed and up-rooted trees surrounding an area of mud covered by broken trees which had been thrown up and subsequently fallen back on top of part of the wreckage (from this area was a wide fan-shaped down-track trail). Apart from the wreckage trail down-track, there was a marked transition from the immediate impact area to the virgin surrounding trees, indicating a steep angle of approach.

A survey of the site produced only one identifiable and clearly orientated ground mark, a gouge made by the extremity of the left wing. Using this as a datum, co-relation with the down-track trail and the surrounding trees suggests the aircraft struck the ground left wing down on a heading of between 50°M and 65°M with a pitch attitude of at least 40° nose down.

The aircraft broken-up on impact, a significant portion being buried by the mud and the remainder scattered in a fan-shaped trail extending some 2,500 feet. There were no significant signs of fire on the foliage surrounding the impact area.

1.12.2 Wreckage

In view of circumstantial evidence pointing to the most likely cause of the accident, it was decided that examination of the wreckage could be limited to that practicable on site with the exception of a

selection of items sent for specialist examination by forensic scientists in Malaysia and the United Kingdom. No attempt was made, therefore, to determine system serviceability by detailed examination of hydraulic, pneumatic, instrument and electrical system components. Details of the forensic tests are included in Section 1-16.

The impact resulted in almost total disintegration of the aircraft, the fuselage structure above floor together with the major part of the wings being thrown down-track and the remainder including most of the landing gear and power plants remaining buried in the mud. A section of fuselage crown skin of approximately 28 square feet in area was the largest intact piece of the structure, with the remainder typically in much smaller fragments. The failure modes of a random selection of structural pieces examined were consistent with an impact loading produced by a very high forward speed.

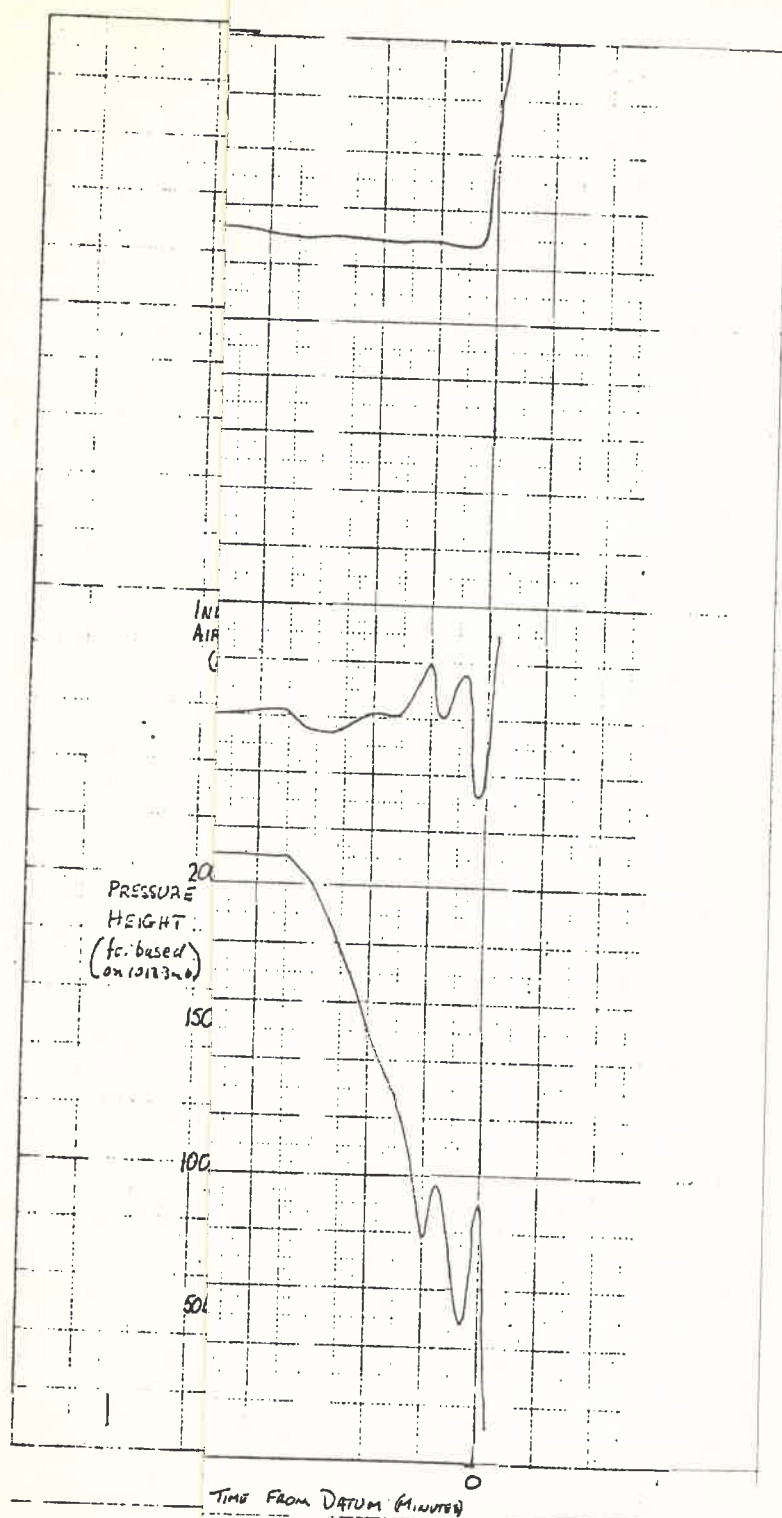
Sufficient fragment of the structural extremities of the aircraft were recovered from the immediate surroundings of the impact area to conclude that the aircraft was almost certainly structurally intact immediately prior to impact, with all flying control surfaces attached. Other evidence shows that the landing gear was in the up position.

No conclusion can be made about the position of the primary flying controls, but the flaps were in the up position, the leading edge devices retracted and the horizontal stabiliser was in a position consistent with normal operation i.e. approximately 3.7 units of trim.

As no electrical bulb filaments were recovered at the site, a detailed analysis to determine the condition of the electrical generation and distribution system was not possible. However, positive evidence of AC and DC power being available was the continued operation of the flight recorders, indicating that at least one alternator was operating.

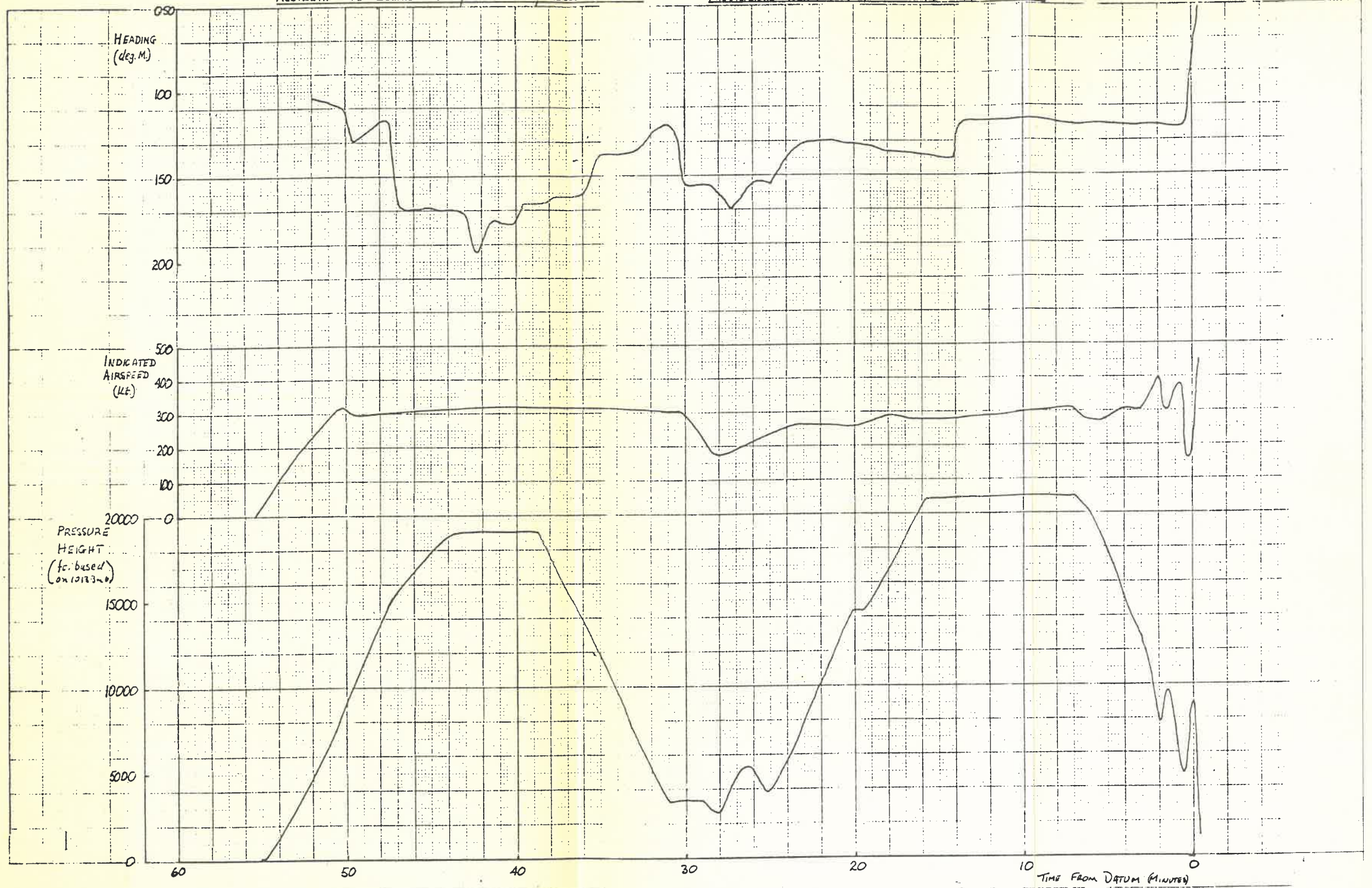
Both engines were severely damaged, with compressor discs liberated and separation having occurred at one or more case flanges, but sufficient evidence remained to indicate that both were rotating under some degree of power at impact and the related thrust reversers were in the forward thrust position. It was not considered necessary to proceed with a detailed engine investigation to determine more accurately the actual degree of power for reasons already given. Estimation of the actual power setting was subsequently produced as part of a computer analysis of the terminal manoeuvres. (See Section 1-16).

All major sections of the structure were examined for signs of fire. Some minor items of upholstery were charred in places and smoke trails and paint blistering were evident on small areas of fuselage



ACCIDENT TO BOEING 737 MALAYSIA DECEMBER 1977

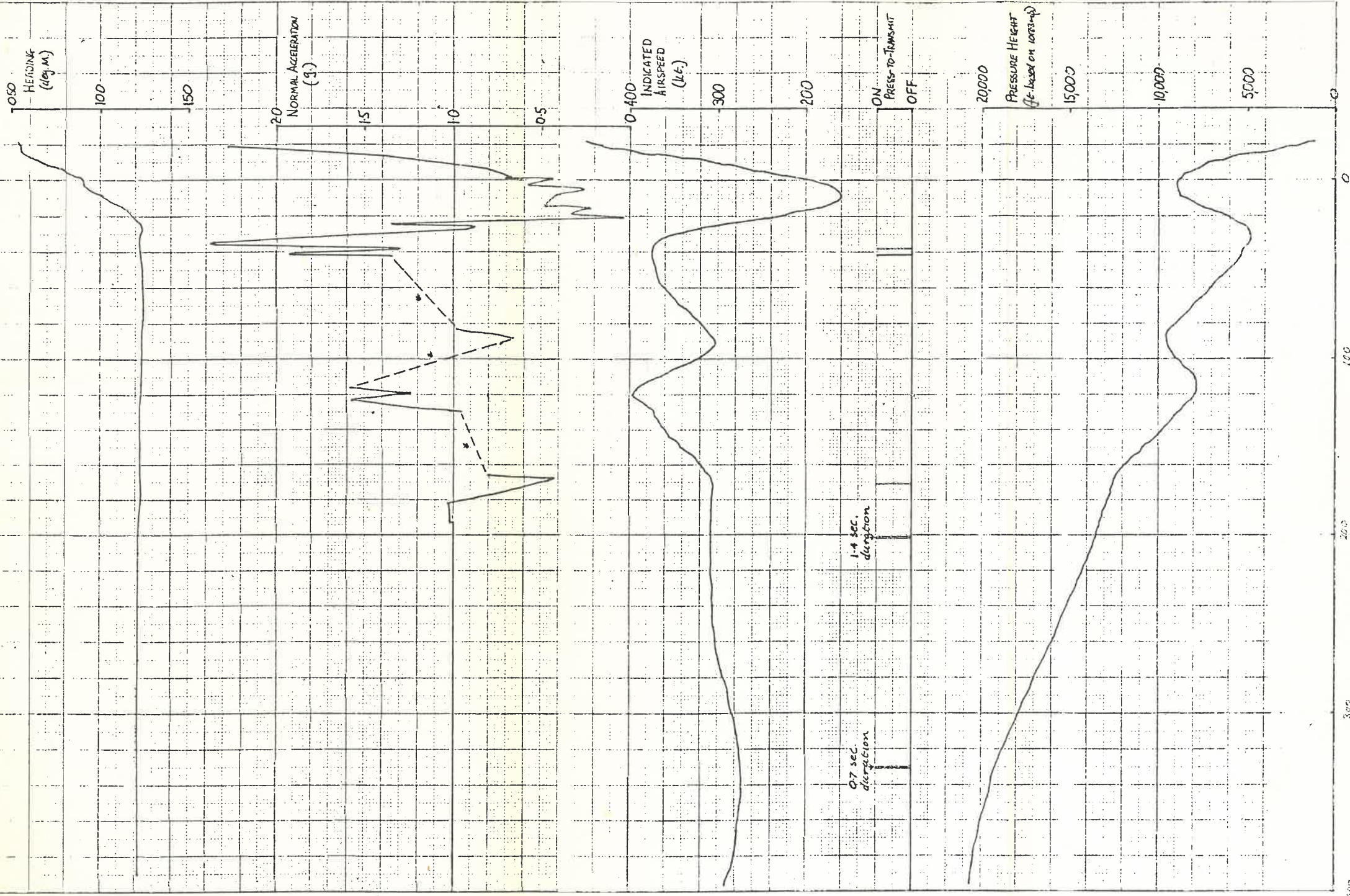
PROVISIONAL F.D.R. DATA & APPROXIMATE FLIGHT PROFILE



ACCIDENT TO B-72C-777 AIRCRAFT T-111-010 1977

PROVISIONAL FDR DATA (RE'S NOT INCLUDED, NOMINAL GAS USED, NORMAL g (NEEDED FOR CORRECTION AMPLIFIED TO HEADING GAS TO ALLOW FOR AIRCRAFT'S AIRCRAFT SYSTEMS BUT NOT CORRECTED FOR AIRCRAFT'S FINAL DESCENT)

* DASHED LINES INDICATE AREAS WHERE DATA WAS UNOBTAINABLE DUE TO FAIL DAMAGE



300

200

100

0

Time from T-111 (sec)

4.1 Flight Recorders

Malaysian Legislation for Air Navigation, which is currently under extensive review, should be further amended to require the following additional requirements to be made mandatory on aircraft required to be equipped with Flight Recorders.

4.1.1 Flight Data Recorders

The following additional parameters should be recorded:

- (a) flap position.
- (b) engine power, pitch and roll attitude where the installed equipment in the aircraft permits these items to be recorded.

4.1.2 Cockpit Voice Recorders

Cockpit Voice Recorders should be capable of recording all conversations on the flight crew intercommunication system in order to improve the recording capability of the CVR.

4.2 Pathology

A forensic pathologist should be appointed as a permanent member of the Department's Accident Investigation Team in all major aircraft accident investigations. He should be responsible for the complete pathological investigation. Aviation pathology is now internationally recognised as a specialist subject. It is recommended that provisions be made for training of selected qualified pathologists at one of the civil/military institutes overseas, such as the Institute of Aviation Medicine in the United Kingdom.

4.3 B737 CVR Area Microphone

The positioning and sensitivity of the area microphone should be reviewed in conjunction with the aircraft manufacturer to decide if a more central location would result in greater CVR speech fidelity and audibility.

4.4 Aircrew Incapacitation Drill

Malaysian Airline System should introduce aircrew incapacitation drills in the event of an aircrew member becoming incapacitated in flight. Malaysian Airline System should review and conduct more realistic anti-hijack drills under simulated conditions in synthetic flight trainers.

OMAR BIN SAMAN
Chief Inspector of Accidents,
Civil Aviation Department, Malaysia.
August, 1978

skin. However, the random patterns of blistered paint and soot were not consistent with an in-flight fire and it is considered that the fire damage found was the result of minor post-impact fires from small pools of fuel.

A concurrent examination was made of the interior of the fuselage skin for any of the characteristic signatures of detonation of an explosive device but none were found.

The majority of the passenger seat belts recovered were fastened indicating that the occupants were strapped in. Of the crew harnesses, the only significant parts found were the sections around the human remains of the economy class steward and these had been fastened.

1.13 Medical And Pathological Information

The impact resulted in almost complete fragmentation of the occupants. Some portions of tissue exhibited signs of burning but it is almost certain that this resulted from post-impact fire. Radiographs were taken of all the human remains and foreign objects removed for examination. Nothing was found which would have justified specialist examination.

It was not possible to carry out any definitive tests to establish the existence of any smoke or toxic fumes prior to the crash, due to the absence of suitable specimens.

1.14 Fire

There were several ground eye-witness close to the scene of the accident who reported an explosion on board the aircraft and fire in flight prior to impact. There were also witnesses who saw the aircraft and accident but reported they did not hear any explosion or see any fire prior to impact. These witnesses saw the aircraft at different locations, at different angles and at different heights. It is evident from the CVR/FDR and ATC data including evidence from the wreckage site that there was no explosion or fire on board the aircraft whilst in flight. All witnesses confirmed there was a very loud explosion and a brief post-impact fire as the aircraft hit the ground. The only logical explanation as to why some of these witnesses reported explosions and fire in flight is that they were very likely deceived by the aircraft's flashing anti-collision lights combined with the normally illuminated, large red and white MAS logo sign on the tail of the aircraft. Speculation on the psychological reasons for the frequent association of in-flight fire with aircraft accidents by eye-witnesses' is beyond the scope of this report.

The evidence of the wreckage and the surrounding vegetation suggests that the impact resulted in very rapid propagation of combustion through the fuel mist generated as the fuel tanks disintegrated (ignited by electrical short circuit or friction), producing a fireball. Most of the remaining fires produced by isolated pools of fuel would have been small and extinguished quickly in view of the wreckage spread and the wet nature of the ground and this is confirmed by the minor fire damage to the wreckage.

1.15 Survival Aspects

1.15.1 Survivability

The accident was non-survivable.

1.15.2 Search and Rescue

Singapore authorities were immediately informed as soon as it was established that the aircraft had been hijacked and was proceeding to Singapore, search and rescue activities were promptly initiated as soon as both radio and radar contact was lost with the aircraft. Helicopter and sea-borne craft carried out a night search. Initially, the aircraft was believed to have crashed in Singapore. The crash site was finally located on Malaysian territory in a swampy, sparsely populated area in the south-western tip of Johor. The initial sighting reported debris scattered over a wide area with small fires and no possible survivors. Ground rescue forces reached the scene of the accident shortly after, cordoned off the area and began a search for survivors. There were none.

1.16 Tests And Research

Various tests and research programmes were carried out to provide more conclusive evidence of the origin of various events, including the aircraft's terminal manoeuvres. These tests and research were conducted at the Boeing Commercial Airplane Company, USA, by Boeing Technology Staff with the aid of computers, whilst UK Scotland Yard specialists assisted through the UK AIB to carry out certain ballistic tests. Ballistic/forensic specialists in country assisted in the conduct of other ballistic tests. The evidence established from these tests and research programmes are as follows:

1.16.1 Aircraft Terminal Manoeuvres

The analysis of the aircraft's terminal manoeuvres by Boeing took into account the following data: calculated weight and Centre of Gravity position; aircraft configuration as determined from the wreckage evidence; meteorological conditions; FDR time history traces of airspeed, altitude, heading and vertical acceleration traces;

- (ii) The crew were properly licensed and were properly rested prior to the flight. There is no evidence to suggest they were not competent in any way to carry out the flight for which they were assigned.
- (iii) The aircraft was hijacked by person or persons unknown. The crew carried out their hijack procedures properly and correctly in accordance with established procedures throughout the flight.
- (iv) The crew and the hijackers had no option but to divert to Singapore because of fuel limitations.
- (v) The hijackers had no intention of landing at Kuala Lumpur. Singapore might not also have been their intended destination.
- (vi) The hijackers were continuously suspicious of radio communications made by the crew to Lumpur and Singapore ATC, despite lengthy explanations. The hijackers had ordered total radio silence but had to reluctantly concede permission to the crew to make normal ATC calls for flight safety reasons.
- (vii) Throughout the flight, the crew obtained permission from the hijackers before making any movements, switch selections or ATC calls.
- (viii) The crew were incapacitated by the hijackers as the aircraft descended under Singapore Radar instructions for the approach to Singapore.
- (ix) The aircraft carried out some unusual pitch-up and pitch-down terminal manoeuvres under the influence of person or persons unknown. The manoeuvres developed until the aircraft became irrecoverable and impacted with the ground.
- (x) There was no explosion (explosive decompression, structural failure) or fire in flight prior to impact.

3.2 Cause

The accident was caused by the fatal incapacitation of the crew by the hijackers resulting in the aircraft being left in the descent to impact without any professional control.

4 SAFETY RECOMMENDATIONS

The following safety recommendations should be implemented as soon as possible.

2 ANALYSIS

- 2.1 There is no evidence to suggest that the aircraft was other than fully serviceable when it departed Penang for Kuala Lumpur. There is also no evidence to suggest that the accident was caused by any failure of the aircraft engines, system or equipment. No defects were referred to on the CVR tape throughout the flight nor was there any evidence found to indicate that the aircraft was otherwise than intact and serviceable just before impact. There was no fire, explosion, explosive decompression or structural failure before impact.
- 2.2 As soon as the hijackers entered the cockpit and identified themselves, the crew in particular the Captain of the aircraft, conducted themselves properly and correctly. They were calm, polite, reassuring and always requested approval before making any movement, switch selection or radio call at all times. Initially, the hijackers ordered strict radio silence. ATC radio calls were permitted after a lengthy explanation was given.
- 2.3 The hijackers positively did not wish to land at Kuala Lumpur. By their actions and their words, the hijackers showed they would not hesitate to shoot to kill if a landing at Kuala Lumpur was made or for any other reason.
- 2.4 The aircraft, crew and the hijackers had no option but to proceed to Singapore for reasons of fuel availability. Despite lengthy explanations on several events such as the need to maintain ATC radio contact for flying safety; the need to divert to Singapore with no other option for fuel reasons and keeping the hijackers informed of the aircraft position at all times as the flight progressed, the hijackers remained threatening, nervous and suspicious. The crew complied with the hijackers instructions throughout the flight.
- 2.5 For reason or reasons which may never be established, the hijackers suddenly incapacitated the crew as the aircraft descended for a landing at Singapore. CVR, FDR and ATC evidence indicate some person or persons then interfered with the aircraft flying controls resulting in the aircraft carrying out some severe pitch-up and pitch-down manoeuvres which developed into an irrecoverable position. These manoeuvres were seen by eye-witnesses on the ground. The aircraft impacted with the ground with considerable speed in excess of the aircraft manoeuvring speed limits.

3 CONCLUSIONS

3.1 Findings

- (i) The aircraft was free of defects and had been properly maintained in accordance with an approved schedule. Its documents were in order.

certain CVR data and Boeing flight test data. This was complemented by a computer programme to determine elevator angle, control column push/pull forces, normal load factor and lift coefficient. The report from Boeing is as follows (figures 1 and 2 are attached to this report as Appendix C).

PERFORMANCE ANALYSIS AND DISCUSSION

Based on the known drag characteristics of the aircraft, and the rate of climb, vertical acceleration, and airspeed acceleration derived from the Flight Recorder data, it has been possible to calculate the thrust and the pitch attitudes required to match the performance shown by the Flight Recorder traces. The results of the calculations are shown in Figure 1. The data of Figure 1 indicate that the airplane was descending in normal steady-state manner to an altitude of approximately 12,000 feet with descent rates between 2000-3000 fpm. At approximately 165 seconds from datum, the airplane appears to have been subjected to a push-over manoeuvre as indicated by the more nose-down pitch attitude and normal acceleration (less than 1g). For the next 20 seconds the pitch angle is held constant and the available energy (engine thrust appears to be slightly increasing) results in an appreciable airspeed increase while the airplane is descending at 6000 fpm. At about 130 seconds from datum, shortly after exceeding V_{MO} (high speed warning clacker should have sounded), the airplane appears to have been subjected to a pull-up manoeuvre (possibly in an effort to reduce speed and rate of sink) as again indicated by the nose-up pitch angle change and positive normal acceleration. At 120 seconds from datum, the airplane has reached the peak velocity (395 KIAS). At this point, there appears to be an attempt to further arrest the acceleration by still pulling the nose up and reducing the thrust. The airplane responds accordingly: the airspeed starts dropping and the available kinetic energy is traded for potential energy which results in a rate of climb of 5000 fpm with attendant deceleration of approximately four knots/second. At 100 seconds from datum, after the airplane has returned to 325 knots within 20 seconds, another push-over manoeuvre was initiated. The airplane was pitched down, the thrust was partially advanced, and the 5000 fpm rate of climb was changed to approximately 5000 fpm rate of descent. At 60 seconds from datum, as airplane once again has accelerated through V_{MO} (350 knots) another mild pull-up appears to have been initiated in order to reduce the speed build-up and check the rate of descent. At this point, the airplane is at 7,000 feet accelerating at a rate of two knots/second through 360 KIAS and descending at 6000 fpm. Beginning 40 seconds from datum and as a result of a higher-than-normal vertical acceleration, the airplane pitch attitude changes from three degrees nose down to 29 degrees nose up with airspeed dropping from 374 KIAS to 230 still decelerating at a rate of 11

knots/second. At 20 seconds prior to datum, another push-over seems to be attempted ($n=1$) and a heading change is initiated. The airplane has a turn rate of two degrees/second and is climbing at 13,000 fpm. In the next ten seconds, the airspeed drops to 161 KIAS while the airplane is experiencing reduced load factor. At ten seconds, prior to datum, thrust has been added, a sharp pitch-down, a drop in rate of climb, an acceleration and increase in bank angle occurs. In the next 26 seconds, the airplane has developed 30,000 fpm rate of descent, 40 degree pitch-down attitude, 375 KIAS (still accelerating at a rate of 12.5/knots/second) and 40 degree bank angle.

STABILITY AND CONTROL ANALYSIS AND DISCUSSION

A digital program was used to compute the elevator angle (δ_e), column forces (F_S), normal load factor (n_z), lift coefficient (CL) at discrete points. The results are shown in Figure 2. The 737-200 aerodynamic derivatives together with control system characteristics and aeroelastic effects are included in this calculation program. The solutions were obtained by entering the program with gross weight, centre of gravity, altitude, Mach number, glide path angle (γ) and stabilizer position (δ_{FRL}). The effect of the Mach trim compensator was included along with the quasi-static aeroelastic effects on the control surface angle (δ_e).

The stabilizer angle (δ_{FRL}), shown in Figure (2) at the time 240 seconds was chosen as the initial trim point. This time was prior to crew disability, per reference, and the airplane was in a descent at constant speed. The stick forces were zero ($F_z = 0$). Another stabilizer angle was determined by investigators at the crash site (shown at time $=-20$ seconds). Based on information from reference (1), some retrim occurred at $t \approx 150$ seconds and again at $t \approx 40$ seconds. Straight line approximation between these stabilizer trim angles were assumed for this investigation.

The column forces (F_S) are plotted without friction forces. The friction force would not exceed 5 pounds, and would always be in a direction to oppose the column motion. If control wheel steering feature of the auto-pilot were engaged, the column force required to achieve the calculated elevator angles (δ_e) could be considerably less. Based on the heading trace being nearly constant, it is likely that lateral control wheel steering was engaged.

CONCLUSIONS

From the evaluation of the FDR read-out traces and observation of the computed performance, it appears that the aircraft was responding in a normal manner to some abnormal control inputs that eventually caused the aircraft to enter into an irrecoverable situation.

1.16.2 Aircraft Floor Panel

Part of an aircraft floor panel made from a material found only along the centre aisle section of the entire aircraft cabin was found in the wreckage. It was pierced by an aperture which could have been a bullet hole. Ballistic tests on the panel and piece of the material concerned conducted in the UK established that it was indeed a bullet hole created by a low velocity lead type bullet discharged from a handgun. It was considered unlikely to be caused by spontaneous discharge through explosive impact forces of a free bullet outside the chamber of a hand-gun. The tests conclude that the bullet was a type in the range 0.32 to 0.45 calibre but was most likely of 0.38 calibre. It has not been possible to positively establish whether the lead bullet was deliberately triggered by hand or shock coincidental with the post-impact forces. Neither has it been possible to positively establish the actual location of this panel other than to confirm its location as somewhere along the centre aisle of the passenger cabin.

1.16.3 Aircraft Flap Section

A small section of aluminium alloy structure was recovered from the crash site which was also considered to have been pierced by a bullet hole. This was identified as a section of the lower skin of the port inboard trailing edge mid-flap, situated between Wing Buttock Lines (WBL) 98 and 106. Ballistic tests carried out by Government forensic scientists in Malaysia conclude that the hole was made by a low velocity lead type bullet fired from a hand-gun, most probably of 0.32 calibre. The direction of firing was such that the bullet would have had to pass through the flap top skin and fuselage side before piercing the lower skin. Again, it was not possible to ascertain if the bullet was discharged deliberately or by post-impact forces.

1.16.4 Handkerchief

A clean handkerchief, neatly folded and relatively unused, was found amongst the wreckage which also had what appeared to be half-moon bullet hole along one edge of the fold. The full bullet-hole is exposed when the handkerchief is unfolded. In-country ballistic/forensic tests confirm that the hole was created by a low velocity, lead hand-gun type bullet and was most likely of 0.32 calibre. The owner of the handkerchief has been positively identified as an adult male passenger on board the flight. It has not been possible to ascertain the location of this handkerchief on board the flight, nor is it possible to confirm if the discharged of the bullet was deliberate or activated by impact/post-impact forces.



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 FIG 1
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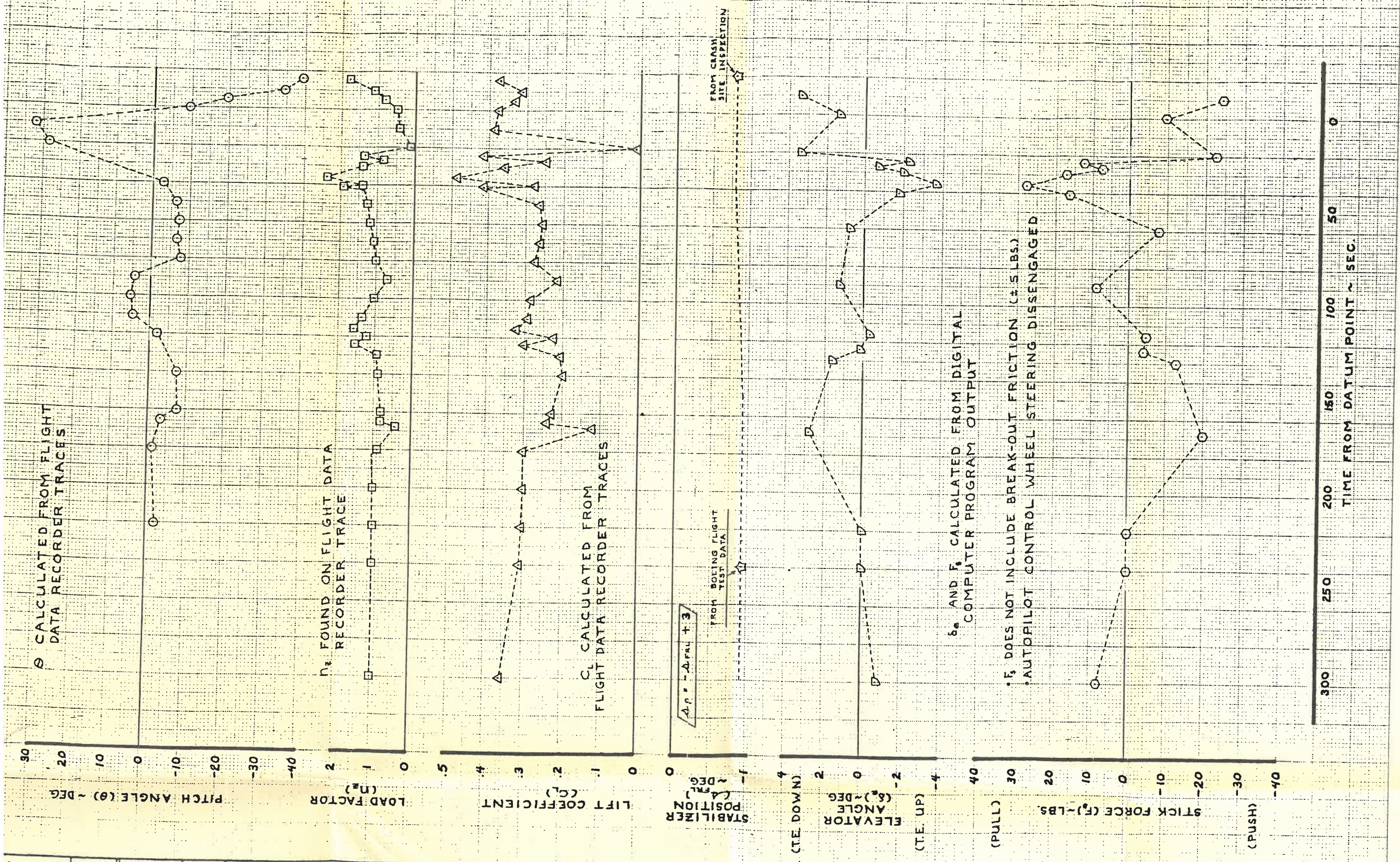
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FIGURE 2
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