FINAL
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NATIONAL TRANSPORTATION SAFETY COMMITTEE

Aircraft Accident Investigation Report

Merpati Nusantara Airlines
Xi 'An Aircraft Industry MA60; PK-MZO
El Tari Airport, Kupang
Republic of Indonesia
10 June 2013

NATIONAL TRANSPORTATION SAFETY COMMITTEE
MINISTRY OF TRANSPORTATION
REPUBLIC OF INDONESIA
2014

This Final Report was produced by the National Transportation Safety Committee (NTSC), Ministry of Transportation Building 3rd Floor, Jalan Medan Merdeka Timur No. 5 Jakarta 10110, Indonesia.

The report is based upon the investigation carried out by the NTSC 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. 3/2001).

The preliminary report consists of factual information collected until the preliminary report published. This report will not include analysis and conclusion.

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ABBREVIATIONS AND DEFINITIONS

AGL	:	Above Ground Level
AMM	:	Aircraft Maintenance Manual
AOC	:	Air Operator Certificate
ATPL	:	Air Transport Pilot License
ATS	:	Air Traffic Service
BMKG	:	*Badan Meterologi Klimatologi dan Geofisika* (Metrological Climatologically and Geophysical Agency)
°C	:	Degrees Celsius
CAAC	:	Civil Aviation Authority of China
CAM	:	Cockpit Area Microphone
CPL	:	Commercial Pilot License
CSN	:	Cycles Since New
CVR	:	Cockpit Voice Recorder
DGCA	:	Directorate General of Civil Aviation
DME	:	Distance Measuring Equipment
EEC	:	Electronic Engine Control
EGPWS	:	Enhance Ground Proximity Warning System
FCOM	:	Flight Crew Operation Manual
FDR	:	Flight Data Recorder
F.I	:	Flight Idle
FL	:	Flight Level
ft	:	Feet
GA	:	Go Around
G.I	:	Ground Idle
hPa	:	Hectopascals
Hrs	:	Hours
ICAO	:	International Civil Aviation Organizationn
IFR	:	Instrument Flight Rules
IIC	:	Investigator in Charge
In Hg	:	Inch Hydrargyrum
Kg	:	Kilogram(s)
Km	:	Kilometer(s)
kts	:	Knots (nm/hours)
L/H	:	Left hand
mbs	:	Millibars
mHz	:	Mega Hertz
Min	:	Minute (S)
Mm	:	Millimeter(s)

MEL	:	Minimum Equipment List
MMF	:	Merpati Maintenance Facility
MTOW	:	Maximum Take-off Weight
Nm	:	Nautical mile(s)
NOTAM	:	Notice to Airman
KNKT (NTSC)	:	*Komite Nasional Keselamatan Transportasi* (National Transportation Safety Committee)
P/A	:	Passenger Address
PF	:	Pilot Flying
PIC	:	Pilot in Command
PL	:	Power Lever
PM	:	Pilot Monitoring
QFE	:	Height above airport elevation (or runway threshold elevation) based on local station pressure
QNH	:	Height above mean sea level based on local station pressure
SIC	:	Second in Command
S/N	:	Serial Number
SSCVR	:	Solid State Cockpit Voice Recorder
SSFDR	:	Solid State Flight Data Recorder
T.O	:	Take off
TSN	:	Time since New
TT/TD	:	Ambient Temperature/Dew Point
UTC	:	Universal Time Coordinate
VMC	:	Visual Meteorological Condition
VOR	:	Very High Frequency Omnidirectional Range

INTRODUCTION

SYNOPSIS

On 10 June 2013, a Xi 'An MA60 aircraft registered PK-MZO was being operated by PT. Merpati Nusantara Airlines on a scheduled passenger flight as MZ 6517.

The aircraft departed from Bajawa Airport (WATB) Nusa Tenggara Timur, at 0102 UTC to El Tari (WATT) Kupang, Nusa Tenggara Timur. On board this aircraft were 2 pilots, 2 flight attendants with 46 passengers consisted of 45 adults and one infant.

The aircraft cruised at 11,500 ft, and the Second in Command (SIC) acted as the Pilot Flying (PF) and the Pilot in Command (PIC) acted as the Pilot Monitoring (PM).

The flight from the departure until commencing for approach was un-eventful.

At 0138 UTC, the pilot reported the aircraft was passing altitude of 10,500 ft, and stated that the flight was on Visual Meteorological Condition (VMC).

At 0150 UTC, the approach was performed visually and the aircraft position was on left base runway 07 at 5 Nm from KPG VOR. The El Tari Tower had visual contact with the aircraft and issued a landing clearance with additional information that the wind condition was 120° 14 kts, QNH 1010 mbs.

At 0154 UTC, the aircraft touched down at about 58 meters from the beginning of runway 07 and halted on the runway at about 261 meters from the beginning of runway 07. The vertical deceleration recorded on Flight Data Recorder (FDR) was 5.99 G and followed by – 2.78 G. The longitudinal deceleration after impact was calculated approximately 0.7 G.

After the aircraft stopped, the flight attendants assessed the situation and decided to evacuate the passengers through the rear main entrance door. One pilot and four passengers suffered injury passenger who seated on row number three, seven and eight.

The aircraft was substantially damaged.

The investigation was assisted by the Civil Aviation Authority of China (CAAC) as accredited representative.

The FDR data retrieved that the left power lever was in the range of BETA MODE at aircraft altitude approximately 112 ft and continued with right power levels in the range of BETA MODE at 90 ft until touchdown on the runway.

Following this accident, the Director of Safety of PT. Merpati Nusantara Airlines has issued safety actions and instructing the MA60 instructor pilots to implement.

Included in this report, the National Transportation Safety Committee (NTSC) has issued several safety recommendations addressed to the Indonesian DGCA, PT. Merpati Nusantara Airlines and Xi'AN Aircraft Industry (group) Company LTD.

1 FACTUAL INFORMATION

1.1 History of the Flight

On 10 June 2013, a Xi 'An MA60 aircraft registered PK-MZO was being operated by PT. Merpati Nusantara Airlines on a scheduled passenger flight as MZ 6517.

The aircraft departed from Bajawa Airport (WATB) Nusa Tenggara Timur, at 0102 UTC[1] to El Tari (WATT) Kupang[2], Nusa Tenggara Timur. On board this aircraft were 2 pilots, 2 flight attendants with 46 passengers consisted of 45 adults and 1 infant. The flight was the second sectors for the aircraft and the crew on that day. The first flight was from Kupang to Bajawa Airport.

During the flight the Second in Command (SIC) acted as the Pilot Flying (PF) and the Pilot in Command (PIC) as the Pilot Monitoring (PM).

The flight from the departure until commencing for approach was un-eventful.

At 0122 UTC, the pilot made first communication with El Tari Control Tower controller (El Tari Tower) and reported their position was on radial 298° 110 Nm from KPG VOR[3] and maintaining 11,500 ft. The pilot received information that the runway in use was 07 and the weather information (wind 110° 11 kts, visibility 10 km, weather NIL, cloud few 2,000 ft, temperature 30° C, dew point 22° C, QNH 1010 mbs and QFE 998 mbs).

At 0133 UTC, the aircraft was on radial 297° 68 Nm from KPG VOR and the pilot ready to descend and approved by El Tari Tower to descend to 5,000 ft.

At 0138 UTC, the pilot reported the aircraft was passing 10,500 ft and stated that the flight was on Visual Meteorological Condition (VMC).

At 0150 UTC, the aircraft position was on left base runway 07 at 5 Nm from KPG VOR. The El Tari Tower had visual contact with the aircraft and issued a landing clearance with additional information that the wind condition was 120° at 14 kts, QNH 1010 mbs.

At 0151 UTC, the pilot reported that their position was on final and the El Tari Tower re-issued the landing clearance.

The Flight Data Recorder (FDR) recorded that the left power lever was in the range of BETA MODE while the aircraft altitude was approximately 112 ft and followed by the right power lever at 90 ft until hit the ground.

At 0154 UTC, the aircraft touched down at about 58 meters and halted on the runway at about 261 meters from the beginning of runway 07. The vertical deceleration recorded on FDR was 5.99 G and followed by - 2.78 G.

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1 The 24-hour clock used in this report to describe the time of day as specific events occurred is in Coordinated Universal Time (UTC). Local time for Kupang is Waktu Indonesia Tengah (WITA) is UTC + 8 hours.

2 El Tari Airport (WATT), Nusa Tenggara Timur will be named Kupang for the purpose of this report.

3 KPG is the code of Very High Frequency Vary Omnidirectional Range (VOR) which used in Kupang Airport.

After the aircraft stopped, the flight attendants assessed the situation and decided to evacuate the passengers through the rear main entrance door. One pilot and four passengers who seated on row number three, seven and eight suffered serious injury.

On 11 June 2013, the aircraft was evacuated from the runway and moved to the Air Force hangar at 2100 UTC.

1.2 Injuries to Persons

Injuries	Flight crew	Passengers	Total in Aircraft	Others
Fatal	-	-	-	-
Serious	1	4	5	-
Minor/None	3	42	45	Not applicable
TOTAL	4	46	50	-

The second in command was a Malaysian and one of the passengers was an American citizen.

1.3 Damage to Aircraft

The aircraft was substantially damaged.

Figure 1: The accident aircraft

Figure 2: Damage on the right side of the aircraft

Figure 3: The rear right view of the aircraft

1.4 Other Damage

There was no other damage to property and/or the environment.

1.5 Personnel Information

1.5.1 Pilot in Command

Gender	:	Male
Age	:	42 years old
Nationality	:	Indonesian
Date of joining company	:	1 November 1994
License	:	ATPL
Date of issue	:	1 December 2004
Aircraft type rating	:	MA60
Instrument rating	:	18 Mach 2013
Medical certificate	:	First Class
Last of medical	:	3 January 2013
Validity	:	3 July 2013
Medical limitation	:	Holder shall wear corrective lenses
Last line check	:	18 May 2012
Last proficiency check	:	18 March 2013

Flying experience

Total hours	:	12,530 hours 33 minutes
Total on type	:	2,050 hours 43 minutes
Last 90 days	:	111 hours 52 minutes
Last 60 days	:	71 hours
Last 24 hours	:	2 hours 20 minutes
This flight	:	1 hours 10 minutes

Note:

The PIC was qualified as route instructor and has been performed approximately 218 instructing flight hours.

1.5.2 Second in Command

Gender	:	Male
Age	:	25 years old
Nationality	:	Malaysian
Date of joining company	:	13 February 2012
License	:	CPL
Date of issue	:	20 June 2012
Aircraft type rating	:	MA60

Instrument rating	:	24 October 2012
Medical certificate	:	First Class
Last of medical	:	1 March 2013
Validity	:	1 September 2013
Medical limitation	:	Holder shall wear corrective lenses
Last line check	:	-
Last proficiency check	:	24 October 2012

Flying experience

Total hours	:	311 hours 44 minutes
Total on type	:	117 hours
Last 90 days	:	89 hours 23 minutes
Last 60 days	:	58 hours 15 minutes
Last 24 hours	:	2 hours 20 minutes
This flight	:	1 hours 10 minutes

Note:

The SIC was on line training program with approximately 141 hours 44 minutes including 24 hours as observer.

The operator had planned to checked the SIC to be a qualified first officer on the next schedule but he requested another multi days schedule to be more confidence prior to flight check.

The SIC have some experiences of delay on moving the power lever to Ground Idle during landing. On the accident flight, the SIC aware to previous experienced and lifted the mechanical power lever stop slots during approach.

Base on the interview data dated 10 June 2013, the SIC realized that he retarded the Power Lever backward unintentionally at about 70 ft of aircraft altitude. The PIC informed that the SIC had experienced late to lift the Mechanical Power Lever Stop Slot at the previous landings.

1.6 Aircraft Information

1.6.1 General

Registration Mark	:	PK-MZO
Manufacturer	:	Xi ‘An Aircraft Industry (Group) Company LTD
Country of Manufacturer	:	China
Type/ Model	:	MA60
Serial Number	:	0608

Year of manufacture	:	2007
Certificate of Airworthiness		
Issued	:	9 December 2012
Validity	:	8 December 2013
Category	:	Transport
Limitations	:	None
Certificate of Registration		
Registration Number	:	2841
Issued	:	9 December 2011
Validity	:	8 December 2014
Time Since New	:	4,486 hours
Cycles Since New	:	4,133 cycles
Last Major Check	:	1C check, 10 August 2012
Last Minor Check	:	4A check, 6 May 2013

1.6.2 Engines

Manufacturer	:	Pratt & Whitney
Country of Manufacturer	:	Canada
Type/Model	:	Turbo Propeller/PW127J
Serial Number-1 engine	:	PCE-EA0074
▪ Time Since New	:	1,954 hours
▪ Cycles Since New	:	2,540 cycles
Serial Number-2 engine	:	PCE-EA0084
▪ Time Since New	:	4,133 hours
▪ Cycles Since New	:	4,486 cycles

1.6.3 Propellers

Manufacturer	:	Hamilton Standard
Country of manufacturer	:	United States of America
Type/Model	:	247 F-3
Serial Number-1 propeller	:	20080832
▪ Time Since New	:	3,002 hours
Serial Number-2 propeller	:	20070326
▪ Time Since New	:	2,723 hours

On 29 May 2013, the L/H propeller was replaced due to vibration.

1.6.4 Weight and Balance

The aircraft departed from Bajawa with configuration as follows:

Zero fuel weight : 17,987 kg

Fuel on board : 1,768 kg

Takeoff weight : 19,755 kg

Landing weight : 19,143 kg

MAC takeoff : 19.9 %

MAC landing : 21.8 %

These configurations were within the operating limit.

1.6.5 Engine power lever

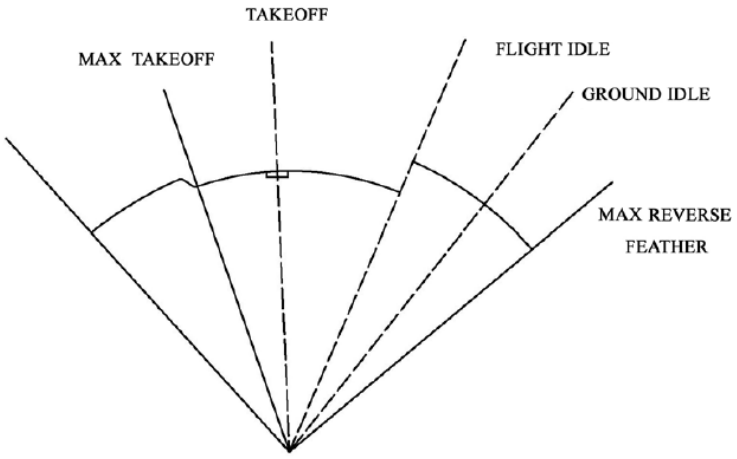

Figure 4: Positions of Power Lever

Power lever has the following function:

Regulate the engine power between the take-off and full reverse feathering function (FCOM 17-25).

Based on the information above can be interpreted that the power lever regulates engine power between takeoff to full reverse and feathering function.

1.6.6 Flight and Ground Power Lever Protection

Electric Magnetic Lock Systems

The description taken from the Flight Crew Operation Manual (FCOM) Paragraph 17.4.1 B Power Lever:

At takeoff, pilot pushes the power lever to T.O position from G.I position.

At the time of approach landing, pilot pulls the power lever to F.I position, at this time, the power lever cannot be pulled below F.I due to the action of electric magnetic stopping lock of the flight idle; after aircraft lands, the electric magnetic lock of flight idle is opened automatically and pilot can pull the power lever to any position below F.I.

Based on the statement in the FCOM it can be interpreted that the 'electric magnetic stopping lock' has function to prevent the propeller moves to BETA range (beyond Flight Idle) in flight.

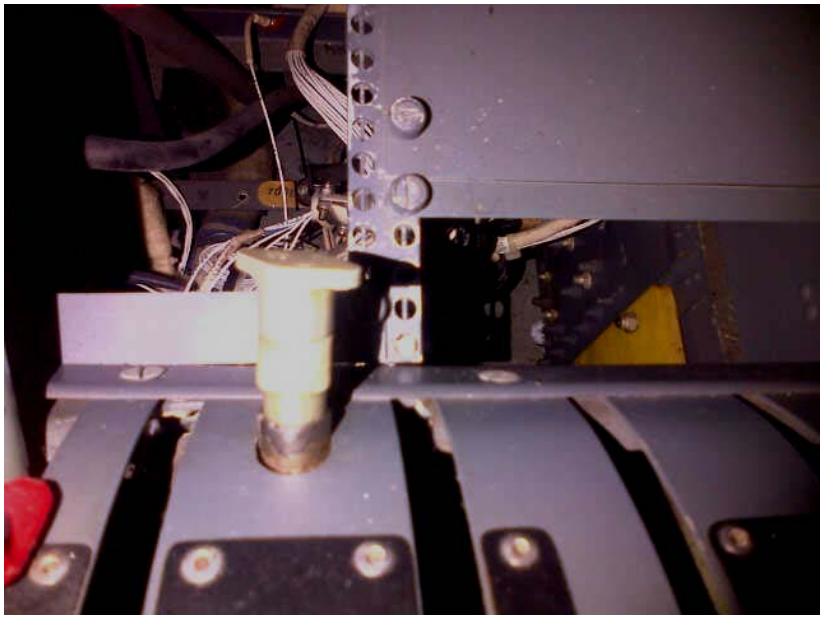

Figure 5: The electric magnetic stop found on "OPEN" position

Mechanical Power Lever Stop Slot

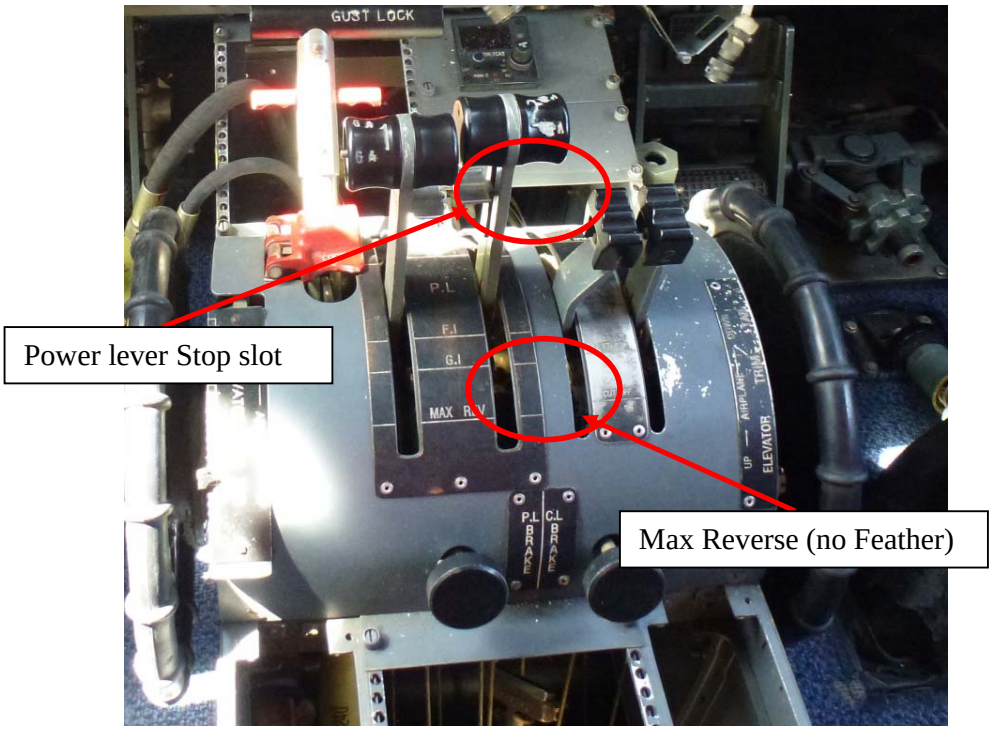

Figure 6: Power lever stop slot

Statement taken from AMM chapter 76-00-00 Engine Control system:

Controls system of power lever is used for providing fuel required by normal working condition of engine within positive pull range and control the operation of propeller from Beta to full negative pull range control system of condition lever is used for control for control rotative speed of propeller, operating manual feathering, shutting off fuel at constant speed working range and triggering propeller under-speed fuel monitoring within Beta and negative pull working range.

Micro-switch assembly is installed with many micro-switches actuated by power lever and condition leve. They are used for presetting PLA and CLA. These micro-swicthes are working in electrically control circuit adjusting and control of propeller and engine fuel and landing gear and flight control systems.

Stop slot of flight idle of power lever can prevent selection of engine ground Beta and anti-feathering operation in the flight due to negligence. Lifting stop of condition lever can prevent the selection of feathering and shut off fuel due to negligence.

In order to avoid the danger caused by pulling power lever below the flight idle in the flight due to error operation of pilot, flight idle electromagnetic stop lock safety devices is equipped in the power lever control mechanism in addition to installation of flight idle stop slot.

Refer to the statement of the AMM it can be concluded that the power levers can be moved from flight idle to ground idle by the function of electric magnetic stop and mechanical flight idle stop slot.

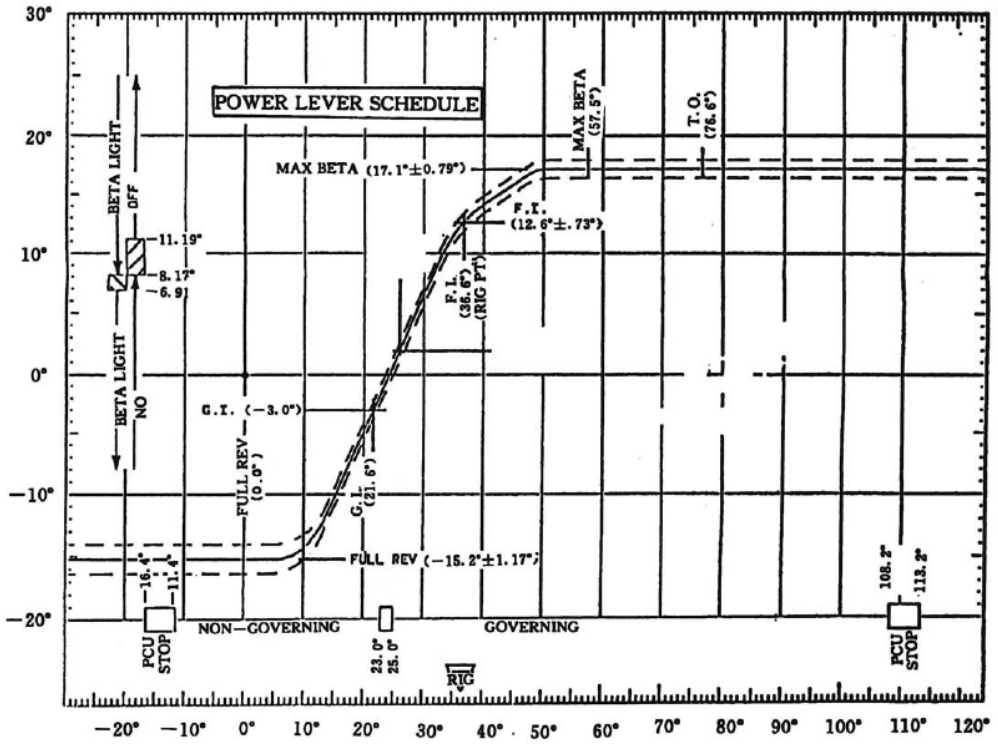

Figure 7: BETA operation curve of propeller

Refer to the graph (figure 5), the BETA range will set the propeller pitch angle below 8°. If the propellers pitch angle moves to BETA range will create significant drag.

On the accident aircraft, the electric magnetic stop was found in OPEN position. This situation was consistent to the operator approach check list which stated “PL LOCK – OPEN“.

Observations on FCOM, Aircraft Maintenance Manual (AMM) and simulator did not find any caution light or aural warning whenever the electric magnetic stop selected to OPEN.

The approach check list taken from the FCOM:

PF	PM
Deicing/anti-icing device…As required Approach course…….Set Navigation frequency…….Set	Cabin crew report……As required
Transition altitude	
Altimeter……Set QFE/QNH	Altimeter……..……Set QFE/QNH
Left and right altimeter cross check	
Order ”Approach Checklist”	Complete “Approach Checklist”

The operator's normal check list revision 11 dated 15 April 2012, on the APPROACH stated "PL LOCK……..OPEN". The PL LOCK OPEN was not found on the FCOM issued by the aircraft manufacturer.

The investigation could not find any evidence of safety assessment, risk analysis and approval related to the checklist revision.

APPROACH	
FASTEN SEAT BELT……....ON	PM
LDG TAXI LIGHTS…….....TAXI	PM
ALTIMETERS……...SET	B
HYD QTY & PRESS.....CHECKED	L
ERS…..…….....TO / GA	PM
PRESSURIZATION…....CHECKED	PM
PL LOCK…….OPEN	PM
CL……..MAX	PM
LANDING FINAL	
CABIN CALL……..GIVEN	PM
IGN INFLIGHT……...ON	PM
FUEL PUMPS…..……..…….ON	PM
LDG TAXI LIGHTS……...…..LAND	PM
ECS BLEEDS……OFF	PM
LANDING GEARS…DOWN&LOCK	PM
FLAPS……..…...SET	PM

1.7 Meteorological Information

1.7.1 Meteorological Report

The weather information reported by Kupang Meteorological Station on local routine (MET REPORT) were as follows:

	0130 UTC	**0200 UTC**	**0230 UTC**
Wind	090° / 12-15 kts	110° / 13 kts	080° / 16 kts
Visibility	10 km	10 km	10 km
Weather	NIL	NIL	NIL
Cloud	Few 2,000 ft	Few 2,000 ft	Few 2,000 ft
TT/DP	29° C / 22° C	30° C / 22° C	30° C / 22° C
QNH	1010 hPA / 29.84 in Hg	1010 hPA / 29.83 in Hg	1009 mbs / 29.82 in Hg
QFE	997 hPA / 29.47 in Hg	997 hPA / 29.46 in Hg	997 mbs / 29.45 in Hg
Remarks	NIL	NIL	NIL

1.7.2 Satellite Image

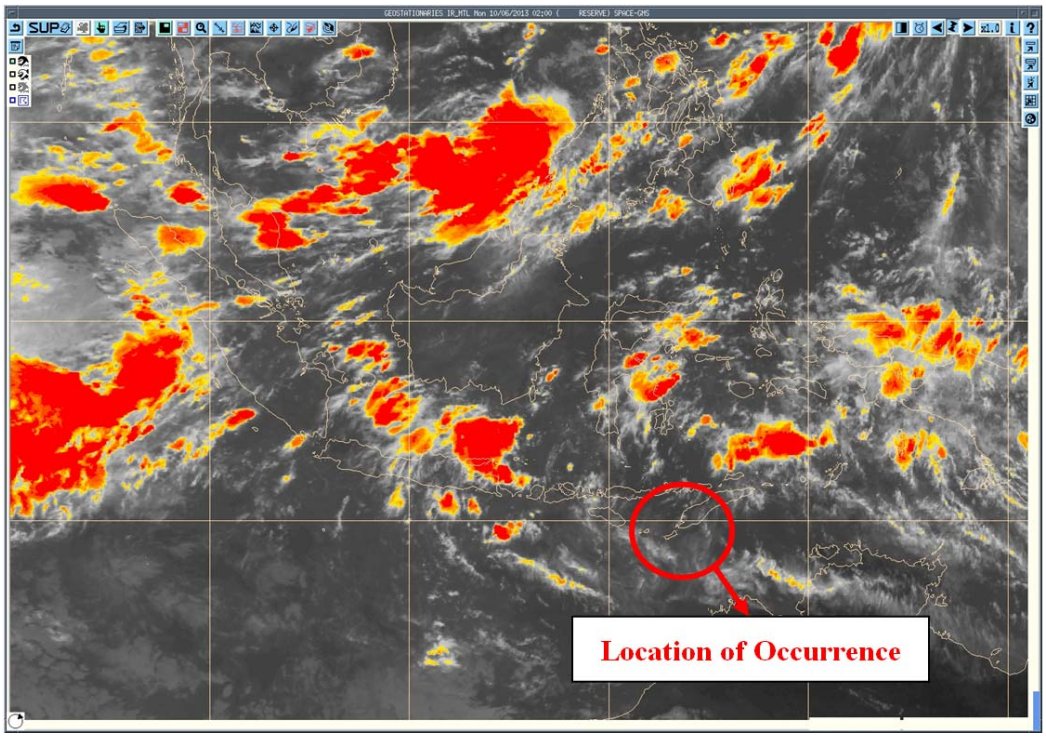

Figure 8: Satellite image at 0200 UTC provided by BMKG

1.8 Aids to Navigation

Runway 07 Kupang Airport was equipped with a Very High Frequency Vary Omnidirectional Range (VOR) and Distance Measuring Equipment (DME) on frequency 122.2 MHz. At the day of the accident, the VOR DME was functioning properly.

1.9 Communications

All communications between Air Traffic Services and the crew were recorded by ground based automatic voice recording equipment and the Cockpit Voice Recorder (CVR) for the duration of the flight. The quality of the aircraft's recorded transmissions was good.

1.10 Aerodrome Information

Airport Name	:	El Tari Airport
Airport Identification	:	WATT
Airport Operator	:	PT. Angkasa Pura I (Persero)
Airport Certificate	:	020/SBU-DBU/VII/2010
Coordinate	:	10°10.7’S 123°39.8’E
Elevation	:	335 ft / 31° C
Runway Direction	:	07 – 25 / 073° – 253°
Runway Length	:	2,500 meters
Runway Width	:	45 meters
Surface	:	Asphalt

1.11 Flight Recorders

1.11.1 Flight Data Recorder

The aircraft was equipped with a solid state Flight Data Recorder (FDR) and the details of the FDR were:

Manufacturer : Shaanxi Qianshan Avionics Co. Ltd., China

Type/Model : FB-30C

Serial Number : 0710012

The FDR was downloaded on 13 June 2013 at Merpati Maintenance Facility (MMF) at Surabaya under the NTSC supervision. The recorder contained over 90 parameters of 47.2 hours in excellent quality data comprising the accident flight and 25 previous flights commencing from the 5 June 2013.

Further analysis of the FDR data was performed at NTSC facility in Jakarta, where the corrupted data of the last 8 seconds of the flight was successfully retrieved (figure 9).

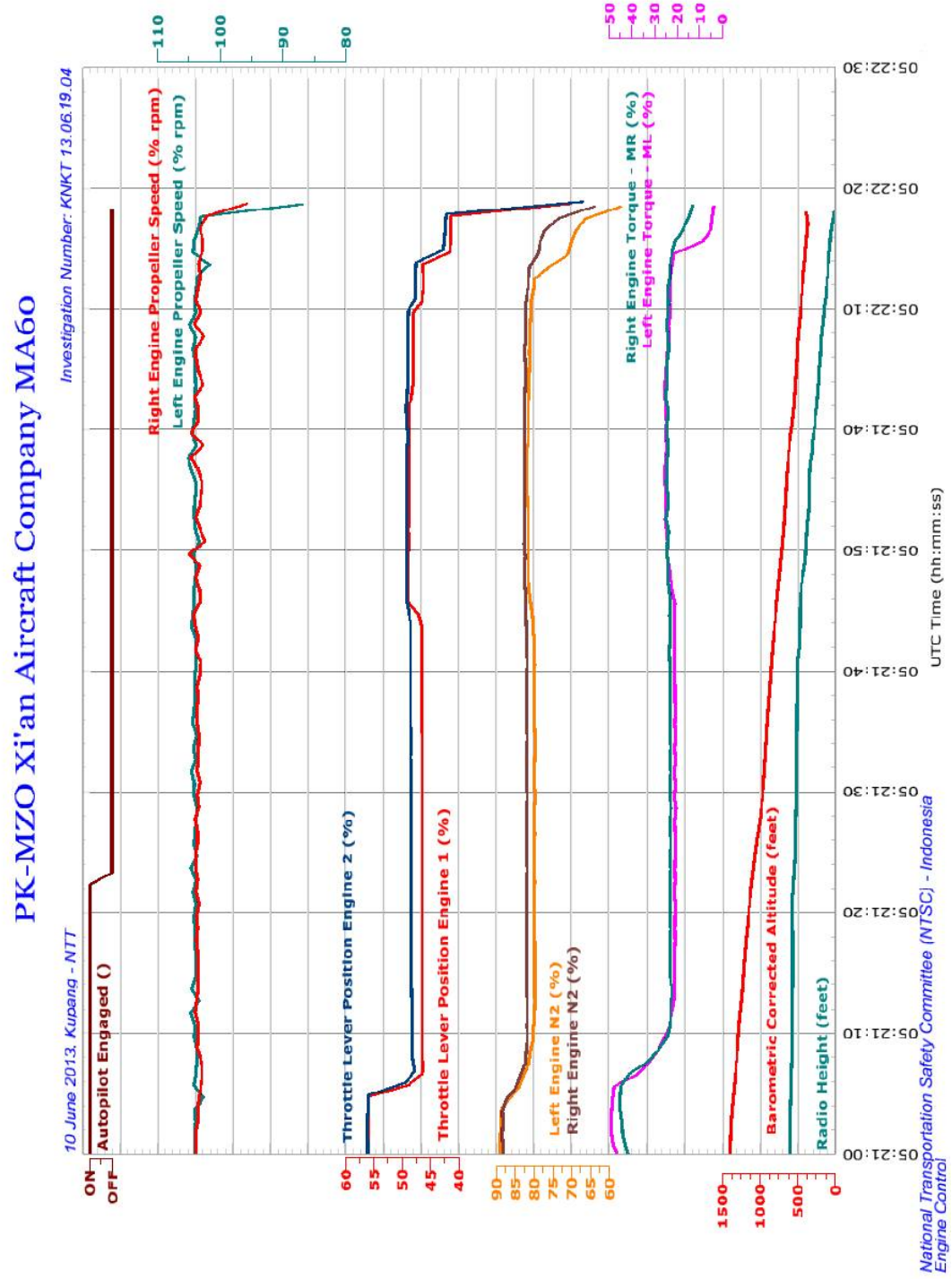

Figure 9: FDR plot of main engine parameters

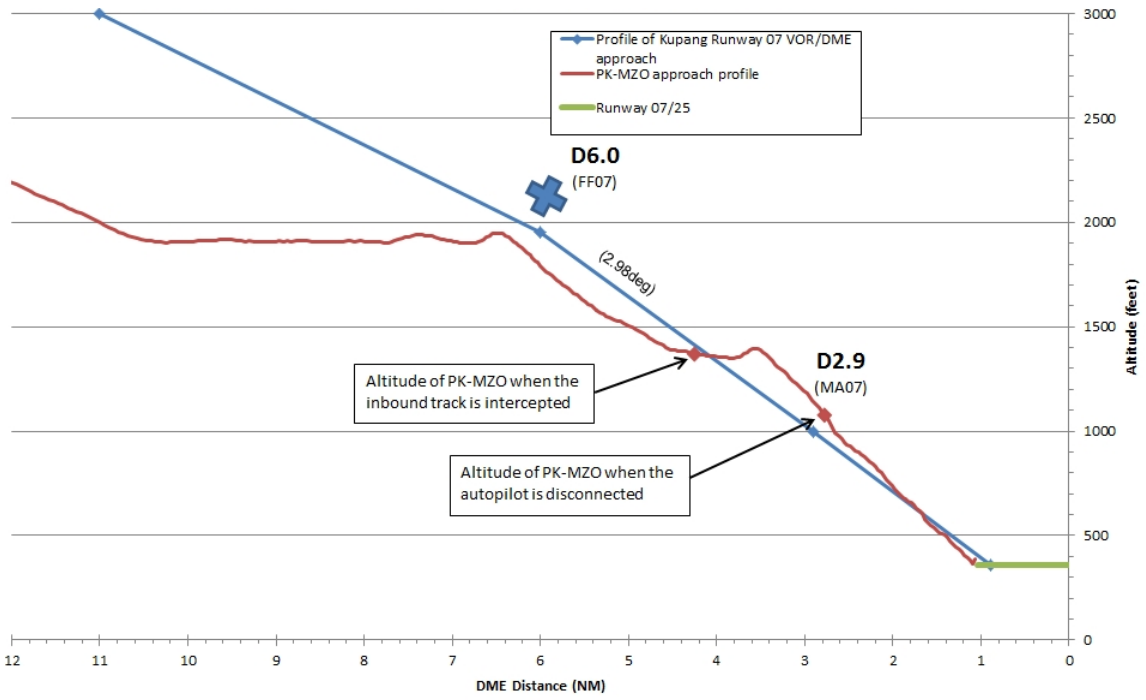

Figure 10: Comparison of published approach and actual profile based on FDR

Figure 10 indicates that based on the FDR data, the approach was not on profile as published for runway 07, while the approach angle greater than 2.9°.

The significant events based on FDR data, showed that:

- At 5:21.14 UTC aircraft altitude was 1336 ft or it was 1000 AGL (RA) radio altitude 565 ft the vertical speed showed -864 ft/minutes.
- At 5:21.24 UTC radio altitude 548 ft the aircraft vertical speed was more than 1100 ft/minutes.
- At 5:21.26 UTC radio altitude 533 ft the aircraft vertical speed was -1264 ft/ minutes.
- At 5:21.29 UTC radio altitude 524 ft the aircraft vertical speed was -1296 ft/ minutes.
- At 5:21.38 UTC radio altitude 511 ft the aircraft vertical speed was -560 ft/ minutes.
- At 5:21.47 UTC radio altitude 462 ft the aircraft vertical speed was -896 ft/ minutes.
- At 5:21.57 UTC radio altitude 344 ft the aircraft vertical speed was -544 ft/ minutes.
- At 5:22.02 UTC radio altitude 262 ft the aircraft vertical speed was -1056 ft/ minutes.

- At 5:22.08 UTC radio altitude 190 ft the aircraft vertical speed was -528 ft/ minutes.
- At 5:22.13 UTC radio altitude 112 ft the aircraft speed 126 kts and left NL 79.9 %, right NL 81.5 %.
- At 5:22.15 UTC radio altitude 90 ft the aircraft vertical speed was -848 ft/ minutes, aircraft speed 123 kts left NL 71 %, right NL 79 %.
- At 5:22.19 UTC radio altitude 10 ft the aircraft vertical speed was -1280 ft/ minutes, left NL 56.7 %, right NL 63.7 % and the elevator angle -23.8°.

The FDR recorded that the left power lever was in the range of BETA MODE while the aircraft altitude was approximately 112 ft and followed by the right power lever at 90 ft until hit the ground.

The FDR also recorded a vertical acceleration of +5.99 G followed by -2.76 G and stopped recording 0.297 seconds after touchdown. The last recorded value of roll angle was 4 degrees left wing down.

1.11.2 Cockpit Voice Recorder

The aircraft was equipped with a Solid State Cockpit Voice Recorder (SSCVR) capable to record up to 120 minutes of audio on four channels (P/A, Co-pilot, Pilot and Cockpit Area Microphone/CAM).

Details of the CVR were:

Manufacturer	:	Honeywell
Type/Model	:	SSCVR
Part Number	:	980-6022-001
Serial Number	:	CVR120-12528

The CVR was downloaded at NTSC facility on 12 June 2013 and contained 120 minutes of good quality recording. The audio files were examined found to contain the accident flight.

The excerpt of the significant information from the CVR for the last four minutes of recording:

01:50:55	Flap 30 selected
01:50:57	Landing check list was performed
01:51:02	The pilot received clearance to land
01:51:28	The autopilot was disengaged
01:51:35	The Enhance Ground Proximity Warning System (EGPWS) aural message “MINIMUM”
01:51:48	The EGPWS aural message “FIVE HUNDRED”
01:52:02	The PF intended to reduce the power to correct the speed
01:52:13	The EGPWS aural message “TWO HUNDRED”

01:52:20	The EGPWS aural message “ONE HUNDRED”
01:52:24	The EGPWS aural message “FIFTY”
	Sounds similar to changing of engine and propeller
	The EGPWS aural message “FORTY”
01:52:25	PF self-exclaiming “Ups”
	The EGPWS aural message “THIRTY”
01:52:26	Sound of aircraft impact
01:52:38	Aircraft stopped
01:54:37	End of recording

1.12 Wreckage and Impact Information

1.12.1 Landing trajectory

The main wheel touchdown marks found approximately 58 meters from the beginning runway 07.

The aircraft halted approximately 261 meters from the beginning runway 07.

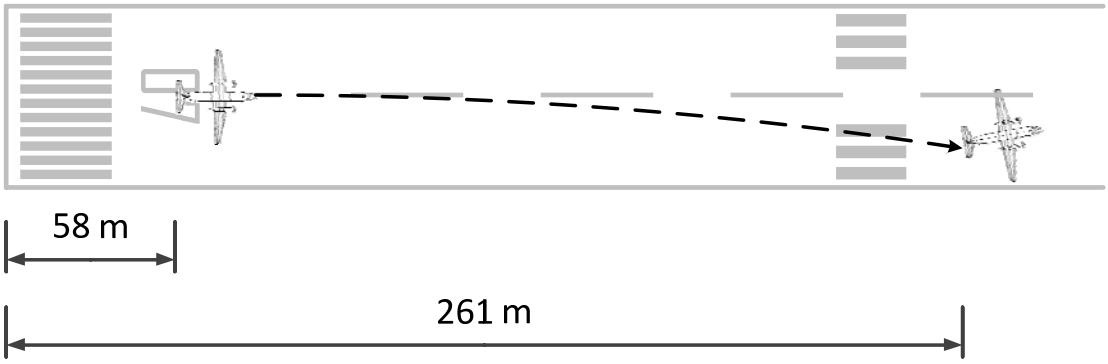

Figure 11: The illustration of the ground roll accident

1.12.2 Marks Found on the Runway

The marks on the initial touchdown showed that the lower fuselage impacted to the runway between the first marks of the main wheels and nose wheels (figure 13). The distance between the main wheels and the nose wheels marks was 7.5 meters while the normal distance was 9.5 meters.

The propeller scratch marks were found on left and right side 13 meters of the main wheels marks.

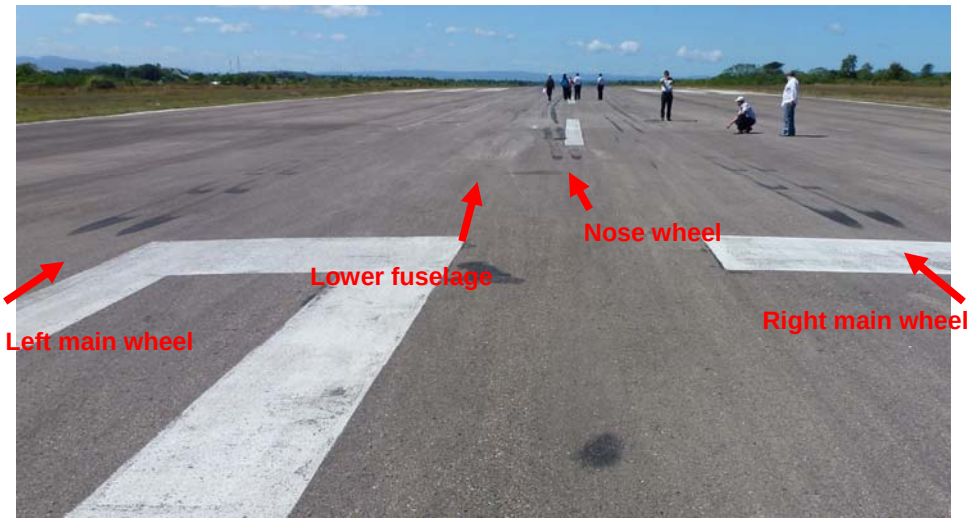

Figure 12: The marks of the initial touch down

Figure 13: The propeller scratch marks

1.12.3 Longitudinal Acceleration Calculation

The FDR was not provided with a longitudinal acceleration data, the longitudinal acceleration G was calculated based on available data.

- Distance from touchdown to stop was 203 meters (659.75 ft);
- Touchdown speed was 113 kts (190.772 ft/s).

The manual calculation result the longitudinal acceleration approximately - 0.7 G.

The MA60 landing run schedule with assumption 102 kts touchdown speed and distance of landing run of 760 meters will result the longitudinal acceleration of - 0.185 G.

1.13 Medical and Pathological Information

No medical or pathological investigations were conducted as a result of this occurrence, nor were they required.

1.14 Fire

There was no evidence of fire in-flight or after the aircraft impact.

1.15 Survival Aspects

The passengers seated on row number seven and eight suffered vertebra disk and fixation collar neck, indicated high vertical G forces on this area, this consistent with the broken fuselage near the landing gear bay area.

Seat Number	Injury
3D	Right hand wrist fracture
7C	Fixation collar neck
7D	Vertebra disk
8A	Vertebra disk
Left hand pilot	Backbone trauma

The flight attendant after assessed the situation and aircraft damage decided to evacuate the passengers via rear main entrance door.

1.16 Tests and Research

A simulator test to verify the FDR data was performed at MA-60 flight training simulator in Merpati Training Center by Merpati MA60 instructor pilots and supervised by NTSC investigators.

The simulator test started from approach at 1500 ft and gradually reducing power until beta range at 200 ft. After both power levers entered the beta range the aircraft was rapidly descent.

Another scenario of the simulator test was attempted to recover the situation after power lever entered the beta range. The recovery attempt was unsuccessful.

1.17 Organizational and Management Information

Aircraft Owner and Operator	:	PT. Merpati Nusantara Airlines
Address	:	Jl. Angkasa Blok B-15 Kav 2-3 Kemayoran, Jakarta 10720
Operator Certificate Number	:	AOC 121/002

PT. Merpati Nusantara Airlines is a state own enterprise, provides domestic flight services throughout the region. The operator operates 5 types of aircraft consist of Boeing 737, Xi 'An MA60, CASA C 212 and De Havilland DHC 6 Twin Otter.

The operator operated 14 aircrafts Xi 'An MA60.

The interview on 8 July 2013 with the Management Personnel noted that; the first two aircrafts had several problems on the Power Lever Lock System, whereas the automatic power lever lock system sometimes failed to open after landing. On May 2008, the board of instructors had agreed to revise the Normal Checklist that the Power Lock system selects to "OPEN" before landing.

This Normal Checklist was also used by the operator to all MA60.

1.18 Additional Information

1.18.1 CASR 25.933 Reversing System

(b) For Propeller reversing system

(1) Each system intended for ground operation only must be designed so that no single failure (or reasonably likely combination of failures) or malfunction of the system will result in unwanted reverse thrust under any expected operating condition. Failure of structural elements need not be considered if this kind of failure is extremely remote.

1.18.2 Master Minimum Equipment List (MMEL)

The Master Minimum Equipment List (MMEL) published by aircraft manufacturer on April 2008 rev 06 and the operator Minimum Equipment List (MEL) stated:

SEQ NO.	① ITEM	② REPAIR INTERVAL	③ NUMBER INSTALLED	④ NUMBER REQUIRED FOR DISPATCH	⑤ REMARKS AND/OR EXCEPTIONS	
76-01	Flight Idle Electromagnetic Stop Lock	C	1	0	(O)	Flight idle electromagnetic stop lock may be inoperative, provided manual unlock handle of flight idle electromagnetic stop lock is placed on the unlock position.

Authority: JKTORMZ	Revision: 01	Date: Feb.04, 08	Page: 1

1.18.3 Un-common aviation terminology taken from MA60 Manuals

FCOM Paragraph 17.4.1 B Power Lever

- *At takeoff, pilot pushes the power lever to T.O position from G.I position.*
- *……., after aircraft lands, the electric magnetic lock of flight idle is opened automatically and pilot can pull the power lever to any position below F.I.*

AMM 76-10-00 Description and operation Power Control Lever

Each handle has several optional setting makes. For example, "F.I" (min. air power setting),"T.O"(setting of max take-off power under control of EEC), "G.I"(setting of ground starting engine and min. thrust),"MAX.REV"(setting of max anti-pull power).

Aircraft Maintenance Manual (AMM) pages 31-12-00.

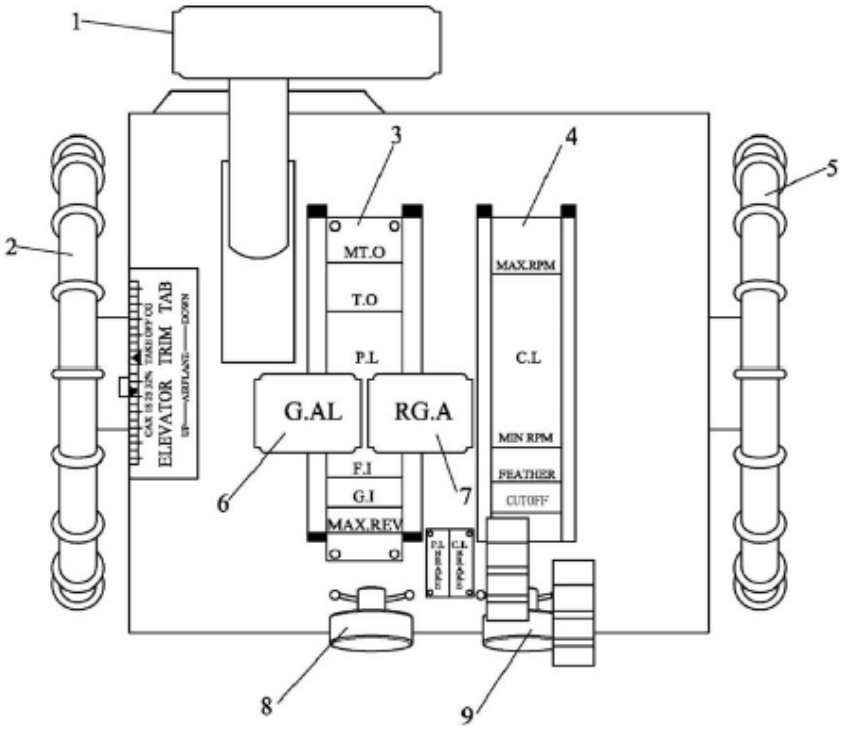

Fig. 009 Central Control Console Middle Portion Layout Diagram

1. Control Surface Locking Handle; 2. Rudder Trim Tab Control Handle; 3. Engine Power Control Handle; 4. Engine Regime Control Handle; 5. Right Elevator Trim Tab Control Handle; 6. Left Go-around Button; 7. Right Go-around Button; 8. Power Lever Stopper; 9. Regime Handle Stopper.

Figure 14: power lever positions described in the AMM

1.18.4 Accredited Representative

The investigation involved the Civil Aviation Authority of China (CAAC) and assisted by Xi ‘An operation and engineering experts as advisors.

1.19 Useful or Effective Investigation Techniques

The investigation was conducted in accordance with the NTSC approved policies and procedures, and in accordance with the standards and recommended practices of Annex 13 to the Chicago Convention.

2 ANALYSIS

The analysis part of this final report will discuss the relevant issues resulting in the hard landing accident involving a MA 60 aircraft, PK-MZO during the approach to Kupang runway 07 on 10 June 2013.

The investigation determined that there were no issues with the aircraft and all systems were operating normally. The analysis will therefore focus on the following issues:

- Power lever lock
- The procedure change process
- Human Factors

And the other issues found as Latent Hazards

- Power lever description and operation
- Uncommon aviation terminology
- Master Minimum Equipment List and Minimum Equipment List.

2.1 Power Lever Lock

The FDR recorded that the both power levers were in the range of BETA MODE while the aircraft altitude was approximately 90 ft and continued until hit the ground.

The investigation could not find any evidence of safety assessment, risk analysis and specific procedure related to the checklist revision

The simulator test found that if both power levers in the beta range the aircraft rapidly descend.

The power levers prevented to move from flight idle to ground idle during flight by the function of Electric Magnetic Lock Systems and Mechanical Power Lever Stop Slot. At the accident aircraft was found that the electric magnetic lock system (Power Lever lock) was on open position.

With power lever lock on open position the solenoid of the electric magnetic lock system disengage and allow the power lever moves to ground idle in flight whenever the mechanical power lever stop slots lifted.

The selection of the PL lock to open position was in accordance with operator Normal Checklist.

2.2 The Procedure Change Process

The operator has revised the Normal Checklist by additional item of Power Lever Lock put to OPEN during approach. The reason of this revision was due to several occasions of power lever difficult to be moved to ground idle during landing.

The Power Lever Lock was designed to prevent the power lever to be able to move to ground idle in flight. The movement of power lever to ground idle will result to the propeller pitch angle changes to low pitch angle which produces significant drag. This drag will make the aircraft wing loss of significant lift.

Power Lever Lock is a part of the safety devices. Selecting of the Power Lever Lock to open in flight is withdrawn a safety device. Hence safety assessment, risk analysis and approval are required prior to withdrawn any of the safety devices and issues specific procedure if necessary.

2.3 Human Factors

The Human Factors discuss two of elements that associate with the Decision Making and the Pilot behavior- attitude which were likely contributed in to this accident.

Perception is an opinion of one or group of person to an object, function or others which comes from previous experiences or background.

Miss-perception may happen due to insufficient data, tools, information or standard references.

The first two aircrafts operated by the operator had several problems on the difficulty of power levers moved to Ground Idle during landing which was suspected to be the problem on the Power Lever Lock System.

The board of instructors had agreed and decided to revise the normal checklist by additional item of selecting the Power Lever Lock to "OPEN" during approach to overcome the problem. The revised procedure has been implemented to all aircrafts that came later. The implementation was based on the board of instructor perception that the new aircrafts would have similar problem with two previous aircrafts.

Aviation Psychology: (University of Southern California, 1985, page 7-16).

> *The more one can anticipate the decision, the better the likelihood of correct action choices. The decision itself takes time, and more time, is required as a number of variables in the situation increase. Snap judgment is apt to be poor judgment.*

The investigation could not find any evidence of safety assessment, risk analysis and specific procedure related to the checklist revision.

Based on the decision that has been made, the board did not explore variable possibilities that might cause the problem of the difficulty of power levers moved to Ground Idle during landing. The problem might exist due to aircraft system problem, runway condition, or pilot operation error. However, the decision has been made without comprehensive risk assessment.

The SIC have some experiences of delay on moving the power lever to Ground Idle during landing. On the accident flight, the SIC aware to previous experienced and lifted the mechanical power lever stop slots during approach. The SIC realized that he retarded the Power Lever backward at about 70 ft of aircraft altitude and unintentionally entered the Beta Range.

Reference; Attitude component refer to Human Factors in Flight (Frank H Hawkins, 1988, page 164).

> *Attitudes may be said to have three components. Firstly is a belief, knowledge or idea about the object of the attitude (Cognitive). Secondly are the feelings held about it (affective). And thirdly is what is said or done about it (behavioral).*

The SIC have some experiences of delay on moving the power lever to Ground Idle during landing. SIC repeated this statement several time during the interview. This experience became his belief (cognitive).

The SIC has been planned to do the flight check to be qualified First Officer. In this flight the SIC possibly tried to prove that he deserve to be check as a qualified First Officer (affective).

The SIC repeated error was delay on moving the power lever to Ground Idle during landing and in this flight the SIC possibly tried to prove that he has overcome the error. In order to avoid delay on moving the power lever to Ground Idle during landing, the power lever stop slot should be operated immediately after landing. In this flight the SIC has operated the power lever stop slot during approach and unintentionally moved the power lever beyond flight idle (behavioral).

2.4 Other Latent Hazards

2.4.1 Power Lever description and operation

Based on the information FCOM 17-25, it can be interpreted that the power lever regulates engine power between takeoff to full reverse and feathering function.

Center console figure in the AMM 31-12-00 displayed that the power lever ranges not include feathering function.

The picture of center console taken from the aircraft (figure 6) showed that the power levers do not have feather position as mention in the FCOM.

2.4.2 Uncommon aviation terminology

FCOM Paragraph 17.4.1 B Power Lever

- *At takeoff, pilot pushes the power lever to T.O position from G.I position. …...after aircraft lands, the electric magnetic lock of flight idle is opened automatically and pilot can pull the power lever to any position below F.I.*

AMM 76-10-00 Description and operation Power Control Lever.

Each handle has several optional setting makes. For example, "F.I" (min. air power setting),"T.O" (setting of max take-off power under control of EEC), "G.I" (setting of ground starting engine and min. thrust), "MAX.REV"(setting of max anti-pull power).

Several section of the FCOM contain of un-common aviation terminology such as Flight Idle (F.I) with additional information of minimum air power setting. F.I is a common terminology the additional information may result in different interpretation. So was Max Rev with additional information of setting of max anti-pull power.

2.4.3 Master Minimum Equipment List (MMEL) and Minimum Equipment List (MEL)

The Flight Idle electromagnetic stop lock was designed to prevent the power lever to be able to move to ground idle in flight.

MEL 76-01 on item Flight Idle Electromagnetic Stop Lock maybe inoperative with remark provided manual unlock handle of flight idle electromagnetic stop lock is placed on the unlock position.

The CASR requires that reversing system should be designed so that no single failure (or reasonably likely combination of failures) or malfunction of the system will result in unwanted power lever movement toward BETA range and reverse under any expected operating condition. Failure of structural elements need not be considered if this kind of failure is extremely remote.

The failure of Flight Idle Electromagnetic Stop Lock increases the possibility of unwanted reverse thrust. MEL stated that to dispatch with unserviceable Flight Idle Electromagnetic Stop Lock the manual unlock handle should be placed on unlock position.

This condition does not meet the CASR requirement that this condition should be extremely remote, unless otherwise the additional operation procedure and limitation is applied.

3 CONCLUSION

3.1 Finding

In this investigation the National Transportation Safety Committee revealed several findings as follows:

a. The aircraft was airworthy prior to departure and there was no any aircraft systems problem reported.

b. All crew has valid licenses and medical certificates.

c. The Second in Command (SIC) acted as Pilot Flying (PF) and Pilot in Command (PIC) acted as Pilot Monitoring (PM).

d. The aircraft departed within the weight and balance operating limit.

e. The approach was not on profile as published for runway 07, while the approach angle greater than 2.9°.

f. The power lever lock was selected to open position in accordance with the operator's normal checklist.

g. The FCOM, Aircraft Maintenance Manual (AMM) and observation in simulator did not find any caution light or aural warning whenever the electric magnetic stop selected to OPEN.

h. The FDR recorded at 5;21 14 UTC aircraft altitude 1336 ft or similar to 1000 ft AGL (RA) the aircraft vertical speed was -864 ft/minutes, then several high vertical speed events bellow 1000 AGL were also recorded between1000 ft/minutes up to – 1296 ft/minutes

i. The FDR recorded that the both power levers were in the range of BETA MODE while the aircraft altitude was approximately 90 ft until hit the ground.

j. The aircraft touched down at 58m and halted at 261 meters from the beginning runway 07.

k. The FDR recorded a vertical acceleration at impact was 5.99 G and followed by -2.78 G.

l. The longitudinal and lateral acceleration were not recorded in the FDR.

m. The calculation of longitudinal acceleration after impact was between - 0.7 to -0.8 G.

n. Simulation of accident flight during approach in the simulator found that the aircraft profile was similar with the FDR data.

o. The operator's Normal Checklist for Approach Phase contained additional item of "PL LOCK……..OPEN" which was not stated in the Flight Crew Operation Manual (FCOM) issued by the aircraft manufacturer.

p. There were no evidence of safety assessment, risk analysis and approval related to the checklist revision.

q. The SIC has repeated error was delay on moving the power lever to Ground Idle during landing and possibly tried to prove that he has overcome the error by operated the power lever stop slot during approach and unintentionally moved the power lever beyond flight idle (behavioral).

r. Several un-common aviation terminologies found in the FCOM that may result in different interpretation.

s. The remark in the MEL for Flight Idle Electromagnetic Stop Lock system did not contain additional operation procedure and limitation to meet the CASR requirement.

3.2 Contributing Factors[4]

- The procedure of selecting Power Lever Lock to "OPEN" during approach was made without comprehensive risk assessment.
- Both power levers entered BETA MODE at 90 feet due to the safety device namely Power Lever Lock has been opened during approach, which was in accordance to the operator procedure and lifting of Mechanical Power Lever Stop Slot which was not realized by the pilots.
- The movement of power levers to BETA MODE resulted the pitch angle changed to low pitch angle which produced significant drag and made the aircraft loss of significant lift.

4 "Factors" is defined as events that might cause the occurrence. In the case that the event did not occur then the accident might not happen or result in a less severe occurrence.

4 SAFETY ACTION

The National Transportation Safety Committee has been informed several safety actions taken by the operator following this occurrence.

On 19 June 2013, the Director of Safety of PT. Merpati Nusantara Airlines issued the following safety actions to the Director of Operation, (refer to the appendix 5.1):

To all MA60 instructors:

a. First officer training will be suspended until the internal investigation has been completed;

b. To perform re-indoctrination:

- To all instructors who currently conducting line training to perform "follow through methods".
- To be wise in relying to the paired pilot.

c. Training on hard/bounce landing recovery should be re-emphasized.

On 1 July 2013 the chief pilot MA60 send official letter about initial mitigation BOI after the accident to the Directorate of Safety as follows:

1. *Review flight procedure and Route Line Training:*

   a) *Follow Through Method.*

      Mean: during critical phase hand of PIC on the control column and PL, feet on rudder, be ready for recover.

      Critical phase are during takeoff from open power until 400 feet and during landing from MDH/DH until taxi speed.

   b) *Follow manual.*

      Revise Normal Checklist, PL Lock put to closed

      Note; approach speed on final should be at Vthr & training pilot with procedure when PL cannot put on GI touch down

   c) *Power Lever operation method.*

      Do not touch PL to GI micro switch during flight

2. *HAZARD*

   a) *Aircraft characteristic: heavy+ nose drop, be aware with loading composition and monitor elevator trim setting.*

   b) *PL operation method: PL to GI micro switch is very sensitive and can lead unintentional GI during operation.*

3. *MITIGATION*

   a) *Implement follow through method.*

      i. *Every pilot will be informed and brief about this procedure.*

      ii. *Will be socialized during recurrent program*

b) DO NOT touch PL to GI micro switch during flight.

c) Implementation of normal checklist, PL Lock closed, begin by instructors evaluation.

Note: action should be taken if after touch down, PL Cannot put to GI are apply maximum braking and pushed control column full forward to get positive green WOW and PF call out " PC LOCK OPEN" , pm will executed the PL lock open.

d) Take off landing at significant airport by PIC

Significant airport: LBJ, RTG, BJW, ENE, ARD, NBX, TLI, UOL, PSJ, SLY, SWQ, BUW.

e) Takeoff landing at significant weather by PIC

Significant weather: max cross wind component more than 10 knots, gusty more than 10 knots.

f) *Additional item for PPC with BOUNCING recovery during landing. Keep attitude within 7 ANU, control sink rate by power, if runway insufficient go around.*

On 17 December 2013, the CAAC issued a comment letter from the CAAC to NTSC which could be classified as safety actions as follows:

- The Power Lever regulates engine between take off and MAX Rev power. The Max reverse in FCOM was not correctly translated it as Max. Rev in the new Version.
- Both FI and GI clear explanation in chapter of abbreviation in FCOM. Contains in bracket after FI, GI and MAX. REV in AMM are convenient for understanding of the ground crew, do not so show different meanings, however, XAC will review AMM and cancel all the notes to avid understanding bias.
- Regarding to the MEL 76-01, it relates to the aircraft airworthiness certification, The CAAC as well as XAC was still discussing on this particular MEL item.

5 SAFETY RECOMMENDATIONS

The examination on the factual data and the associate findings which is known may have contributes in to this accident, the National Transportation Safety Committee issued several safety recommendations and some improvement suggestion addressed to:

5.1 Directorate General Civil Aviation

Similar issues on the Flight Data Recorder and an element associate with manuals from the previous MA 60 accident were also found. During this investigation, the NTSC found several additional safety issues and strongly recommend:

a. To review the DGCA quality system in controlling the operator in conduct any changes of the safety related procedures to assure the authority acknowledgement and approval.

b. To review Master Minimum Equipment List (MMEL) of MA 60 to comply with the Indonesia CASR.

c. Refer to previous accident of MA60, The NTSC re-issue recommendation to emphasis the DFDR parameters shall meet with the CASR requirements.

5.2 PT. Merpati Nusantara Airlines

The investigation could not find any evidence of safety assessment, risk analysis and specific procedure related to the checklist revision as such the NTSC recommends:

a. Prior to revise any procedure, the operator should perform follow process as required by a standard of Quality System including the safety assessment and risk analysis.

b. To review Minimum Equipment List (MEL) to comply with the Indonesia CASR.

c. The investigation had examined the safety actions planned by the operator and has the same perspective and considered relevant, as such, the NTSC recommends that the safety actions planned should be implemented systematically and oversight periodically by the Safety Department.

d. The **follow through method** was an old method which considered ineffective by most operators worldwide as it created hazard especially in the critical situations such as rejected take off or go around etc. However, as long as the operator could perform consistently this would be subject to the operator’s policy.

5.3 Xi' An Aircraft Industry (Group) Company LTD.

The FCOM contain information that contrary to the other aircraft manual and to the actual condition in the aircraft and was written in un-common aviation terminology. The NTSC has issued recommendation to revise the FCOM with common aviation terminology following the accident of MA 60 which occurred in May 2011.

On 17 December 2013, the NTSC received a comment letter from the CAAC which could be classified as safety actions. However the NTSC is waiting for the information of the follow up of those safety actions.

6 APPENDICES

6.1 Safety Action of the PT. Merpati Nusantara Airlines

Merpati
AVIATION SSQ FORM

Dok No: F-DS-07-01
PENERBITAN PRODUK SSQ

Aviation SSQ RECOMMENDATION

No : DS/VI/2013/R- 015A
Attn : OF
Date : 19 Juni 2013
CC : DZ, DO, DC, OR

Letter Status:

Red	Yellow	Green
	✓	

Subject : **Rekomendasi Awal Paska Kejadian Accident PK – MZO di Kupang**

1. Sehubungan dengan terjadinya accident pada tanggal 10 juni 2013, PK – MZO dengan route BJW – KOE yang terjadi di Kupang.

2. Maka Safety and Quality Division mengeluarkan rekomendasi awal paska kejadian tersebut yaitu :

   Kepada OF:
   a. Training untuk copilot training dihentikan dahulu sampai hasil investigasi internal Merpati selesai.
   b. Reindoktrinasi untuk :
      1) Menerapkan follow through methode kepada semua pilot terutama instruktur pilot yang sedang membawa siswa.
      2) Not over confident during flight terhadap pairing terbang.
   c. Emphasize training on Hard landing/bounce landing recovery.

3. Demikian disampaikan, atas perhatian dan kerjasamanya kami ucapkan terimakasih.

An. DIRECTOR OF AVIATION SSQ
GM. AVIATION SAFETY

CAPT. RAHADI M. MANTIKNO

SA/SCA

MOHON RECOMMENDATION INI DAPAT DI RESPON DALAM WAKTU 3 HARI
IF YOU RECEIVED THIS MESSAGE, PLEASE RESPONSE US IMMEDIATELY BY PHONE/FAX/EMAIL, THANK YOU

REVISI: 02 — *AVIATION SAFETY, SECURITY & QUALITY DIVISION* — *01/11/2012*

6.2 Official letter of the Chief pilot MA60

PT. MERPATI NUSANTARA AIRLINES

NOTA DINAS

Nomor : OF / ND / 397 / VII / 2013
Kepada Yth : DS
Dari : OF
Perihal : Hasil Mitigasi Awal BOI MA-60 Pasca Kejadian PK MZO di KOE

---

1. Berdasarkan Ref. DS/R-015/VI/2013, perihal Aviation SSQ Reccomendation,tgl 27 Juni 2013.

2. Dengan ini disampaikan
   - **Evaluasi ulang Procedure Penerbangan dan Pelaksanaan RLT :**
     a) Follow Through Method.
        Mean: during critical phase hand of PIC on the control column and PL, feet on rudder, be ready for recover.
        Critical phase are during take off from open power until 400 ft and during landing from MDH/DH until taxi speed.
     b) Follow manual
        Revise normal check list, PL lock put to closed.
        Note: app speed on final should be at Vthr & training pilot with procedure when PL can not put GI touch down.
     c) PL oper method
        DO NOT touch PL to GI micro switch during flight.

   - **HAZARD**
     a) Aircraft characteristic: heavy + nose drop, be aware with loading composition and monitor elevator trim setting.
     b) PL operation method: PL to GI micro switch is very sensitive and can lead un intentional GI during operation.

   - **MITIGATION**
     a) Implement follow through method.
        i. Every pilot will be informed and brief about this procedure.
        ii. Will be socialized during recurrent program
     b) DO NOT touch PL to GI micro switch during flight.
     c) Implementation of normal check list, PL LOCK closed, begin by instructors evaluation.
        Note: action should be taken if after touch down, PL can not put to GI, are apply maximum braking and pushed control column full forward to get

positive green WOW and PF call out " **PC LOCK OPEN** " , pm will executed the PL lock open.

d) Take off landing at significant airport by PIC.
   Significant airport : LBJ, RTG, BJW, ENE, ARD, NBX, TLI, UOL, PSJ,SLY, SWQ, BUW
e) Take off landing at significant weather by PIC.
   Significant weather: max cross wind component more than 10 kts, gusty more than 10 kts.
f) Additional item for PPC with BOUNCING recovery during landing.
   Keep attitude within 7 ANU, control sink rate by power, if runway insufficient go around.

3. Demikian disampaikan, atas perhatian dan kerjasamanya diucapkan terima kasih.

Jakarta, 01 Juli 2013

PH. JKTOFMZ

CAPT. DEDY HERMANSYAH

Tembusan:
1. DO (sebagai laporan)
2. OF
3. OR

OF/admtj