

INDEPENDENT AIRCRAFT ACCIDENT INVESTIGATION COMPILATION

PT. Garuda Indonesia Airways
Boeing 737-400 PK-GZC
Adi Sucipto International Airport 7 March 2007

Compiled By: Gerry Soejatman

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All inquiries regarding the official investigations should be directed to:

The National Transportation Safety Committee, the Republic of Indonesia
Ministry of Communications
National Transportation Safety Committee
Gedung Karsa Lt. 7
Departemen Perhubungan
Jalan Medan Merdeka Barat No. 8
Jakarta 10110 - Indonesia

Glossary of Abbreviation

AGL	Above ground level
AMSL	Above mean sea level
AOC	Air Operator's Certificate
ATC	Air Traffic Control
ATPL	Air Transport Pilot's License
CASR Part 121	Operations Permit for scheduled aircraft with more than 20 seats
CPL	Commercial Pilot's License
CVR	Cockpit Voice Recorder
DGAC	Directorate General for Air Communication
DME	Distance Measuring Equipment
F/O	First Officer
FDR	Flight Data Recorder
IFR	Instrument Flight Rules
ILS	Instrument Landing System
Kg	Kilograms
Km	Kilometers
Kt	Knots (Nautical Miles per hour)
Lbs	Pounds
MLW	Maximum Landing Weight
MTOW	Maximum Take Off Weight
Nm	Nautical Miles
NTSC	National Transportation Safety Committee
°C	Degrees Celsius
PIC	Pilot In Charge
QFE	Height above airport elevation on local station pressure
QNH	Altitude above mean sea level on local station pressure
QRH	Quick Reference Handbook
S/N	Serial Number
SOP	Standard Operating Procedures
UNKN	Unknown
UTC	Universal Time Coordinated
VFR	Visual Flight Rules
VMC	Visual Meteorological Conditions

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The compiler hereby apologize for the misunderstanding, in particular to the National Transportation Safety Committee.

Compiler.
12th April 2007

NOT OFFICIAL

INDEPENDENT AIRCRAFT ACCIDENT INVESTIGATION COMPILATION
Garuda Indonesia Airways 737-400, GA200, Yogyakarta, 7 March 2007

FACTUAL INFORMATION

1.1 Summary Information

Landing Facility/Approach Information					
Airport Name Adi Sucipto International Airport	Airport ID JOG/WARJ	Elevation 350'	Runway Used 09	Runway Length 2200m	Runway Width 45m
Runway Surface Type: Asphalt					
Runway Surface Condition: Dry					
Type of Instrument Approach: NONE					
VFR Approach/Landing: FULL STOP; STRAIGHT IN					
Aircraft Information					
Manufacturer: Boeing		Model/Series: B737-400/737-497		Serial Number: 25664	
Airworthiness Certificate(s): Transport			Landing Gear Type: Retractable – Tricycle		
Number of Seats: 16C/130Y		Certified Max Gross Weight: 64 tons estimated		Number of Engines: 2	
Engine Type: Turbo Fan	Engine Manufacturer: CFM International	Model/Series: CFM56-3C1	Rated Power: 22,000lbs - 23,500lbs		
Aircraft Inspection Information					
Type of Last Inspection:	Date of Last Inspection:	Time since last inspection:	Airframe Total Time:		
Emergency Locator Transmitter (ELT) Information					
ELT Installed: YES	ELT Operated in search: NO		ELT Aided in search: NO		
Aircraft History:					
Registration	Airline		Date Delivered		
PK-GZC	Garuda Indonesia		2002-10-04		
N664AL	Private (AFTTS 1)		2002-06-11		
VT-JAP	Jet Airways		1997-10-28		
F-GRSC	Star Europe		1996-04-23		
N402AL	Aloha Airlines		1992-11-13		
Owner/Operator:					
Registered Aircraft Owner:		UNKN			
Registered Aircraft Operator:		Garuda Indonesia			
Operator does business as:		Commercial Regular Passenger Air Transport (Scheduled)			
Operator Designation Code:		GA/GIA			
Operator Certificate:		CASR Part 121			
Operating Certificate:		Flag Carrier and Domestic			
Regulation Flight Conducted Under:		Indonesian, Commercial, CASR part 121 operator			
Type of Flight Operation Conducted:		Scheduled; Domestic; Passenger only			
First Pilot Information					
Name:	City	Sex	Date Of Birth	Age	
Marwoto Komar	Jakarta	Male	UNKN	UNKN	
Seat Occupied: LEFT		Principal Profession: Occupational Pilot		Certificate Number: UNKN	
Certificate(s): Air Transport; Commercial					
Airplane Rating(s): Multi-Engine Land, Single-Engine Land, Boeing 737-300/400/500					
Instrument Rating: Airplane					
Medical Cert: Class 1	Medical Cert. Status: Without Waivers/Limitations		Date of Last Medical Exam: UNKN		

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Second Pilot Information				
Name:	City	Sex	Date Of Birth	Age
Gagam Rochman	Jakarta	Male	UNKN	UNKN
Seat Occupied: RIGHT		Principal Profession: Occupational Pilot		Certificate Number: UNKN
Certificate(s): Commercial				
Airplane Rating(s): Multi-Engine Land, Single-Engine Land, Boeing 737-300/400/500				
Instrument Rating: Airplane				
Medical Cert:		Medical Cert. Status:		Date of Last Medical Exam:
Class 1		Without Waivers/Limitations		UNKN
Flight Plan / Itinerary:				
Type of Flight Plan: IFR				
Departure Point		Code	Scheduled Departure	Time Zone
Jakarta Soekarno Hatta Intl.		CGK/WIII	2300	UTC
Destination Point		Code	Scheduled Arrival	Time Zone
Yogyakarta Adi Sucipto		JOG/WARJ	0000	UTC
Route:		HLM1J/2J.HLM.W17.GEPAK		
Weather Information:				
Source: Airport (Air Force/Angkasa Pura)				
WARJ 2200UTC 080/06 5000HZ SCT018 24/23 Q1003.6				
WARJ 2230UTC 060/06 5000HZ SCT018 24/23 Q1003.6				
WARJ 2300UTC 050/06 5000HZ SCT018 24/23 Q1004				
WARJ 2330UTC 050/07 5000HZ SCT018 24/23 Q1003.6				
WARJ 0000UTC 050/05 6000HZ SCT018 24/23 Q1003.6				
WARJ 0030UTC 060/10 6000HZ FEW017 26/23 Q1004				
Accident Information				
Aircraft Damage:		Aircraft Fire:		Aircraft Explosion:
Destroyed		During Evacuation		During Evacuation
Injuries				
Type:	Flight Crew	Cabin Crew	Passenger	Total
Fatal	0	1	22	23
Serious/Minor/None	2	4	108	114
Total Complement	2	5	130	136
Note: Please refer to officially released figures				

1.2 History of Flight

On March 7, 2007, 0657 local time, Garuda Indonesia Flight 200, a Boeing 737-400, registration PK-GZC, overran the runway upon landing at Yogyakarta Airport, Indonesia. The airplane was destroyed by post crash fire. There were 21 reported fatalities and 50 serious injuries among the 133 people on board (Captain, First Officer, 5 Flight Attendants and 126 Passengers). Visual Meteorological Conditions (VMC) prevailed at the time of the accident. The scheduled domestic passenger flight was conducted under the provisions of the Civil Aviation Safety Regulations (CASR) Part 121, and an instrument flight rules (IFR) flight plan had been filed. The captain, first officer, five flight attendants and 126 passengers were on board.

The flight originated from Soekarno-Hatta International Airport, Jakarta (CGK/WIII) at around 2300 UTC and was conducting its landing at Adi Sucipto International Airport, Yogyakarta (JOG/WARJ) when the accident happened.

According to an interview of the Captain by the chief of Garuda Pilots Association, Capt. Stephanus, The flight was normal until 1000 feet. When the aircraft flared for landing, the Captain reported feeling something pushing the aircraft from behind. According to Capt. Stephanus' interview, the Captain of the flight did not know why he was going so fast that he could not stop ⁽¹⁾. The Captain, Capt. Marwoto Komar was the Pilot In Charge of the flight with his co-pilot, First Officer Gagam Rohman.

There were no reports of any problems with the aircraft during the approach and landing segments. The aircraft was cleared to land on runway 09 after a visual approach, landed long, touching down at 685 meters after the threshold and bouncing before contacting the runway again at 885 meters after the threshold. During one of those two ground contacts, the nose wheel tires of the aircraft disintegrated, and after the second ground contact, the aircraft continued on its landing roll, deploying its spoilers and the number two engine thrust reverser. Witnesses stated sparks were produced from the nose wheel rims during the landing roll. The aircraft departed the runway beyond the threshold of runway 27, to the right of centerline and crossed the main access road to Yogyakarta's Air Force Academy before coming to a stop around 300 meters beyond the runway. An evacuation order was given from the cockpit, first from the first officer and then from the captain, however it is unclear at this stage whether that was heard in the cabin. Smoke was reported to have entered the cabin and a fire started from the front right of the fuselage. The cabin crew initiated cabin evacuation and passengers deployed through the emergency exit windows and the rear exit door on the left side. All exits on the right were blocked by fire and the front left door was unusable. Video footage recorded by a passenger revealed the evacuation from the outside of the aircraft, with fire progressively increasing until help arrived. Severely injured passengers were evacuated to ambulances waiting nearby at the Air Force Academy road to hospitals while the lightly injured and uninjured were transported to the terminal.



The path of PK-GZC during the landing roll and overrun (Google earth)

1.3 Damage to Aircraft

Aircraft destroyed by fire. The tailplane and starboard horizontal stabilizer were charred and no part of the starboard fuselage walls remained in tact. On the left side of the aircraft, fire engulfed the fuselage to the cabin window level from the top. The right wing outboard of the engine mounting had rested on top of the left wing facing 135 degrees from the direction of the aircraft. All landing gears were detached and both engines were detached.



Fire had destroyed most of the fuselage (detik.com)

1.4 Personnel Information

The Captain, held an airline transport pilot certificate with an airplane multiengine land rating, commercial privileges in airplanes single-engine land, and type ratings in the Boeing 737-300/400/500. Past ratings reported to have included Fokker 28. His 1st-class airman medical certificate is reported to have contained no restrictions and limitations. He has been a pilot in Garuda over 20 years. No information has been collected on his total logged hours, hours on type, and hours as command on type.

The first officer, held an a pilot's license with commercial privileges in airplanes single engine-land, with an airplane multiengine land rating, and type ratings in the Boeing 737-300/400/500. His 1st-class airman medical certificate is reported to have contained no restrictions and limitations. He has been a pilot in Garuda since 2005 fresh from the national flight school (Curug). No information has been collected on his total logged hours and hours on type.

Five flight attendants had been trained, licensed and were certificated on the 737-300/400/500.

1.5 Aircraft Information

The Boeing Company built PK-GZC (s.n. 25664), a model B737-497, in 1992. It was powered by two CFM International CFM56-3C1, each rated at 22,000lbs - 23,500lbs. The airplane has been maintained under an airworthiness maintenance program compliant with the requirements of the Civil Aviation Safety Regulations of Indonesia. No inspections information has been collected for this compilation.

The aircraft was reported to have brake problems the day before the accident after the brakes malfunctioned. The damage was repaired and the aircraft was declared flight-worthy prior to undertaking the flight of the accident ⁽²⁾.

1.6 Meteorological Information

Jogjakarta's Weather Observations recorded the following METAR (Aviation Routine Weather Report) at 2330 UTC: Wind, 050 degrees at 5 knots; visibility 5000 meters, hazy; sky condition, scattered clouds at 1,800ft; temperature, 24 degrees Celsius (C.); dew point, 23 degrees C.; altimeter 1004 milibars. Remarks: None

And at 0000 UTC:

Wind, 050 degrees at 5 knots; visibility 6000 meters, hazy; sky condition, scattered clouds at 1,800ft; temperature, 24 degrees Celsius (C.); dew point, 23 degrees C.; altimeter 1004 milibars. Remarks: None

1.7 Aerodrome Information

JOG is located 7 kilometers east of downtown Yogyakarta, and is situated at an elevation of 350 feet amsl (above mean sea level). The airport have 2 runways, runway 09/27 (asphalt), and 09R/27L (grass). PK-GZC landed on runway 09 (2200m meters x 45m, asphalt).

The surrounding terrain resulted in JOG having only 1 ILS for 09 and none for 27, which is visual only. For runway 09 approaches, there is terrain of >2000ft 4NM after the runway, with 1000ft contour about 3NM from the other end of the runway. The terrain to the right of centerline is >2500ft extending to the southwest from the airport. The north side is dominated by Mount Merapi, where the 1000ft mark is 5NM to the left of centerline and 2000ft at 10NM, thereafter rising rapidly to 10,000ft.

Approaches into 09 require intermediate steps on the latter part of the descent. This is due to a terrain obstruction of up to 2820ft at 20NM from the airport along the approach path. It is in the published approach procedures that aircraft descend to 4000ft initially until 8NM from the JOG VOR where they would hold at or above 4000ft, or continue. To continue the approach, aircraft normally intercept the localizer from 4000ft, or descend to the initial fix at 2500ft by:

- 3NM from JOG for a VOR/DME approach 09, giving a 4.93% descent gradient, and then a 5.12% gradient approach to the missed approach point.
- 3.5MN from JOG, for a 5.48% descent gradient to the decision altitude.

Both approaches have the same missed approach procedure, that is climb to 1500ft and turn left to holding fix via JOG VOR, continue climb to 4000ft, cross JOG VOR/DME at or above 2500ft.

1.8 Fire Fighting & Rescue Unit Reaction

Activation of the airport crash bell immediately dispatched the rescue vehicles. However, upon reaching the eastern end of the perimeter, the foam trucks cannot cross the Air Force Academy access road. This hindered other rescue vehicles too. Units on foot however, from both the air base and the academy were first on the scene, moving survivors away from the burning aircraft. 1 person with a fire extinguisher was on hand. It took sometime for the fire fighting unit to find a way to fight the fire, that is to circle the airport and enter the access road from outside the airport perimeter, and then deploying the hosepipe to the scene. Ambulances were quick to arrive on the scene.

1.9 Flight Recorders



Photo of the flight recorders being removed from the site (*indoflyer.net*)

The airplane was equipped with a cockpit voice recorder (CVR) and a flight data recorder (FDR). The recorders were secured and quarantined on the day of the accident and then sent to the Australian Transportation Safety Board (ATSB) for download and readout. The CVR was unable to be downloaded in Australia and has been sent to Honeywell in the United States due to damage caused preventing it to be read in Australia.

1.10 Video Footage

A video footage by a passenger of the flight after the evacuation has commenced revealed the state of the aircraft between evacuation and the aircraft being destroyed by fire. The aircraft fuselage was intact except for the cockpit, the front doors and the first few rows of business class. Those parts have been deformed by the impact and the nose of the aircraft was below the cabin floor level, inverted.

The footage shows that most of the passengers evacuated using the emergency exit windows and the rear door. It also shows fire quickly ravaging through the fuselage and accompanied by small explosion and a large explosion. It is possible that the small explosions came from the passenger chemical oxygen generators above the cabin. From the video, it is apparent that the explosions did not cause the destruction.

1.11 Wreckage and Impact Information

1.11.1 Airframe and Systems

JOG operations officials examined runway 09/27 prior to it being reopened. It is reported that the airplane touched down approximately 685 meters from the threshold of 09, before bouncing and the second runway contact was at 885 meters from the threshold of 09. Photographic evidence taken by persons on the scene revealed marks of heavy braking and imprints on the asphalt caused by the nose wheel rims making runway contact. The remains of the nose wheel tires were found within the airport perimeter.



Heavy Braking Marks (*indoflyer.net*)

Heavy braking marks are evident near the threshold of runway 27 and the nose gear contact imprint continued into the overrun area with a few of the threshold red/green lights knocked from its positions. Imprints continue into the 60 meter paved overrun area, and the remaining 73 meters of clearway.

However, it remains unclear when did the heavy braking started during the landing roll except that it has been reported to have started only a few hundred meters from the end of the runway.

The aircraft had crossed the access road at the end of runway 27 beyond the clearway which is lower than the surrounding elevation. No credible information damage on the embankment (15 meters horizontal traveling distance) adjacent to the runway on the west side of the road. The road surface suffered little or no damage except for the center divider was hit on 2 positions by the airplane main landing gears, which knocked the road divider bricks clean of its position. The road is 16 - 17 meters wide along the path of the airplane. Impact marks on the opposite banks were the main landing gear imprints from the airplane, with nose and nosegear impact about 2/3s up the embankment opposite from the runway. No further reliable information is publicly available until the wreckage area.



Nose gear rim ground contact (*indoflyer.net*)

Most aircraft components were found within 30 meters rear of the aircraft. Those parts include the main landing gears with the wheels attached, one rested abeam of the horizontal stabilizer the aircraft engines without the cowlings. Part of the engine cowling rested adjacent to the fuselage between the left horizontal stabilizer and the rear left exit door.

The nose of the airplane have been severely damaged by the crash, the cockpit left windows can be see pointing back and inverted, behind is the L1 door, which was unusable in this accident.

1.11.2 Engines and Wings

One engine was found without its cowlings detached to the left of the aircraft with parts of the cowling and a flap fairing. This engine also had impact marks on the rear where the exhaust was crumpled.

Although the right wing outboard of the right engine had ended up resting on top of the left wing, based on photographic evidence, it is found that the flaps were not in normal position for landing. The

trailing edge flaps were found to be deployed around the 15 degrees based on photographic estimates.



Right wing on top of left wing and a detached engine (*indoflyer.net*)



Left wing flaps (*detik.com*)

1.11.3 Fire

There are no concrete information regarding pre-impact fire on the airframe and engines, all reported statements on fire and smoke has been attributed to wing flap vortices/condensation and the nosegear leg contact on the runway during landing roll.

After impact, fire started from the front right of the fuselage, possibly due to spilled fuel coming out of the broken right wing and contact with hot material.

1.12 Survival Aspect

According to his interview with Captain Stephanus, Captain Marwoto had stated that after the aircraft came to a stop, they initiated the emergency evacuation procedure. Capt. Marwoto stated that both the first officer and he, ordered the crew to evacuate. It is not clear whether the whole procedure was completed but the evacuation command was reported not to have been heard in the cabin, possibly due to cables being severed by the impact. The cockpit crew then evacuated ^(*).



The wreckage (*indoflyer.net*)

Door L1 was unusable due to its position after impact. No exits on the right hand side were used due to fire. The left emergency exit windows and rear door on the left were used for evacuation. The slide on the rear left was not used for evacuation, although the "slide armed" tape is still attached to the door. This indicates that the crew had checked the conditions outside of the door prior to opening, and that the risk of fire and the height above the ground would have deemed slide deployment as a hindrance.

It is also reported that most of the victims that had died were found to have remained in their seats, citing the possibility of unconsciousness due to the impacts.

1.13 Tests and Research

1.13.1 Witness (South side, touchdown zone).

The eyewitness is an officer of the Indonesian Air Force who at the time was located along the flight line between taxiways A and B. As a pilot and instructor, and having been station in Adi Sucipto Airbase for a few months, the witness is frequently present at that location and is familiar with observing the approaches of air traffic landing on runway 09.

On the morning of 7 March, the witness was conducting a morning briefing on the flight line and observed PK-GZC on the final stages of the approach. The witness observed that the aircraft was

coming in above slope and appeared to try to make it to the touchdown zone, resulting in the unavoidable "altitude for speed trade off". Many other witnesses present had their attention to the aircraft due to its unusual approach. When the aircraft flared, the witness reported the aircraft floating above the runway before touching down roughly on the centerline in an almost direct line between his positions at the tower. He reported the aircraft made one large bounce of about 200 – 300 meters before a second touchdown, after which the witness stated he was unsure on how many bounces the aircraft endured.

By the time of the first touchdown, several of the witness' colleagues had commented that a mishap was imminent and were already heading off to several cars. He also recalled several shouting "Go Around!" However, upon hearing the thrust reversers being deployed, he and most of his colleagues were already on the way to the other end of the runway either by foot or any other ground vehicles available. The witness stated that the aircraft had overrun before he made it to the runway.

Upon reaching the wreckage, the witness saw that the right fuselage of the aircraft was already burning and that the passengers (though not all) had already evacuated. The witness stated his annoyance at one of the cabin crew's insistence that rescuers enter the aircraft to help evacuate the remaining passengers. The witness judged that it would put the rescuers in severe risk of injury or death should a person enter the aircraft at that stage without special equipment.

The witness recollection on what happened afterwards is vague except that personnel on the scene had in turn focused on extinguishing the fire and evacuating the passengers that had got out.

1.13.2 Witness (Passenger).

The eyewitness is a passenger on the flight, and was seated on left aisle in the row behind the rear emergency exit windows. The witness flies regularly to Jogjakarta for business trips, in particular, making day trips by flying in the morning and returning to Jakarta on an afternoon flight.

Due to him being seated on the aisle seat, the witness cannot recall much during the descent and approach phase. The witness stated that the speed of the approach "seemed faster than normal" and that the aircraft flared for some time before making ground contact. The witness remembers seeing the control tower passing through the cabin window on his left, but it was after passing the terminal with the aircraft's speed faster than one normally would at that stage in the landing did he sense that something was wrong.

The witness then prepared for a ground impact and said no announcements were made through the P/A system. The aircraft hit the opposite embankment with some force and came to rest shortly afterwards. The witness stated that nothing abnormal went on in the cabin in terms of fire or smoke until that impact.

After the aircraft had come to a rest, the witness reported that he saw people beginning to evacuate because fire and smoke was "apparent" on the front right cabin. The passenger grabbed his backpack and tried to find a way out. With fire imminent and people were lining up to exit from the rear, he saw the passengers in the emergency exit window row in front struggling to remove the window. He assisted with the removal of the window and disposed of the window outside on the wing, and after assisting one or two passengers, he too made it out.

1.13.3 CVR Data

Not available for this compilation.

1.13.4 FDR Data

Not available for this compilation.

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1.13.5 Airport Accident Report and Actions

The airport report consists of the ATC transcripts and the actions by the airport. These documents were leaked from the investigations and have been determined as genuine and were used as part of this independent investigation.

1.13.5.1 ATC TRANSCRIPT:

All times in UTC, Certain Military Traffic/Area Details edited, certain details edited. Format is: Frequency CALLSIGN Transcript

A = Approach frequency, T = Tower Frequency

Freq.	Time	Callsign	Transmission
T	UNKN	IW8901	Adi Tower, Selamat Pagi, Wing 8901
T	UNKN	TOWER	Wing 8901, Adi Ground, Selamat pagi, Go Ahead.
T	2348	IW8901	Roger, 8901, {Papa Kilo} Lima Mike Kilo {PK-LMK} Stand Number 2 request Push and Start destination Jakarta, level 260.
T		TOWER	Wing 8901 Start and pushback approved, heading east report ready to taxi expect runway 09.
T		IW8901	Heading east, runway 09, err, request ah, runway 27 is approved?
T		TOWER	Standby
A		MIL-1	MIL-1 reaching area **/** H
A		APPRC	MIL-1 report leaving area
A		MIL-1	Report leaving area **/** H
T		TOWER	Wing 8901 expect Runway 09, traffic 1 Boeing by Indonesia 200 position leaving Kebumen for Approach Runway 09
T		IW8901	Traffic Copied.
A		GIA200	Indonesia 200 approaching 9000 feet {in} Victor Mike Charlie {Visual Meteorological Conditions}
A		APPRC	Indonesia 200, VMC continue descend to 4000
A		GIA200	Descending to 4000 feet, Indonesia 200
T		IW8901	Adi Tower, 8901 ready for taxi
T	2350	TOWER	Wing 8901, taxi enter backtrack runway 09, ATC clearance available
T		IW8901	Ready for clearance, Cleared backtrack 09, thank you
T		TOWER	Wing 8901 cleared to SOETA Jakarta via W17 level 260 Squawk Number 4644
T		IW8901	Cleared to SOETA W17 level 260 transponder 4644, 8901
T		TOWER	Adi Tower, Wing 8901 report ready for departure runway 09
T		IW8901	Report ready for departure runway 09, 8901
A		APPRC	Indonesia 200, confirm visual?
A		GIA200	Affirm, Indonesia 200
A		APPRC	OK, cleared to visual approach runway 09 proceed to long final report runway in sight.
A		GIA200	Proceed to long final runway 09, check runway insight Indonesia 200, and confirm descent to circuit altitude?
A		APPRC	Descend to 2500 initially
A		GIA200	Descend to 2500... Indonesia 200
A		APPRC	200, traffic Wing 8901, one minute will be taking off runway 09 bound for Bali
A		GIA200	Indonesia 200, copied.
A		APPRC	Sorry, Wing8901 traffic, errr, Indonesia 200, traffic Wing 8901 bound for Jakarta
A		GIA200	Roger that, Indonesia 200.
T	2352	J-406	Tower, selamat pagi, J-406
T		TOWER	J-406, Adi Tower, good Morning, hold short {taxiway} Alpha
T		J-406	Hold short on Alpha, J-406
T		IW8901	Adi Tower, 8901, ahh lining up and ready
T		TOWER	8901, wind calm, cleared for take off

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T	2353	IW8901	Cleared for take off, 8901
T		TOWER	J-406, able for immediate take off? Traffic 1 Boeing now position leaving 10 miles to touchdown.
T		J-406	Say again your message Sir?
T		TOWER	Traffic 1 Boeing position ahhh, 9 miles to touchdown, able for immediate take off?
T		J-406	Affirmative
T		TOWER	J-406 cleared for line up report ready
T		J-406	Cleared lined up call ready, J-406
A	2354	APPRC	Indonesia 200, seven miles to the air.... to the touchdown confirm runway in sight?
A		GIA200	Affirm, Indonesia 200.
A		APPRC	Roger, next traffic a Bravo mentor will be lining up, contact tower 122.4
A		GIA200	122.4, Indonesia 200
T	2355	GIA200	Adi Tower, Indonesia 200, selamat pagi
T		TOWER	Selamat Pagi Indonesia 200, surface wind calm, continue approach runway 09, Report final, traffic one Bravo on line up position.
T		GIA200	Continue approach, check final, copy traffic, Indonesia 200
T		J-406	J-406 Ready
T		TOWER	J-406 Wind Calm, cleared for take off
T		J-406	Wind calm, cleared for take off, J-406
T		TOWER	Wing 8901, airborne at double 5 {2355UTC}, contact 123.4, happy landing!
T		IW8901	Thank you Sir, Good Morning.
T		TOWER	Good Morning
T	2356	TOWER	Indonesia 200, Wind Calm, check gear down and lock, cleared to land.
T		GIA200	Cleared to land, Indonesia 200
A		IW8901	Jogja Approach, Good Morning, this is Wing 8901 departure left turn
A		APPRC	Wing 8901, Jogja Approach. Radar contact, departure. Climb to Level 260 direct to GEPAK
A		IW8901	Roger to GEPAK, FL260, 8901
T		TOWER	Bravo errr... Indonesia 406... (radio interference/scramble/static)... s... s...
T		J-406	406, leaving traffic... ss...
T		TOWER	J-406 turn right errr, contact Jogja Approach
T		J-406	Tower, 406, leaving traffic 1000, turn right now to ** Low
T		TOWER	Indonesia ahhhh, J-406, contact Jogja Approach Sir
T		J-406	Contact Jogja, 406
A		J-406	Jogja Good Morning, J-406
A		APPRC	J-406, good morning, go ahead.
A		J-406	J-406 now climbing passing 1200 proceed to ** Low
A		APPRC	J-406, report reaching area to ** Low
A		J-406	Report reaching area ** Low, 406.
23:57:50 GIA 200 crashed			
T	2358	VCP	Tower, VCP
T		TOWER	VCP, Go ahead Sir.
T		VCP	Errr, request crossing grass
T		TOWER	VCP, silahkan
T		VCP	Terima Kasih
A		J-406	Approach, 406
A		J-406	Approach, 406
A		APPRC	406, Jogja, Go ahead.
A		J-406	Ada apa Pak diujung Runway?
A		APPRC	Iya Pak, Ini 200 kelihatannya jatuh pak, diujung landasan Pak.
End.			

1.13.5.2 POST CRASH ACTION BY TOWER

- Crash Bell activated, radio contact to PK-PPK (Ground Rescue/Emergency Unit)
- Broadcast to Airbase officials via Base Radio
- Broadcast to Airport officials via Airport Radio
- Called Approach
- Called Briefing Office

1.13.5.3 Briefing Office Action

After receiving information:

GIA200/*_****/PK-GZC/*_*****, TOUCH RUNWAY 09 AT 23:57UTC (TWR INFO)
GIA200 OVERRUN AIRPORT PERIMETER END OF RUNWAY AND SMOKE RISING

The following actions were taken by the Airport Briefing Office:
Called hospital, rescue, ops, milpolice, Garuda, etc.
NOTAM issued:

NOTAM B-0167, "AERODROME CLOSED 0000-0200EST
(B0167/07 NOTAMR B0166/07
Q)WAAF/AFALC/IV/NBO/A/000/999/0747S11025E005
A)WARJ
B)0703070024 C)0703070200 EST
E)AD CLSD DUE TO ONE ACFT BLOCK RWY)

1.13.5.4 Airport infrastructure inspections

At 0200UTC, the airport conducted checks on VOR, ILS, NDB, approach lights on 27 approach.

1.13.5.5 Airport Status and Serviceability

- RUNWAY = Serviceable
- TAXIWAY = Serviceable
- APRON = Serviceable
- FLIGHTLINE = Serviceable
- GRASS STRIP = Serviceable

COMMS AND NAV

- ADI TWR 122.4 P, 118.1 S = Serviceable
- YOGYA APP 123.4 P, 120.2 S = Serviceable
- ADI GND 118.5 = Serviceable
- ATIS 128.5 = Serviceable
- OF NDB 270 = Serviceable
- JOG VOR/DME 112.8 = Serviceable
- JOG ILS 109.1 = Serviceable

LIGHTING

- RWY & TXY = Serviceable
- OBSTRUCTION = Serviceable
- FLOOD = Serviceable
- ROTATING BEACON = Serviceable
- PAPI 09/27 = Serviceable
- APPROACH 09/27 = Serviceable

EMERGENCY FACs

- FIRE FIGHTING = Serviceable
- AMBULANCE = Serviceable
- BASE RESCUE = Serviceable

VISUAL COMMS

- GUNLIGHT = Serviceable
- PISTOL SIGN = Serviceable

Other Information:
None

2. ANALYSIS

2.1 Failure to stop

Load manifest was not obtained for this investigation; hence no accurate weights have been used in the analysis. Analysis is based on 52 tons, 54 tons and 56 tons landing weights for the purpose of this independent compilation.

For the landing distance required for the 737-400 on flaps 15, the FAR Landing Runway Requirements on Flaps 15 position (based on D6-58325-2, July 1990), for the maximum landing weights of 121,000 lbs (54,900kg) and 124,000 lbs (56,250kg), for dry runways with zero slope, zero wind at sea level, automatic speed brakes, max manual brake and no thrust reversers, are 6,200 ft (1890m) and 6,300 ft (1920m) respectively. Those figures already assumes touchdown at the usual 1000ft (300m) beyond the runway threshold.

Wheel brakes of the aircraft had malfunctioned the day before the flight but the brakes have been replaced and are deemed not a factor to this accident. Max manual brakes appeared to have been applied by the flight crew based on photographic evidence showing the wheel marks which have been stated by some sources as "consistent with heavy manual braking."

Apart from the reported landing positions where the first touchdown occurred 685m down the runway and the second being at 885m, there is little to go on to assess the failure to stop. At 54.9 tons, the aircraft would require a landing roll of 1590 meters without the use of any thrust reversers. At 52 tons landing weight, the aircraft would require a landing roll of 1406m. After the first touchdown, the runway length remaining is 1515 meters, and after the second, 1315m (or 1375m when including the 60m paved overrun area).

From the above figures it can be determined that the bounce after the first touchdown resulted in the aircraft running out of runway length in which it could use to stop. Once the aircraft left the paved surface of the runway and the overrun area, there is no guarantee as to how long the remaining landing roll would be.

2.2 Flaps

There are three possibilities on why the flaps were not in landing configuration after the aircraft have comes rest.

The first is a normal landing configuration, followed by a late go-around decision. A go-around would require the throttles to be moved to command TO/GA thrust and the flap lever be moved to 15. However there are no other indications that a normal landing with a late go-around did happen.

The second possibility is a flap asymmetry. Asymmetry occurs when a new flap selection results in a difference of flap positions between the left wing and the right wing of more than 2.4 degrees. The asymmetry protection system would stop flap movement should the difference exceed 2.4 degrees at any stage. A failure or error in the comparator switch (which measures the difference in flap deployment between the wings) would also lock out the flap system (which can again happen in the trailing edge flap disagreement). A flap asymmetry would be indicated in the flight deck through the flap position indicator, with the flap position needles representing the left and right wing to be in separate positions.

The third possibility is a trailing edge flap disagreement. This occurs where the flap position indicators disagree with the flap handle position and no asymmetry is indicated.

Unfortunately, the information required to determine which of the last two possibilities have happened, as access to the Cockpit Voice Recorder and the Flight Data Recorder is required.

2.3 Landing Configuration Recognition

Should the aircraft be unable to reach landing configuration by a certain phase in the approach (1000ft AGL for instrument approach and 500ft AGL for visual as recommended by Boeing as stipulated in the Flight Crew Training in Garuda), the crew would be able to recognize the problem through the flap position indicator. Further warnings would be given by the GPWS flap warning, which would give an aural warning should the aircraft become too low without landing flaps being selected (flap 30 or 40). There are no details publicly available as to whether the flight crew heard the warning should they have not followed the required procedures for normal abnormal landings. However, the flight crew's claims that the flaps have not been able to be deployed to landing configuration, indicates that the flight crew recognized the problem. What remains unclear is whether it was a flap asymmetry or trailing flaps disagreement that occurred.

2.4 Pilot Procedures

Conversations in the cockpit and data from the flight data recorders have not been publicly released, hence it cannot determine what conversational exchanges occurred in the flight deck at that time. This has been a source for criticism on the flight crew that the necessary non-normal procedures were completed in time.

In the Boeing 737-300/400/500's Flight Crew Operations Manual (D6-27370-400E, December 2, 2005), in the Quick Reference Handbook section, for Trailing Edge Flap Asymmetry, it states the items to accomplish are:

TRAILING EDGE FLAP ASYMMETRY	
Condition:	An uncommanded roll occurs when a new flap selection is made and/or a difference between the left and right flap indication is observed.
FLAPS	Set
	Move flap lever to the detent nearest the smallest indicated flap position.
CAUTION:	Do not attempt to move the trailing edge flaps with the alternate flaps switch as there is no asymmetry protection.
If flaps are 15 or more:	
	Set VREF for smallest flap position. Note: VREF + wind additive must not exceed the flap placard speed for the next larger flap setting. Continue checklist at DEFERRED ITEMS, DESCENT.
If flaps are 1 or greater and less than 15:	
	Set VREF 40 + 30 knots. Check the appropriate Non-Normal Configuration Landing Distance table in the ADVISORY INFORMATION section of the Performance-Inflight chapter. Continue checklist at DEFERRED ITEMS, DESCENT.
If flaps are less than 1:	
	Accomplish the TRAILING EDGE FLAPS UP LANDING

checklist.

NOTE: Do not use FMC fuel predictions with flaps extended.

-----DEFERRED ITEMS -----

==> DESCENT
 Recall. **Checked**
 Autobrake _____
GROUND PROXIMITY FLAP
 INHIBIT switch **FLAP INHIBIT**
 Landing data VREF ____, Minimums

 Approach briefing **Completed**

-----DEFERRED ITEMS -----

==> APPROACH
 Altimeters _____

-----DEFERRED ITEMS -----

==> LANDING
 ENGINE START switches **CONT**
 Speedbrake **ARMED**
 Landing gear. **DOWN**
 Flaps ____, **green light**

Furthermore, in the Boeing 737-300/400/500's Flight Crew Operations Manual (D6-27370-400E, June 9, 2006), in the Quick Reference Handbook section, for Trailing Edge Flap Asymmetry, it states the items to accomplish are:

TRAILING EDGE FLAP DISAGREE

Condition: The flap position indicators disagree with flap handle position and no asymmetry is indicated.

If indicated flap position is 30 or greater and less than 40:
 Land using existing flaps.
 Set VREF 30 for landing.

NOTE: VREF 30 + wind additive must not exceed the flap placard speed for flaps 40.

If indicated flap position is 15 or greater and less than 30:
 Land using existing flaps.
 Set VREF 15 for landing.

NOTE: VREF 15 + wind additive must not exceed the flap placard speed for the next larger flap setting.

Continue checklist at **DEFERRED ITEMS, DESCENT.**

If indicated flap position is less than 15:
 Plan to extend flaps to 15 using alternate flap extension.

NOTE: The drag penalty with the leading edge devices extended may make it impossible to reach an alternate field.

Set VREF 15 for landing.

-----DEFERRED ITEMS -----	
==> DESCENT	
Recall	Checked
Autobrake	___
GROUND PROXIMITY FLAP	
INHIBIT switchFLAP INHIBIT
Landing dataVREF ____, Minimums
Approach briefing	Completed
-----DEFERRED ITEMS -----	
==> APPROACH	
Altimeters	___
-----DEFERRED ITEMS -----	
==> LANDING	
ENGINE START switches	CONT
Speedbrake	ARMED
Landing gear	DOWN
Flaps	, green light

Both the above are possible given the statement made by the flight crew according to the NTSC ^(*) that the flaps had malfunctioned and that they were unable to properly extend them. Based on the photographic evidence, that the flap had deployed to around 15 degrees or slightly more, for both the flap asymmetry (flaps 15 or more) and flap disagreement cases (flaps 15 or greater and less than 30), the QRH items to complete are brief.

For asymmetry with flaps 15 or more, the flow is:

- Set flap to nearest smallest position
- Set Vref to Vref 15 (or Vref 15 plus additive wind correction)
- Proceed with the Deferred Items Checklist.

For flap disagreement, with flaps 15 or greater and less than 30, the flow is:

- Set Vref to Vref 15 (or Vref 15 plus additive wind correction)
- Proceed with the Deferred Items Checklist.

Although recalculating the landing distance required is wise, it is not necessary and could have wasted significant time and resources for the crew in dealing with the situation on the final approach.

Reference to the QRH on the abnormal situations stated above, under the ADVISORY INFORMATION for 737-300/400/500 with CFM56-3_22k (D6-27370-400E, June 9, 2006), for 48 Tons landing weight, with flaps asymmetry at 15 to 30, and/or flaps disagreement 15 to 30, the landing distance required is 2750ft, with adjustments for weights at 160ft per 2 tons above 48 tons. A single engine flap 15 landing would only increase this by 20ft and the adjustments are the same as for the previous two non-normals. If we assume the aircraft would land at 54 tons, the required runway for landing would be $2750\text{ft} + (3 \times 160\text{ft}) = 3230\text{ft}$ (or 3250ft if we use the single engine landing figures), or 984 meters (or 990m respectively). This number includes the assumption of touching down 1000ft after the threshold, and the use of maximum manual braking and maximum reverse thrust on the available engine.

Based on the landing distances required, the planning for the landing by the flight crew does not breach any procedures stated by the manufacturers.

Referring to the QRH items, it is not impossible and not difficult for the flight crew to have completed the items.

2.5 Similar Accident

The NTSB database shows that a recent and similar accident happened in Indonesia. The accident of PK-LIJ (NTSB ID: DCA07WA017), Boeing 737-400 of Lion Air, on December 24, 2006 at Hassanudin International Airport, Makassar. The flight was a scheduled domestic passenger flight from Jakarta

carrying 157 passengers, 2 flight crew and 5 flight attendants. On arrival, the aircraft was executing a visual approach via a left downwind pattern to runway 31. The crew maneuvered in a close pattern due to proximity of terrain on under the base and final approach areas of runway 31. The weather was reported to be 10 km visibility (approximately 6 sm), surface wind calm, no clouds, and surface temperature 29 C. According to a written report from the crew, when they selected the flaps from 15 deg. to 30 deg. on final, they observed that the flaps indicator indicated an asymmetrical condition. According to the report, the crew re-selected the flaps back to 15 deg. and they elected to continue approach and landing. The report said that the crew referred to the QRH for the situation and they also checked the actual landing distance for flaps 15 deg. landing configuration. The captain was the pilot flying.

According to ground witness reports, on landing the aircraft was not on centerline, it bounced twice, and swerved down the runway. The aircraft came to rest beyond the runway in the overrun area. The passengers were evacuated with no reports of injuries. According to a report from the local airport authority, the aircraft sustained substantial damage; the right main landing gear was detached, the left main gear protruded through the left wing structure, and some fuselage skin was wrinkled. There was a significant ground scar on the runway surface. The FDR and CVR has been removed and secured after the event.

This Accident is still under investigation by the NTSC.

2.6 Passenger Evacuation

Based on the evidence publicly available, it is determined that the aircraft upon resting, the aircraft fuselage and left wing had rested on the ground. It is apparent that the emergency slide from the rear left door was not deployed and that the wing flaps were not deployed to 40 as per evacuation procedures. The lack of flap deployment is likely to be caused by the loss of power and hydraulics after the aircraft came to a rest and also the risk of fire as well as a flap malfunction. The lack of slide deployment can be attributed to the cabin crew assessing the situation prior to opening the door and fire risk as well as distance to ground level is determined to be a factor in their decision.

None of the exits on the right hand side were used due to risk of fire.

The front left door was not usable due to the deformation of the aircraft structure and that the fuselage walls had it self rotated more than 135 degrees from its normal position. The decision not to use this exit can therefore deemed to be correct as it was likely that exiting through the opening due the fuselage deformation be an easier and faster exit way.

Analysis of crew actions in the evacuation cannot go further due to lack of access to the crew involved. Based on the video evidence and eyewitness testimonies, it would appear that the initial actions by the female flight attendants concern the passengers. Three F/As appeared to have guided passengers to the safety zone and attended to injured passengers. However, it remains unclear whether their actions in directing passengers out of the aircraft is satisfactory and the risks of fire and smoke inhalation is prevalent in this case, possibly leading to some of the cabin crew being reluctant to re-enter the cabin to evacuate remaining passengers. It is reported that one cabin crew did re-enter the cabin to evacuate more passengers and lost his life as a result.

Eyewitness reports however reveal a less satisfactory performance in that although it is understandable that the reluctance of the cabin crew to re-enter the cabin is due to the risk of fire, their requests to rescuers to enter the cabin to rescue passengers has been deemed inappropriate by some as it would put more life in danger. Whether their insistence on rescuers was resulted from shifting responsibility or a genuine care for the passenger or as an effect of shock, remains unclear at this stage.

3. SPECULATIVE ANALYSIS

Pilots are trained on how to approach on a flap 15 situation, which results in a higher than normal pitch attitude during the approach. With this, there is a tendency to push the nose down to obtain a normal visual sight picture and flight crews are warned to use caution to avoid going below the normal glide path. This warning is repeated under the non-normal procedures for a flap asymmetry or trailing

edge flaps disagreement landing. For the purpose of this compilation, several pilots have been asked on their experiences and opinions on landings in abnormal configurations.

Whilst a flap less than 15 landing would result in a high nose attitude during the approach, the same applies for the flare, and flight crews are warned about the possibilities of tail strikes. Such aircraft behavior is attributed to the lack on low speed lift that the flaps would produce.

A flap 15 landing would also produce the requirement for a higher nose attitude on the approach, however, one should do a small check flare which is enough to reduce the descent rate for the landing. Excessive flare is hazardous as it could prolong the flare without quick reduction in airspeed. Most flap 15 landing training, however, is done as part of a simulated single engine in flight, where the flight crew chooses the airport for the landing based on variables such as distance and runway length available.

For a 2-engine flap 15 landing, the non-normal situation would happen near the final phases of flight, this leaves the flight crew with less time and fewer choices than most cases of dealing with an in-flight engine failure. In the case of flap movement failure after flap 15, it was found that several crew's mindset is that flap is "greater than 15" assumes that it's a high drag situation, resulting in drag concerns in a go-around which is not desired and therefore continuing to land may be perceived to be compulsory.

Two cases were discussed in this investigation with one of the flight crew members involved in those flights, one being a training flight and the other a scheduled flight suffering from flap asymmetry when the flaps were deployed from 15 to 30. In both cases, the flight crew noticed a prolonged flare due to the lower drag configuration. On one case, the aircraft had used more than 3000m of runway to stop, and on another, the full 3000m runway length was used. Both have stated that there is a reduced depth perception in flap 15 or lower configuration on those occasions and during other training situations. This led them to perform an incorrect flare. The crew involved also mentioned that caution is needed not to bring the nose down too much to put the aircraft on the ground as it would have resulted in a hard landing, or possibly a nose wheel first ground contact.

To further add the problems facing the crew of GA200, the time and the sun angle have been cited as possible factors. Early morning flights into JOG runway 09 normally have difficulty resulted by sun glare, and this not only reduces contrast reception by the eyes, but also reduced depth perception. With a higher than normal pitch attitude on approach, the sun glare would intensify not only in a more direct attitude to the sun, but also a lower reflection of the sun on the nose of the aircraft into the flight deck. Furthermore, the lower contrast reception by the eye would also reduce the ability to decipher the visual slope indicators (VASIs or PAPIs) normally used to judge one's approach slope in relation to the runway (normally 2 reds and 2 whites). The use of sun glasses normally help, but its effectiveness is also limited to how the windscreen behaves in such glare situations, which for the case of PK-GZC, we have no information on.

Pending the final report and/or actual data from the Flight Data Recorder and the Cockpit Voice Recorder, it can be speculated that visual difficulties caused by the nose pitch of the aircraft and the effects of the morning sun can be a factor in the accident, possibly resulting in pilot-induced-oscillations.

4. CONCLUSION

4.1 Findings

- I. Flight Crews have the proper qualifications to fly the aircraft.
- II. No evidence of weather, acts of terror, sabotage or excess weight as a cause to the accident is found.
- III. No evidence of gross negligence can be extracted from the information gathered for this compilation.
- IV. No evidence of an in-flight fire has been found.
- V. ATC communications reveal that no problems were ever reported by the flight.

- VI. The flaps were found to be between 15 degrees and 30 degrees, instead of the normal 30 degrees as per Garuda's SOP.
- VII. It was more than possible for the crew to have completed the items required by the QRH upon identifying the problem.
- VIII. Traffic may have been a factor for the flight crew's reluctance to go around.
- IX. Visual misperception/difficulties may exist despite the reported good visibility by the airport.
- X. No evidence of mishandling of the accident by the airport as delays was caused by the geography between the airport's perimeter and the aircraft wreckage.
- XI. No evidence of negligence on behalf of the cabin crew for not deploying the slides and for not using the front left emergency exit.

4.2 Final Remarks

Based on all publicly available information, but limited by the lack of CVR and FDR data being made available for this compilation, it is determined that the most probable is pilot error precipitated by a flap malfunction.

5. RECOMMENDATIONS

As a result of this investigation, the following safety actions are recommended for:

5.1 Directorate General of Air Communications

None

5.2 Airport

Ensure that the grounds immediately adjacent to the Air Force Academy access road be accessible to airport emergency and rescue vehicles without compromising airport security requirements, and without the need for vehicles to rely on public access roads.

5.3 Operator(s)

Evaluate training policies and procedures on flap malfunction in particular flap asymmetry or trailing edge flap disagreement on the final phases of flight. Assess the documentation on flight crew procedures in the event of an unstable approach in a flap asymmetry or trailing edge flap disagreement for flap positions beyond 15 degrees.

5.4 Manufacturer

Emphasize on the hazards involving abnormal landing configurations and the need for the correct landing technique in those situations with flaps less than normal landing flaps. Assess the documentation on flight crew procedures in the event of an unstable approach in a flap asymmetry or trailing edge flap disagreement for flap positions beyond 15 degrees.

5.5 National Transportation Safety Committee

To confirm the possibility of flap asymmetry or trailing edge flap disagreement and find the contributory factors/causes leading to the pilot committing the error so as to answer why the pilot error took place.

REFERENCES:

Contributors:

"A", Flight Crew, B737

"AB", Flight Crew, formerly on B737

"C", Flight Crew, formerly on B737

"EK", Flight Crew, B737

"HP", Flight Crew, B737

"TA", Flight Crew, Formerly on B737

"FB", Licensed Aircraft Maintenance Engineer & Accident Investigation Engineer, also on B737

"RR", Aircraft Maintenance Engineer, Formerly on B737

"BH", Flight Operations

"R", Witness/Military Flight Crew

"A", Witness/Passenger

Sources:

Boeing 737 300/400/500/600/700/800/900 Flight Manual 2001, a US Airline

Boeing 737-300/400/500 Flight Crew Operations Manual 2006 (D6-27370-400E-TBCE, June 9, 2006)

Boeing 737-300/400/500 Airport Compatibility Manual (D6-58325-2, July 1990)

(*1) Video stream at: <http://www.liputan6.com/view/8,138349,1,0,1174295736.html> (*Stephanus interview did not reveal downdraft but a strong push.*)

(*2) The Jakarta Post & Capt. Novianto, Garuda's Flight Safety Department. Link: <http://www.thejakartapost.com/yesterdaydetail.asp?fileid=20070310.@01>

(*3) Mark Forbes and Aubrey Belford, <http://www.theage.com.au/news/national/evidence-supports-pilots-claims/2007/03/16/1173722750242.html> (17 March 2007)

Data still to be analyzed:

DECELERATION RATE AT MAX A/B is 12ft/sec sq. for below 80kts, 14ft/sec sq. for above.