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NATIONAL TRANSPORTATION SAFETY COMMITTEE

Aircraft Serious Incident Investigation Report

PT. Garuda Indonesia

Boeing 737-300; PK-GGO

Abdul Rahman Saleh Airport, Malang
Republic of Indonesia

22 July 2011

NATIONAL TRANSPORTATION SAFETY COMMITTEE
REPUBLIC OF INDONESIA
2014

This Final Report was produced by the Komite Nasional Keselamatan Transportasi (KNKT), Transportation Building 3rd Floor, Jalan Medan Merdeka Timur No. 5, Jakarta 10110, Indonesia.

The report is based upon the investigation carried out by the KNKT in accordance with Annex 13 to the Convention on International Civil Aviation Organization, the Indonesian Aviation Act (UU No.1/2009), and Government Regulation (PP No. 62/2013).

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GLOSSARY OF ABBREVIATIONS

AGL	:	Altitude above Ground Level
AFDS	:	Autopilot Flight Director System
APP	:	Approach Control
AOC	:	Air Operator Certificate
ATC	:	Air Traffic Control
ATPL	:	Air Transport Pilot License
°C	:	Degrees Celsius
CPL	:	Commercial Pilot License
CRM	:	Crew Resource Management
CSN	:	Cycles Since New
CVR	:	Cockpit Voice Recorder
DME	:	Distance Measuring Equipment
EGPWS	:	Enhanced Ground Proximity Warning System
GPWS	:	Ground Proximity Warning System
FCT	:	Flight Crew Training
FCTM	:	Flight Crew Training Manual
FDR	:	Flight Data Recorder
FOD	:	Foreign Object Damage
ft	:	feet
HDG SEL	:	Heading Select
ICAO	:	International Civil Aviation Organization
IFR	:	Instrument Flight Rules
ILS	:	Instrument Landing System
IMC	:	Instrument Meteorological Conditions
kg	:	Kilo Grams
KHz	:	Kilo Hertz
km	:	Kilo Metres
Kts	:	Knots
lbs	:	Pounds
m	:	Metres
MAC	:	Mean Aerodynamic Chord
mbs	:	Milibars
MCP	:	Mode Control Panel
MDA(H)	:	Minimum Descent Altitude/Height
MHz	:	Mega Hertz
MTOW	:	Maximum Take-off Weight
NDB	:	Non-Directional Radio Beacon
KNKT / NTSC	:	*Komite Nasional Keselamatan Transportasi* / National Transportation Safety Committee

PF	:	Pilot Flying
PIC	:	Pilot in Command
PM	:	Pilot Monitoring
QFE	:	Height above airport elevation (or runway threshold elevation) based on local station pressure
QNH	:	Altitude above mean sea level based on local station pressure
ROD	:	Rate of Descend
sct	:	Scattered
SOP	:	Standard Operating Procedure
TNI AU / IAF	:	*TNI Angkatan Udara* / Indonesia Air Force
TOW	:	Take-off Weight
TSN	:	Time Since New
Twr	:	Tower
USA	:	United State of America
UTC	:	Universal Time Coordinate
VFR	:	Visual Flight Rules
VMC	:	Visual Meteorological Conditions
VNAV	:	Vertical Navigation
VOR	:	VHF omnidirectional radio range
Vref	:	Reference Landing Approach Speed

INTRODUCTION

SYNOPSIS

On 22 July 2011, a Boeing 737-300 aircraft registered PK-GGO was being operated by PT. Garuda Indonesia Airways as a scheduled passenger flight GA 292, from Soekarno - Hatta International Airport (WIII) Jakarta to Abdul Rahman Saleh Airport (WARA) Malang.

The flight crew member was three pilots which consist of Pilot in Command (PIC) acted as Pilot Monitoring (PM), First Officer (FO) who was under a line training acted as Pilot Flying (PF), Second in Command (SIC) a qualified FO acted as a third pilot occupied the pilot jump seat and 5 Flight Attendants (FA). The aircraft departed from Jakarta at 0546 UTC and carried 100 passengers.

During the flight there were no abnormal condition related to aircraft system or other significant information was reported.

The ATC instructed the pilot to commence the VOR approach Runway 35 and circling Runway 17. The pilots were able to see the runway at approximate 4 DME and continued the circling procedure by joined circuit pattern of runway 17. When turned on the base leg runway 17, the PM saw and assessed that the aircraft was above the normal glide path, turned too early and the aircraft was on the right of the centerline. Realizing to the conditions, the PM decided to take over the control and continued the approach to land. The PIC tried to correct the glide path by increasing the rate of descend (ROD), reducing the power and rolled to bring the aircraft aligned with the runway centerline.

At 0709 UTC, the aircraft touched down on runway 17 and was slightly deviated to the right of the runway centerline and stopped on the runway. The ATC instructed the pilot to stop the aircraft and verified of a probability of a hard landing which was confirmed by the pilot. The FDR recorded vertical acceleration of 3.473 G.

There were no one injured in this occurrence.

The investigation had determined that there were no issues with the aircraft and all systems were operating normally. The analysis was focus on these following 3 safety issues:

- Un-stabilized approach below 500ft.
- The decision to take over the control and continued the landing.

The investigation concluded that the aircraft approach was un-stabilized since 500 ft prior to land. The decision to take over control during the un-stabilized approach was not consistent to the operator standard operating procedures as well as the Crew Resources Management (CRM) Policy implementation.

At the time of issuing this Final Report, the Komite Nasional Keselamatan Transportasi has been informed of safety actions resulting from this accident by PT. Garuda Indonesia and the Indonesia Air Force Base Abdul Rahman Saleh as the airport operator.

Included in this final report, the KNKT has issued several safety recommendations to the PT. Garuda Indonesia and Directorate General of Civil Aviation to address the safety issues identified in this final report.

1. FACTUAL INFORMATION

1.1 History of the Flight

On 22 July 2011, a Boeing 737-300 aircraft registered PK-GGO was being operated by PT.Garuda Indonesia Airways as a scheduled passenger flight from Soekarno - Hatta International Airport (WIII) Jakarta to Abdul Rahman Saleh Airport (WARA) Malang[1] with flight numberGA 292.

The flight crew member was three pilots which consisted of Pilot in Command (PIC), one First Officer (FO) under a line training, Second in Command (SIC) a qualified FO and 5 Flight Attendants (FA). This flight carried 100 passengers.

The aircraft departed from Soekarno - Hatta International Airport, Jakarta at 0546 UTC to Malang. In this flight, the FO under line training acted as Pilot Flying (PF) and the PIC acted as Pilot Monitoring (PM) while the SIC acted as a third pilot occupied the jump seat.

During the flight there was no abnormal condition related to aircraft system or other significant information was reported. The flight from the departure until commenced for approach was uneventful.

During descend the Abdul Rahman Saleh Tower controller[2] informed the pilot that there were two traffics ahead of them and instructed to fly over the VOR/DME prior to approach runway 35.

After traffic permitted, the pilot instructed to commence the VOR/DME approach runway 35 and circling runway 17. This procedure was due to the latest surface wind condition was southerly with velocity between 10-15kts.The pilots acknowledged the instruction and flew the aircraft according to the procedure as instructed.

During the final VOR/DME approach runway 35, the pilots were able to see the runway at approximate 4 DME and continued the circling procedure to join circuit pattern of runway 17.

Based on pilot interview, the pilot stated that while turning on base leg runway 17, the PIC saw and assessed that the aircraft turned too early which might resulted to the aircraft above normal glide path and on the right of the runway centerline extension. Realizing to the conditions, the PIC decided to take over the control and continued the approach to land.

The PIC corrected the glide path by increasing the rate of descend, reducing the power and rolled to bring the aircraft align with the runway centerline.

At 0708:25 UTC, the aircraft touched down on runway 17 slightly on the right of the runway centerline and decelerated to taxi speed. The pilot then conducted a 180° turn at the turning area to taxi to the apron. While taxi,the ATC controller instructed the pilot to stop the aircraft and asked of a probability of a hard landing occurrence. The pilot confirmed that the aircraft experienced a hard landing.

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1 Abdul Rahman Saleh Airport (WARA) Malang will be named as Malang for the purpose of this report.

2 Abdul Rahman Saleh Tower controller will be named as ATC controller for the purpose of this report.

Figure 1:The flight profile from approximately 300 feet AGL based on FDR animation

Following the report of hard landing, the local Airport Safety Officers conducted runway inspection. The inspection found some metal debris on the touchdown area of runway 17 which were parts of the nose wheel of the aircraft.

While waiting for further clearance from ATC controller, the pilots checked the aircraft system and indicators which might exist as consequence of the hard landing but not found any abnormality.

After completion the runway inspection the Airport Safety Officer informed to the ATC controller that the aircraft safe to continue taxi. The pilot taxied the aircraft to the apron and disembarked the passengers.

No one injured in this occurrence.

After the engines shutdown the PIC requested to the maintenance personnel to conduct the hard landing inspection.

During the visual inspection, found that nose wheel hub broken, left engine inlet cowling and several vane blades damaged. Based on the finding of the initial inspection, the aircraft was grounded for further damage assessment and repair.

Figure 2: Boeing 737-300 aircraft registration PK-GGO

1.2 Injuries to Persons

Injuries	Flight crew	Passengers	Total in Aircraft	Others
Fatal	-	-	-	-
Serious	-	-	-	-
Minor	-	-	-	Not applicable
Nil Injuries	8	100	108	Not applicable
TOTAL	8	100	108	-

1.3 Damage to Aircraft

The observation on the aircraft found several damaged were as follow:

- Left nose wheel inner cylinder hub broken;
- Left nose tire worn out and deep cut;
- Right main landing gear cracked;
- Right nose tire deep cut;
- Left engine inlet cowling damage;
- Left engine blades 12ea damage;
- Left engine acoustic damage.

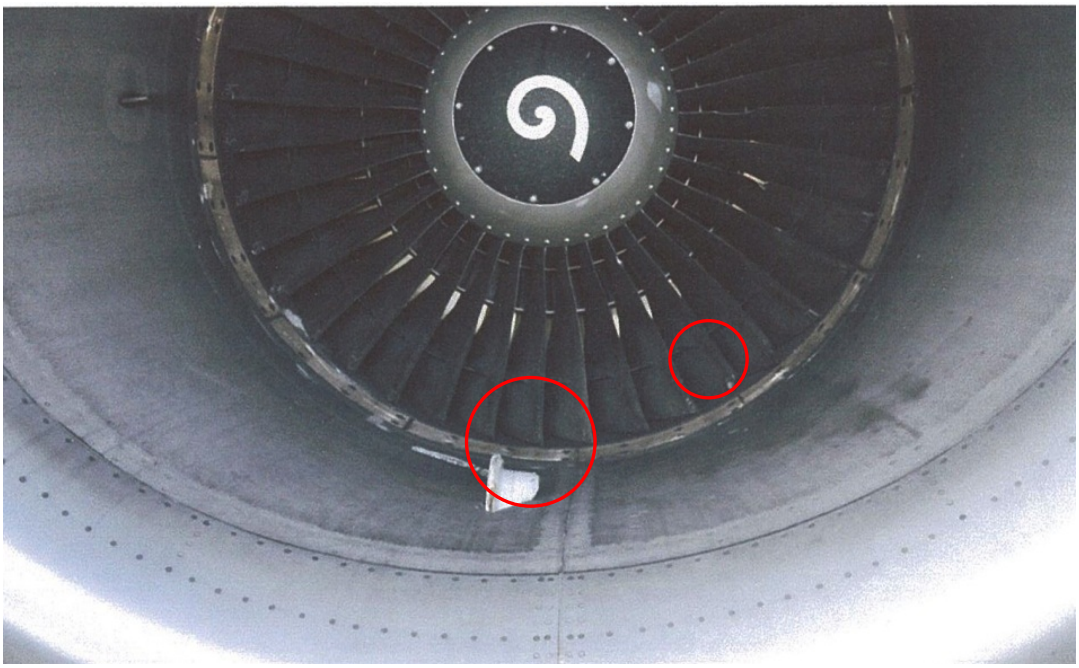

Figure 3: The damages on the left engine

Figure4: The damage on the nose landing gear

1.4 Other damage

There no other damage was reported on this occurrence.

1.5 Personnel information

1.5.1 Pilot in Command

Gender	:	Male
Nationality	:	Indonesia
License	:	ATPL
Aircraft type rating	:	Valid
Medical certificate	:	Valid, until 28 August 2011
Last line check	:	5 October 2010
Last proficiency check	:	13 July 2011
Total hours	:	14,197 hours
Total on type	:	5,275 hours
Last 180 days	:	307hours
Last 30 days	:	41 hours
Last 7 days	:	12 hours
This flight	:	1 hour 33 minutes

1.5.2 Second in Command (occupied observer seat)

Gender	:	Male
Nationality	:	Indonesia
License	:	CPL
Aircraft type rating	:	Valid
Medical certificate	:	Valid, until 19 January 2012
Last line check	:	28 April 2010
Last proficiency check	:	28 April 2011
Total hours	:	206 hours
Total on type	:	206 hours
Last 180 days	:	185 hours
Last 30 days	:	32 hours
Last 7 days	:	9 hours
This flight	:	1 hour 33 minutes

1.5.3 First Officer 2 (as Pilot Flying)

Gender	:	Male
Date of birth	:	5 January 1983
Nationality	:	Indonesia
License	:	CPL
Aircraft type rating	:	Valid
Medical certificate	:	Valid, until 13 December 2011
Last proficiency check	:	14 April 2011
Total hours	:	457 hours
Total on type	:	457 hours
Last 180 days	:	243 hours
Last 30 days	:	48 hours
Last 7 days	:	12 hours
This flight	:	1 hour 33 minutes

1.6 Aircraft Information

1.6.1 General

Aircraft manufacturer	:	Boeing Company, USA
Aircraft model/type	:	737 - 300
Serial number	:	28736
Year of manufacture	:	1998
Aircraft registration	:	**PK-GGO**
Certificate of Registration	:	1837
Valid to	:	11 March 2012
Certificate of Airworthiness	:	1837
Valid to	:	25 June 2012
TSN	:	32,625 hours
CSN	:	24,998 cycles
MTOW	:	63,276kg
Actual Take Off Weight	:	52,822 kg
Estimated Landing Weight	:	49,472 kg
Last Major Inspection	:	A66 inspection dated 11 June 2011 at 32,354 FH

1.6.2 Engines

Engine type	:	Turbofan
Manufacturer	:	CFM International, Canada
Model	:	CFM56-3C1
Serial Number Engine #1	:	858961
TSN	:	30,321 hours
CSN	:	23,320 cycles
Serial Number Engine #2	:	858659
TSN	:	29,628 hours
CSN	:	24,239 cycles

1.6.3 Weight and Balance

The aircraft departed from Soekarno-Hatta International Airport (WIII) Jakarta within the proper weight and balance envelope, as shown in the following table:

Maximum take-off weight	:	61,234 kg
Actual take-off weight	:	52,822kg
MAC TOW	:	23.8%
Maximum landing weight	:	51,709 kg
Estimated landing weight	:	49,472kg or 108,900lbs

The Vref Speeds table for landing weight 108,900lbs with flaps 40 is shown in the table below. The Vref is a reference speed for landing which should be maintain and should not to be less until 50 feet above the runway threshold.

WEIGHT 1000 LB	FLAPS 15	30	40
135	160	149	147
132	158	147	145
128	155	144	142
124	153	142	140
120	151	140	137
116	148	138	135
112	145	135	132
108	142	133	129
104	140	130	126
100	137	127	123
96	134	124	120
92	130	122	118
88	127	119	115
84	124	116	112
82	121	115	111

Landing weight 108,900lbs → 130

1.7 Meteorological information

Weather reports at Malang issued on 22 July 2011 were as follow:

	0700 UTC	0730 UTC
Surface wind	200 / 10 knots	200 / 10 knots
Visibility	5 km	North 4 km, South 7 km
Present weather	Haze	Haze
Cloud	SCT 1,400 ft	SCT 1,400 ft
Temperature	27° C	27° C
Dew Point	19° C	19° C
QNH	1,011mbs	1,011mbs
QFE	949mbs	949mbs

1.8 Aids to Navigation

The navigation aids available at Abdul Rahman Saleh Airport were a VOR (Very High Frequency Omni-Directional Range) which identify as "ABD" on frequency 116.1MHz and two NDB (Non Directional Beacon) identify as "ML" 342 KHz and "LW" on frequency290 KHz. On the day of the occurrence all the navigation aids were in good condition.

The published VOR/DME approach procedure for runway 35 at Malang indicated that the Minimum Descend Altitude (MDA) for category C aircraft was 2,540 ft and the circle to land minima was 2,800 ft. The Malang airport reference elevation was 1,726 ft, hence the MDA was 824 ft AGL and the circle to land minima was 1,074 ft. The procedure for circle to land in Malang was the minimum visibility of 5,000 meters and circle to land not authorized to be conducted on the east side of the runway.

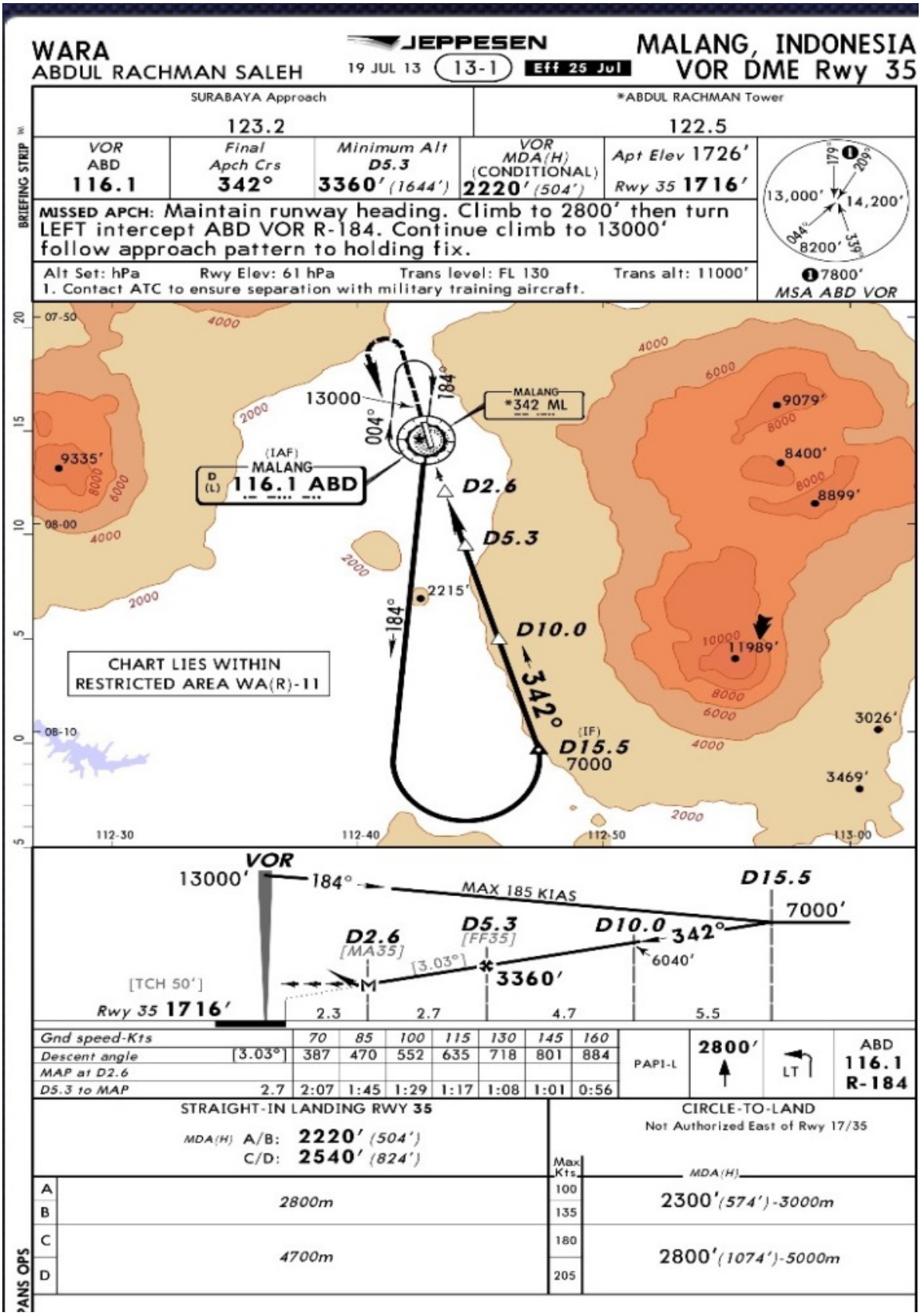

Figure 5: VOR DME approach chart Runway 35 taken from Jeppesen

1.9 Communications

All communications between ATC controller and the pilot were recorded by ground based automatic voice recording equipment as well as Cockpit Voice Recorder (CVR) for the duration of the flight. The quality of the voice recorded was good.

1.10 Aerodrome information

Airport Code	:	WARA / MLG
Airport Name	:	Abdul Rahman Saleh Airport
Airport Address	:	Landasan Udara Abdul Rahman Saleh Malang, East Java
Airport Service	:	Tower (ATS)
Type of Traffic Permitted	:	IFR and VFR
Coordinates	:	$07^{o}55'$ 46"S, $112^{o}42'43''$ E
Elevation	:	1,726ft
Runway Length	:	1,987 meters
Runway Width	:	40 meters
Azimuth	:	17 – 35 (165°-345°)
Runway Surface	:	Asphalt

This airport was normally used for military and civil flight operation.

1.11 Flight Recorders

The aircraft was equipped with Flight Data Recorder (FDR) and Cockpit Voice Recorder (CVR).

1.11.1 Flight Data Recorder (FDR)

Manufacturer	:	Honeywell, USA
Type	:	Solid Stated
P / N	:	980 – 4700 – 001
S / N	:	0281

The graph of the FDR data shows from approximately aircraft altitude 2,000 ft is as follow:

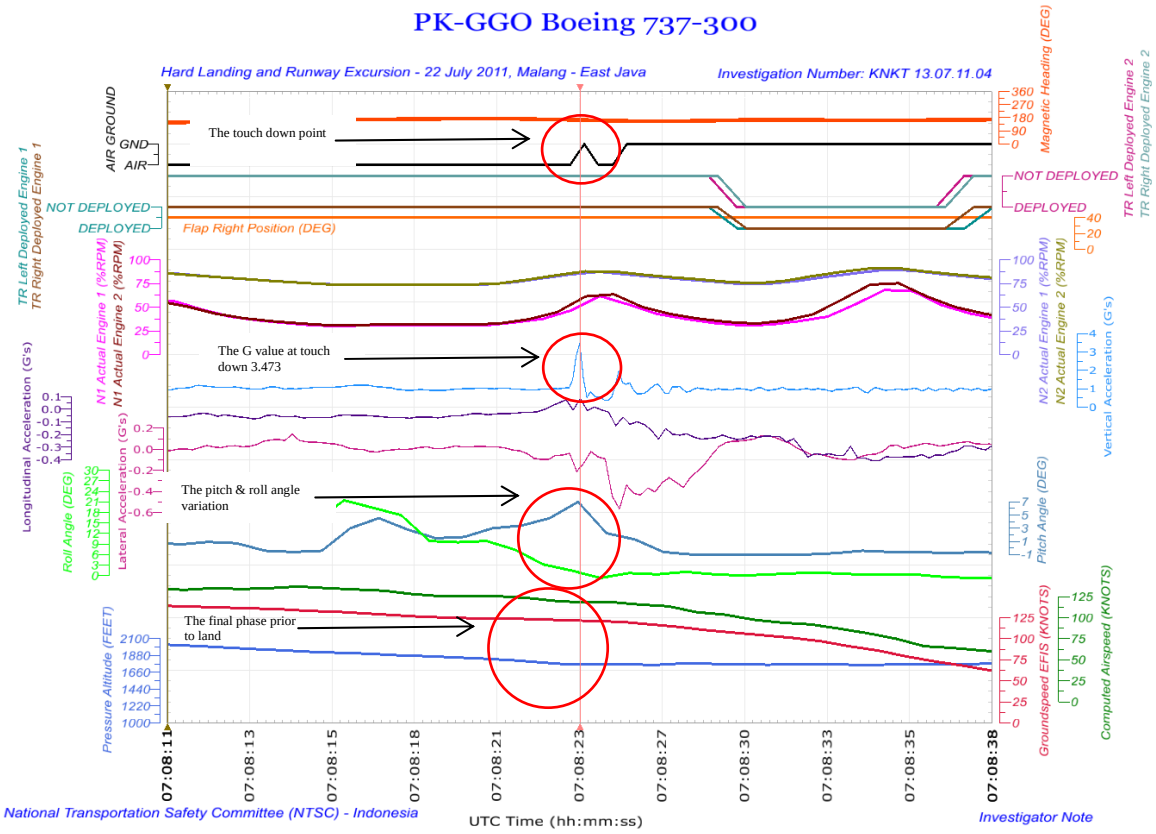

Figure 6: The FDR data of significant events on approach from approximate 300 ft (red circles)

UTC Time (hh:mm:ss)	Pressure Altitude (FEET)	Radio Height (FEET)	Computed Airspeed (KNOTS)	Groundspeed EFIS (KNOTS)	AIR GROUND		Pitch Angle (DEG)	Roll Angle (DEG)	Magnetic Heading (DEG)
	2048	315	137	141	AIR	AIR	0,878905	15,4688	140,625
	2032	299	136	140	AIR	AIR	1,23047	16,1719	143,438
7:08:10	2020	282	134,5	139	AIR	AIR	0,878905	18,6328	147,305
	2004	260	133	138	AIR	AIR	1,23047	23,9062	151,523
	1984	242	135	137	AIR	AIR	1,05469	21,0938	156,797
	1964	213	134	136	AIR	AIR	0	15,8203	160,664
7:08:14	1948	194	135	135	AIR	AIR	-0,17578	15,8203	165,938
	1928	167	137	133	AIR	AIR	0	15,4688	167,695
	1916	147	135	132	AIR	AIR	3,16406	21,4453	168,398
	1904	126	133,5	130	AIR	AIR	4,57031	19,3359	168,398
7:08:17	1884	110	132	128	AIR	AIR	2,98828	17,2266	169,805
	1872	93	128	126	AIR	AIR	1,75781	9,84375	171,914
	1856	79	125,5	125	AIR	AIR	1,93359	9,49219	173,32
	1840	62	126	124	AIR	AIR	3,16406	9,84375	174,023
7:08:21	1820	48	125,5	124	AIR	AIR	3,51562	7,38281	172,617
	1792	30	123,5	123	AIR	AIR	4,57031	3,16406	167,695
	1764	15	120	122	AIR	AIR	6,85546	1,40625	165,938
	1768	2	118	121	GND	AIR	2,46093	-0,70313	161,016
7:08:25	1768	0	118,5	120	AIR	GND	1,58203	0,703125	157,148
	1756	-3	115,5	117	GND	GND	-0,17578	0,351562	156,445

The FDR graph above showed he aircraft roll angle and heading (in the red box) on approach from approximate 300 ft (AGL) prior to touch down and the yellow boxes indicated the touchdown.

The examination on the final segment from approximately 300 ft AGL found several significant events as follow:

1. The aircraft heading changed from 140°, 156°, 167° and 174°;
2. Roll angle changed from 15°, 21°, 15° and 9°.
3. Pitch angle changed from 0.8°, 1°, -0°, 4°, 1.7°, 3° and 6°.
4. Speed constantly decelerated from 140 to 118 knots during touchdown.
5. 4 seconds prior to touch down the calculation of rate of descend was 1,080 feet/minute.
6. The aircraft bounced and the first touchdown was 3.473 G.

1.11.2 Cockpit Voice Recorder (CVR)

Manufacturer	:	Honeywell, USA
Type	:	Solid Stated
P / N	:	980 – 6020 – 001
S / N	:	1194

The CVR removed from the aircraft by the Garuda Maintenance Facility personnel and sent to the KNKT laboratory for investigation purposes. The CVR contained four channels of 30 minutes and two channels of 120 minutes of good quality recording including all the conversations between pilots and air traffic controller involved in this serious incident flight.

The significant excerpts taken from CVR after PIC realizedthat the aircraft was too high while turning on base leg then took over control and acted as PF are as follows:

At 07:06:49 UTC	FO requested to select gear down
At 07:07:17	PIC reminded the FO for the selection of flap 40
At 07:07:23	Sound of similar the auto pilot disengaged
At 07:07:24	PIC reported that the landing checklist completed
At 07:07:36	PIC reminded the FO to set the runway heading and was acknowledged by the FO.
At 07:07:41	FO set runway heading.
At 07:07:44	EGPWS sounded ‘FIVE HUNDRED’.
At 07:07:45	PIC asked to the FO about the runway position
At 07:07:48	PIC saw the runway and expressing a surprise
At 07:07:48	PIC reminded that the speed was not on the target
At 07:07:54	PIC expressing that the last turn was too early.
At 07:07:59	PIC asked that they have received clearance to land and was replied that the clearance has received.
At 07:08:20	FO called to PIC to check the aircraft speed.
At 07:08:21	GPWS “FIFTY” (*reminder that the aircraft altitude at 50 ftAGL)*.
At 07:08:22	GPWS “FOURTY”
At 07:08:23	GPWS “THIRTY”
At 07:08:24	GPWS “TWENTY”
At 07:08:24	GPWS “TEN”
At 07:08:25	the first aircraft touched down

1.12 Wreckage and Impact Information

The tire marks of both main wheels and nose wheel were found on the runway surface. The marks started from touchdown at about 300 meters from the beginning of runway 17 heading to the right until the mark of the right main tire out of pavement at about 100 meters from the initial marks.

Figure7:The tire marks found on the runway

Some broken parts of nose wheel hub were found on the runway by Airport Safety Officer as shown on figure below.

Figure 8: The broken parts of nose wheel hub

Figure 9: The damage on the nose wheel hub

1.13 Medical and Pathological Information

No medical or pathological investigations were conducted on the flight crew.

1.14 Fire

There was no evidence of fire in this occurrence.

1.15 Survival Aspects

It was asurvivable occurrence.

1.16 Tests and Research

There was no issue that requires to test and research.

1.17 Organizational and Management Information

Aircraft Owner	:	PT. Garuda Indonesia
Aircraft Operator	:	PT. Garuda Indonesia
Address	:	Jl. Kebon Sirih No. 44
		Jakarta 10110 Indonesia
AOC Number	:	AOC 121/001

1.17.1 Operator Standard Operating Procedures

FCTM (Flight Crew Training Manual) FCT 737 CL (TM), 4.37

Circling Approach - General

The circling approach should be flown with landing gear down, flaps 15, and atflaps 15 maneuvering speed. Use the weather minima associated with the anticipated circling speed. Maintain MCP altitude or MDA(H) using ALT HOLD mode or VNAV ALT mode (as installed) and use HDG SEL for the maneuvering portion of the circling approach. If circling from an ILS approach, fly the ILS inVOR/LOC and VNAV or V/S modes.

Note : If the MDA(H) does not end in "00", set the MCP altitude to the nearest 100 feet above the MDA(H) and circle at MCP altitude. Use of the APP mode for descent to a circling approach is not recommended forseveral reasons:

- *exiting the APP mode requires initiating a go-around or disconnecting the autopilot and turning off the flight directors.*
- *The AFDS (Autopilot Flight Director System) does not level off at MCP altitude*

When in altitude hold at MDA(H) and prior to commencing the circling maneuver, set the missed approach altitude.

Initiating the turn to base leg, select landing flaps and begin decelerating to the approach speed plus wind correction. To avoid overshooting final approach course, adjust the turn to final to initially aim at the inside edge of the runway threshold. Timely speed reduction also reduces turning radius to the runway. Complete the landing checklist. Do not descend below MDA(H) until intercepting the visual profile to the landing runway.

Leaving MDA(H), disengage the autopilot and auto throttle. After intercepting the visual profile, cycle both F/D to OFF, then to ON. This eliminates unwanted commands for both pilots and allows F/D guidance in the event of a go-around. Complete the landing.

Note : If a go-around is selected with F/D switches off, the F/D commands disappear when the first pitch or roll mode is selected or engaged.

Holding, Approach and Landing .FCT 737 CL (TM) 4.5 - 4.6

Stabilized Approach Requirements

Maintaining a stable speed, descent rate, and vertical/lateral flight path in landing configuration is commonly referred to as the stabilized approach concept.

Any significant deviation from planned flight path, airspeed, or descent rate should be announced. The decision to execute a go-around is no indication of poorperformance.

Note: Do not attempt to land from an unstable approach.

Recommended Elements of a Stabilized Approach

The following recommendations are consistent with criteria developed by the Flight Safety Foundation.

All approaches should be stabilized by 1,000 feet above airport elevation in instrument meteorological conditions (IMC) and by 500 feet above airport elevation in visual meteorological conditions (VMC). An approach is considered stabilized when all of the following criteria are met:

- *the aircraft is on the correct flight path*
- *only small changes in heading/pitch are required to maintain the correct flight path*
- *the aircraft speed is not more than VREF + 20 knots indicated airspeed and not less than VREF*
- *the aircraft is in the correct landing configuration*
- *sink rate is no greater than 1,000 fpm; if an approach requires a sink rate greater than 1,000 fpm, a special briefing should be conducted*
- *power setting is appropriate for the aircraft configuration*
- *all briefings and checklists have been conducted.*

Specific types of approaches are stabilized if they also fulfill the following:

- *ILS approaches should be flown within one dot of the glide slope and localizer*
- *a category II or category III ILS approach should be flown within the expanded localizer band*
- *during a circling approach, wings should be level on final when the aircraft reaches 300 feet above airport elevation.*

Unique approach procedures or abnormal conditions requiring a deviation from the above elements of a stabilized approach require a special briefing.

***Note**: An approach that becomes unstabilized below 1,000 feet above airport elevation in IMC or below 500 feet above airport elevation in VMC requires an immediate go-around.*

Approach charts use the abbreviation DA(H) or MDA(H). A decision altitude "DA" or minimum descent altitude "MDA" is referenced to MSL and the parenthetical height "(H)" is referenced to TDZE or threshold elevation. Example: A DA(H) of 1,440' (200') is a DA of 1,440' with a corresponding height aboveTDZ of 200'.

When RVR is reported for the landing runway, it typically is used in lieu of the reported meteorological visibility.

1.17.2 Training and Assessment

1.5 TRAINING AND ASSESSMENT

1.5.2 Assessments Standards

05. GENERAL TOLERANCES

- *Height* : *± 200 feet Maximum*
  ±100 feet NOT more than 15 seconds
- *DH* : *0 / + 50 feet to initiate overshoot*
- *MDA* : *0 / + 50 feet to maintain*
- *Airspeed* : *± 15 kts Maximum*
  ± 10 kts in cruise NOT more than 15 seconds

± 5 kts on approach

- *Heading* : *± 10º degrees of assigned or intended heading*
- *Airway Tracking* : *5° of specified track*
  ILS approach : *½ scale deflection of "G/S or LOC" (1 scale =1 dot=1 degree for ILS)*
- *VOR approach* : *½ scale deflection (1 scale = 1 dot = 5 degrees for VOR)*

1.17.3 Crew Resource Management

1.4.2 CREW RESOURCE MANAGEMENT (CRM)

The Principles, Philosophy, Policies, Procedures and Practices (Behaviours) define the Garuda Indonesia approach to CRM. Principles form the basis for our philosophy; our philosophy shapes our policies; policies guide the development of procedures and practices.

1.4.2.2 CRM Philosophy

(a). CRM is the effective use of all available resources -- people, equipment, and information -- to achieve the highest possible levels of safety and efficiency.

(b). CRM ability and a facility for teamwork shall be selection criteria for all crewmembers.

(c). CRM is based on the principle of synergy (teamwork) functioning within a cultural environment that supports and encourages human growth and commitment.

(d). CRM involves the continuous improvement of procedures, attitudes, and behaviours, applying human factor concepts to enhance individual and crew performance.

(e). CRM training is focused on specific teamwork, communication, decision-making, and workload management behaviours that have been proven to enhance personal effectiveness and job satisfaction. As a result of CRM training, employees will be better able to function as members of self-criticizing, self-correcting teams.

1.4.2.3 CRM Policy

(a). CRM principles and behaviours must be fully integrated into all aspects of flight operations training.

(b). Periodic CRM assessments and performance feedback will be conducted for all flight crewmembers, flight-attendants, and dispatchers, in order to assure effective teamwork.

(c). Flight schedules for crewmembers will be prepared and administered to assure adequate rest and safe crewpairings (i.e., new captains will not be scheduled with new first officers unless a DGCP/CCP or FIA is part of the crew).

(d). The PIC shall be responsible for establishing an environment of trust and mutual-commitment prior to eachflight, encouraging his fellow crewmembers to speak up and to accept mutual responsibility for the safety and well-being of the passengers, cargo, and equipment entrusted to them. "What's right, not who's right" shall be the motto of all

members of the Garuda Indonesia operating team.

(e). Each Garuda Indonesia crewmember shall be responsible for notifying the pilot-in command of any condition or circumstance that might endanger the aircraft or impair the performance of any flight crewmember.

(f). CRM skills and performance will be periodically evaluated at all organizational levels to provide regular feedback and ensure continuous improvement.

(g). CRM skills and performance will be a factor in the promotion of all Garuda Indonesia crewmembers.

1.18 Additional Information

Circle to land

Circle to land can be defined when the surface wind dictates that a landing must be made on a runway other than the instrument approach runway. The aircraft shall fly the approach according to the instrument approach procedure up to a specified minimum descent altitude, and then in visual conditions, circle to land to the opposite runway aligned with the wind.

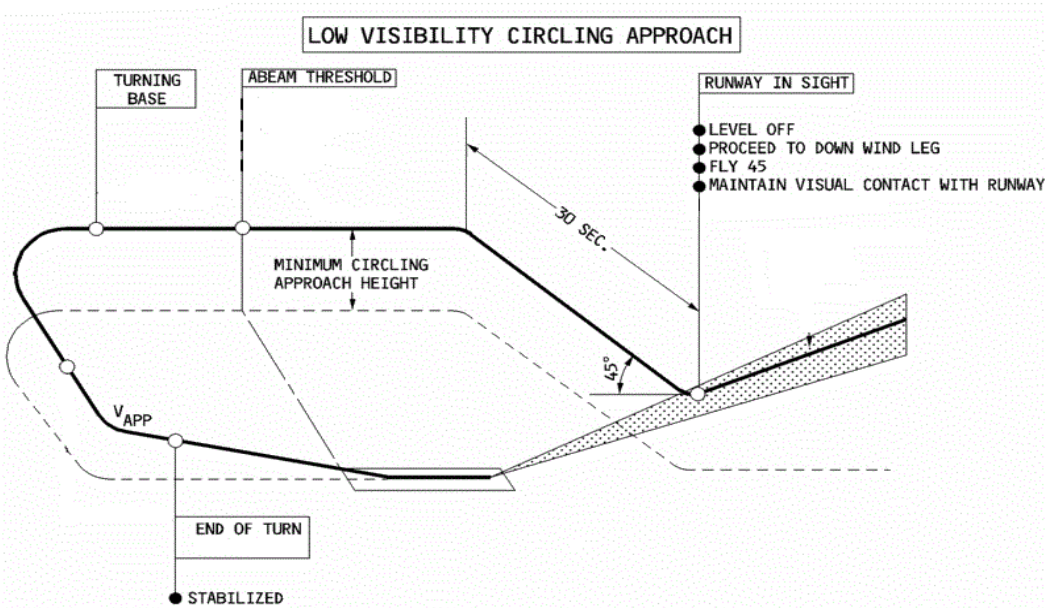

Figure 10: The general circle to land procedure

1.19 Useful or Effective Investigation Techniques

The investigation was conducted in accordance with KNKT approved Policies and Procedures Manual, and in accordance with the standards and recommended practices of Annex 13 to the Chicago Convention.

2. ANALYSIS

The investigation of hard landing involving a B737-300 aircraft, PK-GGO on 22 July 2011 at Abdul Rahman Saleh Airport, Malang determined that there was no issue related to the aircraft.

Therefore the analysis will focus on the following safety issues:

- Approach below 500ft;
- The decision to take over the control and continued the landing.

2.1 Approach below 500ft

The flight conducted VOR/DME approach runway 35 and continued for circle to land runway 17.The VOR/DME approach procedure chart of runway 35 at Malang showed that the inbound track was 342° and the circle to land altitude was 2,800ft or 1,074 ft above the airport altitude reference.

The FDR recorded that during the final segment from approximately 300ft AGL, found several significant events as follow:

1. The aircraft heading changed from 140°, 156°, 167° and 174°;
2. Roll angle changed from 15°, 21°, 15° and 9°.
3. Pitch angle changed from 0.8°, 1°, -0°, 4°, 1.7°, 3° and 6°.
4. Speed constantly decelerated from 137 to 118 knots until touchdown.
5. 4 seconds prior to touch down the calculation of rate of descend was 1,080 feet/minute.
6. The aircraft bounced and the first touchdown the recorded vertical acceleration was 3.473 G.

The FCTM also added the Recommended Elements of a Stabilized Approach which should be accomplished by 1,000 ft above airport elevation in instrument meteorological conditions (IMC) and by 500 ft above airport elevation in visual meteorological conditions (VMC). The procedure also noted that an approach that becomes un-stabilized below 1,000 ft above airport elevation in IMC or below 500 ft above airport elevation in VMC requires an immediate go-around.A circle to land approach should be performed in VMC hencethe approach should be stabilized at 500 ft.

During the final segment from approximately 300ft AGL, the FDR recorded that aircraft heading were changed from 140° to 174°, and theroll angle varied from 9° to 21°.The changing of heading of more than 30 degrees with roll angle varied between 9° to 21° were not the small roll angle as mentioned in the stabilized approach criteria.

The FDR also recorded that pitch angle changed from 0.8°, 1°, -0°, 4°, 1.7°, 3° to 6 while the aircraft vertical speed reached up to 1,080 ft/minute. The criteria of stabilized approach required sink rate not greater than 1,000 ft/minute.

The aircraft speed recorded decelerated from 140 to 118 kts when the Vref speed for the particular weight was 130 kts. The CVR recorded that on short final the FO called to the PIC to check the speed. The stabilized approach criteria also stated that the aircraft speed should not below Vref.

Refer to the recorded data in the FDR indicated that the aircraft was on un-stabilized approach while in an VMC condition until below 300 feet which required to go-around.

2.2 The decision to take over the control and continued the landing

The CVR record and the pilot information during the interview it was known that during turning from base leg to final course runway 17, the PIC assessed that the aircraft was turned too early, higher than normal glide and on the right of the centerline.

Realized the condition and considered that the PF was under line training the PIC decided to take over the control and continued the approach to land. The PIC considered that the aircraft was on condition that might not be able to be handled by the SIC and decided to take over the control and continued the approach to land.

The PIC tried to correct glide path by increase rate of descend and reduced the thrust levers simultaneously the PIC rolled to align with runway centerline. The PIC continued the approach and landing while the approach was un-stabilized.

The Boeing FCTM on subtitle Holding, Approach and Landing (FCT 737 CL (TM) 4.5 - 4.6) Stabilized Approach Requirements, stated:

Any significant deviation from planned flight path, airspeed, or descent rate should be announced. The decision to execute a go-around is ***no*** *indication of poor performance.*

Note*: Do not attempt to land from an unstable approach*.

According to the operator CRM Policy which stated, *"each Garuda Indonesia crewmember shall be responsible for notifying the pilot-in command of any condition or circumstance that might endanger the aircraft or impair the performance of any flight crewmember"*.

The analysis chapter 2.1 of this report described that the aircraft was in condition of un-stabilized approach below 300 feet AGL on final approach. The CVR did not record any statement or comment of both FOs on board to remind the PIC of un-stabilized condition which was required by operator CRM policy.

The descriptions above showed that the PIC decision to take over control and continued the approach on an un-stabilized approach and absent of reminder from the other crew was not consistent with the operator standard operating procedures as well as the CRM Policy.

3. CONCLUSION

3.1 Findings

1. The aircraft was airworthy and there was no system malfunction reported prior to the serious incident.
2. All three pilots have valid license and medical certificates.
3. The aircraft was within the correct weight and balance limitation.
4. The flight conducted VOR/DME approach runway 35 and circle to land to runway 17 procedures due to the wind condition.
5. The pilot was able to see the runway at about 4 DME then continued following the circling procedure in VMC.
6. While turning on the base leg runway 17, was turned too early, higher than normal glide and on the right of the centerline which might not be able to be handled by the SIC and took over the control
7. The PIC tried to correct glide path by increase rate of descend and reduced the thrust levers simultaneously the PIC rolled to align with runway centerline.
8. The FDR data recordedthat aircraft heading were changed from 140° to 174°, and the roll angle varied from 9° to 21° which were indication that the aircraft was on un-stabilized approach.
9. There was no call out from any other crew member to remind the un-stabilized condition.
10. The aircraft touched down with vertical acceleration of 3.473 G then bounced.The aircraft veered off to the right of runway centerline.
11. The runway inspection found some broken parts of nose wheel hub.

3.2 Contributing Factor

During thecircle to land approach, the aircraft was turned too early that might cause the aircraft higher above the normal approach path and not on the correct track and was taken over by the PIC.

The approach was un-stabilized until below 300 feet and the absent of reminder from the other crew to go-around. These actions inconsistent to the operator standard operating procedures as well as the CRM philosophy.

4. SAFETY ACTIONS

At the time of issuing this Final Report, the Komite Nasional Keselamatan Transportasi has been informed of several safety actions taken PT. Garuda Indonesia as resultof this accident. The detail is as follows:

a. PT. Garuda Indonesia has issued an Engineering Instruction Sheet No. B3/05-0202-TEA on 23 July 2011 about "*Maintenance after Hard landing and Off-Runway* Excursion". This Engineering Instruction issued as an instructions to conduct inspection of the PK-GGO aircraft and do corrective action as necessary,

b. PT. Garuda Indonesia conducted a bore scope inspection for CFM56-3 engine serial number 858961 and serial number 858659,

c. PT. Garuda Indonesia conducted a series of NDT inspections with High FrequencyEddy Current andultra-sonic methods.

5. RECOMMENDATION

Based on the examination of the factual data and the safety issue findings which contributed to this serious incident such as, the OperatorStandard Operating Procedures mentioned that when the approach becomes un-stabilized at and below 500ft above airport elevation in VMC, it requires an immediate go-around.

KNKT has received Engineering Instruction related to the inspection and corrective action for the aircraft.

Therefore the Komite Nasional Keselamatan Transportasi issued several safety recommendations addressed to:

5.1 Recommendation to PT. Garuda Indonesia

a It was identified that in consistency to the operator policy and procedure related to the un-stabilized approach and landing procedures was as a contributing factor in this serious incident. KNKT recommends to re-emphasize the implementation of the published standard operating procedures and toconsider that this condition might possible extend to the other flight crew.

b Associated with the PIC decision, that the implementation of the CRM Philosophy was requiring flight crew focuseson specific teamwork, communication, decision-making, and workload management behaviors that have been proven to enhance personal effectiveness and job satisfaction. As such, KNKT recommends to re-emphasizea well implementation of the CRM philosophy especiallyto the topics described above and to consider that this condition might possible extend to the other flight crew.

5.2 Recommendation to Director General of Civil Aviation

The Komite Nasional Keselamatan Transportasi recommends to the Director General of Civil Aviation to monitor and over sighting periodically the recommendation implementation as stated above.