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AIRCRAFT ACCIDENT INVESTIGATION REPORT

GARUDA INDONESIA
DOUGLAS DC-10-30, PK-GIE
FUKUOKA AIRPORT
June 13, 1996

November 20,1997

AIRCRAFT ACCIDENT INVESTIGATION COMMISSION

MINISTRY OF TRANSPORT

This report on the accident of a Douglas DC-10-30 of Garuda Indonesia, PK-GIE, has been prepared based upon the investigation carried out by the Aircraft Accident Investigation Commission in accordance with Annex 13 to the Convention on International Civil Aviation and Article 20 of the Aircraft Accident Investigation Commission Establishment Law of Japan.

Kazuyuki Takeuchi
Chairman,
Aircraft Accident Investigation Commission

Abbreviations used in this report are as follows:

AOM	:	Aircraft Operation Manual
AOW	:	All Operators Wire
AP	:	Autopilot
ATIS	:	Automatic Terminal Information Service
AUX	:	Auxiliary
BOM	:	Basic Operation Manual
CAS	:	Computed Airspeed
CVR	:	Cockpit Voice Recorder
CWS	:	Control Wheel Steering
DFDR	:	Digital Flight Data Recorder
FD	:	Flight Director
HPC	:	High Pressure Compressor
HPT	:	High Pressure Turbine
IGO	:	Intergranular Oxidation
JST	:	Japan Standard Time
LPT	:	Low Pressure Turbine
MAC	:	Mean Aerodynamic Chord
MHz	:	Mega-Hertz
N_1	:	Revolution Number % (Low Pressure Compressor)
N_2	:	Revolution Number % (High Pressure Compressor)
PA	:	Public Address
PF	:	Pilot Flying
P/N	:	Part Number
QNH	:	Altimeter sub-scale setting to obtain elevation when on the ground
RTO	:	Rejected Take-off
SB	:	Service Bulletin
STA	:	Fuselage Station
V_1	:	Takeoff Decision Speed
V_R	:	Rotation Speed
V_2	:	Takeoff Safety Speed
VTR	:	Video Tape Recorder

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1. PROCESS AND PROGRESS OF THE ACCIDENT INVESTIGATION

1.1 Summary of the Accident

On June 13, 1996, a Douglas DC-10-30 of Garuda Indonesia (GIA), registration PK-GIE, making a takeoff roll from runway 16 of Fukuoka airport as scheduled passenger flight 865 to Bali International Airport, aborted the takeoff and overran the departure end of runway 16.

The aircraft subsequently traveled over grass-covered ground and at about 1208 JST, the landing gears and the lower lips of the wing-mounted engines impacted the concrete side of a raised public road located approximately 320 meters from the threshold of runway 34. The aircraft finally came to rest within a grassed buffer zone for aircraft noise abatement approximately 620 meters from the threshold of runway 34 and caught fire.

On board the aircraft were 275 persons—260 passengers (including one infant), 14 crew members and one interpreter—of whom 3 passengers were fatally injured, and 16 passengers and 2 flight crew members were seriously injured.

The aircraft was destroyed by the fire.

1.2 Outline of the Accident Investigation

1.2.1 Organization of the Investigation

1.2.1.1 On June 13, 1996, the Aircraft Accident Investigation Commission assigned an investigator-in-charge and five investigators. Subsequently, two further investigators were assigned on June 14 and June 24, 1996.

1.2.1.2 The following four technical advisers were appointed for the investigation of specialized matters with respect to the accident. (Their titles are as of their dates of appointment.)

(1) For analysis of the power plants:
Hiroyuki Nose, Director, Aeroengine Division, National Aerospace Laboratory, Science and Technology Agency.
Shinichiro Kikuchi, President, JAL Engine Technology Co., Ltd.

(2) For analysis of flight performance:
Professor Nagakatu Kawabata, Department of Science and Engineering, Nihon University.

(3) For analysis of operations:
Captain Katumi Yoda, Japan Airlines (retired).

1.2.1.3 Upon the occurrence of the accident, the technical advisers, investigator-in charge and investigators were dispatched to the crash site where an investigation team was established. The team stayed at the site until July 4, 1996 to conduct an on-site investigation.

1.2.1.4 During the accident investigation, cooperation was received from a number of related organizations and personnel including the Police Agency, Defense Agency, Science and Technology Agency, Meteorological Agency, local government (Fukuoka Prefecture etc.) and fire fighting organizations, and so on.

1.2.1.5 Accredited representatives from the USA, the state of design and manufacture of the airframe and power plants, and Indonesia, the state of operation of the aircraft, participated in the factual investigation.

The AAIC was provided with information relevant to the accident by the Accident and Incident Investigation Bureau of the Kingdom of the Netherlands.

1.2.2 Implementation of the Investigation

The investigation proceeded as follows.

June 13 ~ July 4, 1996	On-site investigation
June 14, 1996 ~ March 31, 1997	DFDR retrieval and analysis
June 14, 1996 ~ March 31, 1997	CVR transcription and analysis
June 14 ~ July 4, 1996	Interview of eyewitnesses
June 14 ~ September 13, 1996	Interview of passengers
June 14, 1996 ~ March 31, 1997	

Investigation of fire fighting and rescue activities

June 16 ～ June 23, 1996

Interview of flight crew and cabin attendants

July 1, 1996 ～ March 31, 1997

Investigation of aircraft flight performance and controllability

September 2 ～ September 30, 1996

Disassembly investigation of equipment

September 13 ～ September 20, 1996

Visit to Indonesia by technical adviser and investigators

September 13 ～ November 19, 1996 Disassembly investigation of engines

November 24 ～ November 29, 1996

Visit to Indonesia by technical adviser and investigators

January 14 ～ January 19, 1997

Visit to the Netherlands by technical adviser and investigators

January 14 ～ March 31, 1997

Disassembly investigation of equipment

January 22 ～ January 30, 1997

Visit to the USA by technical adviser and investigator

January 27 ～ February 2, 1997

Visit to the USA by technical adviser and investigators

February 11 ～ February 15, 1997

Visit to Indonesia by technical adviser and investigators

February 16 ～ February 22, 1997

Visit to the USA by investigators

1.2.3 Hearings from Persons relevant to the Cause of the Accident

Hearings were held.

1.2.4 Public Hearing

The AAIC published a draft of the Factual Investigation Report on February 24, 1997, and a public hearing was held on March 19 to hear the accounts of three witnesses.

(1) Date : 10:00 ～ 11:55 March 19, 1997

(2) Venue : Assembly Hall, 10th Floor, Ministry of Transport

(3) Hearing Chairman : Ikuji Takebayasi, Director-General, Secretariat of the AAIC

(4) Witnesses (in order of speech)

Ms. Kyoko Nishiyama : Vice President, Federation of Aviation Workers' Unions
(Flight Attendant, Japan Airlines)

Mr. Ryohei Yabuno : President, Airline Pilot Association of Japan
(Captain, Japan Airlines)

Mr. Syunnji Masuya : Deputy President, Flight Crew Unions Federation of Japan (Flight Engineer, Japan Airlines)

(5) Summary of Statements

Omitted.(Refer to "MINUTES OF HEARING ON AIRCRFT ACCIDENT".)

1.2.5 Reporting and Publication

Progress made during the investigation, including major facts uncovered by the factual investigation, was reported to the Minister of Transport and made public on June 21 and December 18, 1996, and February 24, 1997.

2 FACTUAL INFORMATION

2.1 Flight History

2.1.1 Aspect until the Flight Crew Members occupied their Seats in the Cockpit

The aircraft, PK-GIE, had arrived at Fukuoka Airport from Bali International Airport as scheduled passenger flight 864 of the subject airline on June 13, 1996, at 0801 JST.

The aircraft was planned to be flown back to Bali International Airport later on the same day as scheduled passenger flight 865 of the subject airline by another crew who had had a layover.

At about 1045, the Captain (CAP) and the First Officer (FO) went to the operation information room for a preflight briefing and, following the briefing, signed on the company flight plan.

The CAP checked the takeoff data and the FO filled out a TAKEOFF DATA CARD.

Major data described in the TAKEOFF DATA CARD were as follows:

TAKEOFF WEIGHT	211.3 tons
FUEL LOADING	62,000 kg
V_1	149 knots (RUNWAY DRY)
V_R	157 knots
V_2	171 knots
Engine N_1	113.6%
Flaps	9°
Stabilizer Trim	5.5°

The Flight Engineer (FE) went to the airport's No.5 spot where the aircraft was positioned and performed a walk-around check of the aircraft.

The aircraft was still being refueled as the flight crew members (the CAP, the FO and the FE) boarded.

The CAP occupied the left seat in the cockpit, the FO occupied the right seat and the FE occupied the flight engineer's seat.

2.1.2 Flight History until the DFDR and CVR stopped recording

Based on the recordings of the DFDR, CVR and Air Traffic Control (ATC) recorder, the subsequent flight history until the DFDR and CVR stopped recording was as follows.

(1) Sequence before takeoff clearance received.

About 1135 The CAP carried out a pre-departure crew briefing, which included briefing an emergency procedure.

About 1144 The aircraft contacted Fukuoka Ground Control to request an ATC clearance and reported that they had obtained ATIS "Information J".

About 1145 The FE conducted a fuel transfer.

About 1154 The aircraft received the ATC clearance.

About 1155 The aircraft carried out a BEFORE STARTING CHECKLIST in preparation for engine start and started the No.2 engine at the No.5 spot.

Subsequently the No.3 engine and then the No.1 engine were started while the aircraft was being pushed back.

About 1200 After performing a TAXI OUT CHECKLIST, the aircraft reported "Ready for Taxi" to Fukuoka Ground Control.

In reply, Fukuoka Ground Control instructed the aircraft "Taxi via E2, contact Tower."

About 1201 Fukuoka Tower instructed the aircraft "Hold short of runway". The aircraft held short of the runway for a few minutes to wait for a landing aircraft.

About 1205 Autopilot (AP) No.1 was engaged in control wheel steering (CWS) mode.

Fukuoka Tower instructed the aircraft "Taxi into position and hold runway 16", in response to the aircraft's request for line-up.

The aircraft performed a BEFORE TAKEOFF CHECK.

(2) Flight history after takeoff clearance received.

See appendix 1 - The CVR Transcriptions and appendix 2 - Plots of the DFDR Major Parameters.

About 1206:53 Fukuoka Tower cleared the aircraft for takeoff from runway 16 with wind information of 280 degrees at 7 kts.

About 1207:01 The CAP commanded the FO "Set autothrottles on".

About 1207:03 The aircraft was aligned almost with the runway center line.

From about this time, the aircraft's longitudinal acceleration (G) gradually began to increase.

The N_1 values of all engines also started increasing and finally stabilized at approximately 113% as shown below:

About 1207:14 N_1 of the No.2 engine stood at 113.7%

About 1207:15 N_1 of the No.3 engine stood at 113.2%

About 1207:17 N_1 of the No.1 engine stood at 113.4%

About 1207:16 AP No.1 disconnected.

About 1207:18 AP No.1 was re-engaged in CWS mode.

About 1207:25 AP No.1 disconnected again.

About 1207:26 The FO called "One hundred". The CAS was 103.8 knots.

About 1207:27 AP No.2 was engaged in CWS mode.

About 1207:38 The FO called "V one".

At about this time, the CAS was 151.5 knots.

N_1 of all engines was stable at approximately 113%.

Elevator angle and pitch attitude began to increase toward aircraft nose up.

About 1207:39 The radio altitude (RA) began to increase and was 9.0 feet at around 1207:44.

The elevator angle and pitch attitude changed from about 1207:38 through about 1207:43 as shown below:

About :38 The elevators were at 5.4 degrees. Pitch attitude was 1.5 degrees aircraft nose up (ANU).

About :39 The elevators were at 6.1 degrees. Pitch attitude was 2.6 degrees ANU.

About :40 The elevators were at 5.1 degrees. Pitch attitude was 5.3 degrees ANU.

About :41 The elevators were at 7.5 degrees. Pitch attitude was 8.1 degrees ANU.

About :42 The elevators were at 6.0 degrees. Pitch attitude was 10.7 degrees ANU.

About :43 The elevators were at 4.5 degrees. Pitch attitude was 11.4 degrees ANU.

About 1207:40 The FO called "Rotate". The CAS was 158.0 knots.

About 1207:43 The N_1 of the No.3 engine, which had been 112.8% at around 1207:39, decreased to 53.3% and further dropped to 23.7% at around 1207:47.

About 1207:44 The elevators traveled to 6.1 degrees ANU. Subsequently the elevators moved toward aircraft nose down (AND) , traveling to 15.5 degrees AND at around 1207:47.

About 1207:45 The FE called "Engine failure number one".

The N_1 of both the No.1 and No.2 engines began to drop at around this time as shown below:

(N_1)	No.1 engine	No.2 engine	No.3 engine
About :41	113.4 %		
About :42		113.4 %	
About :43			53.3 %
About :45	109.3 %		
About :46		99.3 %	
About :47			23.7 %
About :49	69.9 %		
About :50		72.1 %	

The RA, which had reached 9.0 feet at around 1207:44, decreased to 5.9 feet and subsequently became −1.2 feet at around 1207:46 and −3.9 feet at around 1207:47.

About 1207:46 There were large transients in vertical G between this time and about 1207:47.

AP No.2 disconnected.

About 1207:47 Pitch attitude, which had increased to 11.43 degrees ANU at around 1207:43, subsequently decreased and almost leveled off (−0.9 degrees) at about this time.

CAS had increased to 172.0 knots at about this time but subsequently decreased continuously.

The thrust reversers were transited from their "STOWED" positions, through "UNLOCK", to their "DEPLOYED" positions from this time through about 1207:49.

About 1207:56 The CVR and DFDR stopped recording. (Data which had been recorded on the DFDR between about 1207:53 and about 1207:56 were unusable.)

2.1.3 Flight History until the Aircraft came to Rest

(See attached figures 1 and 2, and photograph 1.)

The aircraft veered gradually to the right from the center line of the runway, ran over an anchor chain for a jet barrier at the right side of the overrun zone and departed the runway onto a grass field.

After the aircraft had traveled over the grass field, the landing gears and the lower lips of the engine nacelles subsequently impacted the concrete side of a public road approximately 320 meters south of the threshold of runway 34. Parts of the engines' lower portions, tires, etc., became detached in the vicinity of the public road.

The aircraft then slid for approximately 300 meters on its belly in a grassed buffer zone for aircraft noise abatement (hereinafter referred to as "the grassed buffer zone"), detaching the No.1 engine, pieces of the No.3 engine, the landing gears and so on, and finally came to rest approximately 620 meters away from the threshold of runway 34.

The accident occurred at about 1208 JST.

2.1.4 Statements of Persons Concerned regarding the Flight History

The following are outlines of statements on the flight history made by the flight crew, witnesses, cabin attendants and passengers.

(1) Statement of the CAP.

"After the engines were started, all of the indications on the engine instruments were normal.

"We performed all checklists and held the aircraft short of the runway.

"After a landing aircraft had cleared the runway, we received takeoff clearance from Fukuoka control tower.

"I assumed control of the aircraft for the takeoff and commanded the First Officer to set the autothrottle systems on.

"Thrust adjustment was performed by the Flight Engineer during the takeoff roll.

"The aircraft was all normal, and I heard the First Officer call 'Vee one' and 'Rotation'.

"When the aircraft commenced the rotation, I felt something unusual because the aircraft would not become positively airborne. Even if it had become airborne, the altitude would have been relatively low.

"While the aircraft was not positively climbing with pitch attitude being 10 or more degrees nose up, the airspeed abruptly began to decrease by 3 to 6 knots.

"At the same time, I seemed to involuntarily make the aircraft pitch down.

"I heard a sound such as 'dun', and I felt a thrust loss.

"As I instinctively sensed that if the aircraft continued the takeoff, it would collide with neighboring buildings, I made a decision to abort the takeoff, pushed the control column, applied maximum braking and deployed full reverse thrust.

"If the aircraft had lifted off the ground completely, I would have continued the takeoff.

"I did not hear the Flight Engineer's call of 'Engine failure'. If there was such a call, it would have been made after I had decided to abort the takeoff.

"There were no anomalous indications during the takeoff.

"I recalled that as I saw poles of approach lights and a small building ahead, I steered the aircraft, by rudder operation, to the right side of the runway."

(2) Statement of the FO.

"I was seated in the right hand seat, and started the preparations for departure with the Captain in the cockpit.

"I reported the aircraft to be 5 minutes to engine start to Fukuoka control tower and then received ATC clearance.

"The Captain and Flight Engineer carried out starting the engines. At that time, the indications on each engine instrument were normal.

"The aircraft was supposed to line up on runway 16 for takeoff via taxiway E-2, but held short of the runway for about 3 minutes because of a landing aircraft.

"The aircraft lined up on runway 16, and held on the runway for a moment because the landing aircraft was still on the runway. Then the aircraft started the takeoff roll.

"The Captain applied takeoff power and all was normal.

"I made calls of 'Eighty', 'One hundred' and 'Vee one'.

"Immediately after the Vee one call, the Flight Engineer called 'Engine Failure'.

"The Captain started to take an action to abort the takeoff.

"As the Captain called 'Stop' and then 'Hold brake', I applied full brake together with the Captain.

"The aircraft traveled till the end of the runway and then rolled on the grass field."

(3) Statement of the FE.

"After the aircraft entered the No.5 spot, I performed a walk-around check of the outside of the aircraft.

"The Captain occupied the left hand seat and the First Officer was seated in the right hand seat, and both were making the preparations for departure.

"As I checked the log book, no abnormal matters were found out.

"The No.2 engine was started first. As the aircraft was being pushed back, the No.1 engine was started, and the No.3 engine was started afterward. The conditions of starting these engines were all normal.

"The takeoff was initiated with the takeoff power set by the Captain. The Captain called 'Autothrottles on,' the First Officer turned on the switch and I confirmed the First Officer's action.

"The indications on the engine instruments were normal and the positions of all three throttle levers were almost the same.

"When the First Officer called 'Eighty', I acknowledged normal indications on the engine instruments.

"I do not remember whether I heard the 'One hundred' call or not.

"Immediately after the 'Vee one' call, as I acknowledged the drops of N_1, N_2 and EGT on the No.3 engine, I called 'Engine Failure', immediately followed by 'Number one'. I intended to call 'Number three' but called 'Number one'.

"At that time, the Captain called 'Unable control'.

"I saw the Captain holding the control column with both hands. I think the aircraft's pitch attitude was considerably high because I could not see landscape through the front window.

"The Captain called 'Emergency stop' and pushed the control column, retarded the throttles to idle, and actuated the three thrust reversers.

"It seemed as if the aircraft had slid on the ground, but at the last stage I experienced severe impacts."

(4) Statements of Witnesses.

The following are based on the statements of witnesses working at the airport's west side apron, approximately 1,800 to 2,000 meters from the end of runway 16.

The aircraft was making a takeoff roll and pitched up at a position approximately 1,800 meters from the end of runway 16. Subsequently, when the aircraft had lifted off about 3 meters above the runway, a loud bang was heard. The No.3 engine first belched out orange sparks and then a 3 to 4 meter long flame from the exhaust.

The flame diminished as the aircraft touched down onto the surface of the runway.

There was a little smoke coming out of the engine.

(5) Statements of Cabin Attendants and Passengers.

Refer to section 2.13.1.1.

2.2 Injuries to Persons

	Crew	Passengers	Others
Fatal	0	3	0
Serious	2	16	0
Minor	1	151	0
None	12	90	N/A

Note: · Numbers indicated in the "Minor" row includes persons who reported themselves as having received minor injuries.

- The item "None" in column "Crew" includes the interpreter.
- The figures exclude fire fighting and rescue personnel who sustained injuries. (See section 2.13.2.4.)

2.3 Damage to Aircraft

2.3.1 Extent of Damage

The aircraft was destroyed.

2.3.2 Damage to Aircraft by Part

See figure 3 and photographs 1 through 4.

(1) Fuselage

① The fuselage was fractured at two places: At around the trailing edges of the wing roots and at approximately 10.5 meters aft of the wing root trailing edges.

Rubs and dents were found on the right side surface of the fuselage aft of the rearmost fracture, and the surface at that location was partially depressed inward.

② The central crown of the fuselage was consumed by the fire.

③ The side walls of the fuselage between the two fractures had bent down to the ground.

(2) Left Wing

① The trailing edge was partially burnt out.

② The inboard flap had separated from the wing structure.

③ The outboard flap trailing edge was partially fractured.

(3) Right Wing

① The trailing edge was partially burnt out.

② The inboard flap had separated from the wing structure.

③ The outboard flap trailing edge was partially fractured.

(4) Tail

① Approximately half of the left horizontal stabilizer had been torn off.

② Open holes were observed in the leading edge and the lower surface of the right inboard horizontal stabilizer.

③ There were open holes in the trailing edge of the right inboard elevator.

(5) Landing gear

① The left and right main landing gears with attached fittings had separated from the wings.

② The nose landing gear had separated, and a fitting of the strut was lodged in the nose landing gear bay.

③ The center gear, which had separated from its fitting, was wedged into the underside of the fuselage.

(6) No.1 Engine

① The engine itself had separated from the pylon.

② All of the engine fan cases, including the cowlings, were torn off and detached.

③ The tips of most of the fan blades were fractured and curled.

④ The accessory gearbox was fractured into small pieces.

(7) No.2 Engine

① There was a hole measuring approximately 2 metres by 3 metres in the right side of the inlet duct. The edges of the opening were partially flared inward and aft.

② One fan blade had separated at just below the midspan. A piece of the liberated blade was wedged into a narrow crack between the fan case and the fan blade. All other fan blades were missing their tips and leading edges.

③ A piece of the outer skin of the right wing was wedged into the fan blades.

④ The inside of the fan case was worn in many places in the direction of fan rotation.

(8) No.3 Engine

① The pylon was twisted inboard, and the engine was pressed between the wing and the ground and was deformed.

② One of the fan blades had been lost. The other blades, which were pressed against the ground, were bent, slanting in an aft direction.

③ Some of the low pressure turbine (LPT) fan blades were bent.

④ The accessory gearbox was fractured into small pieces.

2.4 Damage to Other than the Aircraft

A portion of the airport perimeter fence, a portion of the grassed buffer zone perimeter fence, and steel pipe rails on both sides of the public road had sustained damage.

2.5 Crew Information

2.5.1 Flight Crew

Captain: Male, aged 38

Airline Transport Pilot License	No. [redacted] issued December 1, 1981
Type Rating	
Douglas DC-10	Issued June 20, 1994
Term of validity	Until July 22, 1996
Class 1 Airman Medical Certificate	Issued February 16, 1996
Term of validity	Until August 16, 1996
Total flight time	10,263 hours
Total flight time on DC-10	2,641 hours
Flight time during the previous 180 days	271 hours
Flight time during the previous 90 days	143 hours
Flight time during the previous 30 days	36 hours
Latest proficiency check	December 7, 1995
Rest period prior to the flight	72 hours

First Officer: Male, aged 31

Airline Transport Pilot License	No. [redacted] issued January 5, 1992
Type Rating	
Douglas DC-10	Issued July 28, 1992
Term of validity	Until August 6, 1996
Class 1 Airman Medical Certificate	Issued January 16, 1996
Term of validity	Until July 16, 1996
Total flight time	3,910 hours
Total flight time on DC-10	1,437 hours
Flight time during the previous 180 days	342 hours
Flight time during the previous 90 days	176 hours
Flight time during the previous 30 days	96 hours
Latest proficiency check	December 6, 1995

Rest period prior to the flight	72 hours

Flight Engineer: Male, aged 34

Flight Engineer Proficiency License	No.[redacted], issued September 6, 1990
Type rating	
Douglas DC-10	Issued September 6, 1990
Term of validity	Until July 11, 1996
Class 1 airman medical certificate	Issued December 19, 1995
Term of validity	Until December 19, 1996
Total flight time	2,935 hours
Total flight time on DC-10	2,935 hours
Flight time during the previous 180 days	365 hours
Flight time during the previous 90 days	223 hours
Flight time during the previous 30 days	59 hours
Latest proficiency check	November 11, 1995
Rest period prior to the flight	72 hours

Note: The total flight time of the CAP on the DC-10 and the latest proficiency checks of the CAP, FO and FE are based on the latest information from Garuda Indonesia.

2.5.2 Cabin Attendants and Interpreter

A. Purser (Male, aged 42)	
Position at the time of evacuation	2L exit
Qualification as attendant	Issued August 8, 1975
Total flight time	15,682 hours
Latest training on evacuation	April 16, 1996
B. Assistant Purser (Male, aged 33)	
Position at the time of evacuation	3R exit
Qualification as attendant	Issued August 24, 1982
Total flight time	9,338 hours
Latest training on evacuation	March 4, 1996
C. Flight attendant (Male, aged 29)	
Position at the time of evacuation	1R exit
Qualification as attendant	Issued March 21, 1987
Total flight time	5,788 hours

	Latest training on evacuation	July 18, 1995
D.	Flight attendant (Female, aged 29)	
	Position at the time of evacuation	1L exit
	Qualification as attendant	Issued April 15, 1987
	Total flight time	5,820 hours
	Latest training on evacuation	March 25, 1996
E.	Flight attendant (Female, aged 29)	
	Position at the time of evacuation	2R exit
	Qualification as attendant	Issued June 8, 1987
	Total flight time	5,277 hours
	Latest training on evacuation	June 7, 1996
F.	Flight attendant (Female, aged 23)	
	Position at the time of evacuation	4R exit
	Qualification as attendant	Issued July 1, 1993
	Total flight time	1,570 hours
	Latest training on evacuation	September 6, 1995
G.	Flight attendant (Female, aged 24)	
	Position at the time of evacuation	2R exit
	Qualification as attendant	Issued August 1, 1991
	Total flight time	2,486 hours
	Latest training on evacuation	July 21, 1995
H.	Flight attendant (Male, aged 29)	
	Position at the time of evacuation	4L exit
	Qualification as attendant	Issued June 8, 1991
	Total flight time	2,501 hours
	Latest training on evacuation	July 31, 1995
I.	Flight attendant (Female, aged 24)	
	Position at the time of evacuation	3L exit
	Qualification as attendant	Issued February 1, 1992
	Total flight time	1,733 hours
	Latest training on evacuation	September 27, 1995
J.	Flight attendant (Female, aged 23)	
	Position at the time of evacuation	2L exit
	Qualification as attendant	Issued October 1, 1992
	Total flight time	1,912 hours
	Latest training on evacuation	December 4, 1995

K. Flight attendant (Female, aged 21)

Position at the time of evacuation	2R exit
Qualification as attendant	Issued December 31, 1993
Total flight time	1,183 hours
Latest training on evacuation	March 1, 1996

L. Interpreter (Female, aged 26)

Note: The dates of the latest evacuation trainings are based on the latest information from Garuda Indonesia.

2.6 Aircraft Information

2.6.1 The Aircraft

Type	Douglas DC-10-30
Serial No.	46685
Date of manufacture	May 25, 1979
Certificate of Airworthiness	824
Term of validity	Until April 21, 1997
Total aircraft flight time	46,325 hours

2.6.2 The Engines

Type General Electric CF6 - 50C

	No.1	No.2	No.3
Serial No.	517664	455996	455298
Date of manufacture	February, 1980	July, 1980	August, 1973
Total time in service	39,311 hours	27,018 hours	61,891 hours
Total cycles in service	9,219	13,127	19,023
Total hours / cycles in service after installation	1,289 / 584	1,944 / 1,021	2,412 / 1,288
Date of installation	August 31, 1995	April 22, 1995	January 25, 1995

2.6.3 Weight and Center of Gravity

The weight of the aircraft at the time of the accident is estimated to have been approximately 211,300 kg, with its center of gravity at 18.9% MAC, both being within allowable limits (maximum takeoff weight being 251,744 kgs, with the allowable range of center of gravity corresponding to the weight at the time of takeoff of 10.6% to 28.4% MAC).

2.6.4 Fuel and Lubricating Oil

The fuel on board was JET A-1. The lubricating oil was Esso Turbo Oil 2380 (MIL-L-23699).

2.7 Meteorological Information

The meteorological observations around the time of the accident, as provided by the Aviation Weather Service Center at Fukuoka Airport, were as follows:

1000	Wind direction/speed:	variable / 2kts
	Visibility:	20 km
	Cloud:	1/8 cumulus 3000ft 4/8 unknown
	Temperature/dew point:	27℃/21℃ QNH: 29.81 inHg
1030	Wind direction/speed:	variable / 3kts
	Visibility:	20 km
	Cloud:	1/8 cumulus 3000ft 5/8 unknown
	Temperature/dew point:	27℃/21℃ QNH: 29.80 inHg
1100	Wind direction/speed:	170° / 4kts
	Visibility:	20 km
	Cloud:	1/8 cumulus 3000ft 6/8 unknown
	Temperature/dew point:	28℃/21℃ QNH: 29.80 inHg
1130	Wind direction/speed:	variable / 3kts
	Visibility:	25 km
	Cloud:	1/8 cumulus 3000ft 3/8 cumulus 4000 ft 6/8 unknown
	Temperature/dew point:	29℃/20℃ QNH: 29.80 inHg

1200	Wind direction/speed:	310° /6kts
	Visibility:	25 km
	Cloud:	1/8 cumulus 3000ft 4/8 cumulus 4000ft 7/8 unknown
	Temperature/dew point:	28℃/20℃ QNH: 29.79 inHg
1211	Wind direction/speed:	270° /8kts
	Visibility:	25 km
	Cloud:	1/8 cumulus 3000ft 5/8 cumulus 4000ft 7/8 unknown
	Temperature/dew point	29℃/21℃ QNH: 29.79 inHg
1230	Wind direction/speed:	290° /7kts
	Visibility:	20 km
	Cloud:	1/8 cumulus 3000ft 5/8 cumulus 4000ft 7/8 unknown
	Temperature/dew point:	28℃/21℃ QNH: 29.79 inHg

2.8 Navigation Aids

During the time period related the operation of the aircraft, all navigation aids relevant to the operation at Fukuoka Airport were operating normally.

2.9 Communications

All communications between the aircraft and Fukuoka Ground Control (121.7 MHz) and Fukuoka Tower (118.4 MHz) were satisfactory.

2.10 Airport and Ground Facility Information

Fukuoka Airport, which is administered by the Ministry of Transport, is served by a single runway. The airport's elevation is 9.1 meters above mean sea level.

The runway, 16/34, is 2,800 meters long and 60 meters wide. The longitudinal slope is +0.2% from the threshold of runway 16 to the threshold of runway 34. It is composed of asphalt and concrete and grooved over an area 2,800 meters long and 40 meters wide. A jet barrier is installed at the end of runway 16 and anchor chains for the jet barrier are situated at both the right and left sides of the overrun zone.

The runway surface condition was dry, and the runway had been operating normally up to the time of the accident.

A public road runs south of the runway in an east-west direction. A plain grassed buffer zone administered by the airport for noise abatement is situated on the south side of the road at a level of about 1.2 meters lower than the road.

2.11 Information on DFDR and CVR

The aircraft was equipped with a Sundstrand model 980-6005-079 CVR (Serial No. 13616) and a Sundstrand model 981-6009-014 DFDR (Serial No. 3027). Both were recovered intact.

2.11.1 CVR Recording

The times, which are not recorded on the CVR, were established by correlating ATC communications recorded on the CVR with those recorded on the ATC recorder installed at Fukuoka airport, which records JST time.

The CVR had recorded approximately 33 minutes of voices and sounds from about 1135 until it stopped recording at about 1207:56.

The transcription of voices and sounds from about the time the aircraft received takeoff clearance until the CVR stopped recording is attached as appendix 1.

2.11.2 DFDR Recording

The times recorded on the DFDR, which were sampled from the cockpit clocks, were determined to be unreliable. The times on the DFDR were thus determined by matching VHF keying discrete data from the DFDR with the radio transmissions on the ATC recorder.

Data on 53 parameters were recorded on the DFDR from about the time when the engines were started until the DFDR stopped recording at about 1207:56 (Data recorded on the DFDR between 1207:53 and 56 were unusable).

Plots of the DFDR major parameters from about the time the aircraft received takeoff clearance until the DFDR stopped recording usable parameters are attached as appendix 2, with parts of the CVR transcription overlaid.

2.12 Medical Information

2.12.1 Injuries to Passengers and Crew Members

Of the 275 persons on board – 260 passengers, 14 crew members and one interpreter – 3 passengers died, 16 passengers, the CAP and the FO were seriously injured, and 151 passengers and the FE sustained minor injuries.

2.12.2 Causes of Death

An autopsy, which was conducted on three remains (all passengers) at the Department of Forensic Medicine, Kyusyu University, school of medicine revealed the causes of death as follows. The three passengers had occupied seats in the right side seating column of the aft cabin (see attached figure 5).

(1) Passenger A, male (seat 34K)

Cause of death: Traumatic bleedig attributed to multiple organ damages.

Portion/Extent of damages: Bone fractures of ribs, pelvis, right leg and skull. Cardiac rupture. Lungs and liver contusion. Subarachnoid hemorrhage.

Others: Burn after death.

(2) Passenger B, male (seat 35K)

Cause of death: Cardiac tamponade attributed to dissection of the aorta and atrium rupture, brain damage.

Portion/Extent of damages: Bone fractures of ribs, leg and arm. Right and left atrium rupture. Dissection of the aorta. Cardiac tamponade.

Others: Burn after death.

(3) Passenger C, male (seat 35J)

Cause of death: Burn.

Portion/ extent of damages: Bone fracture of ribs. Flare of pharynx and larynx.

2.12.3 Details of the Injuries

Details of the extent of injuries to the sixteen passengers, the CAP and the FO who were seriously injured are as follows.

(1) Ten passengers jumped out of a crack in the right side of aft fuselage and suffered lumbar vertebra oppression fracture and/or leg fracture at the time when they touched the ground. In addition, two of these passengers had sustained bone fractures in the cabin due to impact during the aircraft overrun sequence.

(2) Two passengers evacuated through the L3 door to the left wing and jumped from the wing. They suffered lumbar vertebra oppression fracture and/or calcaneal bone fracture at the time they touched the ground.

(3) Four passengers sustained whiplash and fractures of the clavicula, sternum and coccyx in the cabin due to impact during the aircraft overrun sequence.

(4) The CAP suffered rib fractures and was bruised on the lower-back, but it is not clear when the injuries were sustained.

(5) The FO suffered lumbar vertebra oppression fracture due to impact during the aircraft overrun sequence.

Most of minor injuries were classified as bruises caused by impact during the overrun sequence and scratches sustained during the emergency evacuation.

2.13 Information on Fire/Fire Fighting and Evacuation/Rescue Activities

2.13.1 Information on Evacuation

2.13.1.1 Situation in the Cabin prior to Evacuation

The following are outlines of the statements obtained from cabin attendants and passengers regarding the situation in the cabin prior to the evacuation. (See attached figure 5.)

(1) Outline of Cabin Attendants' Statements

The Purser briefed the ten cabin attendants and one interpreter prior to boarding the aircraft. At about 1045, all cabin attendants boarded, checked the door levers in their charges, and checked the lavatories and galleys. Subsequently they checked that the emergency equipment, seat belts, life vests and safety pamphlets for passengers were in the correct places.

The passengers boarded between about 1130 and 1150. Prior to the takeoff roll, the cabin attendants made a welcome announcement and, in line with the announcement, demonstrated to the passengers the use of the life vest, oxygen mask and safety equipment, and the locations of emergency exits, etc.. The announcement was made in three languages — Indonesian, English and Japanese. (Indonesian and English were addressed by a cabin attendant who was in charge of the 1L door, and Japanese was addressed by the interpreter who was near the 2L door.)

The takeoff was signaled to the cabin attendants from the cockpit and the aircraft commenced the takeoff roll. Shortly after the aircraft pitched up and then lifted off, it landed hard on the runway with a loud bang.

Therafter, the cabin attendants felt continuous vibrations and strong impacts to the aircraft. They observed that luggage came out of the overhead bins, ceiling panels fell down from the ceiling in the aft cabin, cracks appeared on the ceiling, and trolleys came out of the galleys.

A flame was observed outside in the vicinity of the right engine. Although passengers were upset and shouted loudly, they all remained in their seats.

At about the time the aircraft came to a stop, fire broke out outside the aircraft in the vicinity of the wings. At first, the area from the mid cabin through the aft cabin was heavy with a white smoke, then the cabin filled with a thick black smoke and visibility deteriorated.

(2) Outlines of the Statements of Passengers.

A little while after the aircraft commenced the takeoff roll, shortly after it pitched up and then lifted off, a loud bang was heard, then the aircraft landed hard on the runway. Subsequently the passengers felt continuous shakings from right to left and then severe impact. The cabin lights went out.

① The forward cabin

Luggage came out of the overhead bins and portions of ceiling panel fell down from the ceiling.

② The middle cabin

A screen in front of them fell to the floor, ceiling panels and luggage dropped down and oxygen masks were dangling down from the overhead console.

A flame blew out of the floor near the root of the right wing. White smoke approached from the aft cabin, and outside the aircraft, fire broke out in the vicinity of the right engine and the left wing.

③ The right side of the aft cabin

Luggage came out of the overhead bins, oxygen masks were dangling from the overhead console and ceiling panels as well as something like water fell down from the ceiling.

Waves of heat and smoke approached from the forward cabin.

Three seats (35H, 35J and 35K) were moved forward by severe shock, and something like panels covered the two window-side seats (35J and 35K).

The backs of many of the seats surrounding these three seats were inclined forward by the shock. Cracks were noted in the fuselage in the vicinity of two seats (30K and 35K).

④ The left side of the aft cabin

Ceiling panels covered some seats from 33A,B to 36A,B. Further, ceiling panels fell down and blocked the aisle between seating columns B and C of 33 through 36 row..

The wall and floor near seat 30A (a window seat) were cracked, and flames were visible through the crack. The cabin in this area was filled with a thick smoke so that visibility was poor and the passengers hardly saw the situation surrounding them.

2.13.1.2 Numbers of Passengers who evacuated each Exit (See attached figures 5 and 6)

Passengers evacuated through eight places; all except two of the six doors (3R and 4R), a crack in the floor near a seat (row 30) at the left side of the cabin and a crack at the rear of a seat (row 35) at the right side of the aft cabin. The number of passengers who evacuated from these places was as follows. The points from which 8 persons exited could not be determined.

1R door : 2, 1L door : 4, 2R door : 19, 2L door : 64,

3L door : 117, 4L door : 27,

Crack near the seat (row 30) at the left side of the cabin: 2

Crack at the rear of the seat (row 35) at the right side of the cabin: 14

2.13.1.3 Information on Emergency Evacuation (See attached figures 5 and 6)

(1) Actions taken by the Flight Crew

Outline of the statements of the CAP, the FO and the FE, regarding the actions taken by the flight crew during the emergency evacuation are as follows:

① The CAP

"3 to 4 seconds after the aircraft came completely to a stop, I came to myself and called ‘On Ground Emergency’, set parking brake and retracted spoilers.

“I seemed to have reported the emergency to Fukuoka control tower.

“I turned on the emergency power supply.

“I did not, however, turn on the EVAC SIGNAL.

“The First Officer and the Flight Engineer carried out their own duties.

“When I opened the left window of the cockpit, I saw one cabin attendant yelling ‘Captain, fire, fire’.

“The Flight Engineer tried to open the cockpit door, but he could not open it.

“By using a rope, I evacuated through the window. Afterwards the Flight Engineer also evacuated through the same window.

“On the ground under the aircraft nose, I asked the Purser ‘Everybody out ?’ He replied ‘Everybody out’.

“As one cabin attendant was seen on the ground near a door, I called her over. At that time, I could barely speak because of my chest ache.

“The First Officer could not walk and was being offered the assistance of people around.”

② The FO

“I do not remember whether I carried out the emergency procedure or not.

“The Flight Engineer tried to open the cockpit door, but he could not open it.

“I could not move because I had suffered back injury during the aircraft overrun sequence on the grassed soil, so I jumped from the aircraft through the cockpit window with the assistance of other people, and after that I could not move at all.

“The Flight Engineer pulled the FIRE SHUT OFF HANDLE.

“I do not remember how the Captain and the Flight Engineer evacuated the cockpit.

“Although I could not walk by myself, I managed to leave the aircraft by being dragged by people around.”

③ The FE

“After the aircraft had come to a stop, the Captain called ‘On ground emergency.’

“I pulled all three FIRE SHUT OFF HANDLEs.

"The fuel switch had already been shut.

"I tried to open the cockpit door, but the door did not move because it was locked.

"Looking forward, the Captain was about to evacuate through the left window by using a rope and the First Officer was also about to leave from the right window.

"Outside the aircraft, a cabin attendant yelled 'Fire'. I could see many passengers were evacuating.

"Getting out of the aircraft, I saw the Captain and one purser standing 10 to 15 meters away from the aircraft nose.

"I asked the purser about the passengers' evacuation, and he replied 'All passengers got out'.

"The Captain shouted to people around to keep away from the aircraft because much fuel remained in it."

(2) Actions taken by cabin attendants during the evacuation

Outline of the statements of the cabin attendants and the interpreter are as follows:

① Flight attendant in charge of the 1R door

"After the aircraft stopped, I assisted in opening the 1L door and then opened the 1R door, through which one passenger evacuated.

"After I looked over the cabin and confirmed that no passengers remained near the area in my charge, I tried to open the cockpit door.

"However, I could not open the cockpit door because ovens and galley containers blocked the passage.

"I could not assess the situation in the economy-class cabin due to smoke.

"Since a colleague who was already outside the aircraft yelled 'Fire', I evacuated and guided passengers away from the aircraft."

② Flight attendant in charge of the 1L door

"Immediately after the aircraft stopped, I turned on the emergency lights but they did not light up.

"I tried to open the 1L door, but I could not do so because the door was shut tight.

"Therefore, the attendant who was in charge of the 1R door helped me to open the 1L door.

"I waved my arm to direct two passengers to evacuate through the door.

"I saw thin smoke in the cabin but it was not heavy.

"After I confirmed no passengers were in the cabin, I evacuated through the 1L door and guided passengers to a safer area."

③ Flight attendants in charge of the 2R door (3 attendants stationed here)

"When the aircraft stopped, we heard the Purser yelling 'Emergency, emergency'.

"After we assessed the situation outside the aircraft, we opened the 2R door.

"While one attendant was opening the door, other two cabin attendants guarded around the door.

"After we confirmed that the slide was inflated, we directed the passengers in English, saying 'Emergency, emergency, open seat-belt, come here out out, everybody out, jump and slide, jump and slide'.

"After the passengers had evacuated, we checked the cabin.

"Although it was not clear to see the aft cabin because of smoke and flames, we confirmed that there were no passengers left in the area as wide as we could see and then we evacuated through the 2L door.

"After evacuated, we moved passengers away from the aircraft.

"We prevented three male passengers from re-entering the aircraft."

④ Flight attendants in charge of the 2L door (2 attendants stationed here)

"When the aircraft stopped, we looked outside the aircraft and saw grass around the left wing burning.

"Although we did not receive the Captain's instruction and the emergency alarm did not go off, we commenced the passenger evacuation based on our judgment that it was an emergency.

"We made a Public Address [PA] announcement 'Emergency, emergency, open doors' but the PA did not work.

"After confirming that there was no fire outside the aircraft around the 2L door, we opened the door.

"After we confirmed that the slide/raft was inflated, we yelled 'Out, out' with our arms waving to guide the passengers out the exit.

"At the time when the passengers around us evacuated, we could not see the aft cabin, which was filled with a thick black smoke, so we could not go to the aft cabin to check the situation there because we judged that it was dangerous.

"After confirming again that there were no passengers left in the cabin in our charge, we evacuated through the 2L door and moved the passengers away from the aircraft.

"Many passengers, the Captain and some cabin attendants stayed on the ground around the aircraft's nose.

"We assumed that all of the people had evacuated the aircraft."

⑤ Flight attendant in charge of the 3R door

"After the aircraft had stopped, since I saw fires around the right wing, I did not open the 3R door. I waved my arm, yelling 'Emergency, out, out', to direct passengers to go to the opposite 3L door.

"I saw flames behind dark black smoke in the aft cabin.

"I evacuated through the 3L door with the last passengers.

"As it was very dark and visibility was poor in the cabin, I could not see if some passengers still remained in the aft cabin when I exited the 3L door.

"When I stood on the left wing after I had exited, 2 to 3 more passengers came out.

"Subsequently, after I confirmed that no more passenger exited, I moved away from the aircraft and guided the passengers to a safer place."

⑥ Flight attendant in charge of the 3L door

"After the aircraft had stopped, I awaited the Captain's instructions but I did not receive any.

"When I opened the 3L door, the ramp inflated but the slide/raft partially deflated.

"I saw fires under the aircraft. Since I was instructed by the Assistant Purser to exit the aircraft and move passengers to a safer area, I got out of the aircraft and guided the passengers.

"Subsequently, when I approached the front of the aircraft, I could see that the captain, the First Officer and the Flight Engineer were still in the cockpit."

⑦ Flight attendant in charge of the 4R door

"After the aircraft had stopped, I headed for the 4R door.

"After I checked the situation outside the aircraft, I tried to open the 4R door but I could not do so because the door was twisted.

"There was so much smoke in the cabin that I could hardly breathe. Looking around me, I could see the 4L door was opened.

"I got to the 4L door by stepping over galley containers and other things which blocked the passage, and helped some passengers to evacuate through the door.

"Because I was suffocated by smoke, visibility was poor and galley containers and other things blocked the passage, I could not check if passengers remained in the seats in my charge.

"I, too, evacuated the aircraft because I was anxious about an explosion of the airframe. A few passengers came out after me."

⑧ Flight attendant in charge of the 4L door

"When the aircraft stopped, there was so much dark smoke in the cabin that I could hardly see the flight attendant at the 4R door.

"I could only see about three rows of the passenger seat in front of me.

"When I opened the 4L door and the slide/raft inflated, I saw that the left wing was engulfed in flames.

"I shouted to the passengers 'Emergency, emergency, out out', but I couldn't see inside the cabin because of the dark smoke.

"After I had evacuated through the 4L door, I assisted passengers' evacuation on the ground under the door.

"I directed passengers to run away from the aircraft.

"The cabin attendant in charge of the 4R door evacuated together with some passengers."

⑨ Interpreter (who had been seated in the seat 9C near the 2L door)

"The Purser yelled 'Emergency' with a microphone but the PA announcement did not work.

"I shouted to the passengers around me 'Exit from here' in Japanese and then I evacuated."

(3) Aspect of the Passengers' Evacuation

Outlines of the passengers' statements are as follows:

① Passengers evacuated through the 1R and 1L doors

"After the aircraft had stopped, cabin attendants opened the 1R and 1L doors and waved their arms to guide several passengers to evacuate through these doors."

② Passengers evacuated through the 2R and 2L doors

"We were anxious about the dimness around the 1R and 1L doors of the forward cabin which was partitioned by a curtain. As an aft area of the forward cabin was brightened when the 2R and 2L doors were opened, we headed for the area and evacuated through these doors, where cabin attendants gestured to guide us.

"When evacuating, cabin attendants guided passengers near the doors and on the ground.

"A male cabin attendant guided near a door until the last minute."

③ Passengers evacuated through the 3L door

"After the aircraft had stopped, a male cabin attendant tried to open the 3R door, but he could not open it.

"The 3L door was opened by a female cabin attendant.

"About the time when several passengers evacuated through the 3L door, because part of the slide/raft between the wing and the ground was deflated, they jumped down from the wing.

"From the outside of the aircraft, a female cabin attendant shouted `Jump, jump', gesturing to direct the passengers.

"Some passengers got down from the wing with the assistance of a male cabin attendant. When a few passengers who had evacuated through the 2L door tried to re-enter the cabin, they were prevented from doing so by cabin attendants in charge of the 2L door. At the time, a cabin attendant who was on the ground guided passengers.

"Although many passengers had been getting into a panic, they became calm by hearing several passengers' voices saying 'Calm down', and evacuated the aircraft."

④ Passengers evacuated through the 4L door

"As a ceiling panel fell down on the seats in the aft left cabin, some passengers stepped over the panel and evacuated through the 4L door. On the other hand, some passengers who had been trapped under the panel took time to evacuate."

"We evacuated by the guidance of a male cabin attendant who also evacuated with us."

"After sliding down, I could not move on the ground, but a male cabin attendant carried me on his back so I could get away from the aircraft."

"Two cabin attendants guided us on the ground under the door."

⑤ Passengers evacuated through a crack in the floor beneath seat row 30 at the left side of the cabin

"There were cracks on the left side wall, ceiling and floor.

"We could peep the outside of the aircraft through a crack in the floor and see a red flame.

"As the crack had opened wide enough so that we could go through, we evacuated through the crack."

⑥ Passengers evacuated through a crack near seat row 35 at the right side of the aft cabin.

"We could not see the exits because of the smoke in the cabin.

"We headed for the aft right side of the cabin where it was bright, and as we could see the outside of the aircraft through a crack, we evacuated through the crack."

Many passengers stated that they did not receive the cabin attendants' guidance, or did not realize that they had.

2.13.2 Fire, Fire Fighting and Rescue

2.13.2.1 Fire Fighting and Rescue System at Fukuoka Airport

(1) Outline of fire fighting and rescue organization at Fukuoka Airport

The fire fighting and rescue service for aircraft accidents is provided by the Fukuoka Airport Office of Oosaka Civil Aviation Bureau (hereinafter referred to as "the Airport Office") under the supervision of the Airport Office Administrator (hereinafter referred to as "the Administrator").

An agreement had been made between the Administrator and the Mayor of Fukuoka City with respect to the fire fighting and rescue services in and around Fukuoka airport.

Also, under the agreement, a memorandum had been made between the Administrator and the Director of the Fukuoka City Fire Fighting Department (hereinafter referred to as "the City Fire Department"), and under this memorandum, the Administrator is able to request the assistance of the neighboring fire fighting organizations when necessary.

An agreement had been made with respect to the fire fighting and rescue services in and around Fukuoka Airport between the Administrator and fourteen Airport Affiliate Companies.

A request of "a cooperation on fire fighting", made by the Administrator to the commander of the Air Self Defense Force's Kasuga base, had been approved.

(2) Fire fighting equipment and personnel at Fukuoka Airport

The fire fighting and security division of the Airport Office (hereinafter referred to as "the Fire Fighting Division") provides an around-the-clock fire fighting and rescue service, in shifts, from a station at the airport.

The equipment and personnel meet the level specified as a recommended practice in Annex 14 ("AERODROMES") to the Convention on International Civil Aviation: The station is equipped with two large chemical fire fighting vehicles (CFFV), one high speed CFFV, one water supply wagon and one ambulance. Twelve personnel were on duty for fire fighting and rescue service at the time of the accident.

The airport branch of the Hakata Fire Fighting Station is located next to the station and is equipped with one CFFV and one water supply wagon. Six personnel were on duty at the time of the accident..

(3) Fire fighting and rescue drill for aircraft accidents

Concerning a fire fighting and rescue drill for aircraft accidents in and around Fukuoka airport, "Comprehensive drill for aircraft accident" was held on October 23, 1995 under the auspices of the Airport Office; personnel from a self-governing body, fire fighting organizations, the airport police station, the Self Defense Force, and medical organizations participated in this drill.

2.13.2.2 Fire Fighting Activities

The statements of personnel who were involved in the fire fighting and rescue operation are as follows (see attached figure 1).

(1) Emergency notification and request for dispatch

At 1208, an Air Traffic Controller of the Airport Office requested, via an emergency telephone call, an officer of the Fire Fighting Division and an Air Traffic Information Officer (hereinafter referred to as "the Information Officer") to dispatch fire services for the accident, in which fire had broken out.

Following the emergency notification network chart, the officer of the Fire Fighting Division requested the assistance of the airport police station, the City Fire Department, and the Fukuoka Prefecture and City Medical Association.

Also following the emergency notification network chart, the Information Officer requested the assistance of the west regional division's headquarters of the Air Self Defense Force, the 4th division's headquarters of the Ground Self Defence Force, the Fukuoka Prefecture Police Department and the airport base of the Maritime Safety Agency.

At 1208, upon receiving notification of the accident made by the airport helicopter platoon and a 119 emergency telephone call, the City Fire Department issued a category I dispatch order, and at 1213, the order was switched to a category II (higher) dispatch order for a heavy aircraft accident.

(2) Mobilization of fire vehicles

At 1208, upon receiving the request, the Fire Fighting Division provided a commander vehicle, two large CFFVs, one high speed CFFV and one water supply wagon, and about 1225 provided an ambulance .

Under the category I and category II dispatch orders issued at 1209 and at 1213 respectively, the City Fire Department dispatched a total of 80 fire fighting and rescue vehicles and a helicopter to the scene, and at 1209 its airport branch provided one CFFV and one water supply wagon under the category I dispatch order.

At 1209, upon being notified from by soldier who had witnessed the accident, the Self Defense Force dispatched one fire fighting vehicle and one rescue vehicle to the site.

(3) Fire extinguishing activities

About 1213, the commander vehicle, two large CFFVs, one high speed CFFV and one water supply wagon dispatched by the Fire Fighting Division arrived at a maintenance gate of a power facility in the grassed buffer zone. One large CFFV commenced extending a hose line, and others tried to move toward the aircraft nose along the public road on the east side of the accident site, but were unable to do so due to a traffic jam and so personnel went to assist other fire fighting activities.

About 1214, one water pump truck and one light CFFV from the City Fire Department, and the fire fighting vehicle and rescue vehicle from the Air Self Defense Force Kasuga Base approached a point about 60 meters away from the aircraft's tailplane.

At around this time, flames and black smoke were issuing from cracks in the aft fuselage of the aircraft. Fire had also broken out under the fuselage and in the vicinity of the wings, from which locations white smoke was issuing.

Hose lines were extended and linked to the fire fighting vehicles which had been unable to approach the aircraft's resting place because of mud and had parked along the road outside the fence.

About 1218, the City Fire Department's water pump vehicle and the Air Self Defense Force Kasuga Base's fire fighting vehicle commenced discharging water onto the aircraft from the aircraft's aft left side.

Subsequently, fire fighting vehicles dispatched by the City Fire Department arrived one after another and commenced fire fighting activities.

About 1223, a CFFV from the airport branch of the Hakata Fire Fighting

Station and a large CFFV from the Fire Fighting Division which had completed the hose link commenced discharging water onto the aircraft from a south side position and a north side position of the aircraft respectively.

About 1228, the fire was brought under control and the smoke changed from black to white.

Subsequently, foam was discharged in order to cover the fuel which had escaped from the wings. The fuselage floor was destroyed by hammers so as to facilitate the fire fighting activities.

About 1420, as the forward cargo hold was being opened using an motorized cutter to extinguish fire in the hold, escaped fuel, ignited by sparks emitted from the cutter, burst into flame, but was soon extinguished.

About 1500, a large CFFV from the Fire Fighting Division discharged water onto the aircraft's nose.

About 1516, the high speed CFFV from the Fire Fighting Division began to discharge water onto the aircraft's tail. (The reason for why the two CFFVs from the Fire Fighting Division began to discharge water after 1500 was that a traffic jam around the scene hindered an appropriate positioning for fire fighting and personnel gave priority to assist other fire fighting activities)

About 1535, the fire was almost quelled and was completely extinguished at 1631.

(4) Aspect of Emergency Treatment

About 1215, an emergency treatment camp was set up at a position in the grassed buffer zone near the maintenance gate for the power facility, and persons who had sustained injuries received first aid at the camp.

A total of 106 persons who had been injured, including the crew members, were first taken to the camp or the airport building and then transferred by ambulances to Kyusyu University hospital and 13 other hospitals.

2.13.2.3 Fire Fighting and Rescue Activities conducted by the Organizations Involved

(1) Immediately after the accident occurred, the airport office set up an "Accident Emergency Countermeasure Headquarters" with the Airport Office Administrator as its head and mobilized 58 employees through emergency call. The Airport Office also organized a "Fukuoka Airport Aircraft Rescue Unit" and conducted its activities using the following personnel, materials and equipment:

Personnel 387 persons (including 217 of the Rescue Unit and other airport personnel concerned)

Materials and equipment 15 vehicles (including an emergency medical treatment and transport vehicle)

(2) The west regional division of the Air Self Defense Force participated in the rescue and other activities by providing:

Personnel 146 persons

Materials and equipment 11 vehicles

With a request from the Airport Office Administrator for disaster dispatch immediately after the accident, the 4th division of the Ground Self Defense Force also participated in the activities by providing:

Personnel 219 persons

Materials and equipment 48 vehicles

(3) Upon receiving a request from the Airport Office, the Fukuoka City Fire Fighting Department participated in the activities by providing:

Personnel 431 persons

Materials and equipment 80 vehicles, a helicopter, and an air tent

(4) Three executives from the Fukuoka Prefecture and City Medical Association conducted medical treatment and rescue activities.

(5) The Fukuoka City Emergency Hospital Association administered first aid to the injured and conducted autopsies by providing:

Personnel 25 persons (consisting of 9 doctors and 16 nurses)

(6) The Japanese Red Cross Society conducted autopsies and administered first aid to personnel who were injured during the fire fighting and rescue activities.

Personnel 24 persons (consisting of 2 doctors, 6 nurses and 16 others)

(7) The Fukuoka Prefecture Police Headquarters conducted rescue activities and policed the site of disaster by providing:

Personnel 1,200 persons

(8) Upon receiving information from TV news, Two doctors from Fukuoka Medical NGO (volunteer disaster relief activists) were dispatched and conducted information-gathering activities.

(9) Immediately after the accident, Ministry of Transport established a "Garuda Indonesia Aircraft Accident Countermeasure Headquarters", with the Minister of Transport as its head. The ministry decided to spare no effort in taking care of the injuries, recovering the remains and keeping in close contact with the organizations involved.

2.13.2.4 Injuries to Fire Fighting and Rescue Personnel

Eighty four personnel suffered from inflammation of the skin, due to performing fire fighting and rescue activities for a long period with fuel which had escaped from the aircraft adhered to their skins.

2.14 Tests and Research to Find Facts

2.14.1 Investigation of Marks and Debris left on the Ground

(See attached figures 2 and 3, and photographs 1 through 4.)

(1) Marks left on the ground

Tire marks of the right and left main landing gears and the center gear started at a point on the runway approximately 2,270 meters from the threshold of runway 16 and traveled toward the end of runway 16.

The tire marks traveled approximately 590 meters, gradually veering to the right side of the runway and overriding the anchor chain of the jet barrier stretched at the right hand edge of the overrun zone by the right main gear, the nose gear, the center gear and the left main gear in that order. The tire marks then continued onto a grass field on the west side of the landing strip.

The grass field over which the aircraft had traveled was burnt in the shape of the letter "L" of a size of approximately 1 meter by 8 meters.

The ground tracks continued approximately 200 meters to the south, making furrows in the soft soil to a depth of about 10 to 20 centimeters. The ground tracks passed a point approximately 20 meters west of the LLZ (ILS localizer) facility and went across the airport internal perimeter road.

The ground tracks crossed over a drainage ditch about 5 meters wide adjacent to the south side of the perimeter road. Impact marks were found on the drainage ditch concrete wall.

Impact impressions consistent with a shape of the engine nacelles were found at two places on the concrete side of the public road, which had a height of about 70 centimeters, approximately 27 meters south of the drainage ditch.

The lower lip of the No.1 engine nacelle impacted the concrete side of the public road to a depth of approximately 25 to 30 centimeters; the width of the impact impression was approximately 1.5 meters. The No.3 engine impacted the concrete side of the public road to a depth of approximately 40 to 50 centimeters; the width of the impact impression was approximately 2 meters. Impact impressions consistent with the landing gears were found at three places on the side of the public road between the impact impressions of the No.1 and No.3 engines.

The airport perimeter fence, of a height of about 2.4 meters, was smashed down to the ground for a length of approximately 50 meters and partially torn off by the impact of the fuselage and wings.

Scrape marks caused by the engine cowlings, the landing gears and so on were observed crossing the approximately 24 meter wide four-lane asphalt concrete road perpendicularly.

Impact impressions, about 2 meters and 3 meters in width respectively, were found at two places on the south concrete side of the public road.

The fuselage sliding track, about 20 to 30 meters wide, traveled approximately 300 meters in the grassed buffer zone, slightly curving to the left, up to the point where the aircraft finally came to rest.

The aircraft resting point was approximately 1,150 meters from the first tire marks on the runway and approximately 620 meters from the threshold of runway 34.

(2) Debris distribution

The distributions of major debris detached from the aircraft were as follows.

① No debris from the airframe, the engines were found on the runway and landing strip zone.

② Distribution between the end of runway 16 and the runway side of the public road.

The right side door of center landing gear strut lay on the ground along the ground tracks.

③ Distribution in the vicinity of the public road

- Pieces of accessory gearboxes of the engines' lower side, engine cowlings, a tire and so on were found scattered.
- Local sooting was found on the fuel pump/control assembly of the No.1 engine and the fuel pump/control assembly and fuel filter of the No.3 engine; the grass in the area of this debris field was burnt.
- There were pipes which had been attached to the fuel pumps, which are assembled to the lower sides of the engines, accessories from adjacent to the fuel filters, pieces of cowling inner wall and so on. There was no evidence of fire on this debris.
- Oil and brown asphalt flakes from the pedestrian footpath were adhered to the leaves of small trees planted along the public road.

④ Distribution within the grassed buffer zone

- Debris detached from the aircraft, which are listed as follows, were scattered within an area about 40 meters wide and 150 meters long south of the public road.

  The No.1 engine
  Skins of the underside of the fuselage
  Landing gears
  Right and left inboard flaps
  Pieces of the No.1 and No.3 engine fan/core cowling etc.
  Pieces of cargo containers and freight
  Tips of the left horizontal tail
  Cabin window panels
  Pieces of window frames
  Pieces of the blue-painted right side skin of the No.2 engine air inlet duct
  Pieces of cabin interior materials and passengers' luggage

- The right landing gear strut, to which part of the skin of the underside of the wing and its fittings were still assembled, had separated from the wing. The fitting and strut were partially stained with blue paint.

(3) State of Damage to the Aircraft at the Resting Point

The aircraft was resting on a grass field on a heading of 80 degrees magnetic. Fire consumed the fuselage from the central portion through the aft portion.

The No.1 engine was detached from the wing.

The forward part of the No.3 engine's right-hand side was pressed against the ground; the pylon was twisted inboard. There was evidence of a fire on the inboard side of the No.3 engine.

The thrust reverser actuators of the No.1 and No.3 engines were in the deployed position.

The thrust reverser of the No.2 engine was in the deployed position, and pieces of pebbles and metal shavings had accumulated on the inside of the thrust reverser cascades. There was a hole measuring approximately 2 meters by 3 meters in the right side of the No. 2 engine's air inlet duct.

The right wing leading edge had many dents which it had sustained on smashing into the airport perimeter fence. Pieces of fence wire remained wrapped around the right wing.

The right and left main landing gears and the right and left inboard flaps were detached.

Dents and rubs were found on the fuselage right-side skin above the 3rd-from-aftmost cabin window, and score marks (in upward, slantwise and aft directions) and cracks were noted on the fuselage right-side skin under the 6th-from-aftmost cabin window.

The cargo compartment, cabin floor and fuselage crown were almost completely burnt off between STA 1381 and STA 1801; the skin, frames and stringers of the underside of the fuselage between these stations survived.

The left horizontal tail was torn off at its midspan. There was damage to the leading edge and underside of the right horizontal tail and the trailing edge of the right elevator.

Cabin doors 1R, 2R, 1L, 2L, 3L and 4L were completely open. The 3R and 4R doors were slightly open.

The slide/rafts of the 1R, 2R, 1L, 2L, 3L and 4L doors were deployed.

About 16 tons of fuel remained in the wing fuel tank; of approximately 62 tons of fuel the aircraft had originally loaded, about 46 tons of fuel escaped and burnt off.

2.14.2 Indications of Major Instruments and Positions of Switches and Levers in the Cockpit.

The following are the findings of the post crash investigation into the instruments and positions of switches and levers in the cockpit. These findings, however, do not necessarily represent the indications and positions at the time of, or just after, the accident since the indications and positions could have been moved at the time the flight crew members evacuated or by shocks during the overrun sequence.

(1) Indications of Airspeed Indicators (ASIs)

Airspeed Indicator	L/H seat (Captain)	R/H seat (First Officer)
ASI Needle	106 knots	104 knots
White Bug (V_1)	147 knots	147 Knots
Red Bug (V_2)	171 knots	170 knots

Note : Setting a bug to V_R is not specified in the operation procedures for model DC-10-30 aircraft of Garuda Indonesia.

(2) Engine Fire Handles

All three levers were in the AGENT position (ready position for discharging extinguishing agent).

Note : The fire extinguishing equipment of the No.3 engine was burnt off, and the fire bottle was empty. The fire extinguishing equipment of the No.1 and

No.2 engines were not in actuation.

(3) Fuel Levers

All three levers were in the OFF position.

(4) Throttle Levers (TL) and Thrust Reverser (TR) Levers

NO.1 TL lever	FULL FWD	TR	lever	STOW
NO.2 TL lever	IDLE	TR	lever	1/3
NO.3 TL lever	IDLE	TR	lever	STOW

(5) Evacuation Signal Switch

ARM, COMMAND ON (GUARD OPEN).

(6) Flap Handle

Approximately 9° .

(7) Stabilizer

FULL NOSE UP position; the stabilizer angle was approximately 5.6° ANU.)

(8) Emergency Power Switch

ON position.

(9) Emergency Light Switch

ARM position.

(10) Spoiler Lever

GROUND SPOILER.

(11) Flight Directors

Captain side FD

Co-Pilot side FD

(12) Autothrottles

No.1 OFF

No.2 OFF

(13) Autopilots

No.1 OFF

No.2 OFF

2.14.3 Disassembly Inspection of the Engines

(1) No.1 Engine

The engine was disassembled down to each module.

① Small score marks were noted on the stator vanes and blades of the Low Pressure Compressor (LPC), but none were fractured.

② Dents, losses on edges and bends were observed on all of the stator vanes and blades of the High Pressure Compressor (HPC), but none of the vanes or blades themselves were fractured.

③ There was no noticeable damage to the combustor and fuel nozzles.

④ With the exception of dents, score marks and adherence of fine metal splatter, there was no noticeable damage to any of the turbine blades and nozzle guide vanes of the High Pressure Turbine (HPT) module.

⑤ The Low Pressure Turbine (LPT) blades were bent in the direction opposite rotor rotation, but had no significant other damage.

(2) No.2 Engine

The HPC, IPT and HPT modules were removed.

① There were score marks, dents and small losses on the stator vanes and blades of the LPC and HPC.

② There was no noticeable damage to the combustor and fuel nozzles.

③ Small dents, score marks and adherence of fine metal splatter were noted on all of the blades and nozzle guide vanes of the HPT and LPT, but the extent of the damage was negligible compared to that of the No. 1 engine.

④ Cracks were noted on the gearbox housing of the gearbox module.

(3) No.3 Engine (See attached photographs 4-5 through 4-7)

The engine was disassembled into to the fan, HPC, HPT and LPT modules, and additionally the fan and HPT modules were disassembled into to parts.

① There was evidence of a bird strike on 17 of the 38 fan blades, but no clear evidence of any bird strike related damage to the blades.

② There was evidence of a bird strike on all of the LPC stage 1 blades, but no clear evidence of any bird strike related damage to the blades.

③ Rub marks consistent with compressor case contact at high revolution were noted on blade tips of HPC stages 2 through 5, but the extent of damage to blades and stator vanes was the least among the three engines.

④ Sooting was noted on the left side of the combustor inner wall, which had no noticeable damage.

⑤ Fine metal splatter were noted adhering to all of the HPT stage 1 nozzle guide vanes, which were missing their trailing edges. All 80 of the HPT stage 1 blade airfoils were fractured at the root or at the midchord of the airfoils and severely blackened. The extent of the damage to the HPT module was the greatest among the three engines.

⑥ Evidence of metal fatigue was found on the fracture surface of one of the HPT stage 1 blade airfoils. Further details are given in section 2.14.4.

⑦ All of the HPT stage 2 blades and nozzle guide vanes were fractured and severely burnt.

⑧ Dents and many missing portions were noted on the inner walls of HPT rotor shrouds, but the extent of the damage was not as severe as that of a burst-out of fractured turbine blades.

⑨ The number 5 bearing inner race, which is located at the trailing edge of HPT disk aft shaft, was worn; the deepest wear was approximately 3 millimeters in depth.

⑩ Deformation, missing parts and a large amount of sooting were noted on all of the LPT nozzle guide vanes and blades.

⑪ Metal splatter were noted adhering to the LPT stage 4 blade surfaces.

(4) Engine Accessories

Disassembly inspection of the Main Engine Control units of the No. 1 and No.3 engines revealed impact marks on the surface of the 3-D cams.

2.14.4 Damage to the HPT Stage 1 Blade Airfoil of the No. 3 Engine

(See figure 7 and photographs 4-5 through 4-7)

(1) The airfoil of one of the No.3 engine HPT stage 1 blades, blade No.74 (P/N: 9299M30G05, S/N: KTWJ0073), had separated outboard of the blade platform, in a plane 12 millimeters above the platform at the leading edge and 5 millimeters above the platform at the trailing edge. Close inspection of the fracture surface revealed intergranular oxidation (IGO) along crystalline metal grain boundaries in the walls of airfoil trailing edge (No. 8) internal cooling air passage.

A fatigue crack caused by IGO-related corrosion, approximately 15 millimeters long, propagated from one of the internal wall origins, through the airfoil wall, and along the concave side of the airfoil.

The blade had accumulated 28,501 hours of time in service since new (TSN) and 4,894 cycles in service since new (CSN) at the time when the blade was assembled to the No.3 engine in December, 1994.

The engine was subsequently assembled to the accident aircraft (DC-10-30, PK-GIE) on January 25, 1995. The blade had accumulated 30,913 hours TSN and 6,182 cycles CNS at the time of the accident.

Note 1 : IGO

Crystalline metal materials are vulnerable to oxidation when exposed to a high temperature oxidizing environment. When the oxidation proceeds preferentially along the grain boundaries, this is referred to as intergranular oxidation (IGO).

Note 2 : Cycles in service

One cycle in service is defined as one flight leg from takeoff to landing.

(2) All of the No.3 engine's HPT stage 1 blades were of the P/N 9299M30 GXX configuration; part number suffixes G02, G03, G05, G08, G09 and G10.

These HPT blades were not the improved blade configuration with a coating applied to the internal cooling air passages. (Refer to paragraph 2.14.5.)

Note: These HPT blades had been replaced at different times or by different service bulletins (SB) and so, with the exception of the 9299M30G11, HPT blades with P/Ns differing in the last two digits had been incorporated.

2.14.5 Actions taken by General Electric Company

The records of the General Electric Company (GE) indicate that the CF6-50 series engines, the same type of engine as that on the aircraft, had experienced 21 events of IGO-related HPT stage 1 blade airfoil separations resulting in engine power loss worldwide between October 9, 1990 and April 30, 1996.

Responding to these events, GE took the following action.

(1) GE issued service bulletin SB72-1007 on December 14, 1992, which released an advanced blade (P/N 9229M30G11) with an oxide coating applied to the internal cooling air passages in order to improve the lifespan of the HPT stage 1 blades.

(2) In November, 1993, GE disseminated a "CF6 Fleet Highlites" article to advise operators of specific information on blade airfoil separation. While noting the availability of the improved HPT blade (P/N 9299M30G11), the article recommended operators to implement a management system to replace HPT blades on the basis of total cycles in service since new.

(3) On June 16, 1994, GE disseminated AOW (all operators wire) 94-50-07 advising operators of the following:

"The purpose of this wire is to advice you that GE is recommending the retirement of high-cycle CF6-50 stage 1 Product Improvement Program (PIP) HPT blades (9299M30 GXX other than G11 configuration).......... GE feels a 6,000 CNS should be considered in a control program for blade retirement.........."

(See appendix 4-1.)

(4) In July, 1994, "CF6 Fleet Highlites" was issued, containing the same contents as item (3) above.

(5) In May and June, 1996, GE called its customers together in a Regional Meeting to explain the "CF6-50/-80A HPT Stage 1 Blade Program", in which it gave examples of IGO-related blade airfoil separations and specific measures to preclude the events. (See appendix 4-2.)

3 ANALYSIS

3.1 General

3.1.1 The flight crew had valid airmen proficiency certificates and valid airmen medical certificates.

3.1.2 The aircraft had a valid airworthiness certificate.

3.1.3 It is estimated that the weather at about the time of the accident was not a contributing factor.

3.2 Analysis of the Flight

3.2.1 Flight Sequence of the Aircraft

Based on the DFDR data, CVR transcription, etc., the AAIC has analyzed the flight sequence of the aircraft as follows. (See appendices 1 and 2.)

3.2.1.1 Flight Sequence before the Occurrence of the No.3 Engine Failure

Pre-takeoff checks such as the "BEFORE STARTING CHECK", "TAXI OUT CHECK", etc. were performed in the cockpit. The following takeoff data were confirmed, and no inadequacy was found in these data.

Takeoff weight	211.3 tons	
Fuel loading	62,000 kg	
V_1	149 knots	(RUNWAY DRY)

V_R	157 knots
V_2	171 knots
Engine N_1	113.6 %
Flap setting	9°
Stabilizer Trim setting	5.5°

The FE conducted a fuel transfer while the aircraft was parked in order to balance the difference in the amount of fuel between the right and left wing fuel tanks.

The aircraft slowly entered the takeoff runway, aligned almost with the runway center line at about 1207:03 (the aircraft assuming a heading of 152.4°) and commenced the takeoff roll, accelerating along the runway for takeoff. Subsequently, the thrusts of all three engines reached takeoff power at about 1207:14.

The FE called "Rata, rata" at about 1207:18. The Indonesian language phrase "Rata, rata" is estimated to mean that the indications of the engine instruments were aligned and the throttle levers were in line with each other. (Note: The DC-10-30 to which the accident occurred was fitted with vertical strip type engine instrumentation.)

AP No.1 was engaged in CWS prior to commencing the takeoff roll, since the aircraft operation manual (AOM) of the subject airline specifies takeoff procedures with the AP in CWS mode. The autopilot CWS mode of model DC-10 type aircraft has functions to control the aircraft's motion in the pitch and roll axes through the control column, and reduces control column forces below those required when the AP is disconnected.

AP No.1 disconnected about at 1207:16 when the CAS reached 55.8 knots, and was soon re-engaged in CWS. After this, AP No.1 disconnected again when the CAS reached 99.5 knots and AP No.2 was engaged in CWS shortly after the FO's call indicating 100 knots airspeed was made. The investigation revealed that the AP lever was in a condition such that it was likely to be rendered OFF by vibrations of the aircraft. Further, although the AOM specifies not to re-engage the AP in case of an auto-disconnect during takeoff, re-engagement was repeated. This action, however, was not a factor in the accident.

Analysis of the CVR transcriptions revealed that no sound warning of AP disengagement had been recorded on the CVR. This is because the AP specifications of Garuda Indonedia include an annunciation light in the event of AP disengagement but exclude a warning sound.

At about 1207:29, the FE called "Dua aja" in the Indonesian language which supposedly means "Two (2) only". This call is considered to refer to the usage of AP No.2.

The FO called "One hundred" near 1207:26, indicating that the airspeed had reached 100 knots.

The FO called "V one" at about 1207:38, indicating that the aircraft had reached takeoff decision speed.

The N_1 values of all three engines were stable near 113 % even shortly after the V_1 call was made.

According to the evidence that the elevator angle and pitch attitude began to increase toward aircraft nose up at about the time that the CAS was near V_1, the CAP is estimated to have commenced rotation of the aircraft. The commencement of rotation was a little premature, but it is estimated that the premature rotation did not contribute to the accident.

The FO called "ROTATE" at about 1207:40, indicating that the aircraft had reached the rotation speed V_R.

It is estimated that although the right rudder had been repeatedly applied until about the time when the CAS reached 140 knots after the aircraft had commenced the takeoff roll, this would not have contributed to the accident because there was no tendency of any right rudder application after the CAS reached 140 knots.

Based on the estimation, as mentioned in paragraph 3.2.1.2, that the failure of the No.3 engine occurred at about 1207:41, there were no anomalies of the aircraft that contributed to the cause of the accident from the time the aircraft had departed spot No.5 until shortly after the FE called "ROTATE".

3.2.1.2 The Occurrence of the No.3 Engine Failure and the Aborted Takeoff

After its speed reached V_R, the aircraft was at the very beginning of liftoff at about 1207:41, when pitch attitude was 8.1°, RA was 0.0 feet and CAS had increased to 162.0 knots. It is estimated that the failure of the No.3 engine occurred at about this time.

Estimation of the time of failure of the No.3 engine is based on the evidence that the N_1 of the No.3 engine, which the DFDR indicates as having been at 112.8% at about 1207:39, decreased to 53.3% at about 1207:43, and that the longitudinal acceleration of the aircraft decreased from 1207:41 through 1207:42.

An anomalous sound was produced, presumably by the No.3 engine, from about 1207:42 through about 1207:43.

It is estimated that the anomalous sound was caused by abnormal combustion and compressor stall, which resulted from the fracture of the HPT blade and associated secondary damage inside the engine.

From about 1207:42 through about 1207:43, control actions were taken to correct the right yaw and right roll resulting from the loss of thrust from the No.3 engine.

From since the "ROTATE" call was made until about 1207:42, pitch attitude had been increasing with a normal rotation rate of approximately 3 degrees per second. Deflections in the elevator angle between about 1207:38 and about 1207:41 are estimated to have been consistent with moving control surfaces to maintain a constant rate of increase of pitch attitude.

The CAP applied elevator inputs to the control column to make the aircraft pitch down in an attempt to abort the takeoff. Responding to the elevator inputs, pitch attitude began to decrease with a slight time lag and a little later the RA began to decrease after it reached its peak value. According to the changes in the RA and pitch attitude described below, it is estimated that the CAP commenced actions to abort the takeoff at about 1207:43. (Refer to appendix 2.)

(1) RA reached its peak of 9.0 feet at about 1207:44 and subsequently decreased.

(2) Pitch attitude reached its peak of 11.4° at about 1207:43, one second earlier than the RA reached its peak value, and then decreased.

The time that the CAP commenced actions to abort the takeoff could not be estimated from the examinations of the elevator angle because the angle had been fluctuating subtly, presumably to adjust pitch attitude.

The elevator angle temporarily increased to 6.1° at about 1207:44. This is considered to be the result of corrective actions to the elevators in order to prevent the nose landing gear from re-contacting the runway first.

Vertical G decreased from about 1207:43 through about 1207:44 as a result of the commencement of the abortion of takeoff, and CAS increased to 167.3 knots at about 1207:44 and continued to increase until shortly after the aircraft re-contacted the runway.

At about 1207:45, the N_1 of the No.1 engine, as recorded on the DFDR, decreased to 109.3% and a sound recorded on the CVR is presumed to have been made from the throttle levers hitting the idle position stop. From this evidence, it is estimated that the CAP's action to retard the throttle levers to idle had been completed by this time.

At about 1207:45, the FE called "Engine failure number one", mistaking the No.1 engine for the No.3 engine, but the call was made after the CAP had commenced actions to abort the takeoff.

Given that the CAS and RA continued to increase from about 1207:41 when the No.3 engine failure occurred and reached 164.0 knots and 5.4 feet respectively at about

1207:43, presumably when the CAP commenced actions to abort the takeoff, it is estimated that the aircraft would have soon reached takeoff safety speed V_2 and attained flight performance which would have enabled it to continue the climb had the takeoff not been aborted.

3.2.1.3 Flight Sequence after Recontact with the Runway until the Aircraft came to rest

The aircraft, which had lifted off, re-contacted the runway at about 1207:46 with large transients of vertical G, which recorded a maximum value of 2.1 Gs.

AP was No.2 disconnected at about this time, presumably by a function which automatically disconnects the AP if vertical acceleration in excess of 2.0 Gs is detected.

The aircraft was braked such that the foot brakes were applied promptly at the time of recontact with the runway, and subsequently the thrust reversers were deployed though the reverse thrust of the No.3 engine was not powered, and ground spoilers were extended.

After recontacting the runway, the aircraft continued traveling, leaving tire marks which veered gradually to the right from the runway center line.

At about 1207:54, when the aircraft was about to run over the jet barrier's right side anchor chain, the words "WUALA STOP" were yelled in the cockpit. The meaning of the words approximates to "Ooh, Stop" in English.

The CVR and DFDR stopped recording at about 1207:56, at which time the aircraft's location is estimated to have been in the vicinity of the public road south of runway 34.

Observations of the ground tracks indicate that the aircraft, which had run over the jet barrier anchor chain, passed to the west of the ILS localizer antenna (which had previously been in front of the aircraft), crossed the public road and entered the grassed buffer zone.

Observations of the subsequent ground tracks indicate that the aircraft slid on its belly on the field within the grassed buffer zone, yawing to the left.

The aircraft finally came to rest approximately 620 meters from the threshold of runway 34 on a heading of 80 degrees magnetic and caught fire.

3.2.2 Crew Coordination

Although it is recognized that the FE should have identified anomalies of the aircraft and called "ENGINE FAILURE" correctly and at an earlier time, and that adequate crew coordination should have been made in an attempt to continue the takeoff, there were no indications of the above behaviors on the recordings of either the DFDR or the CVR.

Additionally, the following examples indicate that the flight crew did not comply with the procedures specified in the BOM and AOM, and it is estimated that there would have been inadequate crew coordination in the cockpit.

(1) A call "TAKE OFF", which the CAP is required to make at the beginning of the takeoff roll, was not recorded on the CVR.

(2) When an AP is engaged in CWS, the CAP should command "SET CWS 1" or "SET CWS 2" and the FO should call "SET CWS 1" or "SET CWS 2" after engagement. Furthermore, a call "AUTOPILOT OFF" should be made when the AP disconnects. Neither call, however, was recorded on the CVR for either the repeated engagements of the AP in CWS mode and or the disconnections.

Although the AOM specifies not to re-engage the AP in case of an auto-disconnect during takeoff, the reengagement was repeated. Following the procedures of the AOM, the AP should not be re-engaged, but if the AP is to be re-engaged, a "COMMAND" from the CAP is required. A call representing such command word, however, was not recorded on the CVR. Additionally, no FO's call advising the CAP (the pilot flying) of AP reengagement was recorded on the CVR.

(3) Rejection of takeoff is to be initiated by the CAP calling "STOP". That call, however, was not recorded on the CVR.

(4) The AOM refers to "ENGINE FAILURE" as an example of a call upon occurrence of engine failure, but the FE called "Engine failure number one", mistaking the No.1 engine for the No.3 engine.

3.2.3 The Abortion of the Takeoff

3.2.3.1 Flight Aspect until the Takeoff was aborted

It is estimated that the flight aspect until the takeoff was aborted was as follows:

(1) Except for the failure of the No.3 engine, there were no other anomalies which contributed to the accident.

The No.3 engine failure occurred when the aircraft had accelerated to well above takeoff decision speed V_1 (149 knots) and had begun to lift off after exceeding rotation speed V_R (157 knots).

(2) About two seconds after the failure of the No.3 engine occurred (CAS was 164.0 knots, RA was 5.4 feet), the CAP commenced actions to pitch the aircraft down in an attempt to abort the takeoff, and about two more seconds later (at which time the CAS was 170.5 knots and the RA was 5.9 feet), he retarded the throttle levers to the idle positions.

3.2.3.2 Manuals with respect to the Rejection of a Takeoff

The manuals of GIA relating to operations consist of the BOM and the AOM. The AOM states that the rejection of a takeoff at high speed can be extremely hazardous and that therefore takeoff should only be rejected in the case that continuation is considered less safe. Additionally, the AOM describes that the decision to reject may only be made before V_1. (See appendix 3.)

Furthermore, although the BOM states "·····above a speed specified in the relevant AOM, ····· rejection of takeoff, should be confined to circumstances where a very positive loss of thrust occurs or where aircraft condition clearly renders it unflyable.", it also states before this sentence that "a rejection of a takeoff on a marginal runway, from high speed close to V_1, in particular when the runway is wet, can be extremely hazardous." Therefore, it is considered that the rejection of a takeoff at speeds exceeding V_1 is basically not assumed in the manuals.

3.2.3.3 The CAP's Situation Awareness etc.

As mentioned above, it is considered that the AOM and BOM of the subject airline do not assume the rejection of a takeoff after airspeed exceeds V_1. However, in this accident the CAP commenced actions to abort the takeoff at around the time when the CAS was almost 15 knots higher than V_1 and after it had exceeded V_R.

Except for the failure of the No.3 engine, there were no anomalies of the aircraft up until the time of the accident that contributed to the cause of the accident. The CAS had reached approximately 162.0 knots, 13 knots higher than V_1, and the RA was 0.0 feet near the time when the failure of the No.3 engine occurred; subsequently the CAS and RA continued increasing little by little up to 164 knots and 5.4 feet respectively at about the time when the CAP commenced actions to abort the takeoff. It is estimated that the aircraft would have reached takeoff safety speed V_2 (171 knots) and attained such flight performance that it could have continued the takeoff, despite flight performance being degraded compared with the all engines operative condition.

Based on the aforementioned circumstances, the takeoff should have been continued from the viewpoint of aircraft operation as well as under the procedures described in the AOM and BOM of the subject airline; however, an inadequacy in the CAP's situation awareness at the time of the failure of the No.3 engine led him to abort the takeoff near the time when the CAS had reached approximately 164.0 knots, 15 knots higher than V_1, and the RA was 5.4 feet.

As background to the fact that the CAP aborted the takeoff, insufficient practical flight training for the pilots may have existed, as set forth in the following paragraph. This was likely to have affected the CAP's decision to abort the takeoff.

Subsequently, the aircraft re-contacted the runway after the RA had reached 9.0 feet, departed the runway, came to rest and caught fire.

3.3 Type Recurrent Training and Crew Proficiency Training for Flight Crew

3.3.1 Requirements of Type Recurrent Training and Crew Proficiency Check

Garuda Indonesia had compiled a Flight Crew Training Manual (FCTM), under which the Type Recurrent Training (TRT) and Crew Proficiency Check (CPC) for flight crew have been implemented. The FCTM was compiled in accordance with the Indonesian Civil Aviation Safety Regulations, which require an operator to establish a training and checking program for flight crews including two periodic checks in each calendar year.

The FCTM establishes the TRT and CPC that must be periodically carried out by flight crews based on their aircraft type rating.

GIA had carried out the TRT and CPC in combination during the same period; the records relating to the CPC had been retained but the records of the TRT, including an instructor's remarks, had not been retained.

3.3.2 Implementation of Type Recurrent Training (TRT)

In the 12 months leading up to the accident, two TRT procedures were published by GIA. One of these included an item that requested briefing (discussion) concerning "Rejected T/O close to V1 in cold weather operation" but it is not clear whether or not the item was carried out since the training records of the TRT for each flight crew member were not retained.

Further, the above two TRT procedures did not provide an practical flight training item covering the continuation of a takeoff in case a failure of one engine occurring after V_1 during a takeoff roll; it is therefore estimated that this sort of practical flight training was not carried out.

3.3.3 Implementation of Crew Proficiency Check

The biannual CPCs for the flight crew of the aircraft had been implemented as follows in the 12 months prior to the accident.

The CAP : June 17 and December 7, 1995

The FO : August 1 and December 6, 1995

The FE : July 11 and November 11, 1995

The flight crew had each received one of the above two CPCs by an actual aircraft, and the other by a simulator.

Each CPC, implemented in the 12 months prior to the accident, established an item regarding rejected takeoff (RTO), but according to the training records, the FE had received the item just once, by an actual aircraft, on July 11 ,1995 and the CAP and FO had never received the item at all.

The training file included items of "Take off : eng. failure" and "V_2 climb and clean up", and a record in the training file showed that all of the subject flight crew received these items at every CPC. But because a record concerning the specific contents has not been retained, it is not clear whether the items simulated an engine failure shortly after V_1 or not.

3.3.4 Importance of Flight Training and Proficiency Check

Considering that a pilot's decision-making and control perception in the case of aircraft anomalies during the takeoff roll are cultivated and maintained through flight training and experience of operation, flight training and proficiency checks play an important role in allowing pilots to deal adequately with various emergencies.

However, each flight training session received by the flight crew in the 12 months prior to the accident did not contain practical flight training item covering the situation of a failure of one engine during the takeoff roll after V_1.

3.4 Damage to the Aircraft

3.4.1 Damage to the Aircraft

(1) It is estimated that the damage to the lower surface of the fuselage in the vicinity of the wing root, the two cracks in the aft portion of the fuselage in the vicinity of the 30th and 35th seat rows, damage to all landing gears, damage to all engines (excluding the interior of the HPT of the No.3 engine), and damage to the LH and RH wing trailing edges and the LH and RH horizontal stabilizers were sustained when the aircraft departed the runway, impacting the side wall of the drainage ditch and the side of the public road, and when and after the aircraft entered the grassed buffer zone.

(2) Considering the conditions of the damage described in item (1) above and the distribution of the debris, it is estimated that the damage to the RH aft portion of the fuselage between the 3rd- and 6th-from-aftmost cabin windows, corresponding to the 34 ~ 35 th row seat area, was sustained when the RH main landing gear was detached at its fitting, bouncing and hitting the fuselage.

Furthermore, it is estimated that the landing gear bounced and impacted the RH side structure of the No.2 engine air inlet duct, damaging the duct and the engine.

3.4.2 Outbreak of Fire and Extinguishing of Engine Fire

(1) Considering the fact that traces of fire were observed on the detached fuel pumps etc. but not on the accompanying pipes etc., it is estimated that sparks, generated when the aircraft impacted the side of the public road, ignited leaked fuel, causing the fire.

(2) Considering the fact that the traces of the aircraft fire after it came to rest were most conspicuous at the RH and LH wing roots and the center portion of the fuselage, it is estimated that fire already in existence ignited fuel leaking from the AUX fuel tank and the fuel pipe running down the LH side of the fuselage to the No.2 engine, resulting in the burning out of the center portion of the fuselage.

(3) The cargo freight had consisted of machine parts, irons, sewing machines, foodstuffs etc., and it is estimated that no particularly flammable or easily ignitable freight had been on board.

(4) Although all of the three engine fire handles in the cockpit were in the "AGENT" position, the fire extinguishing bottles of the No.1 and No.2 engines had not activated and it was impossible to determine whether or not the fire extinguishing bottle of the No.3 engine had activated because it was burnt. Moreover, since the electrical power supply had been stopped, it is estimated that even if the engine fire handles had been actuated, the engine fire extinguishing system would not have activated.

3.4.3 Stoppage of Electrical Power Supply

(1) It is estimated that the generators of the No.1 and No.3 engines stopped supplying electrical power when the aircraft impacted the side of the public road.

Judging from the condition of the damage, it is estimated that the accessory gearbox of the generator of the No.2 engine was damaged by the impact which was brought about when the aircraft entered the grassed buffer zone, and at this point in time the generator of the No.2 engine stopped generation of electrical power.

(2) It is estimated that the entire lower portion of the fuselage and the support structure of the aircraft's main battery were deformed by impact when the aircraft hit the side of the public road or entered the grassed buffer zone, and that electrical power supplied from the battery stopped at this point in time.

3.4.4 Fuel Spillage

Judging from the condition of damage to the fuel piping and fuel tanks, it is estimated that part of the loaded fuel escaped from the tanks while the aircraft was sliding on the grassed buffer zone.

3.4.5 Loss of Hydraulic Pressure

It is estimated that hydraulic pressure was lost when the engine-driven hydraulic pumps impacted the side of the public road or when the aircraft entered the grassed buffer zone.

3.5 Analysis of Engines

3.5.1 Causes of the Failure of the No.3 Engine etc.

Based on the disassembly inspection of the engines, it is recognized that the damage to the No.3 engine was caused by the IGO-related fatigue fracture of an HPT stage 1 blade and the resulting secondary damage to the engine interior. It is recognized that the other engine damage was caused by secondary factors arising after the takeoff was aborted.

The fact that there was no trace of rupture of the casing of the No.3 engine compressor and turbine, which would have resulted in a blowout of high temperature and high pressure gas, is consistent with the fact that the fire warning by a sensor located on the outside of the casing had not been activated, and consequently no fire warning sound was recorded on the CVR.

Traces of bird strikes were noted on the fan blades of the No.3 engine, but were negligible. It is therefore estimated that bird strikes had no influence on the failure of the engine.

Garuda Indonesia had been conducting borescope inspections at 150 flight hour intervals in accordance with the maintenance manual approved by the Indonesian authorities. According to the maintenance record, the latest borescope inspection of the No.3 engine HPT stage 1 blades was conducted on May 26, 1996 and no anomalies were found.

Since IGO-related fatigue cracks develop from the inner walls of the blades' cooling air passages, they are difficult to detect by borescope inspection.

3.5.2 Measures to prevent Damage to HPT Blades

General Electric had notified each customer of an improved turbine blade to prevent IGO-related failure of the HPT stage 1 blades and to avoid high future maintenance costs, and recommended a management system for blade cumulative cycles in service with soft time, which would allow customers to work out individual discard plans with approximately 6,000 cycles as a standard.

Garuda Indonesia had conducted on-wing maintenance of GE CF6-50 engines, while off-wing factory maintenance as well as technical judgments on the handling of engineering information etc. had been contracted out to KLM Royal Dutch Airlines (KLM).

Further, GIA had a pooling contract with KLM on the factory maintenance of CF6 engines. KLM also had a pooling contract with several other foreign airlines, and engines were shared for common use among the pooling contract partners. The previous user of the No.3 engine of the aircraft was not GIA.

Based on the results of a technical investigation within the company and the soft time management system recommended by the GE, KLM decided on a company policy on July 31, 1995 to build in HPT stage 1 blades of which total cycles in service were less than 6,000 cycles at the time of installation in the factory, even if the total cycles in service could exceed 6,000 cycles during operations.

The No.3 engine of the subject aircraft was sent to the engine maintenance plant of KLM for factory maintenance on November 4, 1994, and its maintenance was completed in December 1994. KLM's policy as mentioned above was established after the maintenance of the subject engine had been completed and installed on the aircraft. Although the total cycles in service of the HPT stage 1 blade which had fractured due to IGO-related metal fatigue in this accident had been 4,894 cycles at the time of the build-in, it had reached 6,182 cycles at the time of the accident.

3.5.3 Coordination between Maintenance and Operations Organization

The factory maintenance of the engines of the subject aircraft had been contracted out to KLM in accordance with the pooling contract. According to the maintenance policy of KLM as mentioned above, even if the total cycles in service of HPT stage 1 blades was expected to exceed 6,000 cycles during service, the blades were supposed to be built into an engine during engine assembly at the factory as long as the total cycles in service were less than 6,000 cycles at that time. Accordingly, it could have been forseen that there was the possibility that the total cycles in service of the HPT stage 1 blades would have exceeded 6,000 cycles, the discard cycle recommended by GE, while the engine was in service.

It is considered that within GIA as an operator, the maintenance organization should have provided the operation organization with such information that: Events of HPT stage 1 blade failures had occurred frequently worldwide; that GE had issued relevant SB and AOWs on this subject; and that the total cycles in service of the HPT stage 1 blades could have exceeded 6,000 cycles with a risk of their failure in operation as long as they complied with the maintenance policy of KLM, to whom maintenance of a removed engine was contracted out. It is also considered that the operations organization, responding to this, should have informed pilots of the pertinent information and improved practical flight training programs to take into consideration engine failure cases. It is, however, estimated that there had been a lack of such coordination among the organizations involved.

3.6 Emergency Evacuation

3.6.1 Emergency Evacuation Training for Flight Crews

There were no rules for evacuation training for flight crews in GIA's FCTM (Flight Crew Training Manual), and thus it was not possible to determine the training syllabuses and training records.

3.6.2 Emergency Evacuation Training for Flight Attendants

(See appendix 3.) Flight attendants were required to undertake emergency evacuation training once a year per type of aircraft on which they are qualified, and it is estimated that the flight attendants who were on duty at the time of accident had taken the training as described in paragraph 2.5.2.

As for training, a RECURRENT TRAINING SYLLABUS had been specified in the Flight Attendant Manual, and records for classroom training and practical training had been retained.

3.6.3 Estimated Time required for Emergency Evacuation

According to the VTR recordings which a passenger had taken after evacuating the aircraft, the time of evacuation of the passenger who was recognized to be the last to be evacuated was about 1210:00.

The time when the aircraft came to rest was estimated to be at about 1208:10, and so the time required for the evacuation was estimated to be approximately 2 minutes.

3.6.4 Situation in which Emergency Evacuation was conducted

(1) It was not clear whether all emergency lights in the cabin (ceiling lights, "Exit" markings, door lights, floor path-marking lights for evacuation) were illuminated or not. Failure of any lights to illuminate is estimated to have been caused by broken wires etc. resulting from the damage to the aircraft due to the impacts until the

aircraft came to rest.

It is estimated that evacuation was interfered with by various events in the cabin such as the fall-down of ceiling panels, a flow-out of carts, ovens and containers from the galleys, dropping of luggage from the overhead bins, cracks in the fuselage and the cabin filling with smoke due to fire, resulting from the impacts until the aircraft came to rest.

(2) According to the Flight Safety Manual of the subject airline, although the CAP must call "EVACUATE AIRCRAFT" to the flight attendants and passengers at the time of evacuation, it is estimated that he was unable to do so because the public address system was unserviceable due to the loss of supply of electrical power. Furthermore, although the AOM of the subject airline specifies that the flight crew must assist passengers in evacuating the aircraft in accordance with the company's AOM, it is estimated that they could not enter the cabin to assist the evacuation of passengers because ovens etc. had flown out of the galley located by the aisle behind the cockpit due to the impacts until the aircraft came to rest, and blocked the cockpit door.

(3) With respect to the statements of many passengers describing that they had not received guidance from the cabin attendants or they did not realize that they had, it is likely that the passengers, almost all of whom were Japanese, did not fully understand the messages of some of the flight attendants due to the language barrier.

There was no evidence that the power megaphones and first aid kits, which were found in the cabin, had been used.

(4) Assuming the possibility that some passengers, after boarding the aircraft, did not listen to instructions given by the flight attendants as to the location of emergency exits etc., or that they did not read the pamphlet for emergencies ("SAFETY ON BOARD" in English and Indonesian) located in the back pockets of the seats in front of them, it is considered that some passengers might not have known the locations of the emergency exits at the time of evacuation and were confused.

3.7 Analysis of Casualties

3.7.1 Fatal

Based on the conditions of the damage to the aircraft, the distribution of the debris and the damage to the bodies, the following are estimated:

(1) It is estimated that the two passengers sitting in seats 34K and 35K were killed instantly by the strong shock resulted when a portion of the RH landing gear strut smashed the fuselage directly.

(2) It is considered possible that the passenger sitting in seat 35J was rendered unconscious after receiving a hard blow to the body during the overrun sequence, and was subsequently burned to death by the fire.

3.7.2 Injuries

(1) Serious Injuries

① It is estimated that the reason why ten passengers, who had jumped to the ground through a crack in the aft portion of the fuselage, suffered lumbar vertebra oppression fracture and/or leg fracture was because they had jumped from the cabin, approximately 3 meters above the ground, down to the ground where the soil was soft.

② It is estimated that the reason why two passengers, who evacuated through the 3L door and jumped to the ground from the left wing, suffered lumbar vertebra oppression fracture and/or calcaneal bone fracture was that they lost balance when they landed on the ground because they jumped from the wing from a height of approximately 1.3 meters above the ground with luggage.

③ It is estimated that the reason why four passengers, the CAP and the FO suffered fractures of the clavicula, sternum and coccyx, or whiplash etc. while on board was because they had received impacts when the landing gears and the lower lips of the engines collided with the public road and when the aircraft entered the grassed buffer zone after crossing the road.

(2) Minor Injuries

It is estimated that the minor injuries suffered by 151 passengers and the FE were bruises etc. caused by impact when the landing gears and the lower lips of the engines collided with the public road and when the aircraft entered the grassed buffer zone after crossing the road, or were scratches suffered during the emergency evacuation.

(3) Injuries sustained by Fire Fighting and Rescue Personnel

It is estimated that the reason that many fire fighting personnel and rescue personnel were injured is that they had been in excessive contact with fuel, with their clothes being wet by fuel as a result of conducting fire fighting and rescue operations at a site where a large amount of fuel had escaped, and that the first aid treatment to such injured personnel was delayed because of the fire fighting and rescue operation. Furthermore, contributing to such injuries it is also estimated that some fire fighting personnel and all of the rescue personnel did not wear protective garments because such garments were not part of their equipment.

3.8 Analysis of Fire Fighting Activities

3.8.1 Fire Fighting Service

Fukuoka Airport, administered by the Fukuoka Airport Office, has been an airport serving international scheduled flights, and it is recognized that it maintained a fire fighting and rescue service for Category 9 Airports, as recommended in Annex 14 ("AERODROME") to the Convention on International Civil Aviation, for the fire fighting and rescue activities.

3.8.2 Fire Fighting and Rescue Operations

The fire fighting and rescue parties arrived at the crash site at about 1214, and were engaged in escort and guidance for the evacuation of injured passengers as well as passengers who were taking care of injuries in the vicinity of the emergency evacuation slides.

The fire fighting party was also engaged in searching for passengers in the forward portion of the fuselage while the fire was being extinguished. The search of the aft portion of the fuselage is estimated to have been difficult because it was in flames. Eventually, three dead bodies were confirmed , one at about 1243 and two at about 1322, in the vicinity of the aft portion of the fuselage.

4 CAUSES

The causes of this accident were as follows.

Although the CAS was well in excess of V_1 and the aircraft had already lifted off from the runway, the takeoff was aborted. Consequently the aircraft departed the end of the runway, came to rest and caught fire.

It is estimated that contributing to the rejection of the takeoff under this circumstance was the fact that the CAP's judgment in the event of the engine failure was inadequate.

5 SAFETY RECOMMENDATIONS

As a result of the accident investigation, the Aircraft Accident Investigation Commission makes the following recommendations to the Indonesian civil aviation authority:

Require Garuda Indonesia to implement the following:

1 Reinforcement of flight training and proficiency checks for flight crew

Garuda Indonesia should reinforce the flight training and proficiency checks which allow pilots to make an adequate "go/no-go" decision in the event of aircraft anomalies, such as an engine failure, while the aircraft is performing a takeoff roll.

2 Improvement of emergency evacuation training and methods of guiding passengers

(1) Thorough implementation of emergency evacuation training

Garuda Indonesia should conduct emergency evacuation training for flight crew periodically and joint training with cabin attendants as necessary.

(2) Improvement of methods of guiding passengers

Garuda Indonesia should study effective measures against fire and smoke as well as methods of a guidance that can easily be understood by passengers so as to facilitate guiding them during an evacuation.

6 PROPOSALS

In view of this accident, the Aircraft Accident Investigation Commission proposes the followings to Minister of Transport of Japan.

Kuui 43
November 20, 1997

TO : Mr.Takao Fujii
The Minister of Transport

SUBJECT : Proposals on the aircraft accident involving Garuda Indonesia
Douglas DC-10-30, PK-GIA. (Proposal No. 12)

As a result of the investigation of the subject aircraft accident which occurred at Fukuoka Airport on June 13, 1996, the AAIC proposes as follows in accordance with Article 22 of AAIC Establishment Law, based on the concept that taking following measure would contribute to preventing a recurrence of aircraft accident.

To secure the flight safety of foreign aircraft flying into Japan

Efforts should be increased to secure the flight safety of foreign aircraft flying into Japan by actively cooperating in the Safety Oversight Program of International Civil Aviation Organization.

Kazuyuki Takeuchi
Chairman
Aircraft Accident Investigating Commission

Figure 1-1 Diagram of Fukuoka Airport

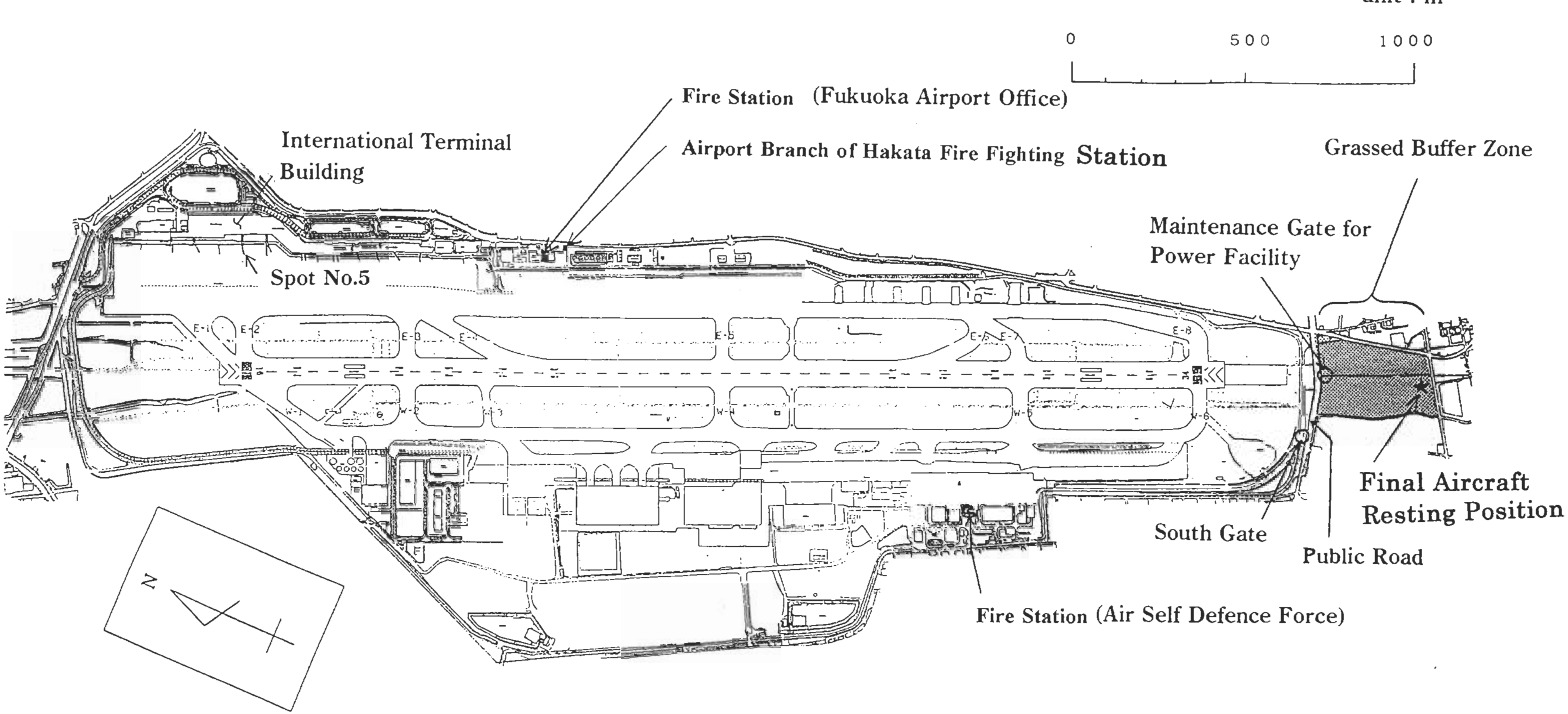


Figure 1-2 Detail of the Accident Site

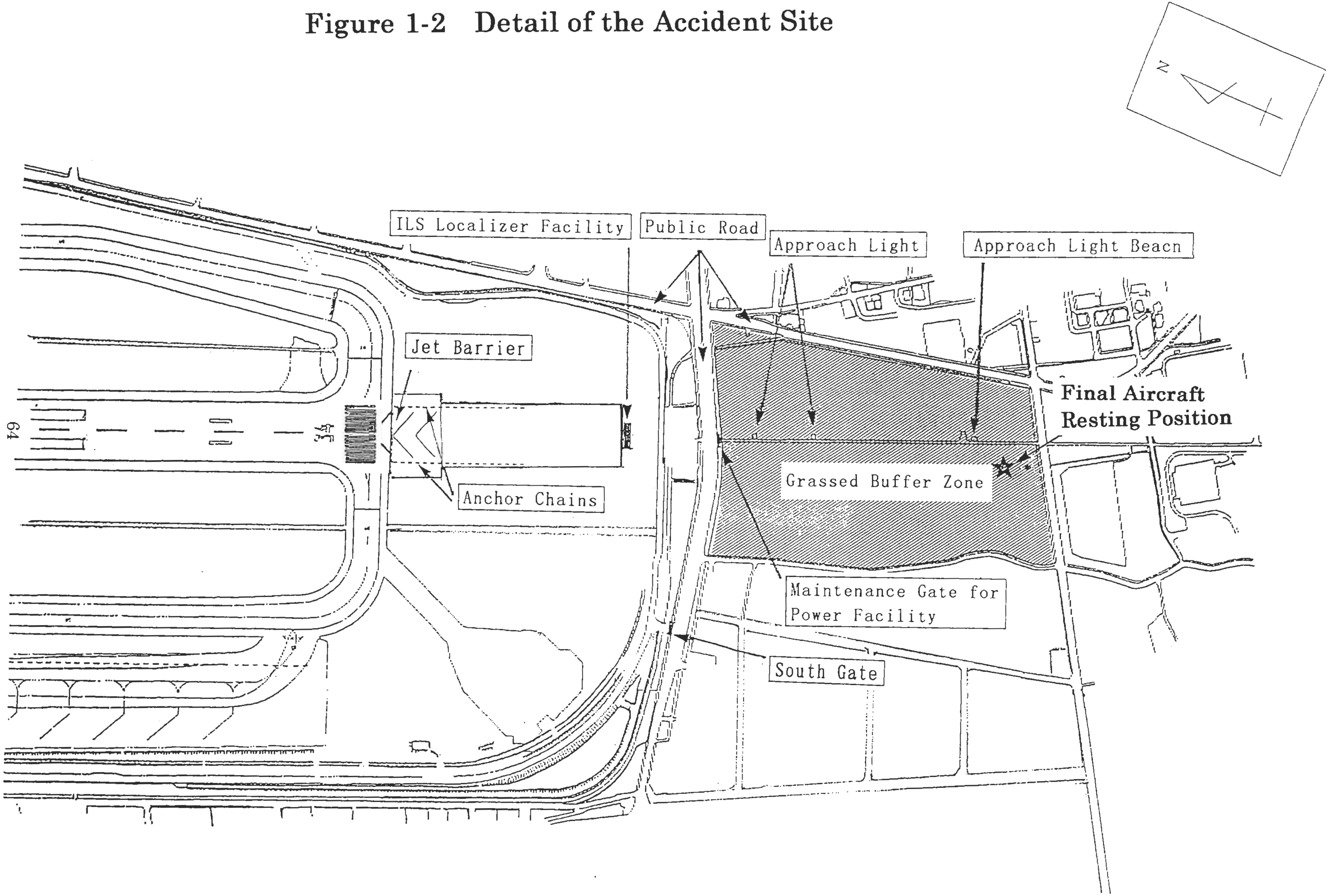
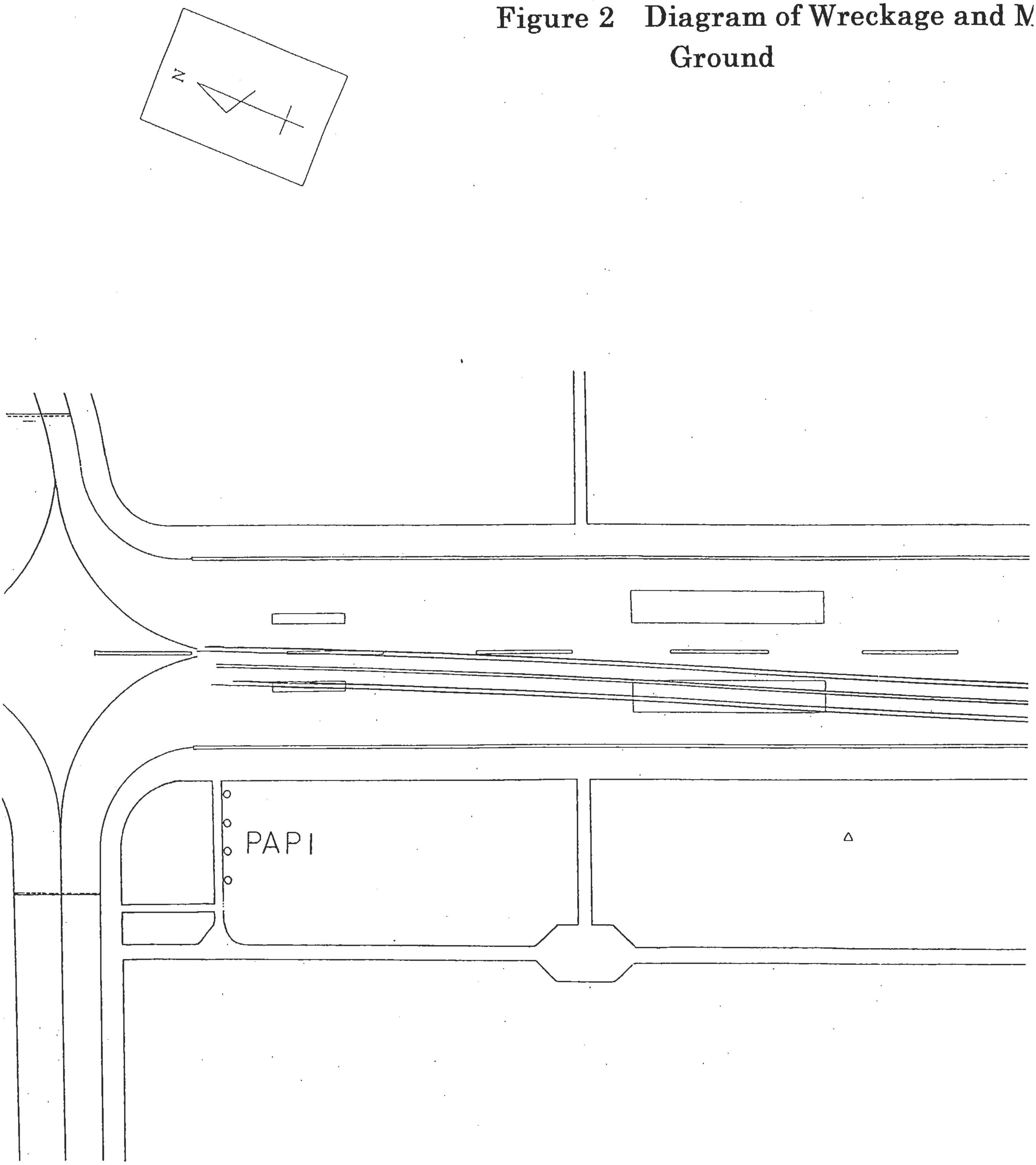
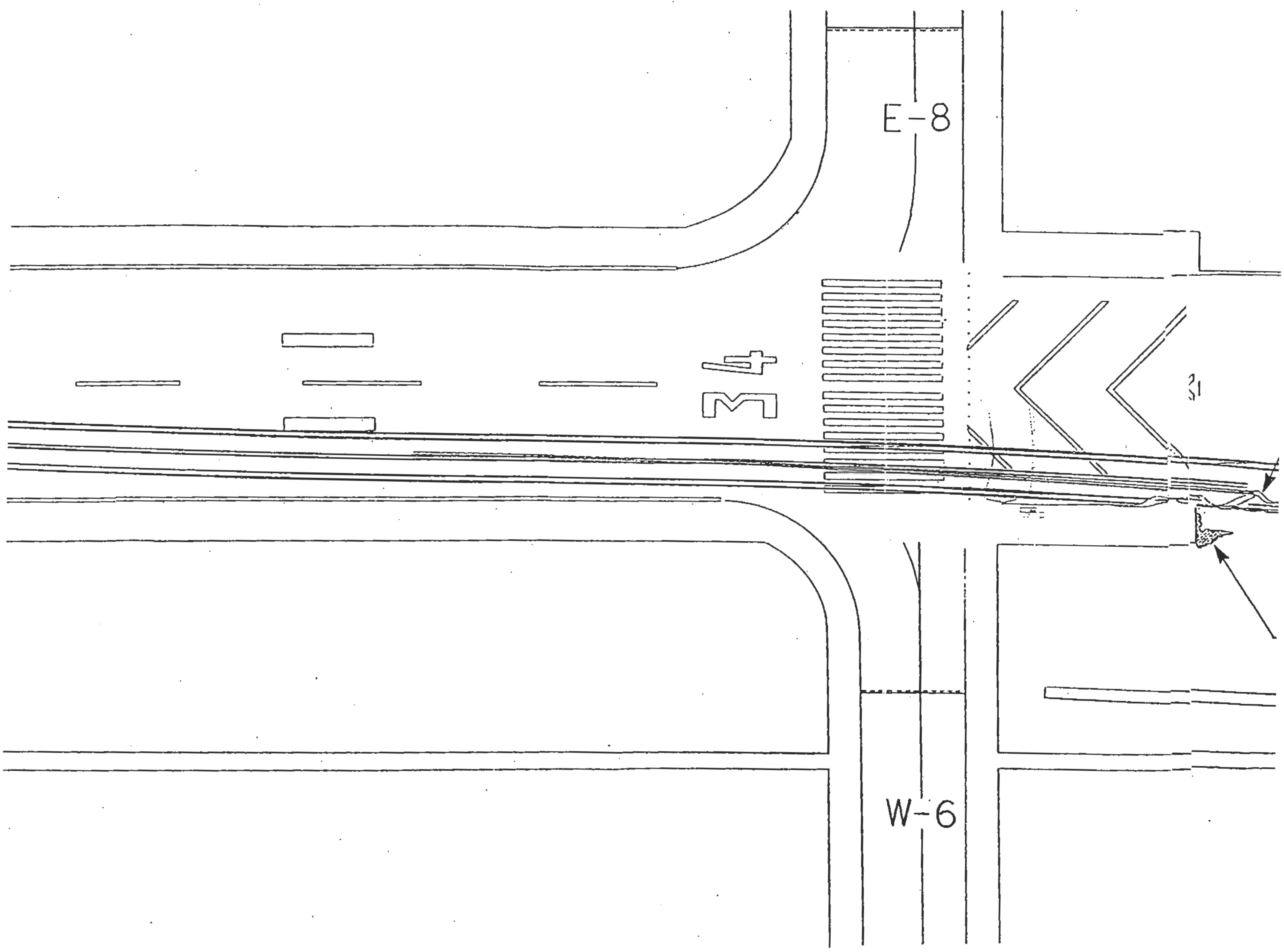
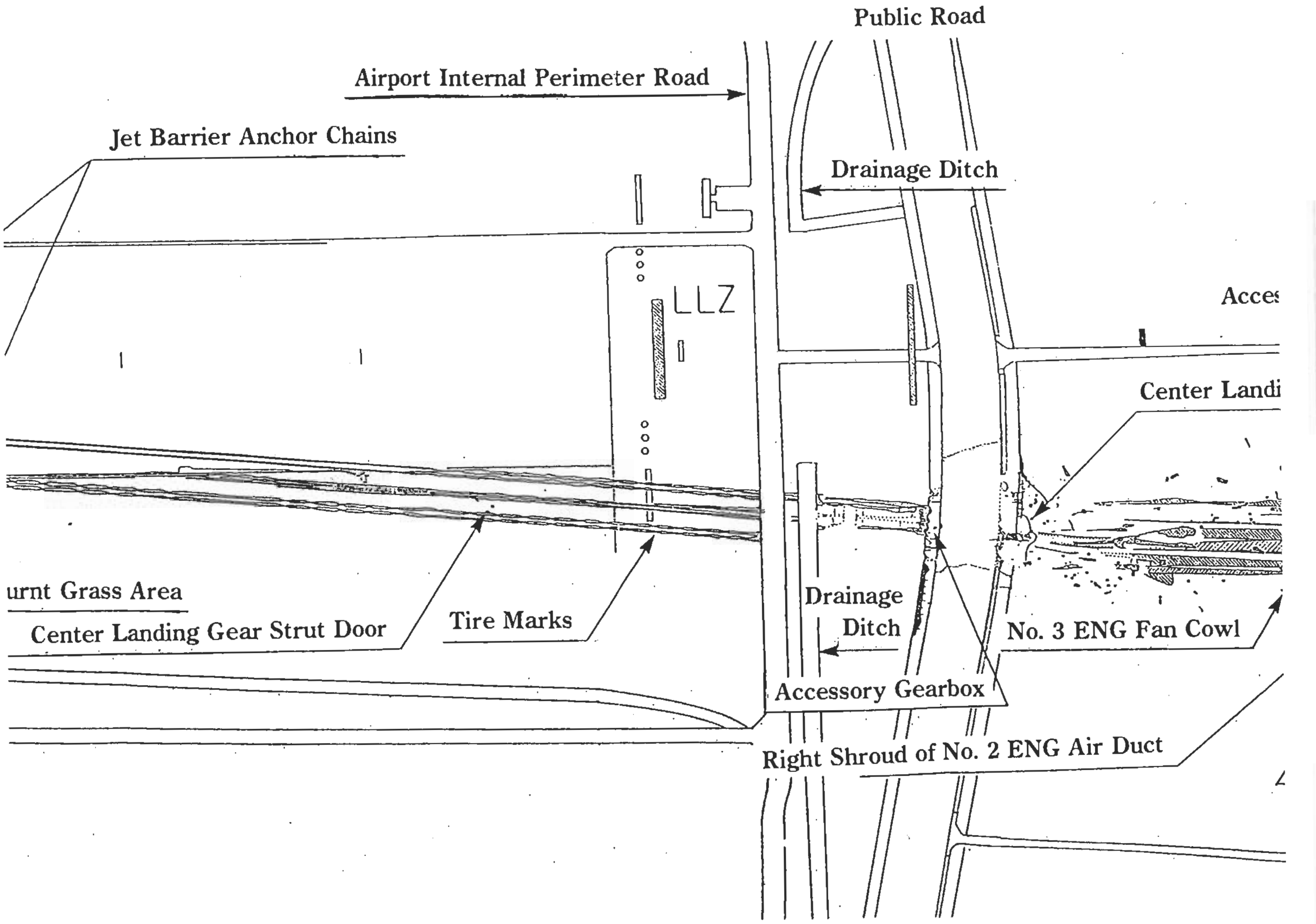


Figure 2 Diagram of Wreckage and M
Ground



Marks left on the




Public Road
Airport Internal Perimeter Road
Jet Barrier Anchor Chains
Drainage Ditch
LLZ
Acces
Center Landi
urnt Grass Area
Center Landing Gear Strut Door
Tire Marks
Drainage Ditch
No. 3 ENG Fan Cowl
Accessory Gearbox
Right Shroud of No. 2 ENG Air Duct

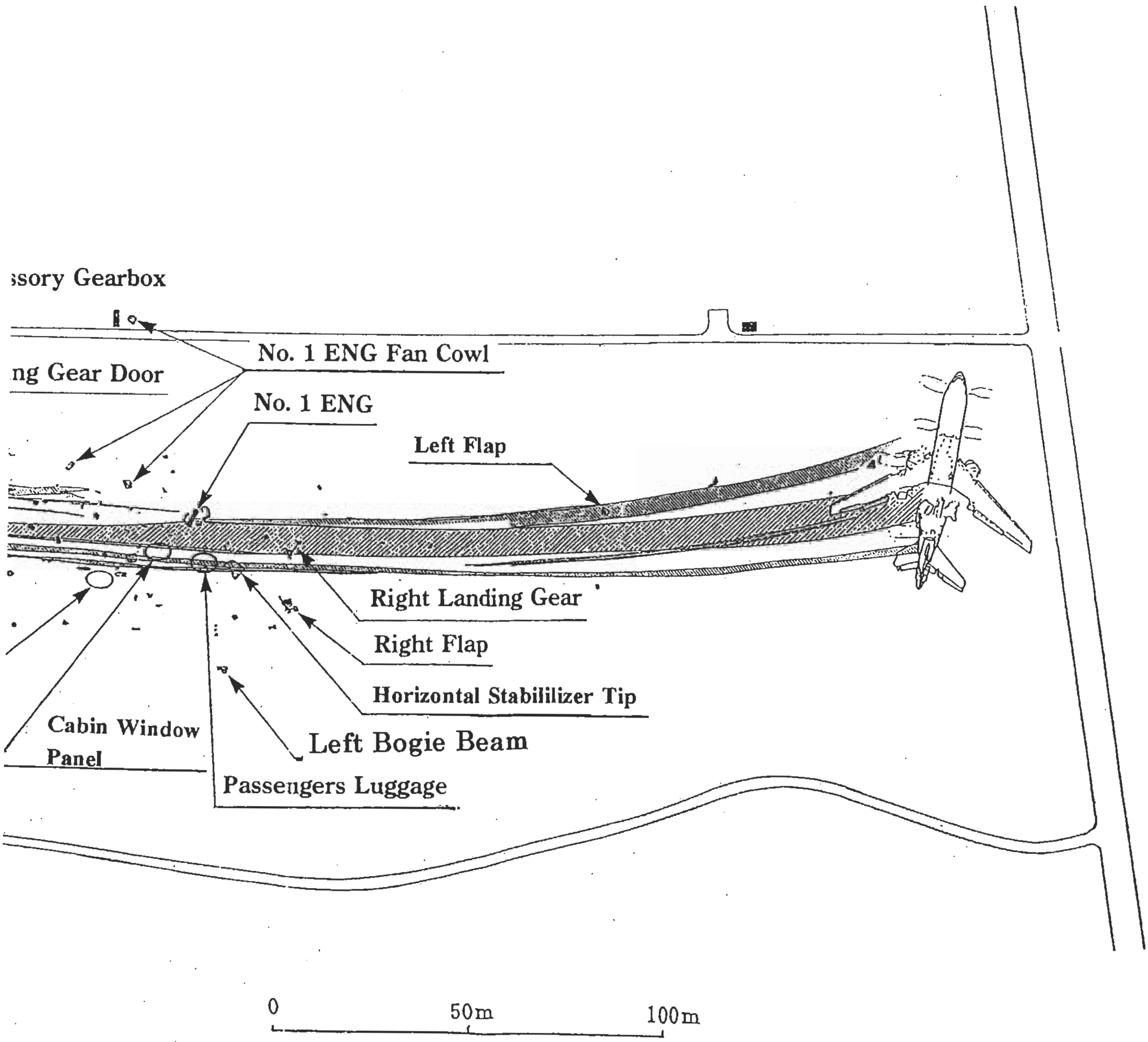
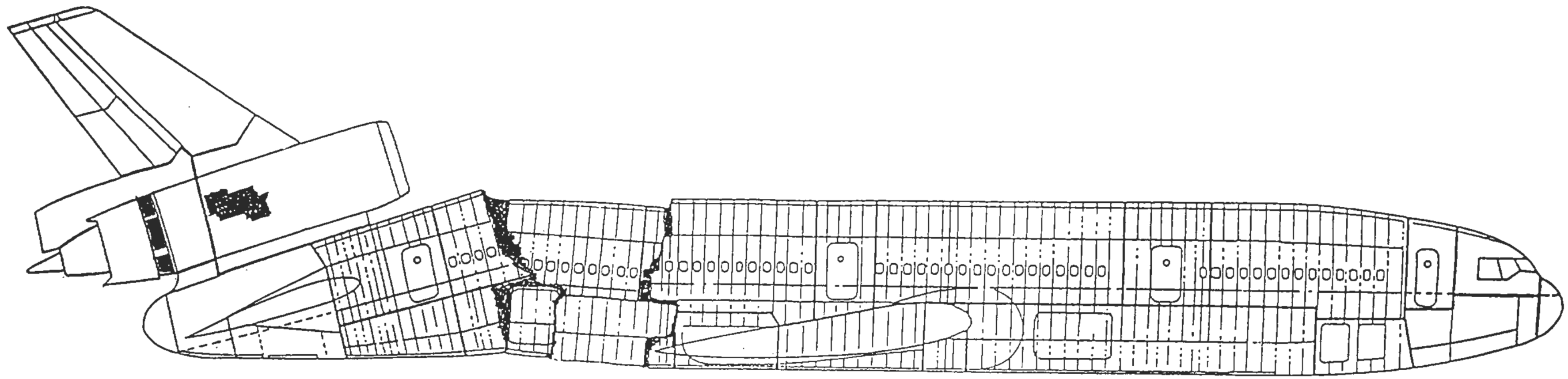
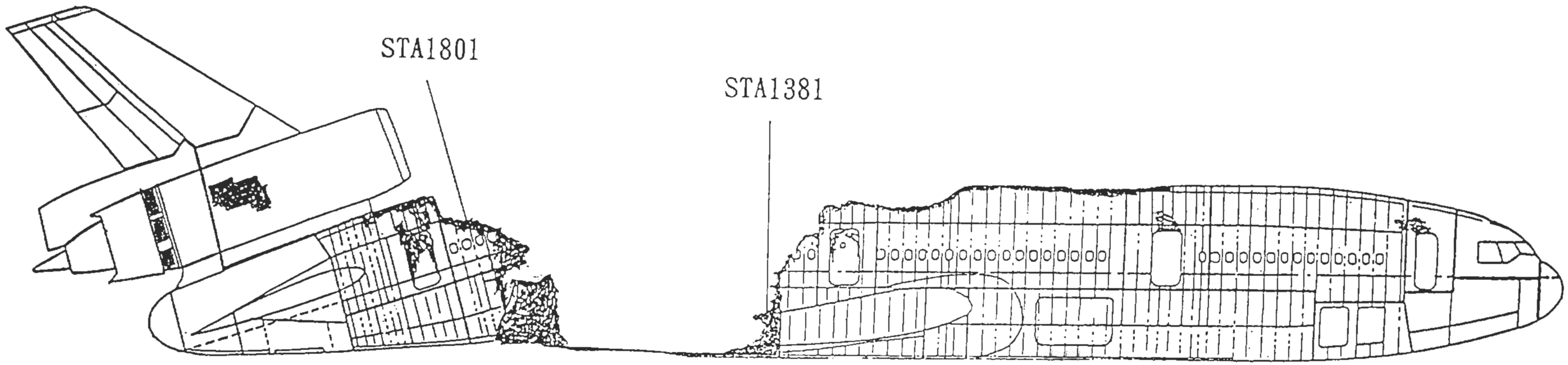

ssory Gearbox
No. 1 ENG Fan Cowl
ng Gear Door
No. 1 ENG
Left Flap
Right Landing Gear
Right Flap
Horizontal Stabililizer Tip
Left Bogie Beam
Cabin Window Panel
Passengers Luggage
0
50m
100m

Figure 3-1 Airframe Damage (right side view)

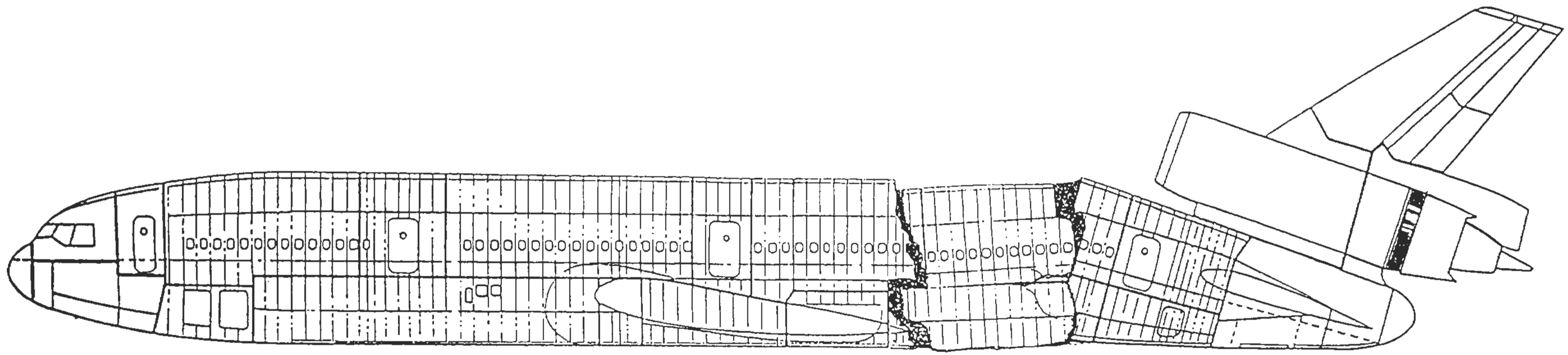


Before fire

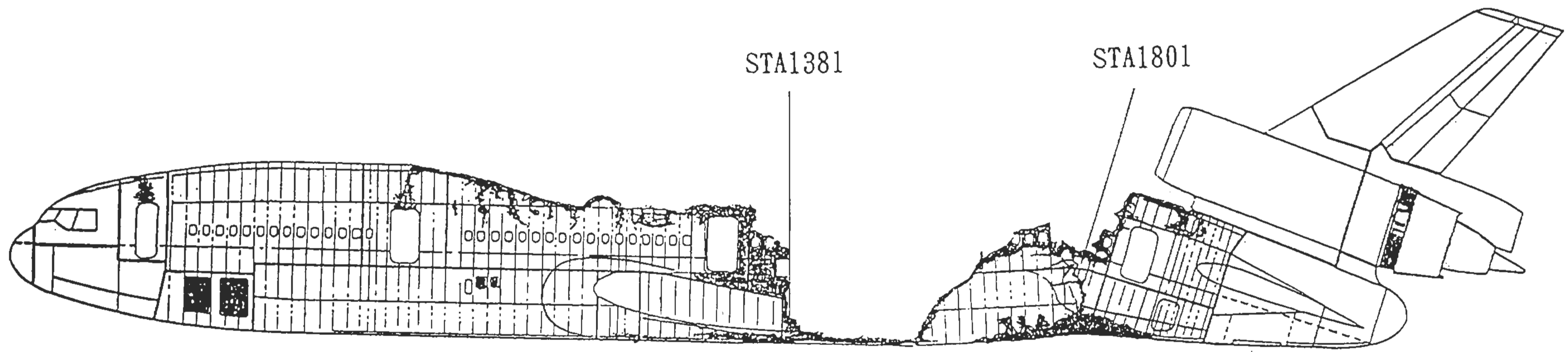


After fire

Figure 3-2 Airframe Damage (left side view)

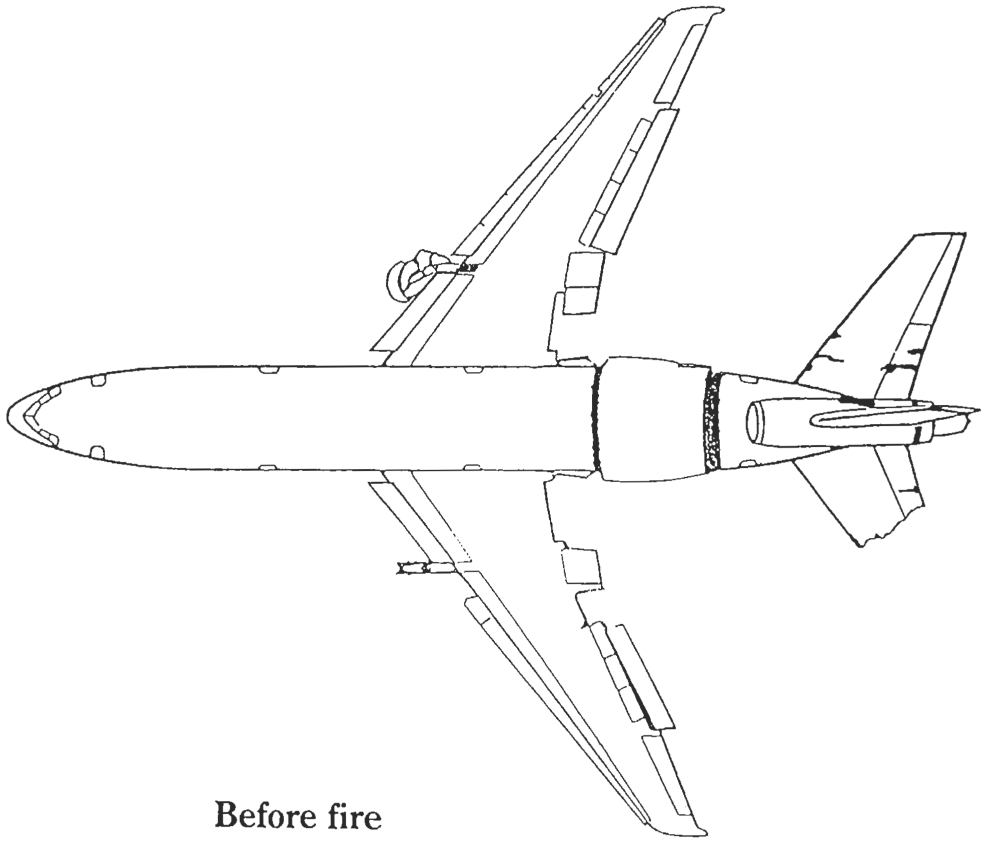


Before fire

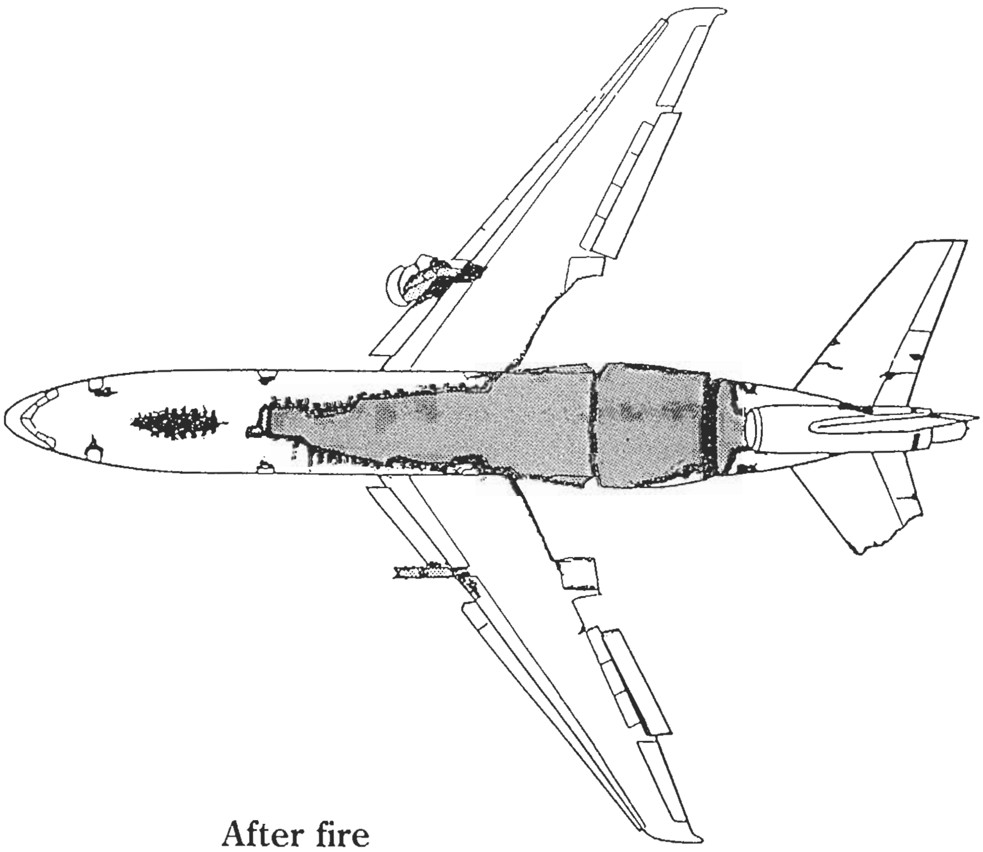


After fire

Figure 3-3 Airframe Damage (plain view)



Before fire



After fire

Figure 4 Douglas DC-10-30 Three Views

unit : m

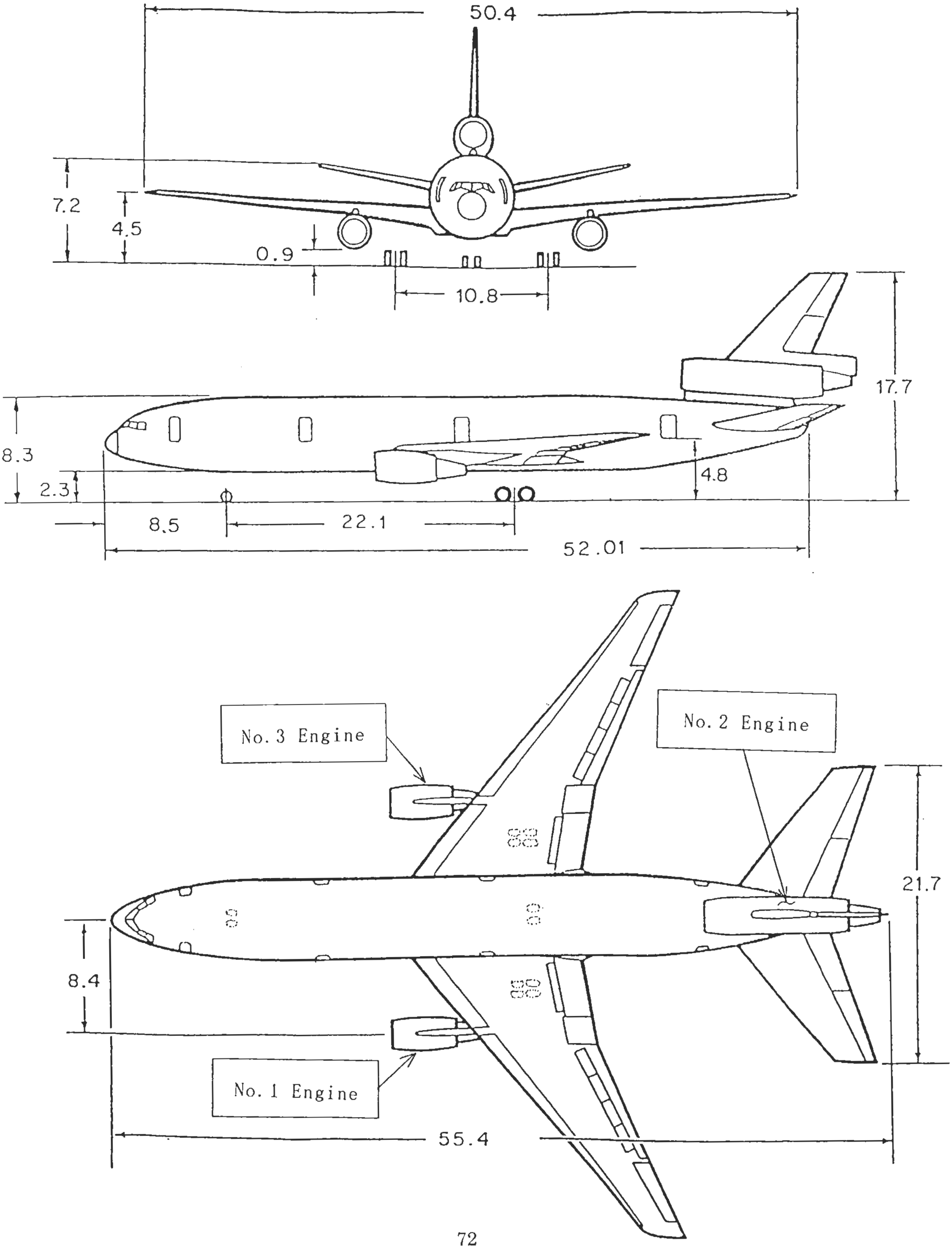


Figure 5 Seat Configuration Chart

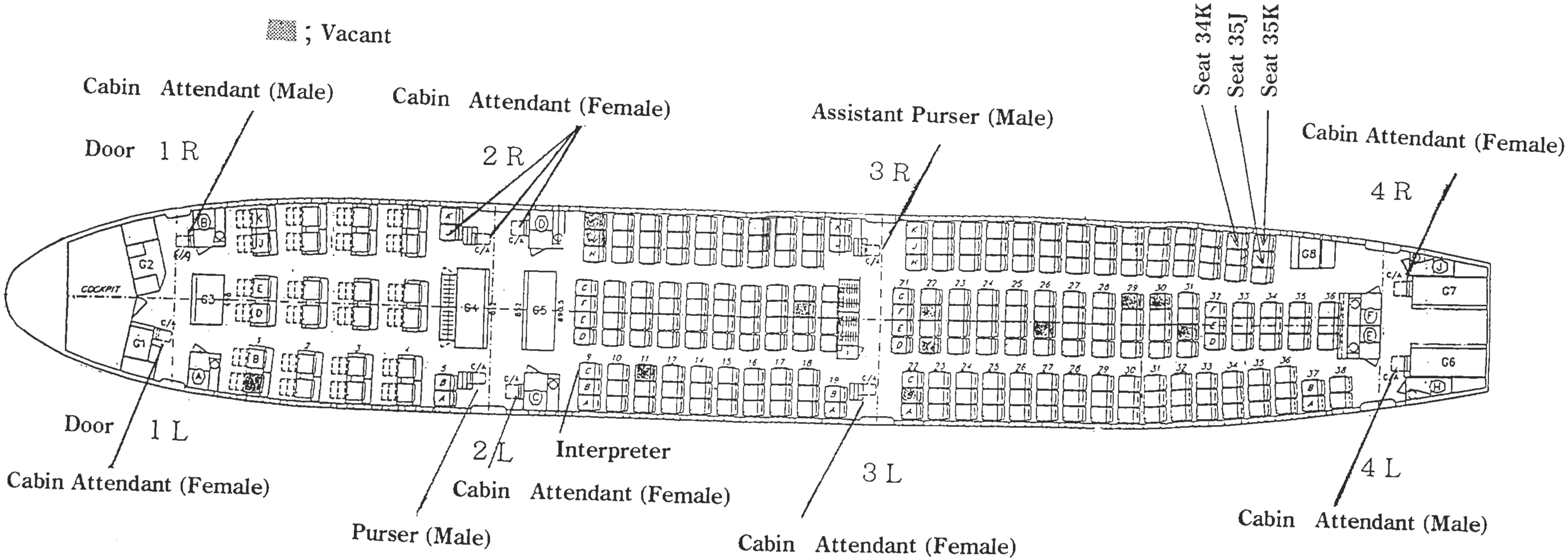


Figure 6 Deployment of Slides/Rafts and Cracked-open Holes on Fuselage Skin and Cabin Floor

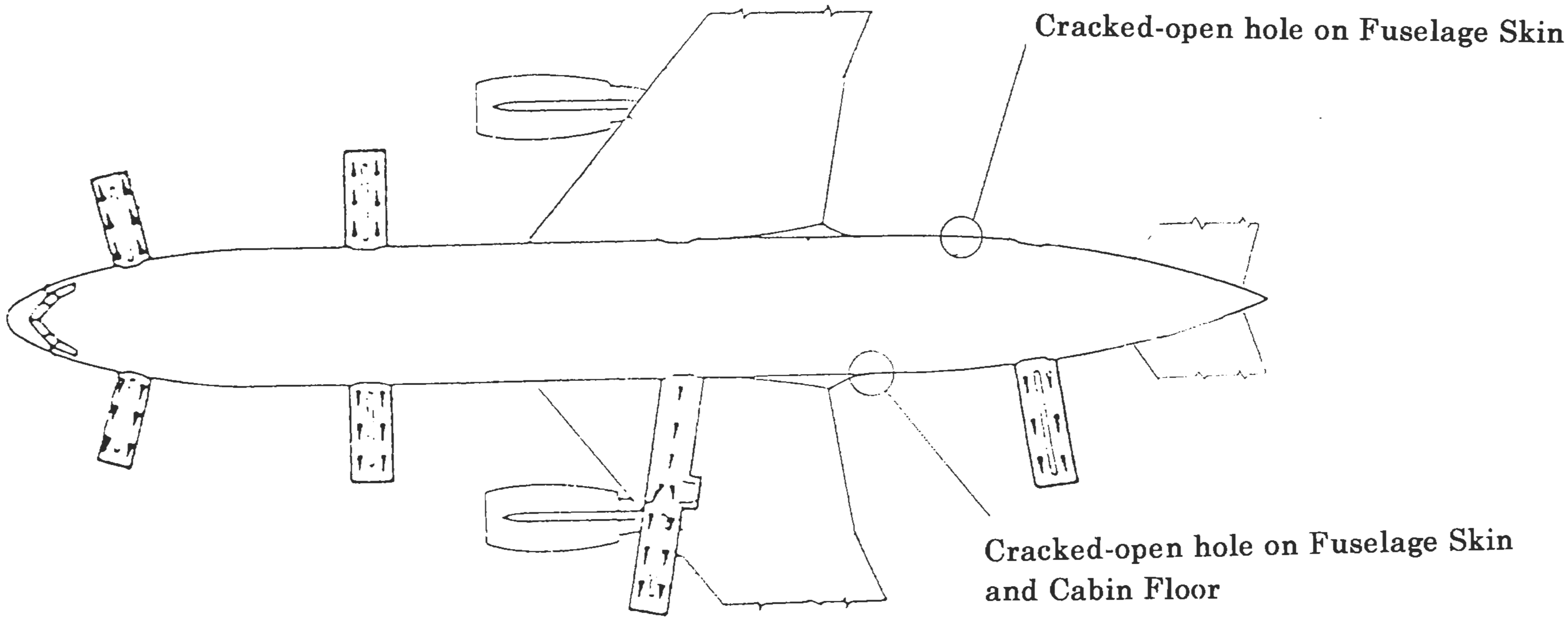


Figure 7 Engine Cross-Section and HPT Blade Damage

Figure 7 (1) CF6-50C Engine Cross-Section

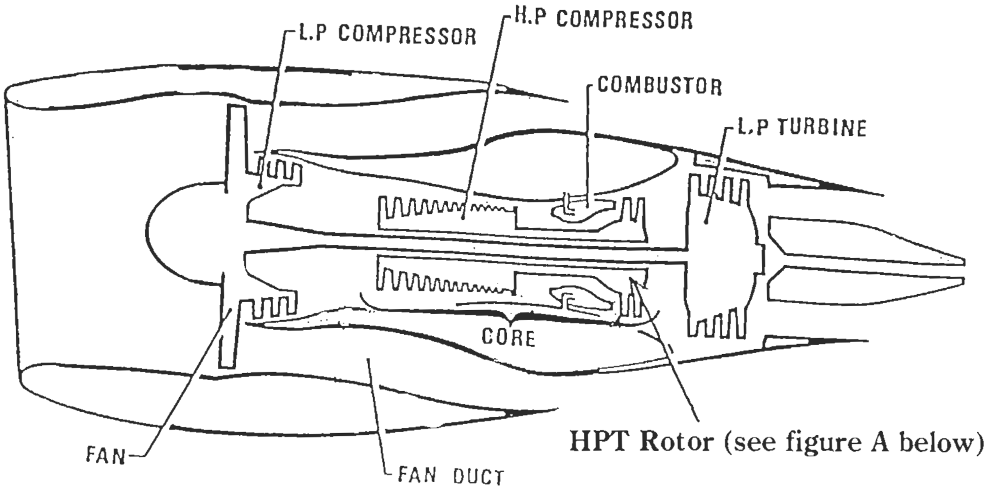


Figure 7 (2) Figure A : HPT Rotor

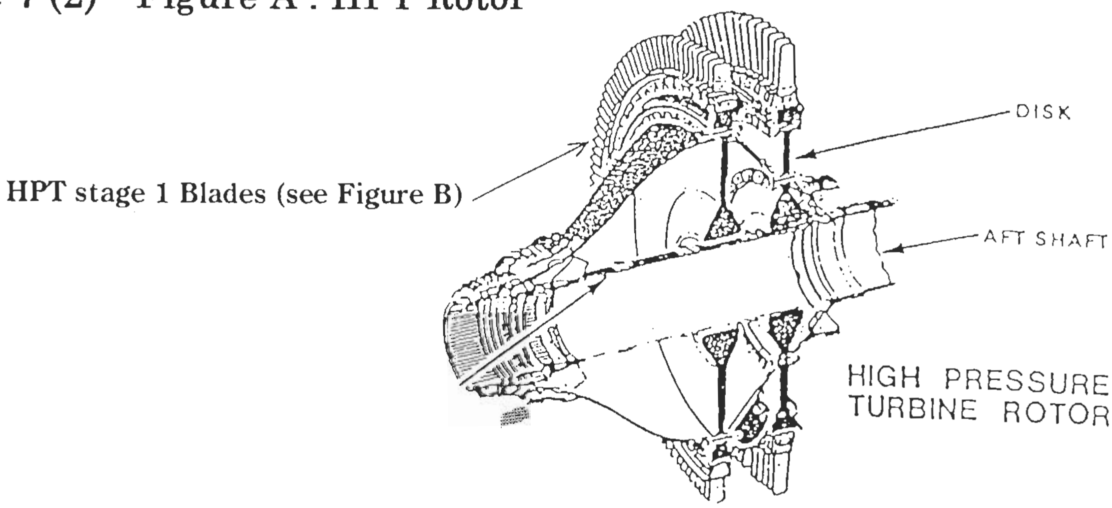
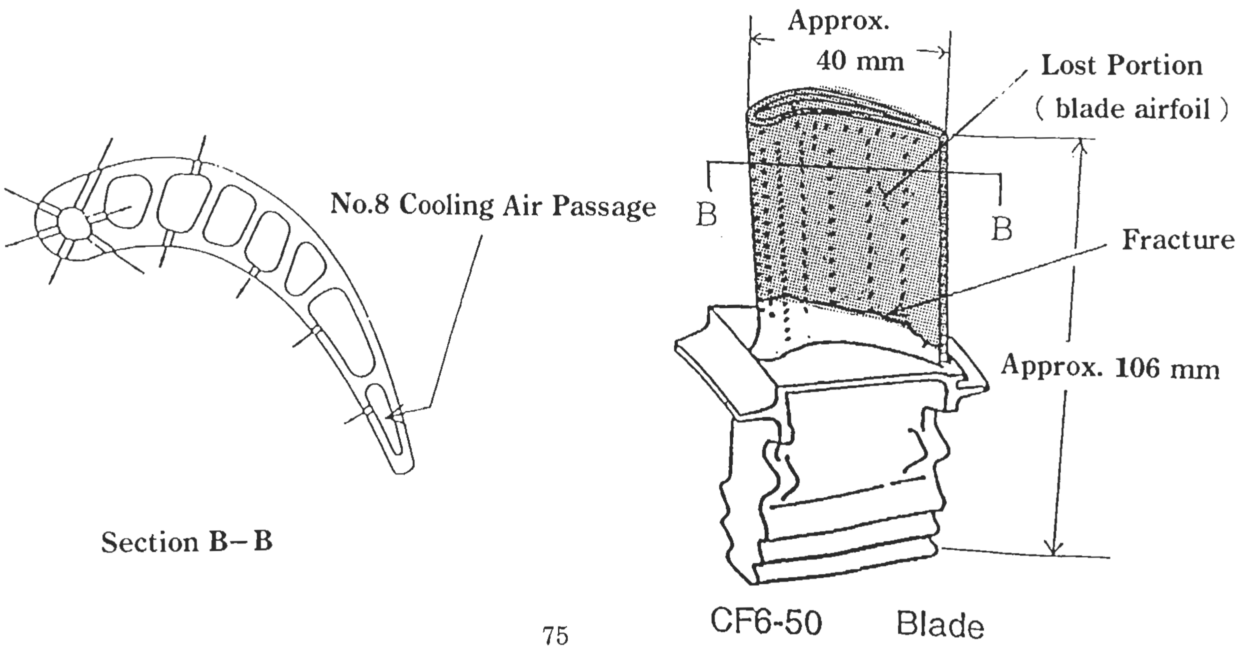
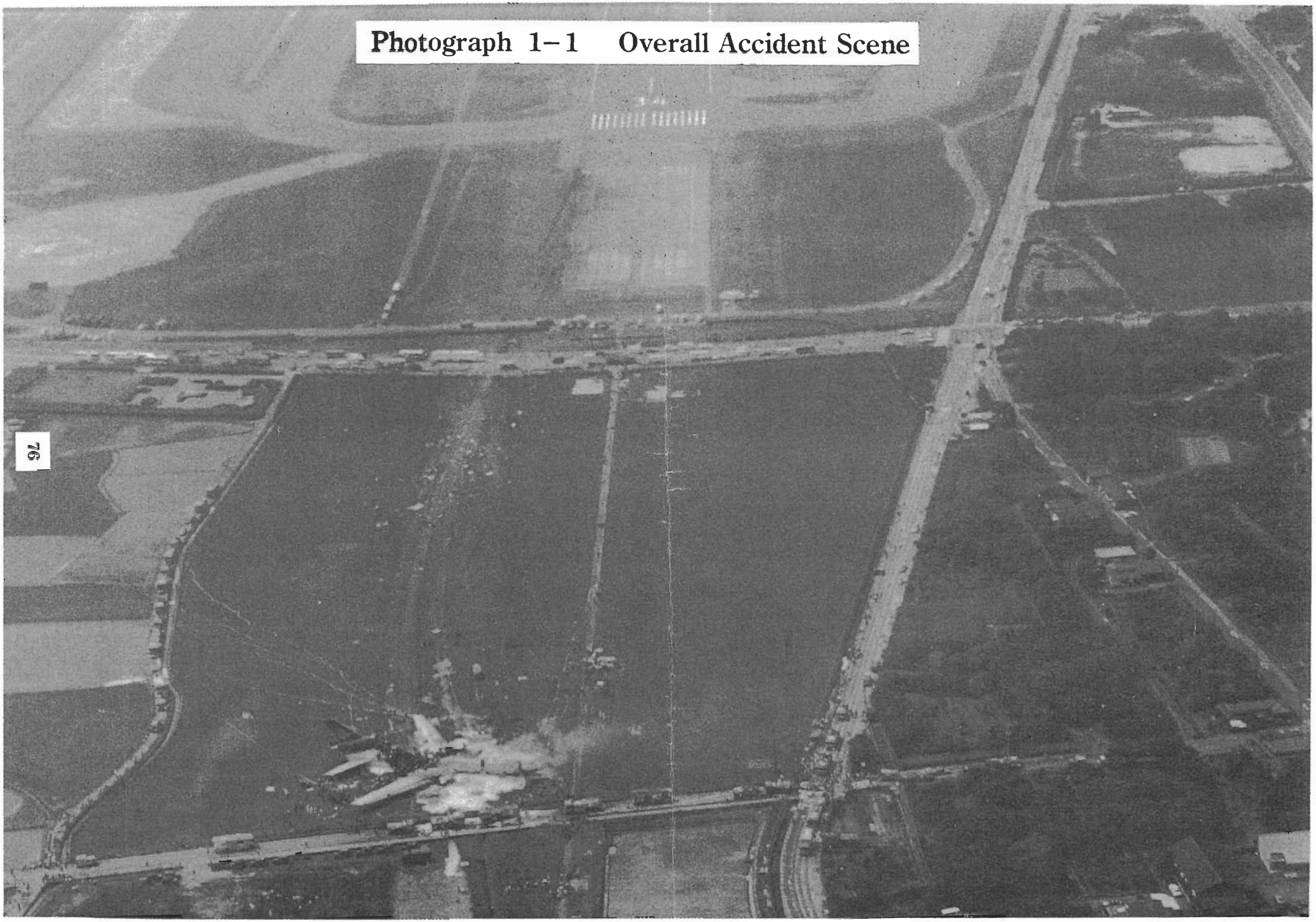


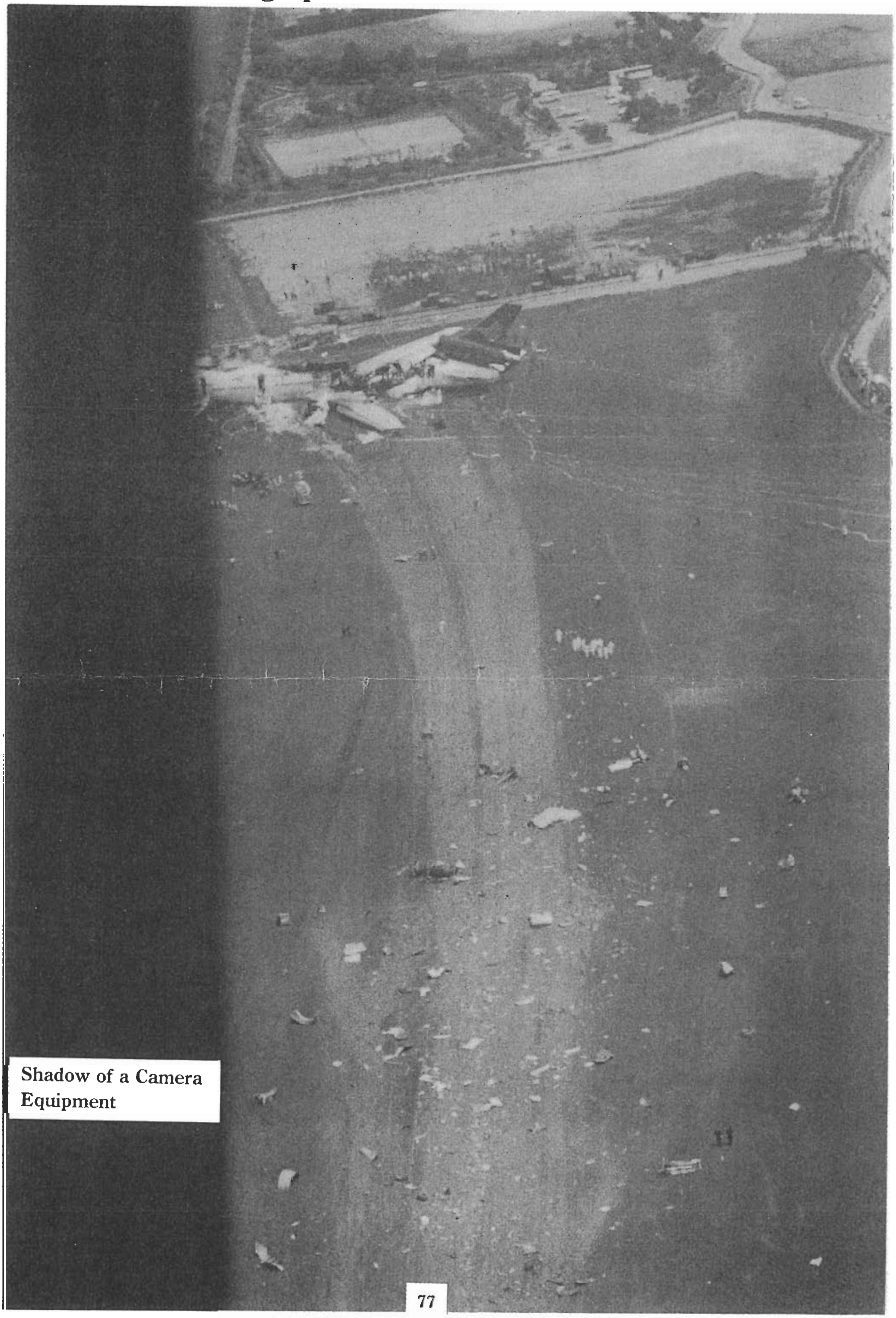
Figure 7 (3) Figure B : HPT Stage 1 Blade



Photograph 1-1 Overall Accident Scene



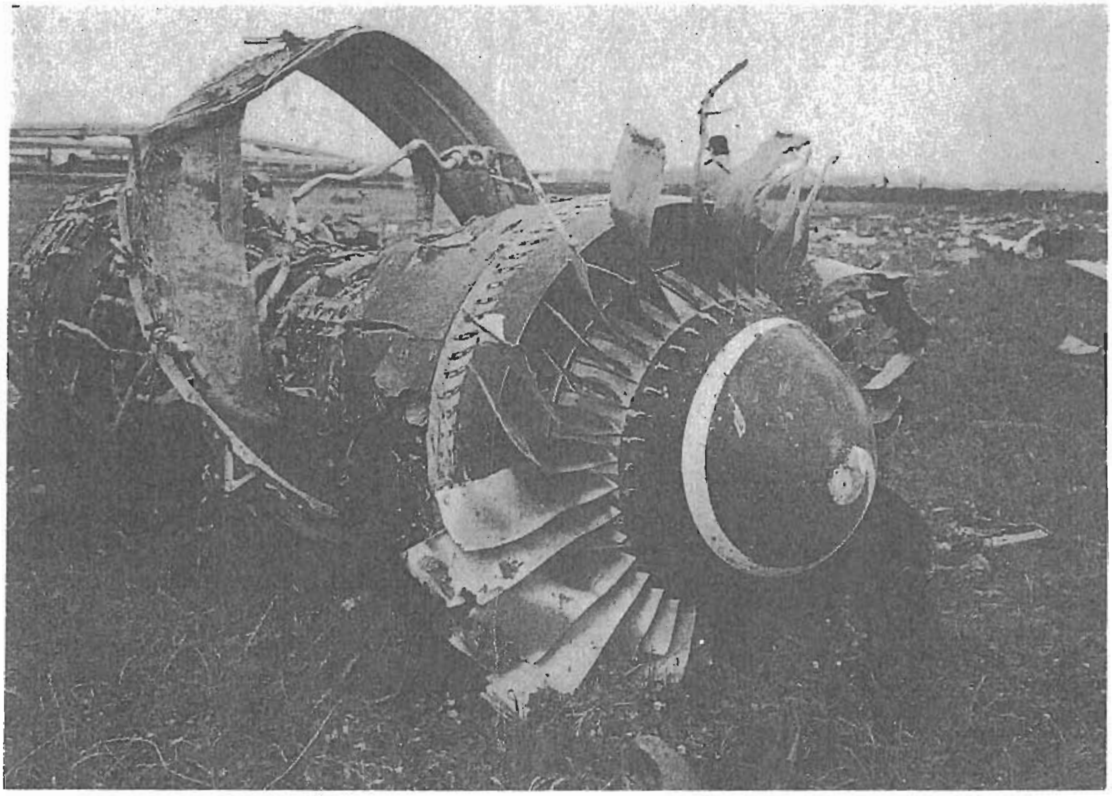
Photograph 1−2 Overall Accident Scene



Photograph 1-3 Overall Accident Scene

Photograph 1−4 Overall Accident Scene

Photograph 2   No. 1 Engine



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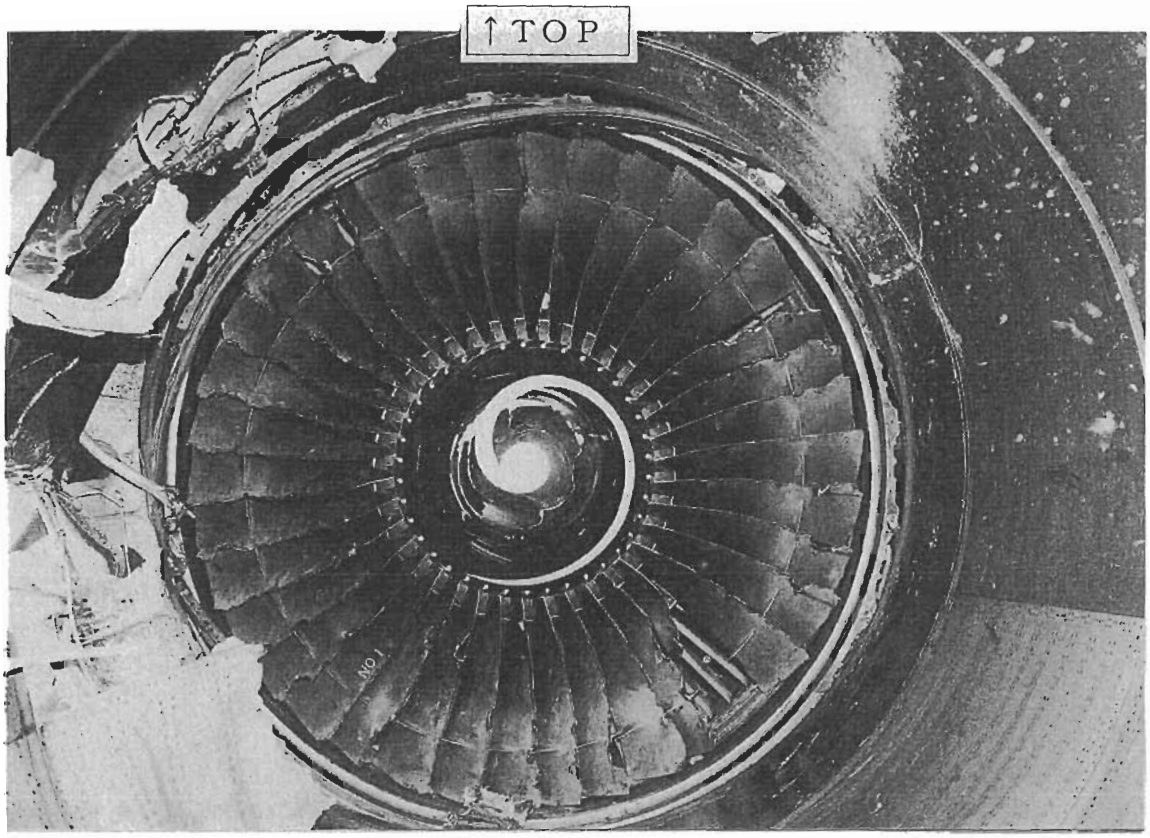
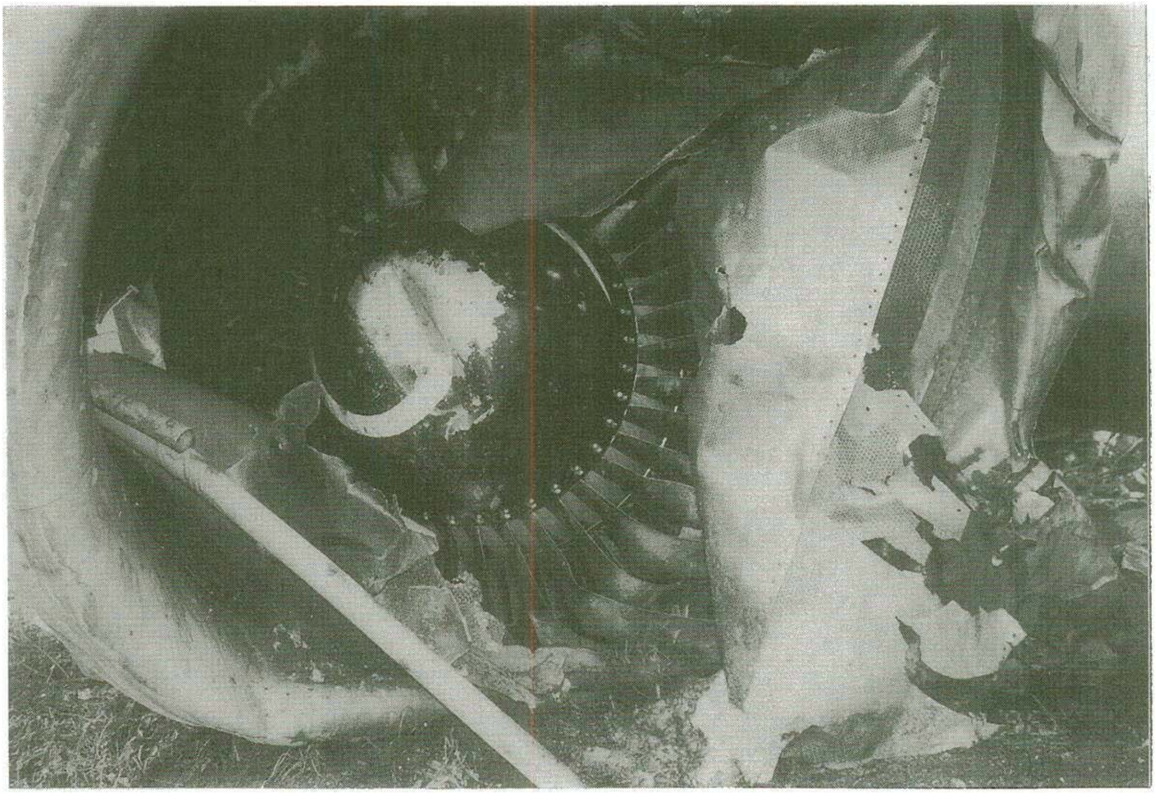
Photograph 3-1 No. 2 Engine



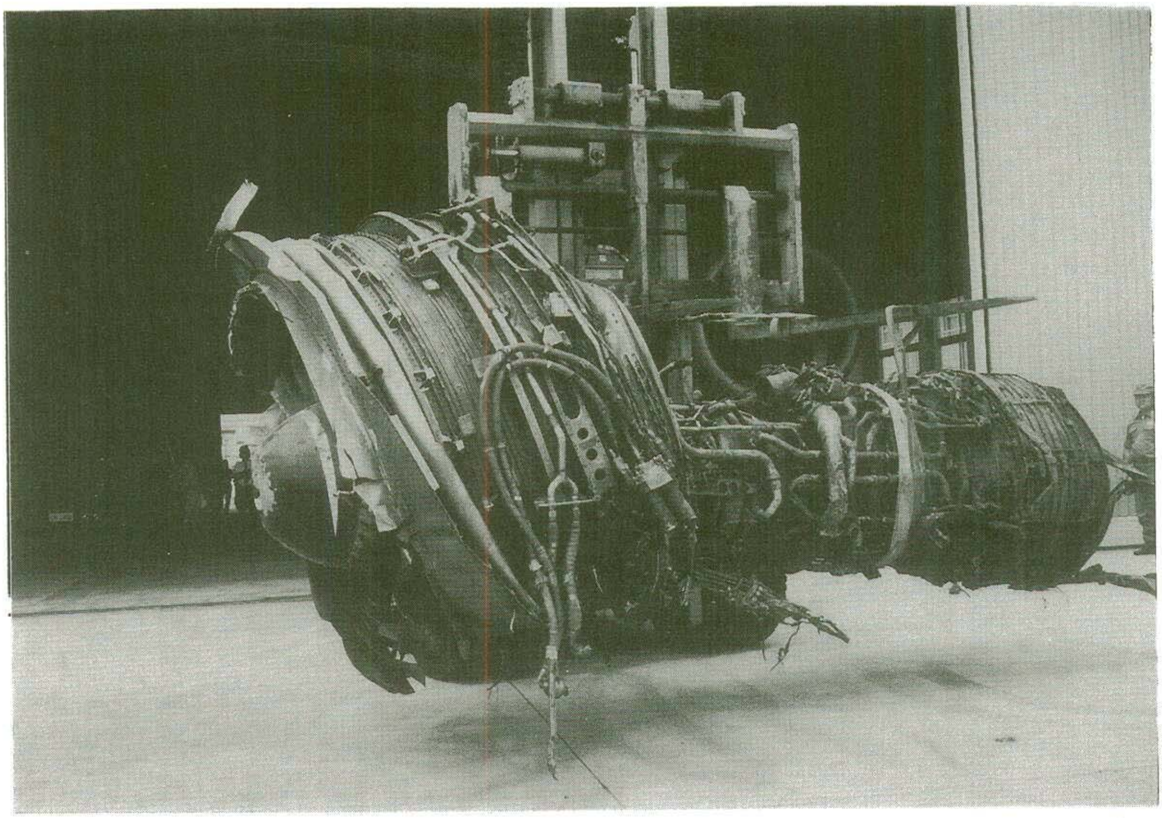
Photograph 3-2 No. 2 Engine (open hole on the air inlet duct)

Photograph 4-1　No. 3 Engine

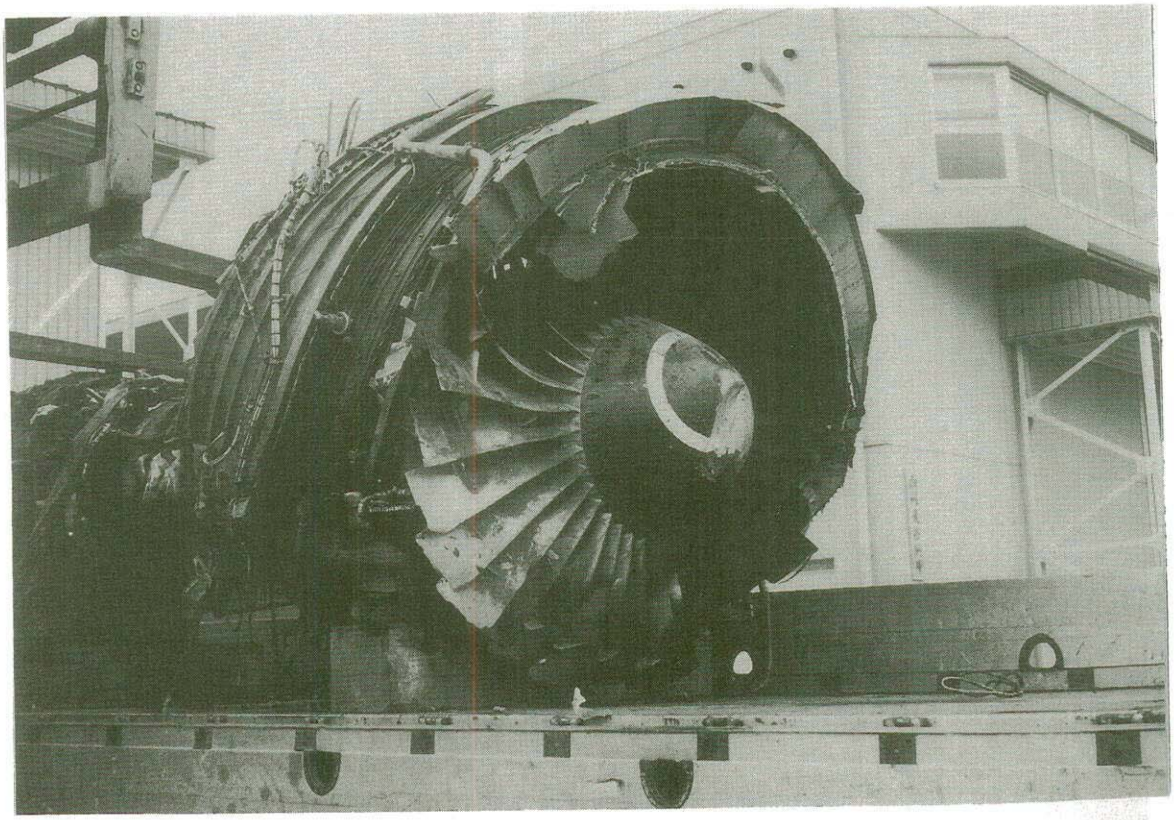
Photograph 4-2　No. 3 Engine



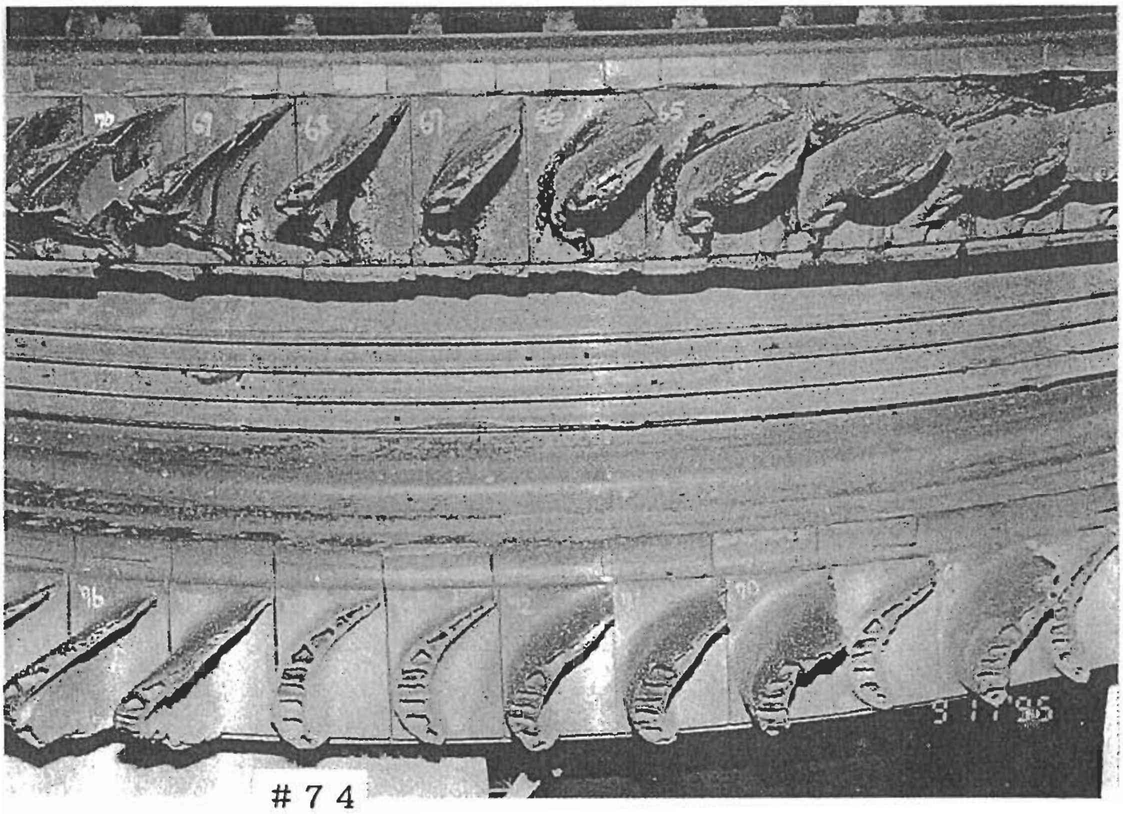
Photograph 4-3 No. 3 Engine (before disassembly inspection)



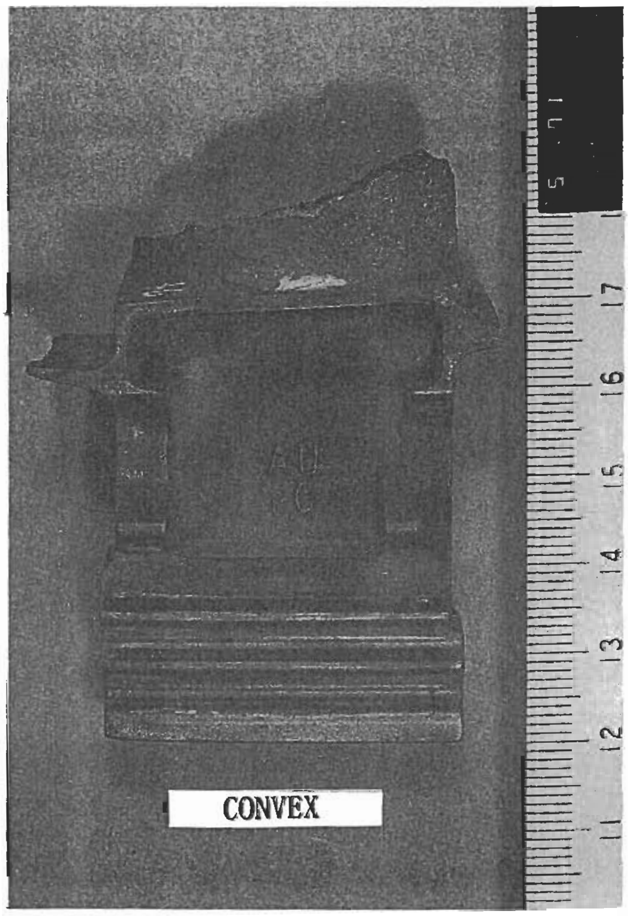
Photograph 4-4 No. 3 Engine (before disassembly inspection)

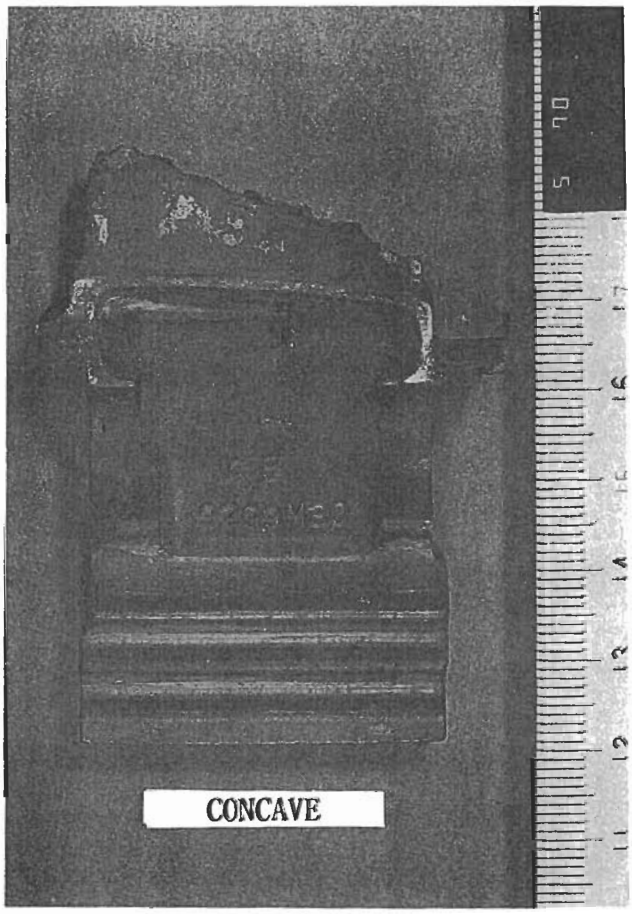


Photograph 4-5 No.3 Engine (state of damage to HPT blades assembled to disk)

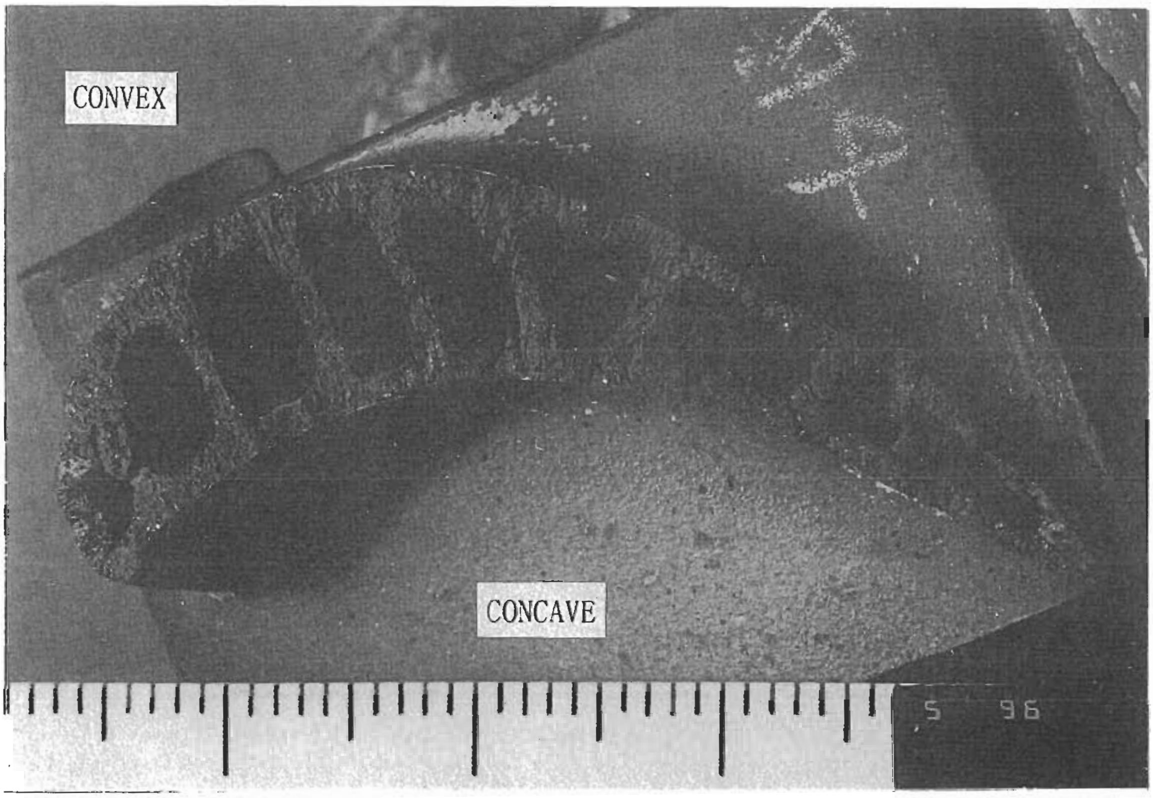


Photograph 4-6 No. 3 Engine (damage to the HPT stage 1 No.74 blade)





Photograph 4-7 No. 3 Engine (fracture surface of the HPT stage 1 No. 74 blade)



Contents of Appendix

CVR Transcription

TWR : FUKUOKA TOWER
CAP : CAPTAIN
FO : FLIGHT OFFICER
FE : FLIGHT ENGINEER

JST	Speaker		Content
around 12:06:53	TWR	:	indonesia 865 wind 280 at 7. cleared for takeoff runway 16.
〃 12:06:58	FO	:	cleared for takeoff indonesia 865.
〃 12:07:01	CAP	:	set autothrottles on.
〃 12:07:03	FO	:	on set.
〃 12:07:10	CAP	:	check thrust.
〃 12:07:18	FE	:	rata, rata. (annotation 1)
〃 12:07:26	FO	:	one hundred.
〃 12:07:29	FE	:	dua aja. (annotation 2)
〃 12:07:38	FO	:	V one.
〃 12:07:40	FO	:	rotate.
〃 12:07:42		・	There is a sound, which is presumed to be an engine failure, through around 43.
〃 12:07:45	FE	:	engine failure number one.
		・	A sound occurs which is presumed to be that of the throttle-levers hitting their idle stops.
〃 12:07:46		・	Shaking noise of the aircraft continues after landing.
〃 12:07:48		・	There is a sound, which is presumed to be the activation of an engine thrust-reverser.
〃 12:07:54	CAP	:	wuala stop. (annotation 3)
		・	Continuous sounds of violent shaking and objects striking the aircraft hard.
〃 12:07:56		・	END OF RECORDING

(annotation 1) Indonesian. It seems to mean that the engines are at the same level.

(annotation 2) Indonesian. It seems to mean “ just two “.

(annotation 3) It seems ” Ooh stop “ in English.
“ wuala “ is the Indonesian.

(annotation 4) ATC communications not relevant to the analysis are not presented.

DFDR parameters

Information on 53 parameters was recorded on the aircraft's DFDR. Of these, the following major DFDR parameters are shown in the charts in appendices 2-1 through 2-7, from about the time of receipt of takeoff clearance until the DFDR stopped recording usable data. Parts of the CVR transcription (Appendix 1) are overlaid.

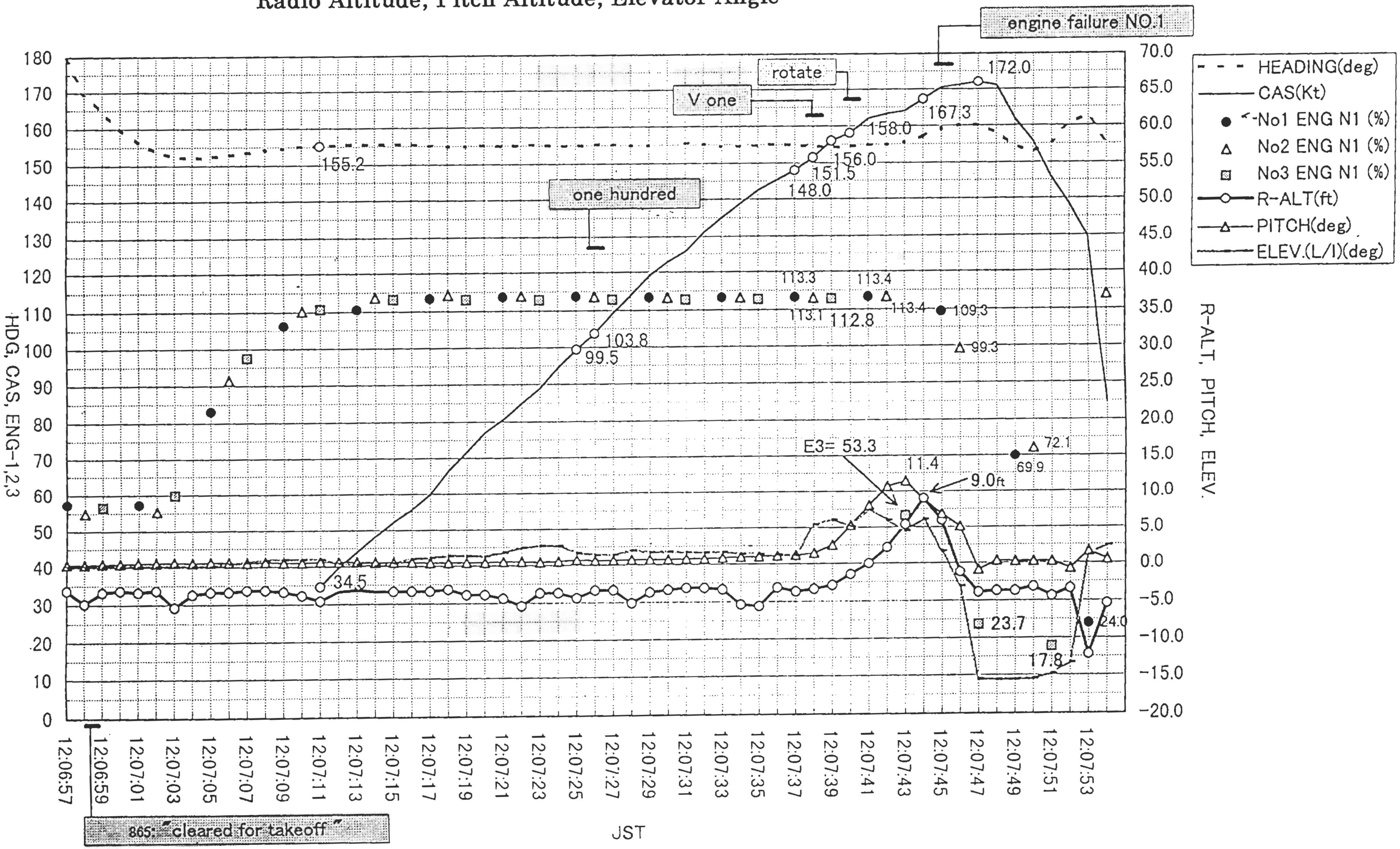
(1) ENG NO.1 N_1 (%)
(2) ENG NO.2 N_1 (%)
(3) ENG NO.3 N_1 (5)
(4) CAS (Kt)
(5) HDG (deg) : Magnetic heading
(6) R-ALT (FINE 1) (ft)
(7) PITCH ANGLE (deg)
(8) ELEVATOR POSITION LH/IB (deg)
(9) RUDDER ANGLE LOWER (deg)
(10) AILERON POSITION LH/IB (deg)
(11) ROLL ANGLE (deg)
(12) VERTICAL ACCELERATION (G)
(13) LONGITUDINAL ACCELERATION (G)
(14) LATERAL ACCELERATION (G)
(15) SPOILER (LEFT 5) (deg)
(16) BRAKE PEDAL RIGHT (deg)
(17) BRAKE PEDAL (LEFT) (deg)
(18) AUOT PILOT NO.1
(19) AUTO PILOT NO.2
(20) ENG NO.1 THRUST REVERSER
(21) ENG NO.2 THRUST REVERSER
(22) ENG NO.3 THRUST REVERSER

Besides the above data, the following 31 kinds of parameters had been recorded on the DFDR.

(1) PRESSURE ALTITUDE
(2) MACH NUMBER
(3) MAXIMUM OPERATING LIMIT SPEED
(4) TOTAL AIR TEMPARATURE
(5) HORIZONTAL STABILIZER
(6) RUDDER ANGLE UPPER

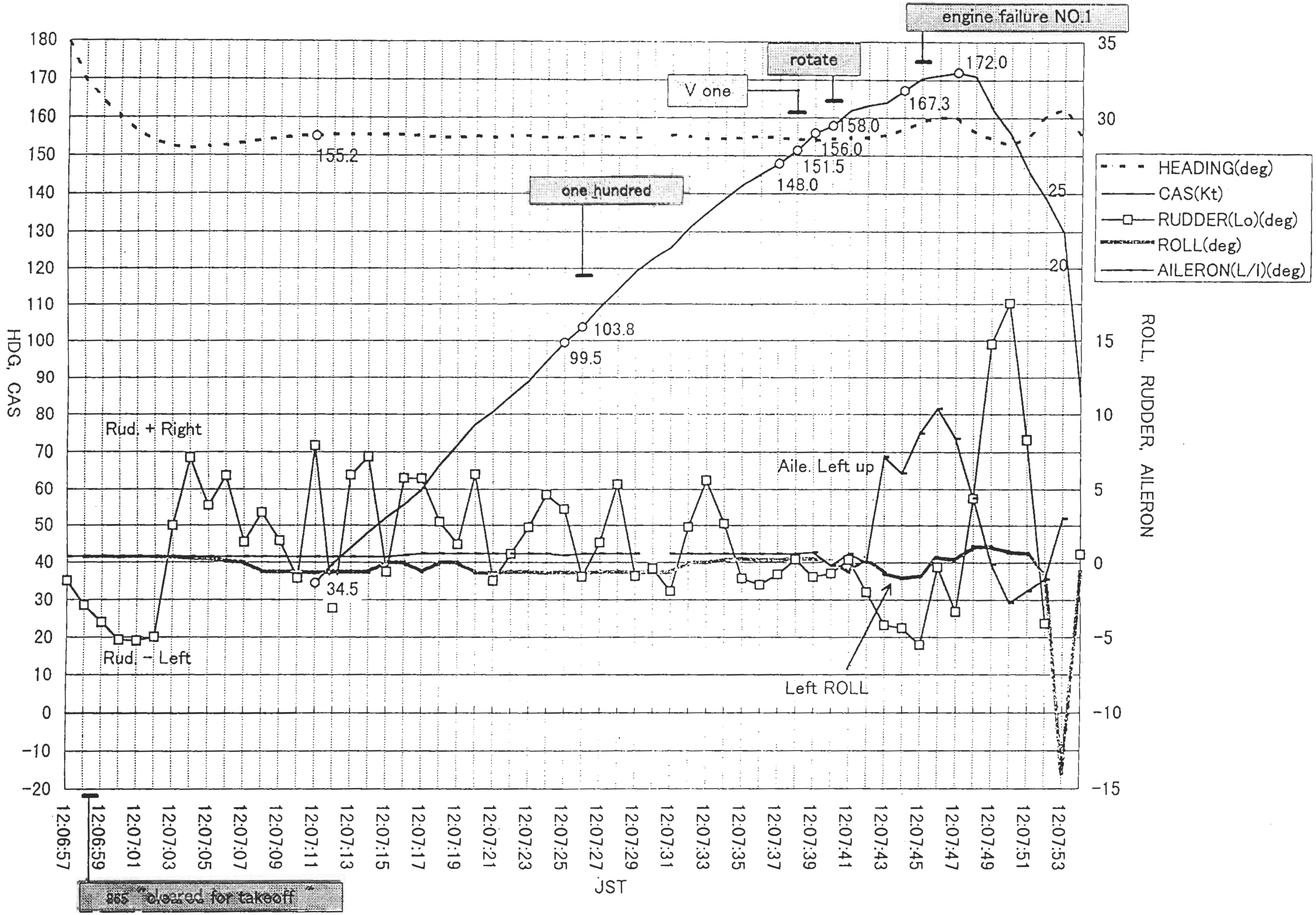
(7) R-ALT (COARSE 1)
(8) R-ALT (COARSE 2)
(9) R-ALT (FINE 2)
(10) AILERON POSITION RH/OB
(11) SPOILER (RIGHT 3)
(12) ELEVATOR POSITION RH/OB
(13) PITCH ANGLE SUPPLEMENT
(14) ROLL ANGLE SUPPLEMENT
(15) FLAP RIGHT INBOARD
(16) BRAKE PRESSURE LEFT
(17) BRAKE PRESSURE RIGHT
(18) LOCALIZER DEVIATION 1
(19) LOCALIZER DEVIATION 2
(20) GLIDE SLOPE DEVIATION 1
(21) GLIDE SLOPE DEVIATION 2
(22) SPEED BRAKE HANDLE
(23) VHF COMMUNICATION KEYING-3
(24) WHEEL BRAKE APPLY
(25) SLAT NO.4 LEFT OUTBOARD
(26) SLAT NO.4 RIGHT OUTBOARD
(27) SLAT NO.2 LEFT INBOARD
(28) HF COMMUNICATION KEYING-1
(29) HF COMMUNICATION KEYING-2
(30) FLIGHT MODE ANNUNCIATOR, ROLL
(31) FLIGHT MODE ANNUNCIAOR, PITCH

Magnetic heading, CAS, N1 on the No.1, N0,2 and No.3 Engine Radio Altitude, Pitch Altitude, Elevator Angle

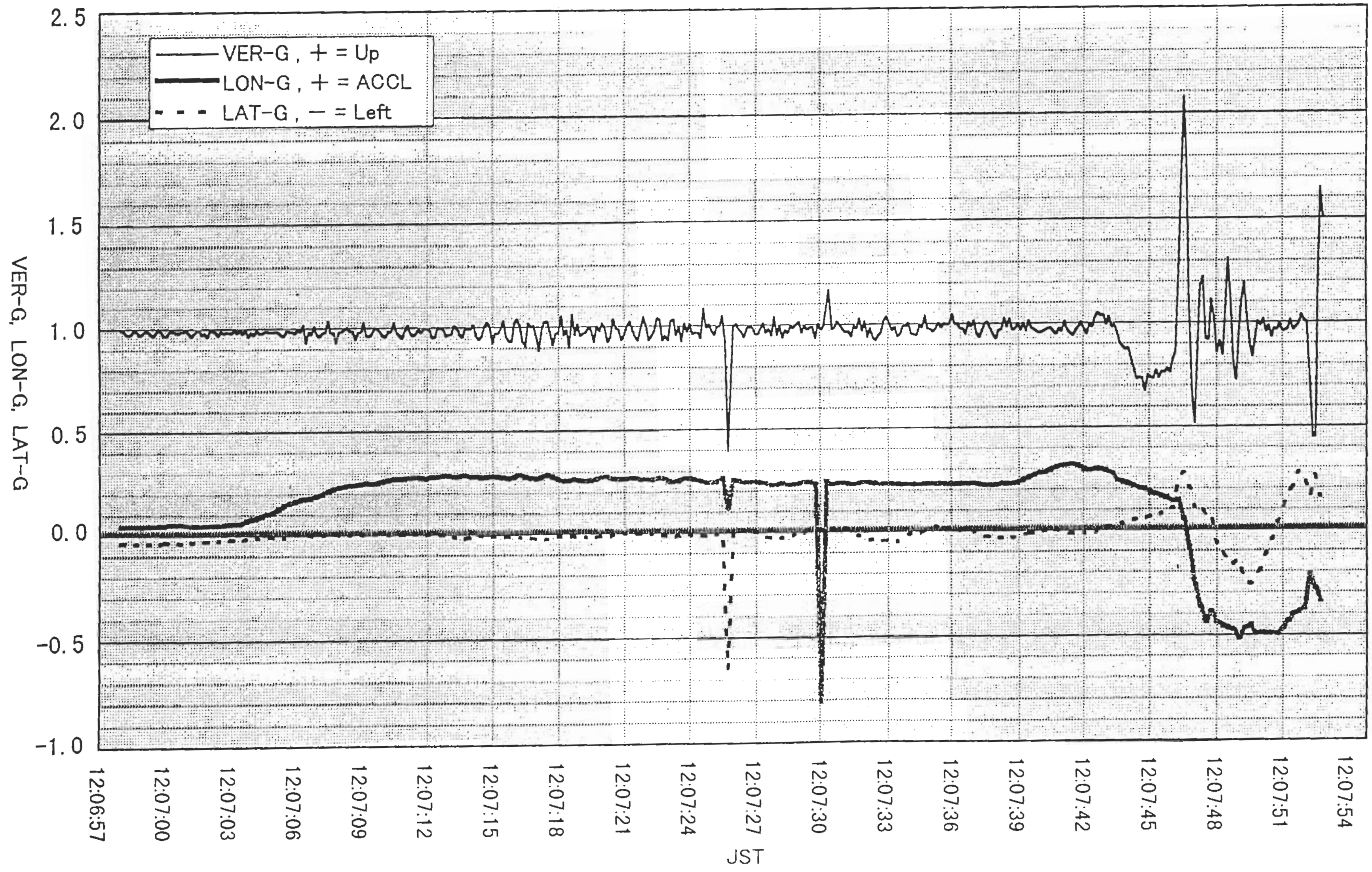


APPENDIX 2-2

Magnetic heading, CAS, Rudder Angle, Roll Angle, Aileron Angle

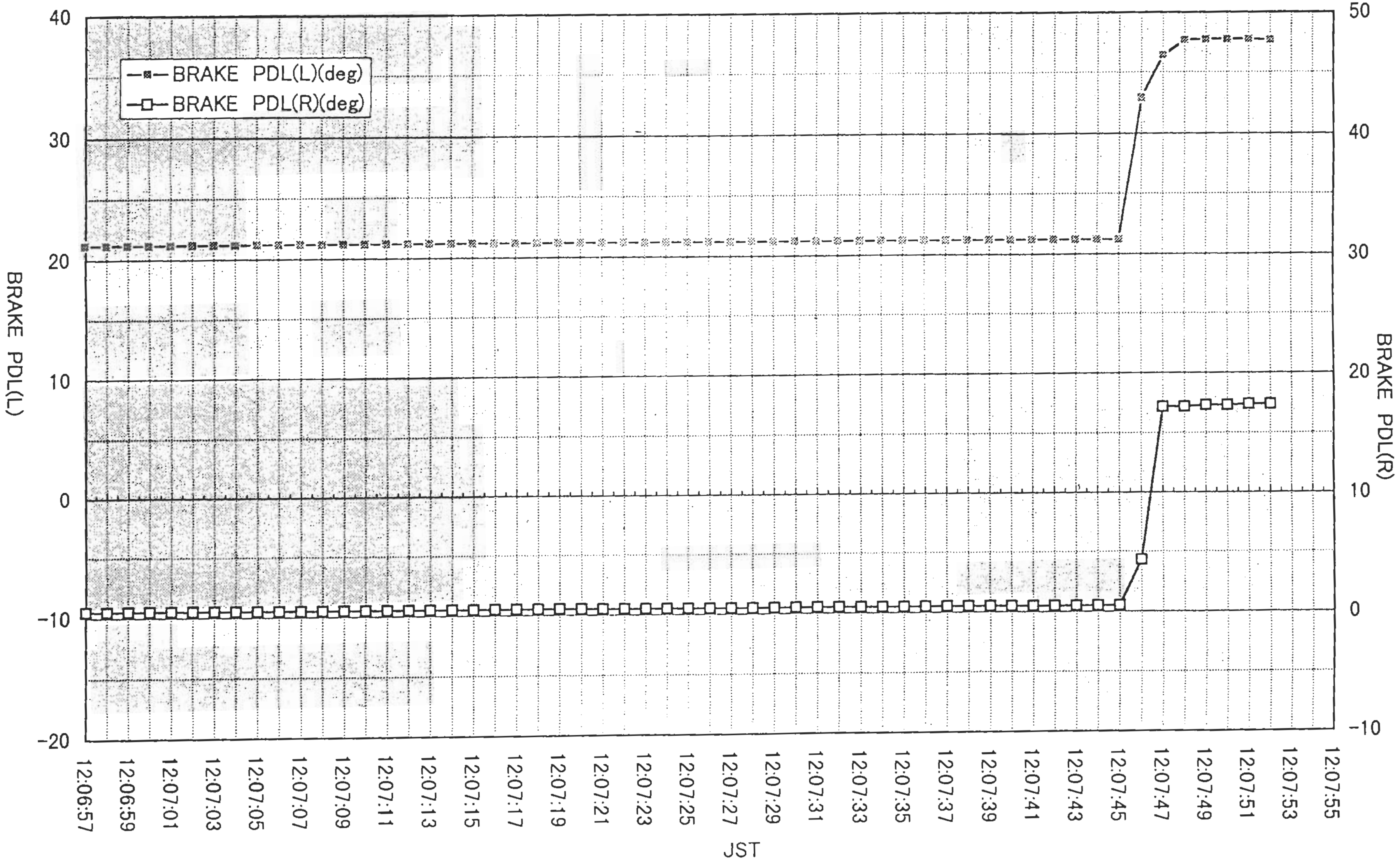


Vertical g, longitudinal g, Lateral g

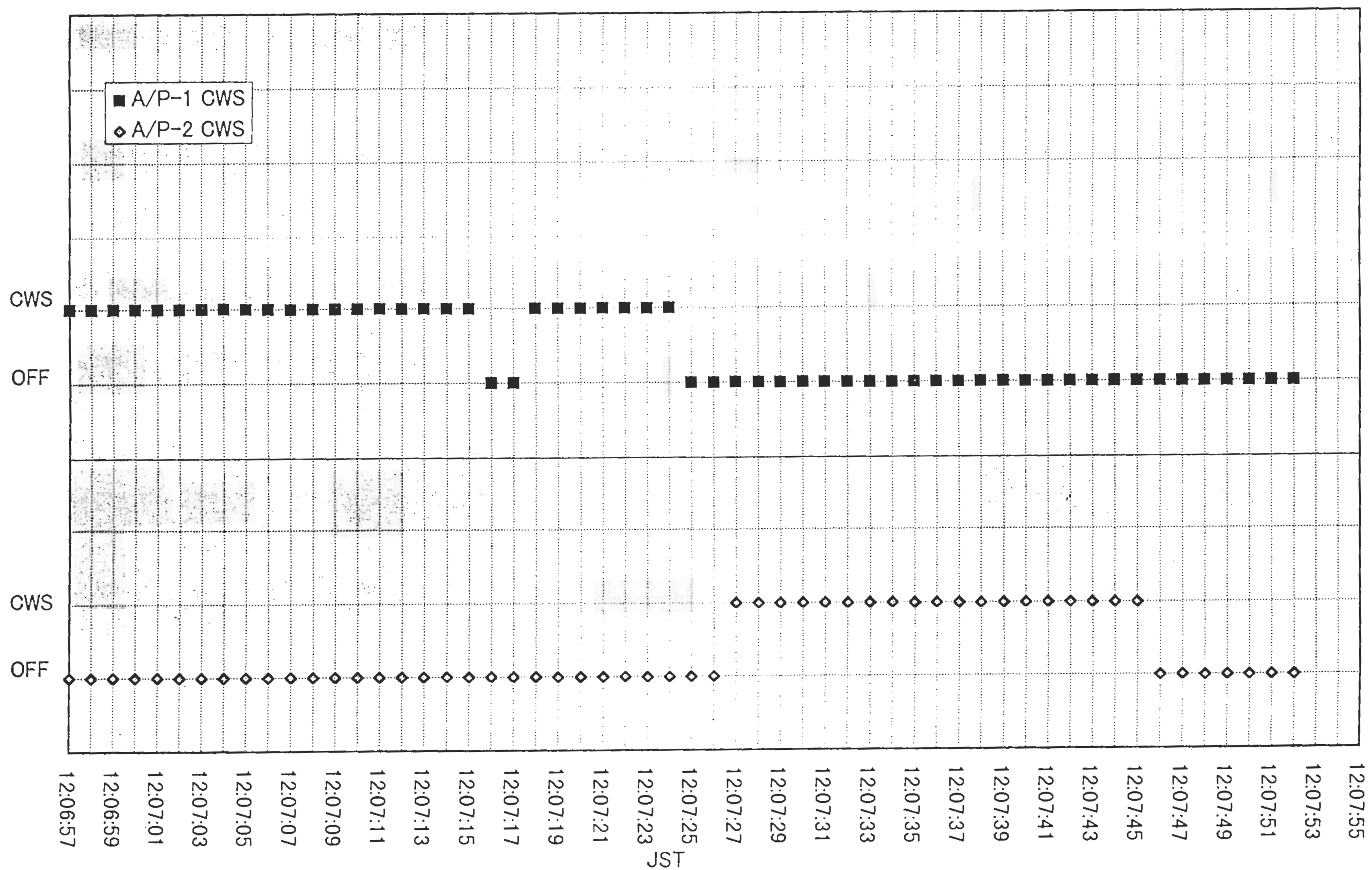


APPENDIX 2-4

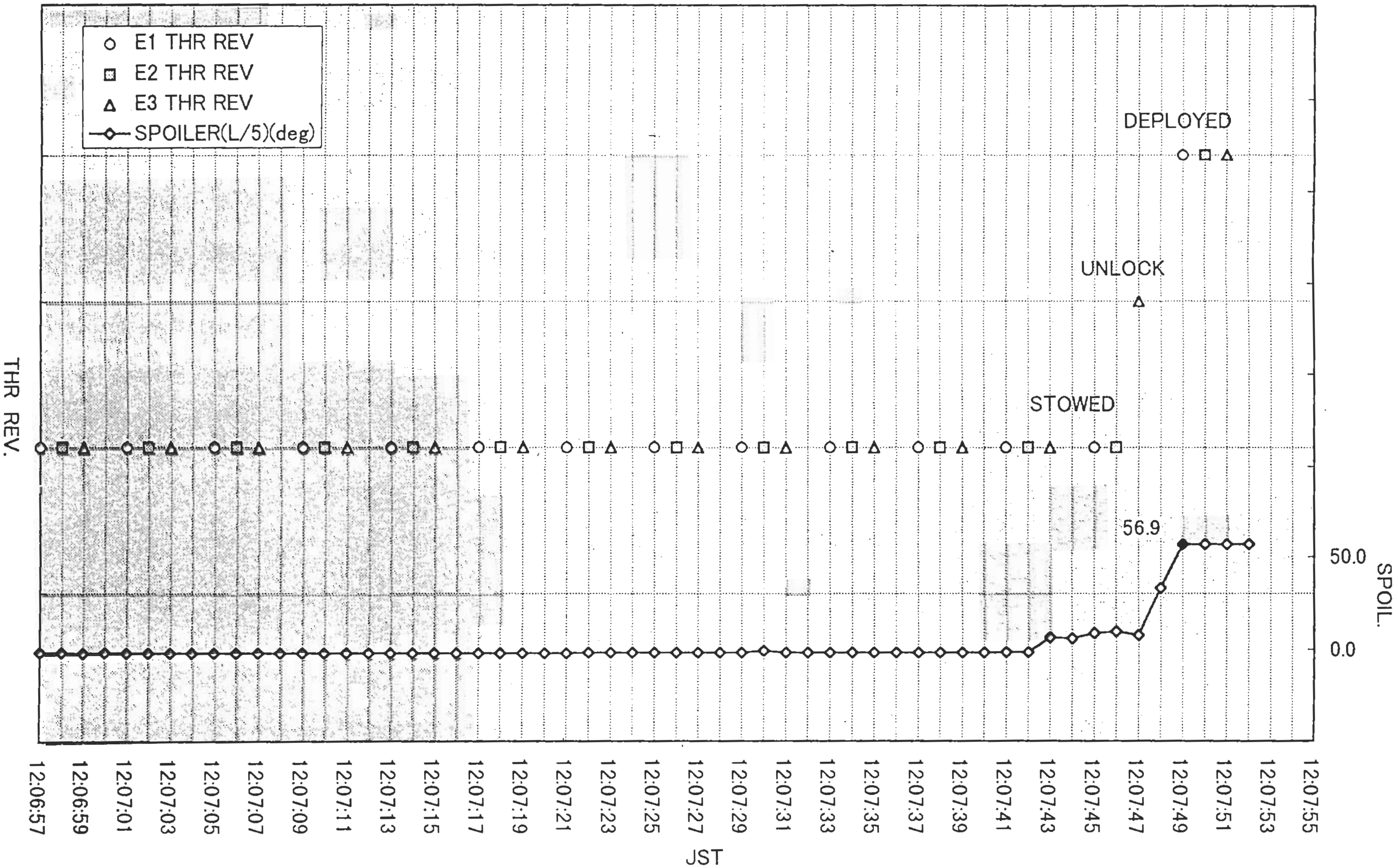
Brake Pedals



Auto Pilots

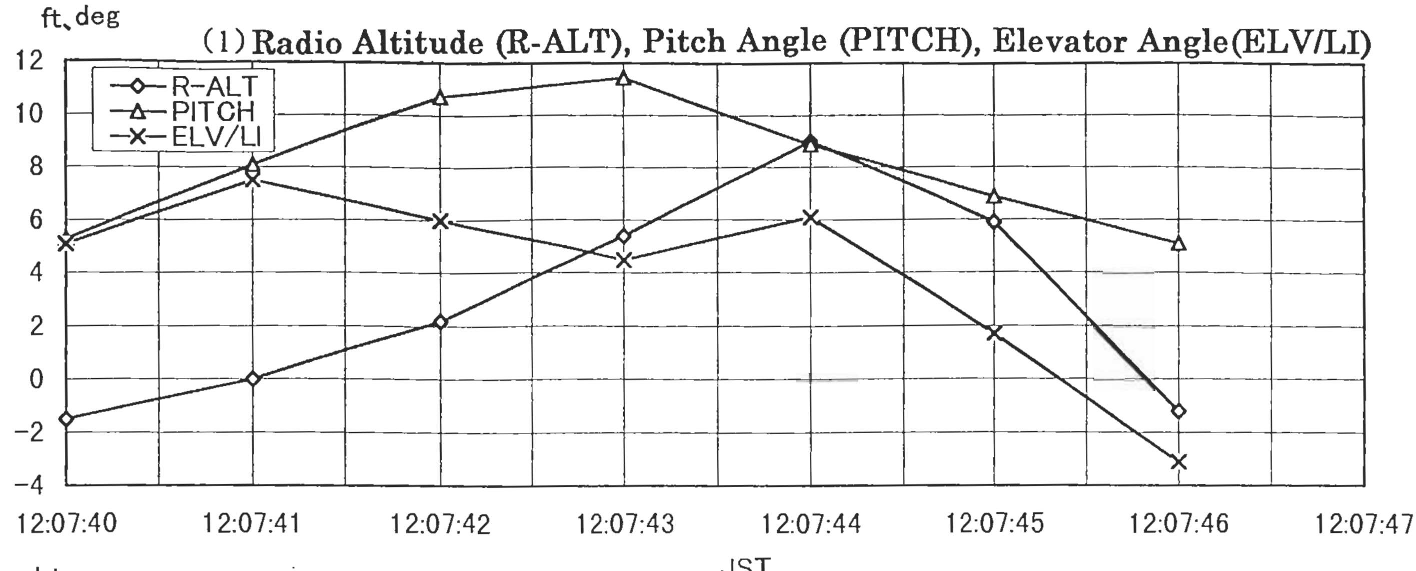

A/P-1 CWS
A/P-2 CWS
CWS
OFF
CWS
OFF
12:06:57
12:06:59
12:07:01
12:07:03
12:07:05
12:07:07
12:07:09
12:07:11
12:07:13
12:07:15
12:07:17
12:07:19
12:07:21
12:07:23
12:07:25
12:07:27
12:07:29
12:07:31
12:07:33
12:07:35
12:07:37
12:07:39
12:07:41
12:07:43
12:07:45
12:07:47
12:07:49
12:07:51
12:07:53
12:07:55
JST

Engine Thrust Reversers, Spoiler

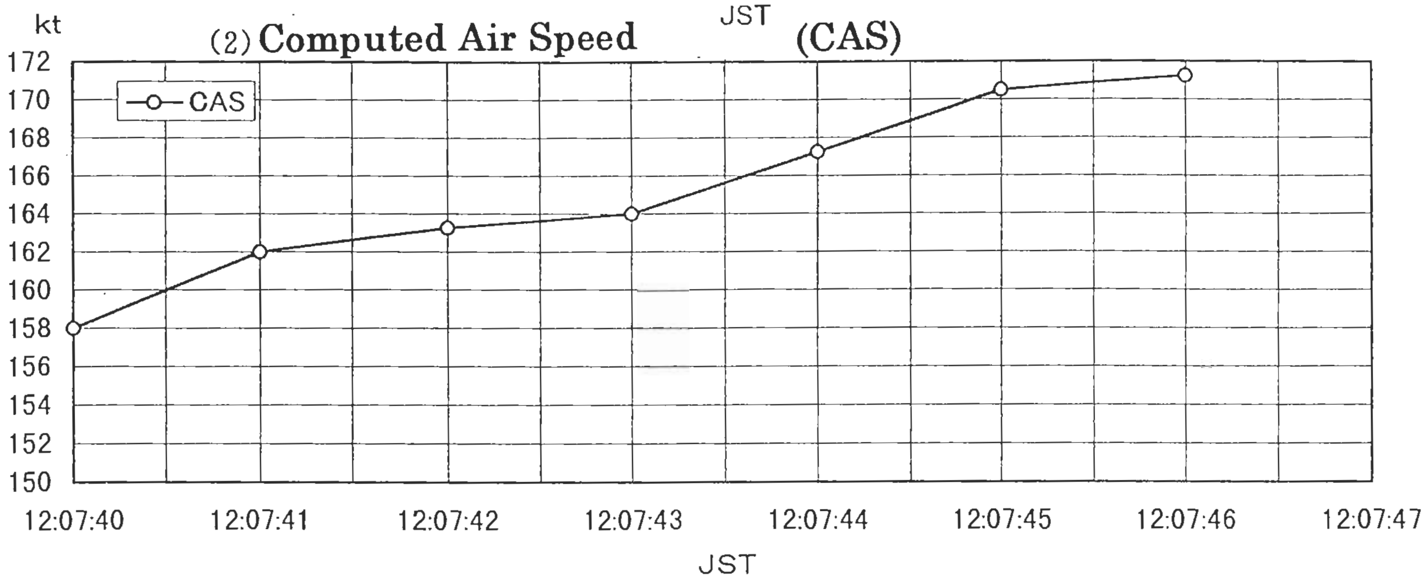


Detailed plots near the time of the aborted takeoff

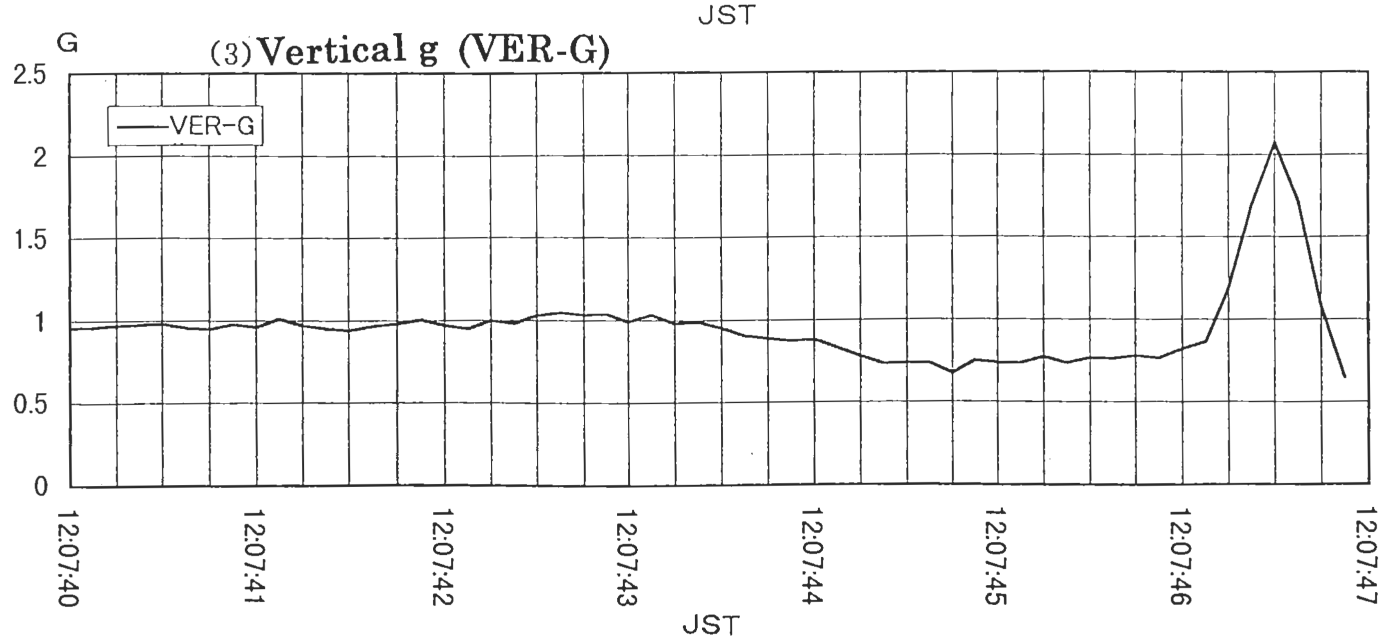
(1) Radio Altitude (R-ALT), Pitch Angle (PITCH), Elevator Angle(ELV/LI)



(2) Computed Air Speed (CAS)



(3) Vertical g (VER-G)



(NOTE) These plots in this page, parts of the whole DFDR plots appended herewith, were scaled up in a time axis for the sake of understanding a critical phase of the aborted takeoff.

BASIC OPERATION MANUAL(BOM) -- Excerpt --

4.2.2. CREW DUTIES BEFORE, DURING AND AFTER TAKE-OFF

01. GENERAL

During taxi and during the climb phase of a flight at altitudes below approximately 5000 ft above terrain, all cockpit crew members shall concentrate on cockpit procedures, cockpit monitoring and look out, and refrain from non-essential matters.

03. DURING TAKE-OFF

Talking should be limited to the required commands and calls as specified in the AOM.

In case of malfunctioning which may affect the take-off, the PiC will decide upon the action to be taken and given the appropriate command when required.

The flight engineer, if on board, is not allowed to stop an engine during take-off without the expressed command to that the effect, except for certain conditions as indicated in the relevant AOM.

To ensure good verbal communication between cockpit crew members, those wearing headphones will keep one ear free during take-off.

04. REJECTION OF TAKE-OFF

The minimum required accelerate-stop distance is based on a smooth, hard and dry runway.

For each aircraft type, this distance is demonstrated to the authorities by a highly skilled factory pilot well prepared for his task, who knows before hand which abnormal condition he will encounter and when this will happen.

For the line pilot the circumstances are different when engine thrust is lost before or at V1, because does not know if and when a failure will occur. Furthermore the line pilot may operate from slippery runways with a braking coefficient which is less than the one used for the ASD demonstrations.

Not-with-standing the use of a time delay before taking the decision to reject and the fact that reverse thrust is excluded for ASD demonstrations, it may be assumed that a rejection of a take-off on a marginal runway, from high speed close to V1, in particular when the runway is wet, can be extremely hazardous.

Therefore, above a speed specified in the relevant AOM, the use of the command word "STOP" or the advisory word "FAILURE" by any crew member, or rejection of take-off, should be confined to circumstances where a very positive loss of thrust occurs or where aircraft condition clearly renders it unflyable.

The decision to reject the take-off lies with the PiC except when the first officer is flying and he observes a malfunction which renders the aircraft unflyable such as flight control malfunction.

The PiC, however, remains responsible to the best of his ability.

AIRCRAFT OPERATION MANUAL(AOM) -- Excerpt --

3.3 FLIGHT TEHNIQUES
3.3.1 General

■ The PF calls and the PNF responds with "CHECKED"
- In case of a mode change that is not the immediate result of a selection.
  If the mode change goes unnoticed by the PF, the PNF calls and the PF responds with "CHECKED"

Summary of COMMANDS and CALLS

COMMANDS	CALLS
SET CWS 1/2 1)	CWS 1/2 SET 1)
SET AUTOTHROTTLE(S/ 1/ 2) ON	N_1 or SPEED or CLAMP
SET N_1	N_1

1) The number may be omitted when switching an already engaged autopilot.

No commands are described to select autothrottle(s) or autopilot(s) OFF, because this is normally done by the PF with the disengage buttons. Otherwise the terminology is as prescribed per procedure.
Announce any disconnection by calling "AUTOPILOT OFF" or "AUTOTHROTTLE OFF" and SCD extinguishing the respective warning light(s).

04.6 AUTODISCONNECT DURING TAKE-OFF

In case of an autodisconnect during take-off do not re-engage, but maintain the existing autopilot/autothrottle configuration until the AFTER TAKE-OFF checklist has been completed.
The Flight Mode of Operation might remain, or change back to, MANUAL.

05 REJECTED TAKE-OFF (RTO)

The rejection of a take-off at high speed can be extremely hazardous, especially when runway length and/or condition is critical. Therefor the take-off should only be rejected in case the continuation is considered less safe. The decision to reject may only be made before V_1.

The PF should reject the take-off in case of:
- Fire warning sound.
- Engine failure.
- Control problems affecting safe aircraft handling.

The rejection of the take-off for other failures than the above mentioned cases, should in principle be limited to speeds below 100 kts.

The rejection of the take-off is initiated by the call "STOP . In the above mentioned cases the PF may call "STOP". In all other cases the decision to initiate the rejection of a take-off is restricted to the captain.

It is very important that the brake pedals are pushed to maximum deflection AND ARE HELD IN THAT POSITION UNTIL THE AIRCRAFT HAS COME TO A COMPLETE STOP.

NOTE: Autobrakes are NOT certified as primary means to stop the aircraft. If installed, they are to be considered as a backup in case the PF fails to produce the required brake force.

Should the F/O or the F/E consider a rejection advisable, (s)he must announce the reason thereof (e.g. "ENGINE FAILURE"). In order not to distract the attention of the cockpitcrew during the rejection of the take-off, no further information about the reason to reject will be given until the aircraft has come to a full stop.

CREW CO-ORDINATION

PF	PNF	F/E
Move throttles rapidly to idle **AND SIMULTANEOUSLY** Apply maximum brake pedal deflection **IMMEDIATELY FOLLOWED BY** Reverse thrust Hold control column slightly forward of neutral	Check spoilers. If not extended: call "NO SPOILERS" Hold control column slightly forward of neutral	Check spoilers. If not extended: extend spoilers. "GREEN LIGHTS" 1)

1): In case of reverser failure the F/E calls "REVERSE NUMBER ...(AND ...) ONLY".

After the aircraft has come to a standstill:
- State nature of the failure.

CAPTAIN	FIRST OFFICER	F/E
Command: "TAKE ACTION". Make a PA announcement: "CABIN CREW AND PASSENGERS, REMAIN SEATED" Evaluate situation and decide on follow-up actions.	Inform ATC. Request assistance (as considered necessary).	Consult the Brake Energy Chart, refer to AOM 2.14.3 and advise pilots to use parking brakes accordingly.

Depending on circumstances:

- Start APU
- Consider to vacate the runway
- Inform ATC accordingly, request technical assistance, stairs and chocks
- Inform purser and passengers
- Shut down engines
- Switch off anti-collision lights and hi intensity lights
- Perform the Normal Checklist
- Consider towing the aircraft to a parking position and/or disembarking passengers via stairs.

03 <u>ENGINE FAILURE BETWEEN V_1 AND UP/RET MIN MAN</u>

The Engine Failure Crew Co-ordination Procedure is based on the n-1 obstacle clearance calculation and consequently applies to the corresponding track and assumes an engine failure at V_1.

<u>ENGINE FAILURE CREW CO-ORDINATION PROCEDURE</u>

<u>NOTE</u>: In the next presentation, the standard response "CHECKED" is not reproduced. No distinction is made between MANUAL and AUTOMATIC flight mode of operation.

FLIGHT PHASE/EVENT		COMMANDS		ACTIONS and CALLS
Engine failure			PF	Keep straight maintaining push force on the control column.
VR			PNF PF	"ROTATE" Rotate in normal way.
When airborne			PF	Keep pitchbar centered.
Positive rate of climb	PF	"GEAR UP"	PNF F/E	Comply. Wing anti-ice ON if required.
When aircraft is under control	CAPT	"TAKE ACTION"	F/E PNF	Perform memory items. Monitor F/E's actions.
When a turn is required	PF	"SET BANK LIMIT 15" "SET HEADING ..."	PNF	"BANK LIMIT 15 SET" "HEADING ... SET"
At 1000 ft HAA min unless otherwise specified	PF	"SET ALTITUDE HOLD"	PNF	"ALTITUDE HOLD"
At Flap Zero speed	PF	"FLAPS ZERO"	PNF	Comply
At Slats RET speed	PF	"SLATS IN" "SET AIRSPEED HOLD"	PNF	Comply "AIRSPEED HOLD"
When Slats are in	PF	"SET MCT" "SET N_1"	PNF	"MCT SET" "N_1"
Clear of obstacles See NOTE	PF	"SET ALTITUDE HOLD"	PNF	"ALTITUDE HOLD"
At UP/RET MIN MAN	PF	"SET AIRSPEED HOLD" -or- "SET SPEED MODE"	PNF	"AIRSPEED HOLD" -or- "SPEED"
If applicable	PF	"SET BANK LIMIT 25"	PNF	"BANK LIMIT 25 SET"
	CAPT PF	"EMERGENCY CHECKLIST" "AFTER TAKE-OFF CHECKLIST"	F/E	Comply

<u>NOTE</u>: Minimum 1500 ft HAA. Unless visual reference is available, or if dictated otherwise by special procedure, at least climb to the MSA or if applicable, to the ESA, MEA, MOCA or MORA.

03 EVACUATION PROCEDURE OPERATING COCKPIT CREW

General

- When cockpit task completed, take flashlight along when applicable. On water, put on life vest, board slide/raft with shoes off.
- When the slide/rafts are needed as shelter (desert, jungle) they should be disconnected from the aircraft when the captain considers it safe to re-enter the aircraft. Refer to AOM 4.2.2 - Post Evacuation.
  However, when during evacuation fire is observed, as many slides as possible should be disconnected from the aircraft before leaving the aircraft.
  On leaving the aircraft pull disengage handle and jump into the slide.

Flight Engineer

- Proceed to cabin area doors 11-21, and assist evacuation.
- When evacuation completed:
  . Check front area and leave aircraft at door 21, if possible.
  . On water: board at door 21.
- If door 21 is assigned to a cabin attendant, immediately after cockpit task is completed, leave aircraft and look after the passengers or in case of landing on water board the slide/raft.

First Officer

- Proceed to cabin area doors 13-23, and assist evacuation.
- When evacuation is completed:
  . Check area and leave aircraft.
  . On water: board slide/raft at door 13.

Captain

- Proceed to cabin area doors 11-21.
- Evaluate situation.
  Perform the final cabin check, proceeding to doors 14-24 to ensure that all occupants have evacuated.
- Check that the radio survival beacon at position 24 has been taken away.
- Leave aircraft:
  . On water: board slide/raft 24.

04 ADDITIONAL COCKPIT CREW

- Terrain:
  . Leave aircraft and assist at bottom of slide(s).
- Water:
  . Put on life vest and board slide/raft (shoes off).

APPENDIX 3-3

FLIGHT CREW REFERENCE GUIDE (FCRG) -- Excerpt --

(Major descriptions in relation to V_1 and V_R)

1.1.2. TAKE-OFF SPEEDS

01. SPEED SUMMARY AND DEFINITIONS

:

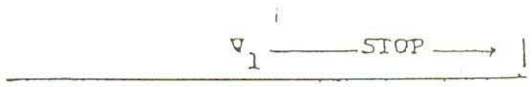
- V_1 : Speed at which the pilot can make a decision, following failure of critical engine:
  . either to continue take-off within limits of available take-off length
  . or to stop the aircraft within limits of available runway length

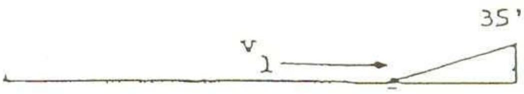
- V_R : Speed at which rotation is initiated to reach V2 at an altitude of 35 feet

04. TAKE-OFF DECISION SPEED, V_1

This speed is used to identify the power failure point at which, for the purpose of determining the required runway length, sudden and total power lost of the critical engine is assumed to occur.

In actual operation this speed is used as a "go" or "no go" parameter.



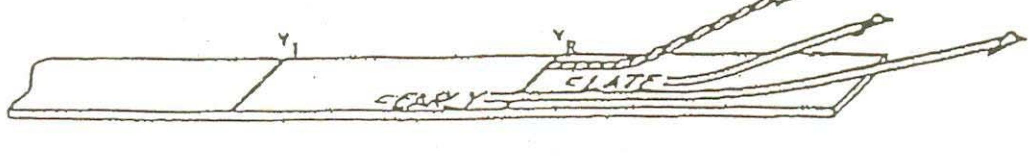


05. ROTATION SPEED, V_R

V_R is the speed at which rotation to the lift-off attitude is to be initiated.

If the rotation is too late and/or too little, the aircraft will pass low over the end of the runway at a speed in excess of V_2'.

If the rotation is too early and/or too much, drag is increased and acceleration will be affected unfavourable, so that also in this case the aircraft will pass low over the end of the runway. In both cases potential performance may be wasted to such an extent that safety is impaired.



AIRPLANE FLIGHT MANUAL -- Excerpt --

(Major descriptions in relation to V_1 and V_R)

SECTION IV PAGE 1. 2

Takeoff Decision Speed, V_1

The takeoff decision speed, V_1, is the speed which the pilot uses as a reference in deciding whether to continue the takeoff or to abort.

The V_1 speeds given in the FAA Approved Airplane Flight Manual are selected such that: (1) if an engine failure is recognized at or above the V_1 speed, the takeoff may be continued, with one engine inoperative, to a 35-foot height; or, (2) if an engine failure is recognized at or below the V_1 speed, a stop may be made in the available accelerate-stop distance on a dry hard surfaced runway without the aid of reverse thrust; and without, in either case, exceeding the takeoff field length. The takeoff field lengths are based on stopping if the engine failure is recognized below V_1 and on continuing if the engine failure is recognized above V_1.

SECTION IV PAGE 1. 3

Takeoff Rotation Speed, V_R

The rotation speed, V_R, is the speed at which the pilot begins to rotate the airplane to the lift-off attitude.

The criteria used in establishing the rotation speed are as follows:

1. The V_R speed is a speed that is at least equal to the ground minimum control speed, $V_{MC\ G}$, and at least 5 percent above the air minimum control speed, $V_{MC\ A}$.

2. The V_R speed is a speed such that, with normal piloting technique, its use will result in the attainment of the V_2 speed at or below the 35 foot point.

3. The V_R speed is a speed such that, with normal piloting technique, its use will result in attainment of the required lift-off speed at or prior to airplane lift-off.

4. The V_R speed is a speed which will not result in increasing the takeoff distance if rotation is commenced 5 knots lower than the established V_R during one-engine-inoperative acceleration or 10 knots lower than the established V_R during all-engine-acceleration.

(Major descriptions in relation to engine failure during a takeoff)

SECTION IV PAGE 2.0/2.1

Engine Failure During Takeoff

An engine failure light is provided to indicate an engine failure during takeoff. With engine failure lights operative the performance in this manual is based on the pilot initiating rejected takeoff procedures within 1 second after illumination of the engine failure light. The takeoff is rejected if failure is recognized prior to V_1 and is continued if failure is recognized after V_1. The rejected takeoff technique is: engine thrust to idle while simultaneously applying maximum anti-skid braking (full pedal deflection) and immediately extending the spoilers (auto spoilers may be used). The stopping performance used in determining the field lengths is based on a dry hard surfaced runway with no reverse thrust. Although not accounted for in the calculated performance, maximum reverse thrust should be used as quickly as possible after initiation of the abort procedure.

With engine failure at or after V_1, the nose wheel is maintained in contact with the ground until V_R is attained, at which point a smooth, steady rotation to the attitude for climbout is initiated. Liftoff will occur in approximately 4 seconds at a pitch attitude of about 12^o to 14^o. After liftoff a smooth rotation should be continued to the pitch attitude required to achieve V_2. A pitch attitude of between 13^o and 20^o will be required to maintain V_2, depending on gross weight and climb gradient. Minor variations in pitch attitude may be required to achieve the initial climb speed. During rotation the normal increase in indicated airspeed will slow due to static position error effect.

If an engine failure occurs after V_1 but not above V_2, maintain V_2 up to the altitude for level flight acceleration or to a height required for obstacle clearance (whichever is appropriate). If an engine failure occurs after V_2, maintaining the speed attained at time of failure but not more than V_2+10 knots up to the altitude for level flight acceleration or to a height required for obstacle clearance (whichever is appropriate) will result in improved aircraft performance and control. If an engine failure occurs at a speed higher than V_2+10 knots with flaps at the takeoff setting at a height lower than the altitude for level flight acceleration, reduce speed to V_2+10 knots until clear of obstacles. If the speed of V_2+10 knots has been exceeded, obstacle clearance may be impaired.

Landing gear retraction is initiated within 3 seconds after liftoff.

FLIGHT ATTENDANT MANUAL -- Excerpt --

Garuda Indonesia

RECURRENT TRAINING SYLLABUS FOR GARUDA
(REC. 1 : B 737-300/400, A 300-B4/600/330)
(REC.2 : DC 10, MD 11, B 747-200/400)

DAY - 1 OF 1

REVIEW

01.	GENERAL SAFETY	08.00 - 10.00

- Procedures
- Rules and Regulations
- Emergency Equipment
- First Aid
- Aviation Security
- Dangerous Goods

02.	AIRCRAFT SPECIFICATION	10.00 - 12.00

- General
- Exits
- Slide/Raft
- Oxygen System
- Communication System
- Emergency Equipment Location
- Lighting System
- Emergency Procedures
- Evacuation Procedures

	LUNCH BREAK	12.00 - 13.00
	COMPETENCE EXAM	13.00 - 14.00
02.	PRACTICAL DRILL	14.00 - 16.00

- Door Drill : - Preflight
  - Operation
- CPR (Cardio Pulmonary Resuscitation)
- Emergency Equipments
- Emergency/Evacuation

ALL OPERATORS WIRE(AOW)

June 16, 1994 No Export License Required

To: All CF6-50 Operators

Copy: All CF6-50 Reps
All Other Reps Information Only

Message No.: 94-50-07

Subject: CF6-50 Stage 1 HPT Blade

The purpose of this wire is to advise you that GE is recommending the retirement of high-cycle CF6-50 stage 1 Product Improvement Program (PIP) HPT blades (9299M30GXX other than G11 configuration). The purpose of this recommendation is to help you avoid future higher maintenance costs. Also, we would like to request your retirement plans for these parts to ensure that we can adequately support your future blade requirements.

Enhancements to the CF6-50 HPT stage 1 turbine blade, specifically the introduction of the PIP stage 1 turbine blades, have increased the life capability of the blade. The population of PIP blades now is beginning to age beyond this capability. As a result, plans need to be developed to retire older PIP blades before costly airfoil separations occur.

As the stage 1 blade ages, intergranular oxidation (IGO) attacks the internal passage walls. This IGO will result in cracking between the material's grain boundaries and eventually initiate high-cycle fatigue (HCF) cracking. The HCF will propagate along the airfoil walls until the airfoil separates from tensile overload. An improvement to the 9299M30G11 blade incorporates an internal aluminide coating that will protect the internal cooling passages from oxidation.

The IGO and airfoil separations are cyclic driven and occur between 4,400 and 6,500 cycles. GE feels a 6,000 CSN should be considered in a control program for blade retirement. There is a large number of blades that are in, or soon will be in, this cyclic range. The IGO condition cannot be determined by nondestructive inspections. Recommendations for a retirement plan can be customized for your particular fleet through your ATPM. Once your retirement plan has been established, please advise us as soon as possible so we can ensure adequate support.

Thank you for your cooperation in this matter.

L. L. Grage
Director Customer Support
GE Aircraft Engines
LAJ

Materials for Regional Meeting -- Excerpt --

Age-Related Problems

CF6-50 HPT Stage 1 Blade

Conclusion

- Prevention of IGO caused blade separation requires establishment of soft-time retirement threshold

  - Incorporation of retirement threshold will reduce the occurrence of IFSD/high-cost engine events

    - Also help prevent T/E thermal fatigue events

PPT-85852-041196 (CF6AO)

Summary

- Overall CF6-50 PIP and -80A reliability continues to improve
  - Added value for CF6-50/-80A customers
- Soft-time management of blades will increase/ maintain reliability and value
- New design release in 1996 incorporates proven technology into CF6-50/-80A HPT stage 1 blade design

GEAE Continues Investment in CF6 Mature Products

Recommendation

- Retire CF6-50 HPT stage 1 blades (pre-P/N 9299M30G11) at approximately 6,000 cycles since new
  - Probability of having separation below 0.1%
  - Compromise between cost of replacing blades versus cost of blade separation

7 COMMENTS FROM INDONESIA AND THE USA

Comments from Indonesia

(Though Japanese translation was prepared by
Indonesian AAIC, it is not attached herewith.)

KOMISI PENELITIAN PENYEBAB KECELAKAAN PESAWAT UDARA

(AIRCRAFT ACCIDENT INVESTIGATION COMMISSION)

DEPARTEMEN PERHUBUNGAN

(DEPARTMENT OF COMMUNICATIONS)

MERPATI BUILDING, JL ANGKASA BLOK B 15 KV2-3, KEMAYORAN, JAKARTA 10720, INDONESIA,
PHONE 62 22 6540674 , FACSIMILE 62 22 654 0675

Dr. Kazuyuki Takeuchi
Chairman,
Aircraft Accident Investigation Commission
Ministry of Transport
2-1-3 Kasumigaseki
Chyoda-ku, Tokyo, 100 Japan.

Jakarta, November 10, 1997.

Dear Dr. Takeuchi,

The Indonesian Aircraft Accident Investigation Commission has carefully read the

FINAL DRAFT AIRCRAFT ACCIDENT INVESTIGATION REPORT
September , 1997

of the Garuda Indonesia DC-10-30 accident at the Fukuoka Airport, June 13, 1996.

The Indonesian Aircraft Accident Investigation Commission is of the opinion that you have made a very thorough and comprehensive evaluation of the possible causes of the accident, and we congratulate you for the professional approach evident in your report.

The Indonesian Aircraft Accident Investigation Commission's comments on the Final Draft Aircraft Accident Investigation Report above, is as follows:

1 p.60 Chapter 4 Causes.

Quote:
It is estimated that contributing to the rejection of the take-off under this circumstance was the fact that the CAP's judgement in the event of the engine failure was inadequate.

Comment:

According to the Appendix. Format of the Final Report of the ICAO Annex 13 quote 3. Conclusions. List the findings and causes established in the investigation. The list of causes should include both the immediate and the deeper systemic causes unquote.

The final draft of the aircraft accident investigation reports a single cause of the accident, which is not according to the standards and recommended practice as stated above.

In accordance to above mentioned Appendix of ICAO Annex 13, the Indonesian Aircraft Accident Investigation Commission emphasizes that an accident is usually caused by more than one factor or cause. It is considered that an accident is usually caused by a chain of cascading failures, either human, technical or environmental, all contributing and eventually accumulating in the inevitability of an accident. If this is true, and looking at so many clues of failures in the Garuda accident at Fukuoka, such as indications of engine failure and unbalanced fuel during rotation occurring at approximately the same time, the issue of flight crew decision-making process resulting in the act to abort take-off, the perceived danger or unusual flight situation right after experiencing a sudden noise (a thud, or a *dun*-like sound), etc. etc., all these single factors may contribute, aggregate and culminate to the occurrence of the accident.

2 p.6, Para 2.1.2. Flight history until DFDR and CVR stopped.

Quote:
"About 1135 The CAP carried out a pre-departure crew briefing, which included briefing an emergency procedure".

Comment:
For the purpose of clarity, it is suggested to explain in detail what is meant by *pre-departure crew briefing* and *emergency procedure.*

3 p.18, Para 2.6.4. Fuel and Lubricating Oil.

Comment:
There is some factual evidence indicating the possibility of a fuel unbalance after the refueling process was completed, and this possibility was not further investigated in the final draft report.

The following table is based on cockpit fuel indicators readings:

FUEL STATUS BASED ON COCKPIT INDICATORS	FUEL TANK #1	FUEL TANK #2	FUEL TANK #3
PLANNED FUEL ORDERED	17,800	26,400	17,800
ACTUAL FUEL AFTER REFUELING	15,750	28,750	17,800
FUEL INDICATORS OF F/E PANEL	17,000	28,000	17,000

Further more, according to the Aircraft Flight Logbook records, the fuel quantity indicators were not reliable. On June 11, 1996, it was recorded that the #1 fuel quantity indicator was *unserviceable,* while on June 12, 1996, it was recorded that the #2 fuel quantity indicator was considered *unreliable.* It is worth mentioning that several complaints concerning the unreliability of the fuel quantity indicators were recorded in the Maintenance Log Book

From the Cockpit Voice Recorder it was also found that the time needed to balance fuel is 65 seconds. A simulation on a DC-10 ground simulator resulted that the process to balance by transferring fuel took approximately 3 (three) minutes to finish. This indicated that there is some uncertainty in the outcome of the fuel balance process, and if this is the case, Garuda procedures required a drip stick check.

The Indonesian Aircraft Accident Investigation Commission would like to include an analysis concerning the effect of this fuel unbalance as a possible contributing factor in the accident.

4 p.20, Para 2.11.2 DFDR recording

Quote:
Information recorded on the DFDR between 1207:53 and 1207.56 were unusable.

Comment:
The Indonesian Aircraft Accident Investigation Commission is concerned about the possibility of important information lost by not recovering some or more data. There are methods known to recover data by special manipulations. It is suggested that the utmost should be done to recover the data, and in this particular case, especially the final moments before the aircraft hit obstacles and the post impact fire.

5 p.36, Para 2.14 Test and research to find facts.

Comment:

On page 9, in his statement, the CAP mentioned that quote *while the aircraft was not positively climbing up with the pitch attitude being ten or more degrees nose up, the airspeed abruptly began to decrease by 3 to 6 knots. At the same time, I seemed to involuntarily make the aircraft pitch down. I heard a sound such as "dun", and I felt a thrust loss. As I instinctively sensed that if the aircraft continued the take-off, it would collide with neighboring buildings, I made a decision to abort the take off, pushed the control column, applied maximum braking and deployed full reverse thrust* unquote.

Comparing this statement with the DFDR results, there seems to be a discrepancy in DFDR speed data and the pilot's observations. The Indonesian Aircraft Accident Investigation Commission is of the opinion that a test-bench check on the airspeed indicators is necessary to ascertain that it was working normally at the time of the accident.

The Commission deemed necessary to study the human factors aspects to understand the reasons why the CAP took the decision to abort take-off.

In Para 2.14 no mention was found about the behavior of the CWS switch. In page 45 it was stated that there are indications that the CWS was not working properly. It is therefore appropriate to test-bench the CWS system and the results of said test to be included in the final draft report.

6 p. 46, Para 3.2.1.1 Flight sequence before the occurrence of the #3 engine failure.

Quote:

As it is likely that the aircraft was performing the take-off roll to the left of the runway centerline, it is considered that the aircraft was being rolled slightly left wing low during the low speed phase of the take-off roll, and that right rudder would have been applied to prevent the aircraft nose from veering to the left because of the runway lateral slope from the centerline to the left edge of the runway.

Comment:

This statement is not consistent with the statement on page 6, which is quote *the aircraft was aligned almost with the runway center line unquote.*

It is considered that the above statement is an opinion, hypothesis or assumption, it is not an actual and observed fact. The Commission is of the opinion that the analysis on page 46 should be based upon factual information on page 6.

The Indonesian Aircraft Accident Investigation Commission considered above statement not to be valid.

7 p.49 <u>Para 3.2.3.1. Flight aspect until the take-off was aborted.</u>

<u>Quote:</u>
.... *(1) Except for the failure of the No.3 engine, there were no other anomalies which contributed to the accident ....*

<u>Comment:</u>
The Indonesian Aircraft Accident Investigation Commission points out that there are other anomalies that is not reported in the investigation and the final draft report, i.e. the question of fuel unbalance, the question of the improper behavior of the CWS switch, the fact of a number of right rudder applications during the take-off run, etcetera, etcetera.

In particular the Indonesian Aircraft Accident Investigation Commission points out that in the statement of the Flight Engineer a possible serious problem was mentioned, i.e. quote *Immediately after the Vee one call, as I acknowledged the drops of N1, N2 and EGT on the No.3 engine, I called 'Engine Failure', immediately followed by 'Number one'. I intended to call 'Number three' but called 'Number one'. At that time, the Captain called 'Unable control'* unquote.

This indicates that there is at least one other problem than engine failure.

The Indonesian Aircraft Accident Investigation Commission requests to the Japan Aircraft Accident Investigation Commission to include and analyze all possible anomalies that might contribute to the accident individually, or cumulatively.

In particular, the Commission strongly suggest that a human factor aspect analysis of the Captain's decision making process should be included in the final report. Note that the Captain's decision to abort the take-off was based on his judgment about an abnormality quote *I felt something unusual because the aircraft would not become positively airborne .... if the aircraft continued the takeoff, it would collide with neighboring buildings, I made a decision to abort the take-off* unquote.

This abnormality was mentioned in the Flight Engineers statement quote *At that time, the Captain called 'Unable control'* unquote.

8 p.57 <u>Para 3.6.1 Emergency evacuation training for flight crew.</u>

<u>Quote:</u>
There were no rules for evacuation training for flight crew in the Garuda's FCTM (Flight Crew Training Manual), and thus it was not possible to determine the training syllabuses and training records.

<u>Comment</u>:
During the meeting on August 28, 1997, the Indonesian Aircraft Accident Investigation Commission submitted several pages concerning the syllabi for flight crew emergency evacuation training in Garuda Indonesia. The Commission considered the importance of including a review of the available records in the final draft.

Dear Dr. Takeuchi,

We finally would like to commend you for the thorough and comprehensive way you have conducted the investigation. We do think that the investigation will be very useful in helping us to understand the what, the how, and the why the accident happened. And in understanding the what, the how, and the why, I am sure that you have contributed to our common aim to prevent accidents to happen in the future.

Thank you very much for your kind attention,

Yours sincerely,

Prof Oetarjo Diran
Chairman
Indonesian Aircraft Accident Investigation Commission

Attachment:
The Japanese translation of this document.

Comments from the USA

1967 ~ 30 Years of Transportation Safety ~ 1997

National Transportation Safety Board

Washington, DC 20594

November 9, 1997

Mr. Atsuhiko Wataki
Investigator in-Charge
Aircraft Accident Investigation Commission
Ministry of Transport
2-1-3 Kasumigasoki,
Chiyoda-Ku, Tokoyo 100, Japan

Dear Mr. Wataki,

Thank you for the opportunity to comment on the Final Draft report of the Garuda DC-10 accident, PK-GIE, June 13, 1996, Fukuoka Airport, Fukuoka, Japan. Although the initial letter stating the draft reports would be sent that day was dated September 12, 1997, we also received a revision letter from you dated October 16, 1997 which informed us of the changes incorporating comments from the General Electric representative, Mr. Robert Green. As of this time, we have not had any comments from the Flight Safety department of the Douglas Product Division.

Copies of the Final Draft report were reviewed by members of the U.S. team, to include NTSB and FAA personnel, and representatives from Douglas (Boeing) and General Electric. We appreciate that copies of the report were sent to us in both Japanese and English.

It is obvious from thoroughness of the report that a great deal of effort went into the investigation. Although we find no areas of disagreement, one area that was not explained pertains to the galley equipment. Other aircraft accident investigations that involved higher impact forces have not had galley equipment found spilled into the aisles like what was found in this aircraft. Although it did not appear to prevent any of the passengers from escaping from the aircraft (except for the flight crew who had to use the cockpit window exits), we found no explanation for why this equipment was not held in place by the galley locks.

The report does document the exit usage very well. A review of those numbers showed that the "flow control" of passengers to exits resulted in unequal use of exits.

Another thing that may also be useful would be information about the R4 door. It's arm/disarm lever was in the disarm position and the door was found slightly open.

The Safety Recommendations presented in Paragraph 5 of the final draft report appear to fully comply with the ICAO 13 (3.1) Objectives of the Investigation. These recommendations send an important message and should serve to promote the prevention of accidents and incidents throughout the world of civil aviation.

Although I was not able to be on hand during your teams visit to the US in January and February, it is obvious from the report that the work they accomplished made for a better and more through report.

With professional regards,

Alfred W. Dickinson

Alfred W. Dickinson
U.S. Accredited Representative