KOMITE NASIONAL KESELAMATAN TRANSPORTASI
REPUBLIC OF INDONESIA

FINAL

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Aircraft Serious Incident Investigation Report

PT. Lion Mentari Airline

Boeing 737-900ER; PK-LFG

Juanda International Airport, Sidoarjo, East Java

Republic of Indonesia

20 February 2016

2017

This Final report was produced by the Komite Nasional Keselamatan Transportasi (KNKT), 3rd Floor Ministry of Transportation, 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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ABBREVIATIONS AND DEFINITIONS

AFML	:	Aircraft Flight and Maintenance Log
ALC	:	Annual Line Check
AOC	:	Airline Operator Certificate
ATC	:	Air Traffic Control
ATPL	:	Aircraft Transport Pilot Licence
BMKG	:	Badan Meteorologi Klimatologi Geofisika
°C	:	Centigrade
CG	:	Centre of Gravity
CPL	:	Commercial Pilot License
CSN	:	Cycle Since New
CVR	:	Cockpit Voice Recorder
DGCA	:	Directorate General of Civil Aviation
EGPWS	:	Enhanced Ground Proximity Warning System
FA	:	Flight Attendant
FCOM	:	Flight Crew Operation Manual
FDR	:	Flight Data Recorder
ICAO	:	International Civil Aviation Organisation
ILS	:	Instrument Landing System
ISA	:	International Standard Atmosphere
Kg	:	Kilograms
KNKT	:	*Komite Nasional Keselamatan Transportasi*
LOFT	:	Line Orientation Flight Training and
LOSA	:	Line Operation Safety Audit
LT	:	Local Time
m	:	Meter
MAC	:	Mean Aerodynamic Chord
PF	:	Pilot Flying
PIC	:	Pilot in Command
PM	:	Pilot Monitoring
PPC	:	pilot proficiency check
RAAS	:	Runway Awareness Advisory System
RFFS	:	Rescue and Fire Fighting Service

SIC	:	Second in Command
TSN	:	Time Since New
UTC	:	Universal Coordinated Time
WIB	:	*Waktu Indonesia Barat* (Western Indonesian standard time which is UTC + 7 Hours)

INTRODUCTION

SYNOPSIS

On 20 February 2016, a Boeing 737-900ER aircraft, registration PK-LFG was being operated by PT. Lion Mentari Airlines on a scheduled passenger flight from Sepinggan International Airport (WALL), Balikpapan East Kalimantan to Juanda International Airport (WARR), Surabaya, with flight number LNI263. On board of this flight were two pilots, five flight attendants and 215 passengers.

At 0230 UTC (1030 LT) the aircraft departed Sepinggan International Airport, Balikpapan, the flight was uneventful until commencing approach to Surabaya.In this flight, the Pilot in Command (PIC) acted as Pilot Monitoring (PM) while the Second in Command (SIC) acted as Pilot Flying (PF).

At 0403 UTC, the pilot received clearance for approach by following the Instrument Landing System (ILS) approach procedure runway 10. While the aircraft passing altitude 600 feet, the autopilot and auto throttle disengaged and the pilot flew manually.

While the aircraft on final approach, the ATC noticed that the visibility decreased to 1,000 meters. On short final, the PIC noticed that the SIC had difficulty in control the aircraft and assisted the SIC to correct the approach profile.

At 0407 UTC, the aircraft landed on runway 10 at aproximately 552 meters from the beginning runway with speed 9 knots above the target. After touched down, the thrust reverser levers could not be selected as the thrust levers were not in idle position, the spoiler deployment delayed for about 10 seconds and the brake pressure increased 9 seconds after touch down.

The aircraft overrun and stopped with the nose wheel position at approximately one meter out of the pavement. No one injured on this occurrence. There was no damage to the aircraft or to property and environment.

The investigation concluded the contributing factors to this accident are:

- The difficulty to control the aircraft and deteriorating weather did not trigger firm action resulted in the combination of lack of communication and leadership.
- The combination of prolong touchdown, delay in spoiler deployment, thrust levers not at idle position, and late of brake application had affected the landing distance.

Following this serious incident PT. Lion Mentari Airlines has issued safety actions which considered relevant to improve safety. In addition, KNKT issued safety recommendations addressed to PT. Lion Mentari Airlines and the Directorate General of Civil Aviation.

1 FACTUAL INFORMATION

1.1 History of the Flight

On 20 February 2016, a Boeing 737-900ER aircraft, registration PK-LFG was being operated by PT. Lion Mentari Airlines on a scheduled passenger flight from Sepinggan International Airport (WALL), Balikpapan East Kalimantan to Juanda[1] International Airport (WARR), Surabaya, with flight number LNI263.

On board of this flight were two pilots, five flight attendants, and 215 passengers that consisted of 205 adults, six children and four infants.

Figure 1: Archive photo of PK-LFG (courtesy of Planespotters.net)

In this flight, the Pilot in Command (PIC) acted as Pilot Monitoring (PM) while the Second in Command (SIC) acted as Pilot Flying (PF).

At 0230 UTC[2] (1030 LT) the aircraft departed Sepinggan International Airport, Balikpapan, the flight was uneventful until commencing approach to Surabaya and there was no report or record of aircraft system abnormality during the flight.

At 0402 UTC, the pilot made first contact with Juanda Tower controller. During approach, the pilots received information that the weather that was slight rain, the wind was 17 knots from 020 degrees, and QNH 1012 Mbs.

During descent after passing 2,500 feet, the pilots discussed concerning to the cloud formation and observed magenta cloud on the flight path.

At 0403 UTC, the pilot received clearance for approach by following the Instrument Landing System (ILS) approach procedure runway 10.

1 Juanda International Airport, Surabaya will be named as Surabaya for the purpose of this report

2 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 that be used in this report is Waktu Indonesia Barat (WIB) which is UTC + 7 hours

At 0404 UTC, the autopilot disengaged un-commanded, the pilot then re-engaged after eight seconds.

At 0406 UTC, while the aircraft passing altitude 600 feet, the autopilot and auto throttle were disengaged and the pilot flew manually.

While the aircraft on final approach, the Air Traffic Control (ATC) broadcast message to inform that the visibility decreased to 1,000 meters.

On short final, the PIC noticed that the SIC had difficulty in control the aircraft. The PIC assisted controlling the aircraft and after the aircraft returned to the correct approach path, the SIC had full control of the aircraft.

At 0407 UTC, the aircraft landed on runway 10. After touched down, the PF could not select the thrust reverser levers and informed to the PIC. The PIC attempted to select the thrust reverser but fail.

The aircraft overrun and stopped with the nose wheel position at approximately one meter out of the pavement. The pilot contacted Juanda Tower controller informed that the aircraft could not continue taxi.

The Juanda Tower controller informed the Rescue Fire Fighting Service (RFFS) who then immediately deployed to the location of the aircraft.

After the aircraft stopped, the PIC commanded “attention crew on station” and the Flight Attendant (FA) checked the condition outside and inside the aircraft. The FA reported to the PIC that the situation was safe. The FA announced to the passengers to inform that the PIC was evaluating the situation and the passenger were requested to keep calm.

At approximately 0425 UTC the passenger stair arrived and the PIC commanded to disarm the slides. The passenger stair connected to the aft left door for passenger disembarkation. At 0435 UTC, all passengers disembarked then transported to terminal building.

No one injured on this occurrence. There was no damage to the aircraft or to property and environment.

Figure 2: The aircraft last position

1.2 Personnel Information

The PIC was 59 years old, male Indonesian pilot, held valid Airline Transport Pilot License (ATPL) and medical certificate. The PIC had experience with total flying hour of approximately 28,000 hours, including 4,218 hours on type.

The SIC was 35 years old, male Indonesian pilot, held valid Commercial Pilot License (CPL) and medical certificate. The SIC had experience with total flying hour of approximately 1,817 hours, including 1,617 hours on type.

1.3 Aircraft Information

The Boeing 737-900ER aircraft registration PK-LFG with serial number 35680 had total Time Since New (TSN) of 26,190 hours and 22 minutes and total Cycles Since New (CSN) of 18,762 cycles. The engines installed were manufactured by General Electric with type/model CFM56-7B26/3, the serial number of engine 1 was 804567 and the engine 2 was 894520.

The Aircraft Flight and Maintenance Log (AFML) on the last 10 days prior to the occurrence did not record any significant issue related to the aircraft serviceability.

The aircraft departed from Balikpapan to Surabaya within the proper weight and balance envelope and shown as follow:

Estimated take-off weight	:	68,241 kg (Maximum 78,017 kg)
Fuel at take-off	:	8,300 kg
Flight Planned Fuel burn	:	3,679 kg
Estimated Landing Weight	:	64,562 kg (Maximum 71,350 kg)

The center of gravity (CG) at take-off was 20.38 % Mean Aerodynamic Chord (MAC) and the CG at landing was 18.67 % MAC, both were within the normal operation envelope.

According to Boeing 737-800/900ER Flight Crew Operations Manual (FCOM) Chapter PI.20.5, the VRef[3] landing with configuration flap 30 for landing weight of 64,562 kg was 141 knots.

Runway Awareness and Advisory System

The aircraft equipped with Honeywell SmartRunway®/SmartLanding® as a Runway Awareness and Advisory System (RAAS) which provides information associated with landing configuration and or profiles. One of the features is the Distance Remaining advisories that provides an aural advisory of the remaining runway during landing roll. Significant descriptions of the RAAS features taken from Honeywell Product Description - SmartRunway®/SmartLanding® are as follows:

4.2.4 Distance Remaining – Landing Roll-Out Advisory

The purpose of the Distance Remaining advisories is to enhance crew awareness of aircraft along-track position relative to the runway end.

3 VRef (reference speed) is the reference speed for landing based on the landing configuration and landing weight, that required to be achieved while the aircraft cross the runway threshold. The approach speed on final is to be maintained at Vref+5.

4.2.4.1 Annunciation Criteria

The Distance Remaining advisory is generated when the following conditions are met: Aircraft is within 100 feet of the ground, over the last half of the runway or a specified distance from the runway end; or Aircraft is on the ground, on the last half of the runway (default) or a specified distance from the runway end, and Aircraft ground speed is above 40 knots.

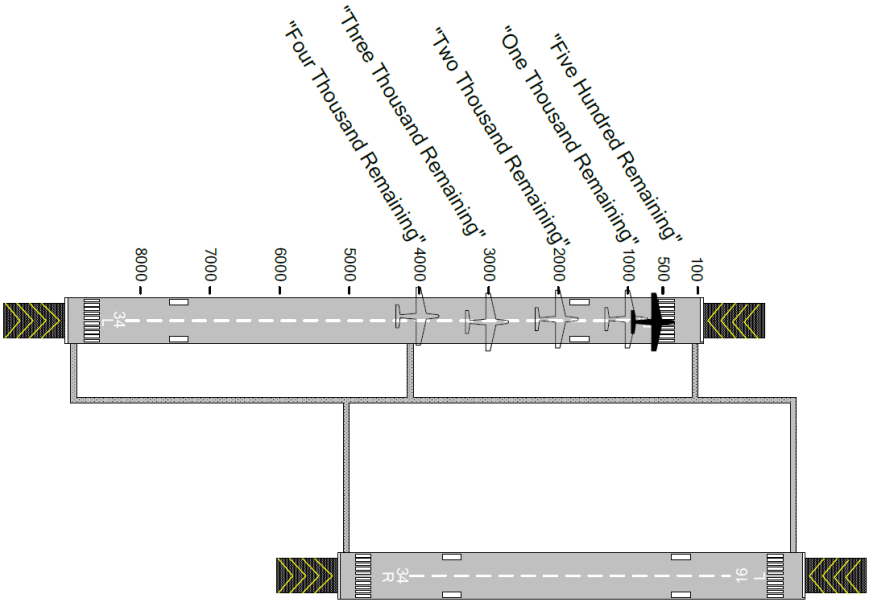

Figure 4-4: Distance Remaining – Landing and Roll – Out (in feet) Advisory

Refer to Figure 4-4. If the crew elects to go-around after the Distance Remaining advisories are triggered, the advisories continue to be annunciated at the appropriate distances along the runway. The Distance Remaining advisories are inhibited once the aircraft climbs above 100 feet Radio Altitude or aircraft climb rate is greater than 450 fpm.

Enhanced Ground Proximity Warning System (EGPWS)

The aircraft was equipped with Enhanced Ground Proximity Warning System (EGPWS), manufactured by Honeywell. The EGPWS has six modes. The description of the relevant modes taken from the Honeywell EGPWS manual is described as follows:

Mode 5 EGPWS, excessive deviation below glideslope

Mode 5 provides two levels of alerting for when the aircraft descends below glideslope, resulting in activation of EGPWS caution lights and aural messages. The first level alert occurs when below 1000 feet Radio Altitude and the aircraft is 1.3 dots or greater below the beam. This turns on the caution lights and is called a "soft" alert because the audio message ***"GLIDESLOPE"*** *is enunciated at half volume. 20% increases in the below glideslope deviation cause additional* ***"GLIDESLOPE"*** *messages enunciated at a progressively faster rate.*

The second level alert occurs when below 300 feet Radio Altitude with 2 dots or greater glideslope deviation. This is called a "hard" alert because a louder ***"GLIDESLOPE, GLIDESLOPE"*** *message is enunciated every 3 seconds*

continuing until the "hard" envelope is exited. The caution lights remain on until a glideslope deviation less than 1.3 dots is achieved.

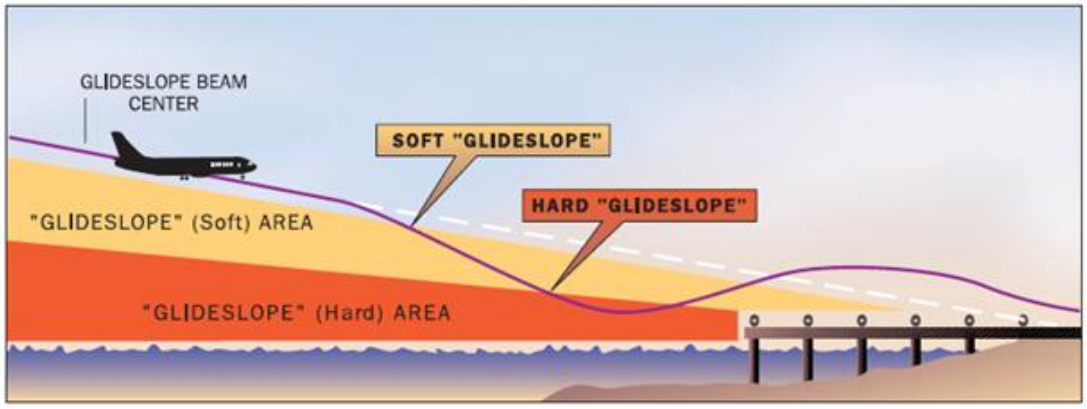

Figure 3: Mode 5 Excessive Deviation below Glideslope

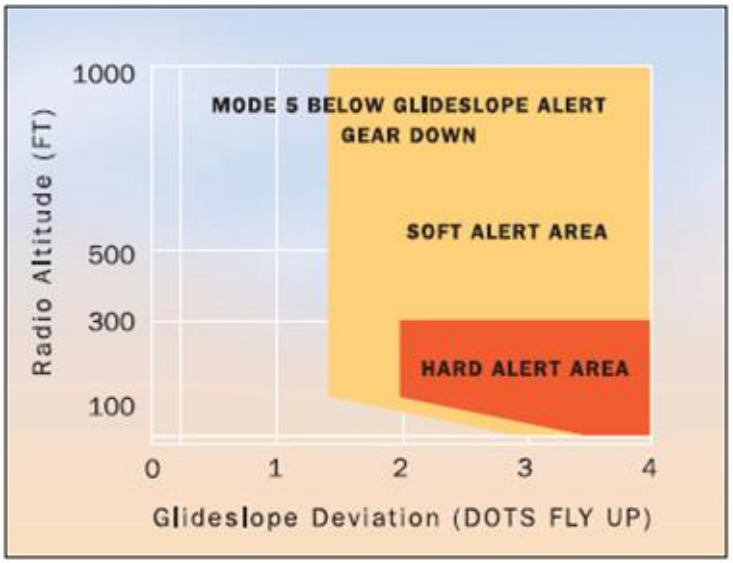

Figure 4: Mode 5 Glideslope Deviation envelope

1.4 Meteorological Information

Weather report for Juanda International Airport, issued by *Badan Meteorologi Klimatologi dan Geofisika* (BMKG- Meteorology Climatology and Geophysics Agency) on 20 February 2016 were as follows:

		0400 UTC	0430 UTC
Wind	:	110 / 04 knots	140/06 knots
Visibility	:	6 km	7 km
Temperature	:	28°C	27°C
Dewpoint	:	25°C	23 °C

Cloud [4]	:	BKN 016 FEW018CB	SCT018 FEW020CB
QNH	:	1012 hPa	1011 hPa
QFE		1012 hPa	1011 hPa
Weather	:	Thunderstorm and rain (TSRA)	Thunderstorm and rain (TSRA)

1.5 Aerodrome Information

Juanda International Airport (WARR) located at Surabaya, East Java operated by PT. Angkasa Pura I (Persero). The airport elevation was nine feet above mean sea level. The runway number was 10-28 with dimension of 3,000 meters (9,842 feet) length and 45-meter width. The 60 meters stop way was available at the end of runway 10.

1.6 Flight recorders

The aircraft was fitted with Honeywell Flight Data Recorder (FDR) with part number 980-4700-042 and serial number 12370 and Honeywell Cockpit Voice Recorder (CVR) 120 model with part number 980-6022-001 and serial number 08433. After the serious incident, both recorders were transported to KNKT recorder facility for data downloading process.

The FDR recorded 26.84 hours which was containing 16 flights and including this serious incident flight with total of 1,237 parameters.

The CVR contained 2 hours and 1 minute of good quality recording data.

Figure 5: The landing trajectory processed from the FDR

Based on the FDR data, the aircraft touched down at approximately 552 meters from the beginning of the runway 10.

4 Cloud amount is assessed in total which is the estimated total apparent area of the sky covered with cloud. The international unit for reporting cloud amount for Broken (BKN) is when the clouds cover more than half (5/8 up to 7/8) area of the sky, scattered (SCT) is when the clouds cover between 3/8 to 4/8 area of the sky and few (FEW) is when the clouds cover 1/8 to 2/8 part of the sky.

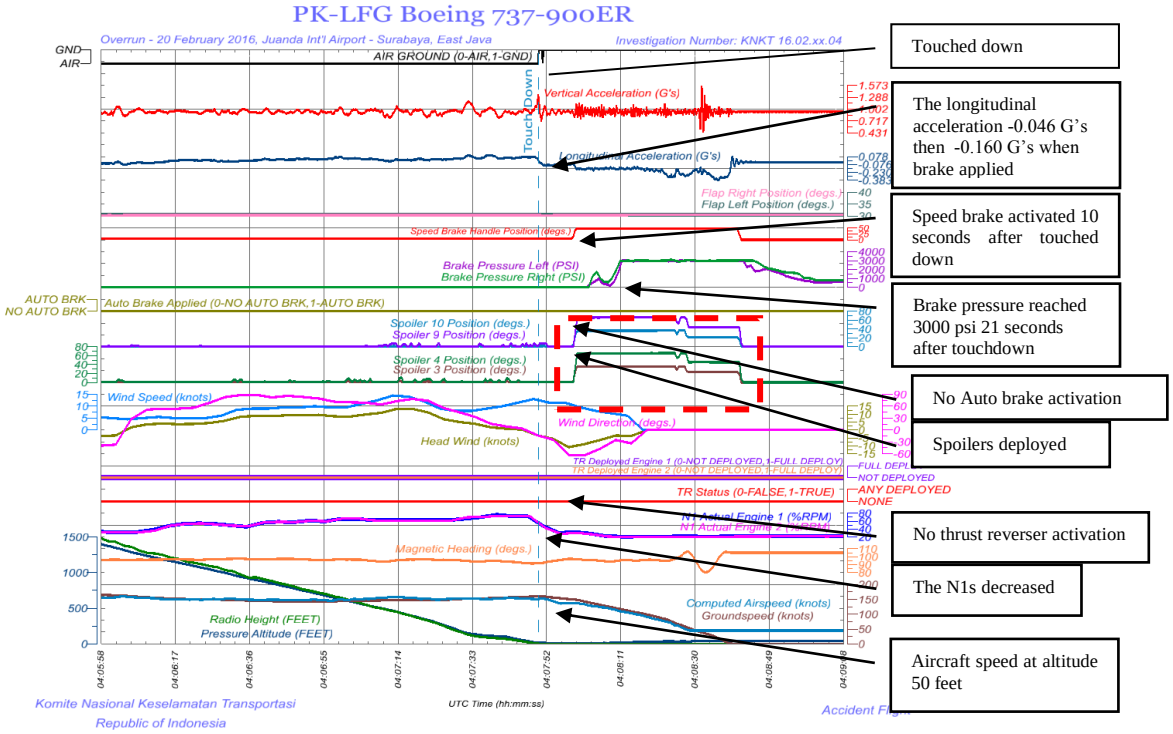

Figure 6: The FDR information started from aircraft altitude 1,500 feet to end of the flight

The significant excerpt recorded on the CVR, from 4:03:00 UTC at approximate aircraft altitude of 3,000 feet to end of recording.

Note:

- EGPWS is Enhanced Ground Proximity Warning System
- TWR is Juanda Tower controller
- RAAS is Runway Awareness and Advisory System

Time (UTC)	Voice of	Communication
4:03:00	PIC	First contact with Juanda Tower
4:03:16	Both pilots	The pilot discussion concerning to weather avoidance on the flight path.
4:03:31	Both pilots	The glideslope interception initiated and the PF requested to select landing gear down, followed by the pilot discussion regarding the possibility of windshear.
4:04;32 – 4:05:12	PIC	PIC reminded to initiate descend and suggested to select flap to 10.
4:05:13 - 4:06:10	Both pilots	Pilot discussion related to aircraft speed.

Time (UTC)	Voice of	Communication
4:06:21	TWR	Issued landing clearance and informed that the wind velocity was 020°/17 Knots, and was acknowledged by the SIC.
4:06:32	GPWS	Altitude callout “One Thousand”. Followed by acknowledgement by the pilots with an additional from PIC to advising to prepare for go around.
4:07:09	RAAS	Callout “Approaching Five Zero” and followed by EGPWS altitude callout “Five Hundred”
4:07:12		Sound similar to windshield wiper activation.
4:07:15	PIC	The PIC confirmed whether the SIC could see the runway and was acknowledged by the SIC, followed by EGPWS altitude call outs “Four Hundred”,
4:07:23	GPWS	Altitude call out “Three Hundred”,
4:07:24	PIC	The PIC confirming that the runway in sight but did not acknowledge by SIC.
4:07:27	GPWS	“Minimum”.
4:07:30	GPWS	Callout “Glide Slope, Glide Slope” acknowledged by the SIC.
4:07:33	SIC	The SIC acknowledged the EGPWS call out.
4:07:34	GPWS	Altitude call out “One Hundred”
4:07:41-4:07:44	SIC	SIC advised the PIC to fly left two times, and was acknowledged by PIC.
4:07:44	GPWS	Altitude call out “Fifty”
4:07:55	PIC	PIC instructed to select the thrust reverser and the SIC stated that the thrust reverser could not be operated.
4:07:57	PIC	PIC called “I have control”
4:08:06	RAAS	Callout “Three Thousand Remaining”
4:08:11	RAAS	Callout “Two Thousand Remaining”
4:08:12	PIC	Instructed to the SIC to assist in applying the brake
4:08:16	TWR	Informed the landing time and instructed the pilot to contact the ground control and did not respond by the pilot
4:08:20	RAAS	Call out “Five Hundred Remaining”

Time (UTC)	Voice of	Communication
4:08:40 - 4:09:04	TWR	The conversation between controller and pilot concerning to the last aircraft position and unable to taxi to the apron.
4:11:27	SIC	Requested for the towing or push back car to the ATC
4:23:15	PIC	Stated that he regret for did not go around
	PIC	Attention crew on station
5:03:20		End of recording

The significant events taken from the recorders from aircraft altitude at approximately 700 feet (all altitude on this sub chapter is based on radio height) until the aircraft stopped are summarized as follows:

- 04:06:57 UTC, at altitude approximately 600 feet the autopilot and auto thrust were disengaged and the pilot started to fly manually.
- 04:07:15 UTC, aircraft passing altitude 500 feet and PIC statement that the runway in sight was acknowledged by SIC.
- 04:07:24 UTC, the SIC confirmed that the runway in sight.
- 04:07:27 UTC, EGPWS callout "Minimum", followed by "Glide Slope, Glide Slope"
- 04:07:34 UTC, the aircraft passed altitude 100 feet.
- 04:07:41 UTC, the SIC advised to the PIC to fly left, two times and was acknowledged by the PIC.
- 04:07:44 UTC, the aircraft passed altitude 50 feet and speed was 153 knots.
- 04:07:48 UTC, the N1s value on both engines at altitude 20 feet was 72% and the speed was 152 knots.
- 04:07:50 UTC, the aircraft touched down.
  - Aircraft speed was 150 knots.
  - The tailwind was 3.4 knot.
  - Speed brake handle stayed at armed position, speed brake armed light illuminated and the spoilers did not deploy for 10 seconds.
  - The brake pressures relatively constant at 25 Psi for 9 seconds.
  - Throttle resolver angles position were at 41.3° and the engine N1s values were 47% and 42% respectively for left and right engines.
- 04:07:55 UTC, the PIC commanded to select thrust reverser and SIC stated the reverser could not be operated.
- 04:07:57 UTC, the PIC called "I have control".
- 04:08:00 UTC, the speed brake handle position moved to 47° and the spoilers deployed.

- 04:08:04 UTC, the brake pressure started to increase and gradually reduced after 6 seconds.
- 04:08:11 UTC, RAAS "Two Thousand Remaining", the PIC asked the SIC to assist braking. The brake pressure increased up to maximum of 3,000 Psi. The engine N1s values reached and maintained at lowest recorded value of approximately 21% and the throttle resolver angles were at 37°.
- 04:08:30 UTC, the aircraft stopped.

1.7 Organizational and Management Information

Aircraft Owner	:	AIRCRAFT MSN 35680 LLC
Address	:	160 Greentree Drive, Suite 101, Dover DE 19904, County of Kent, United States of America
Aircraft Operator	:	PT. Lion Mentari Airlines
Address	:	Jalan Gajah Mada No. 7 Jakarta Pusat, Republic of Indonesia
Operator Certificate Number	:	AOC/121-010

1.7.1 Company Operation Manual

According to the Company Operation Manual chapter 4.10.4.6 subjected to Autopilot Engagement and Monitoring stated that the minimum height above airport elevation to engage the autopilot after takeoff is 400 feet.

During automatic flight the PF shall guard the flight controls and thrust levers whenever the aircraft is below 2500 feet above ground level as indicated by the radio altimeter. The PF shall at all times be prepared to revert to manual control if required.

1.7.2 Boeing 737 Flight Crew Operation Manual

1.7.2.1 Thrust reverser

According to the Boeing 737 FCOM chapter 7.20.12 describe that the thrust reverser can be deployed when either radio altimeter senses less than 10 feet altitude, or when the air/ground safety sensor is in the ground mode. Movement of the reverse thrust levers is mechanically restricted until the forward thrust levers are in the idle position.

1.7.2.2 Speed Brake

According to Boeing FCOM chapter System Description Section 9.20.15 Ground Operation stated that during landing, the auto speed brake system operates when:

- the speed brake lever is in the ARMED position;
- SPEED BRAKE ARMED light is illuminated;
- radio altitude is less than 10 feet;
- landing gear strut compresses on touchdown;

- both thrust levers retard to IDLE;
- main landing gear wheels spin up (more than 60 kts).

The SPEED BRAKE lever automatically moves to the UP position and the spoilers deploy.

If a wheel spin-up signal is not detected, when the air/ground system senses ground mode (any gear strut compresses) the SPEED BRAKE lever moves to the UP position and flight spoiler panels deploy automatically. When the right main landing gear strut compresses, the ground spoilers deploy.

If the SPEED BRAKE lever is in the DOWN position during landing or rejected takeoff, the auto speed brake system operates when these conditions occur:

- main landing gear wheels spin up (more than 60 kts);
- both thrust levers retard to idle;
- reverse thrust levers are positioned for reverse thrust.

The SPEED BRAKE lever automatically moves to the UP position and spoilers deploy.

After an RTO or landing, if either thrust lever is advanced, the SPEED BRAKE lever automatically moves to the DOWN detent and all spoiler panels retract. The spoiler panels may also be retracted by manually moving the SPEED BRAKE lever to the DOWN detent.

1.7.2.3 Landing Roll Procedure

According to Boeing FCOM chapter Normal Procedures Section NP.21.56 Landing Roll Procedure stated that during landing the task sharing and coordination between Pilot Flying and pilot monitoring were as follows:

- After the autopilot disengagement, The PF should control the airplane manually;
- The PF should verify that the thrust levers are closed, verify that the SPEED BRAKE lever is UP and without delay, fly the nose wheel smoothly onto the runway;

  The PM should verify that the SPEED BRAKE lever is UP and the PF should made call out “SPEED BRAKES UP.” If the SPEED BRAKE lever is not UP, call “SPEED BRAKES NOT UP.”
- The PF and PM should monitor the rollout progress and verify correct auto brake operation;
- The PF should immediately move the reverse thrust levers to the interlocks and hold light pressure until the interlocks release.

  The PM should verify that the forward thrust levers are closed. When both REV indications are green, call "REVERSERS NORMAL." If there is no REV indication(s) or the indication(s) stays amber, call "NO REVERSER ENGINE NUMBER 1", or "NO REVERSER ENGINE NUMBER 2", or "NO REVERSERS”.
- The PF should apply reverse thrust as needed and after 60 knots, start movement

of the reverse thrust levers to be at the reverse idle detent before taxi speed.

The PM should made call out "60 KNOTS."

- After the engines are at reverse idle, the PF should move the reverse thrust levers full down. Before taxi speed, disarm the autobrake, then use manual braking as needed.

1.7.2.4 Performance In flight

The Boeing FCOM, chapter Performance Inflight, Advisory Information, provide the calculation the factors affecting the landing distance. The distances are including 1,000 feet from the runway threshold to touchdown point. For the existing conditions in good and medium runway braking action, the calculations are as follows:

Condition	Runway length required (feet)	
	Runway braking action Good	**Runway braking action Medium**
Aircraft landing weight of 64,562 kg	5650 – 320 = 5,330	6,310 – 370 = 5,940
Tailwind 3.4 knot	3.4/10 x 820 = 278	3.4 x 1140 = 388
Temperature 28°C (13 above ISA[5])	+1.3 x 160 = 208	+1.3 x 180 = 234
Approach speed at threshold 150 kts (9 kts above the target)	+9/5 x 300 = 540	+9/5 x 290 = 522
No thrust reverser	+40	+1110
Manual speed brake and Manual brake	+190	+190

1.7.3 Operation Manual

8.3.1.5.5 CONTROL HANDOVER

During handover and undertaking of flight control, the following phraseology must be used in order to make the transfer clear:

• Pilot handing over the control: "YOU HAVE CONTROL"

• Pilot undertaking the control: "I HAVE CONTROL"

Flight crew who handed over the control must convert to PM after normal control of

5 ISA is a standard against which to compare the actual atmosphere at any point and time. The ISA is based the values of pressure, density, and temperature at mean sea level each of which decreases with increase in height.

- Pressure of 1013.2 millibar - Pressure is taken to fall at about 1 millibar per 30 feet in the lower atmosphere (up to about 5,000 feet).
- Temperature of +15 °C - Temperature falls at a rate of 2 °C per 1,000 feet until the tropopause is reached at 36,000 feet above which the temperature is assumed to be constant at -57 °C. (The precise numbers are 1.98 °C, -56.5 °C and 36,090 feet)
- Density of 1,225 gr/m^3.

airplane, by the flight crew who has undertaken the control is confirmed.
Any change over of control from Second in Command to the PIC should be done any time the PIC deems it necessary.

8.3.2.5.1 Crew Coordination during Holding, Approach and Landing

Normally the PF programs and monitors the auto-pilot/flight director and auto-throttle, and gives the necessary commands (e.g. checklist, gear down, flaps etc.). The PM, monitors the approach, keeps lookout, executes the allocated system operation on command of the PF and confirms its execution, does the radio communication and checks for visual reference. The PM therefore, must be fully familiar with the intentions of the PF, and must have facts and figures ready when needed.

The use of facilities must be planned beforehand, and on passing one facility, the PM must inform the PF and be ready to retune to the next facility immediately.

1.8 Useful or Effective Investigation Techniques

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

2 ANALYSIS

The factual information showed that the pilots had difficulty to operate the thrust reverser during landing that affected the landing distance. Other than the thrust reverser issue, the investigation also considers other factors that contributed to the aircraft overrun. Therefore, the analysis will discuss the following issues:

- Factors affecting landing distance;
- Crew coordination during approach and landing.

2.1 Factors Affecting Landing Distance

The FDR recorded that after touched down, the N1s values of both engines were 47% and 42% which then gradually decreased and stopped at lowest value of 21% after 20 seconds. This indicated that after touched down the thrust levers were not at idle position for 20 seconds.

The CVR recorded that the pilot unable to operate the thrust reverser levers and the FDR recorded that the thrust reversers did not deploy until the aircraft stopped. Inability of the pilot to select the thrust reverser was due to the thrust levers were not at idle position and the thrust reverser was mechanically restricted. The engine N1 that were not at idle might also affected the landing distance as the engines still produced forward thrust.

The performance calculation was based on the touch down at 1,000 feet or 305 meters from the threshold. The FDR showed that the aircraft touched down at approximately 552 meters from the threshold. This data showed that the touchdown was prolonged for about 247 meters (810 feet).

The calculation of the required landing distance for the existing condition of the estimated landing weight 64,562 kg, flaps 30, touchdown speed at 150 knots, auto brake selected at position 3, and temperature 28°C.

The calculation of both good and medium runway braking action are as follows:

Component	Good Braking Action Adjustment (feet)	Medium Braking Action Adjustment (feet)
Landing Weight reference (70,000 kg)	5,650	6,310
Landing Weight (64,562 kg)	-352	-407
Elevation (11 feet)	0	0
Tailwind 3.4 knot	+ 278	+ 388
Slope (0)	0	0
Temperature (28°C / 13 °C above ISA)	+ 208	+ 234
Approach speed (Vref + 9)	+ 540	+ 522
Thrust reverser	+40	+1,110

(reversers not deployed)		
Manual speed brake and Manual brake	+190	+190
Prolong touchdown	+ 810	+ 810
Total	7,364 feet (2,244 m)	9,157 feet (2,791 m)

Based on these calculations, the available runway of Juanda Airport with 9,842 feet length was sufficient for the aircraft to full stop in both runway braking actions good and medium with existing conditions.

The FDR recorded that after touched down, the spoiler deployment occurred 9 seconds after touchdown. The delay of spoiler deployment reduced the deceleration effectiveness due to the tire might not firmly contacted to the runway. The FDR also recorded the average of deceleration during first 9 seconds landing roll was -0.07 G which then increased after the spoiler deployed.

The FDR also recorded that the auto brake did not active and the brake pressure increased to 3,000 psi at 21 seconds after touchdown. This delay of brake application would affect the landing distance.

The combination of prolong touchdown, delay in spoiler deployment, thrust levers not at idle position, and late of brake application likely had affected the landing distance required.

The delay of spoiler deployment, late of brake application and thrust levers not at idle position had contributed to the aircraft overrun.

2.2 Crew coordination during approach and landing

Approach Coordination

The SIC as PF followed the ILS approach procedure runway 10, the pilot used autopilot and auto throttle and the aircraft was on proper speed and altitude. At approximately 600 feet, the auto pilot and auto throttle were disengaged and the pilot flew manually. Fly manually means that one pilot hand on the flight control column and the other hand on the thrust levers.

The Juanda Tower controller informed that the wind direction was 020 and velocity was 17 knots, this means that the cross-wind component was approximately 16 knots from the left side. Thereafter when the aircraft was on short final approach, the Juanda Tower controller broadcasted a message addressed to all flights, informing that the visibility decreased to 1,000 meters.

The PIC confirmed to the SIC whether the runway was in sight two times after the EGPWS altitude call out FIVE HUNDRED and after THREE HUNDRED. This indicated that the PIC concerned to the limited visibility condition.

After the EGPWS call out MINIMUM, during manual flying, the SIC had difficulty to control the aircraft that might cause by significant change of wind and visibility. The difficulty was indicated by the activation of EGPWS hard alert ‘GLIDE SLOPE, GLIDE SLOPE’ and the SIC advise to fly left while the PIC assisted the SIC to control the aircraft. The SIC advise to the PIC indicated that the SIC was acting as PM while the PIC acting as PF.

The operator’s Operation Manual stated the standard phraseology when pilot handing

over the control shall call “YOU HAVE CONTROL” then act as a PM, and the pilot undertaking the control shall call “I HAVE CONTROL” than act as PF. The PIC has a right to take over of control from the SIC at any time when the PIC deems it necessary. The transfer of control was not clearly communicated and this indicated that the crew had lack of communication on that particular condition.

While the aircraft on short approach, the PIC concerned to the deteriorating weather and noticed that the SIC had difficulty to control the aircraft. However, the PIC did not show a firm decision by implementing the procedure, resulted in the improper task distribution of pilot flying and pilot monitoring. The improper task distribution indicated the lack of leadership.

Landing

Just prior to touch down the SIC advising PIC to fly left which could be assumed that the PIC acted as PF, and after touched down the PIC commanded to select the engine thrust reversers and replied by the SIC that the thrust reversers could not be operated. This indicated that at this phase the SIC had full control of the aircraft. Thereafter, the PIC took over the control by announce “I have control”. This PIC command was accordance to the company procedure which clearly communicated the task distribution.

It has been discussed that the thrust reversers could not be operated as the thrust levers were not at idle position.

After took over the control, the PIC unable to select the thrust reversers. This indicated that the PIC did not select the thrust levers to idle position prior to select the thrust reversers. The FDR recorded that the thrust lever reached idle position 20 seconds after touched down, indicated by the N1 values of both engines reached the lowest recorded value and the thrust levers angle stopped at 37°.

As mentioned in the operator’s manual that after touched down the PM should monitor system operation and call out any abnormality, including the speed brake, auto brake and thrust reversers operation. The FDR recorded that the thrust reverser did not deploy, the auto-brake and spoiler operation were delayed however, the CVR did not record PM call out related to these abnormalities.

The deteriorating weather condition and difficulty of the SIC to control the aircraft did not trigger a firm decision and resulted in improper task distribution of pilot flying and pilot monitoring during approach and landing. This condition showed lack of leadership.

3 CONCLUSIONS

3.1 Findings[6]

1. The pilots held valid licences and medical certificates.
2. The aircraft was airworthy prior to the departure, there was no report or record of aircraft system abnormality during the flight and was operated within the weight and balance envelope.
3. In this flight, Pilot in Command (PIC) acted as Pilot Monitoring (PM) while the Second in Command (SIC) acted as Pilot Flying (PF).
4. The weather deteriorated during the aircraft on approach, the visibility decreased from 6 km to 1,000 meters and the wind changed to 020/17 knots.
5. The SIC had difficulty to control the aircraft while flying manually indicated by the activation of EGPWS hard alert 'Glide slope, Glide slope' and the SIC advise to fly left while the PIC assisted the SIC to control the aircraft.
6. The aircraft passed the runway threshold with speed 9 knots above the target and touched down on runway 10 at approximately 552 meter from the runway threshold.
7. After touched down, the thrust levers were not at the idle position for 20 seconds and the pilot unable to operate the thrust reverser levers. The brake pressures increment and spoiler deployment delayed.
8. The available runway of Juanda Airport with 9,842 feet length was sufficient for the aircraft to full stop in both runway braking actions good and medium with existing speed, prolong touchdown and absence of thrust reversers.
9. The combination of prolong touchdown, delay in spoiler deployment, thrust reversers did not deploy, and late of brake application had affected the landing distance required.
10. The delay of spoiler deployment, late of brake application and thrust levers not at idle position had contributed to the aircraft overrun.

3.2 Contributing Factors[7]

- The difficulty to control the aircraft and deteriorating weather did not trigger firm action resulted in the combination of lack of communication and leadership.
- The combination of prolong touchdown, delay in spoiler deployment, thrust levers not at idle position, and late of brake application had affected the landing distance.

6 Findings are statements of all significant conditions, events or circumstances in the accident sequence. The findings are significant steps in the accident sequence, but they are not always causal, or indicate deficiencies. Some findings point out the conditions that pre-existed the accident sequence, but they are usually essential to the understanding of the occurrence, usually in chronological order.

7 Contributing 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

At the time of issuing this final investigation report, PT. Lion Mentari Airlines has notified the safety actions taken to the Komite Nasional Keselamatan Transportasi resulting from this occurrence.

The summary of the safety actions were as follows:

- The flight operation to develop training to specifically address the pilot recognition of situation in which the speed brakes do not deploy timely and autobrake do not apply as expected after landing.
- Established best practices for conducting both single and multiple emergency and abnormal situation training.
- To modify pilot training programs to contain modules to emphasize monitoring skills and workload management and include opportunities to practice and demonstrate proficiency in these areas.
- Publish notification to pilots regarding deceleration characteristic and close monitoring during recurrent or Line Orientation Flight Training (LOFT), pilot proficiency check (PPC), Annual Line Check (ALC) and Line Operation Safety Audit (LOSA).

5 SAFETY RECOMMENDATIONS

Komite Nasional Keselamatan Transportasi (KNKT) considered the safety actions taken by PT. Lion Mentari Airlines were relevant to improve safety by referring to the occurrence. In addition, KNKT issued safety recommendations to address safety issues identified in this report.

5.1 PT. Lion Mentari Airlines

- The deteriorating weather condition and difficulty of the SIC to control the aircraft did not trigger a firm decision, therefore KNKT recommends to review pilot training program in order to improve pilot decision making.
- During manual flying, the SIC had difficulty to control the aircraft that was indicated by the activation of EGPWS hard alert 'GLIDE SLOPE, GLIDE SLOPE', therefore KNKT recommends to review the procedure regarding the use of autopilot and pilot training program in order to improve manual flying skill.

5.2 Directorate General Civil Aviation

- To emphasize the other aircraft operator to review pilot training program in order to improve pilot decision making.
- To emphasize the other aircraft operator to develop training specifically address the pilot recognition of situation in which the speed brakes, thrust reverser and autobrake do not operates as expected after landing.

6 APPENDICES

6.1 Aircraft Operator Comments

According to the proposed recommendation stated on the draft final report KNKT.16.02.05.04; PK-LFG, the aircraft operator has been review the pilot training programs subjected to decision making concept when the approach was un-stabilized and marginal weather condition. The detail of comments from Aircraft operator are as follows:

Lion air

Tanggal : 23 November 2016
Nomor : 089/JKTDSJT/EXT/XI/2016
Lampiran : 3 file
Perihal : **Tanggapan Draft *Final Investigation report* KNKT 16.02.05.04 (PK-LFG)**

Kepada Yth.
Ketua Komite Nasional Keselamatan Transportasi
Jl. Medan Merdeka Timur No.5
Jakarta Pusat

Dengan hormat,
Menanggapi surat No. KTU.RH/1/24 KNKT 2016 perihal: Draft Final Investigation report KNKT 16.02.05.04 (PK-LFG). Dengan ini kami sampaikan bahwa kami sudah melakukan review terhadap draft final investigation report KNKT 16.02.05.04 (PK-LFG) ini.
Tanggapan terkait Rekomendasi KNKT terhadap Lion Air pada point 5.1

- *To review pilot training program in order to improve pilot decision making.*

Kami sampaikan sebagai berikut:

I. Telah dilakukan review bersama antara Training dan Safety Departement yang membahas perihal Pilot Decision Making concept ketika pesawat mengalami un-stabilize approach pada short final dengan kondisi weather marginal adalah bagian dari abnormal situation.
   Training Department agar menjelaskan dan mengingatkan kembali kepada semua pilot perihal OM-A 8.3.1.5.3 (*The PIC may change over the control at any time to ensure that the highest level of safety is maintained*).
II. Pilot Decision Making concept merupakan bagian dari CRM training syllabus dalam pilot training program chapter 5.3.8 yang terdapat di dalam Operation Training Manual (OM-D).
   Berikut disampaikan, CRM training untuk pilot yang terdapat pada pilot training program:
   1. 5.2.2 Initial Training/ Mandatory Training.
   2. 5.2.6 Upgrading Training/ Command Training.
   3. 5.2.7 Re-Qualification Training.
   4. 5.2.8 Recurrent Training, termasuk dalam Recurrent/ LOFT

Demikian kami sampaikan, terima kasih atas perhatiannya.

Hormat kami,

Direktur Safety & Security

Tembusan:
1. Direktur Operasi Lion Air
2. DKPPU

6.2 Accredited Representative Comments

No	Reference chapter, page, paragraph	Proposed amendment	Reason for proposed change	Remarks
1	Introduction - Synopsis (page 7, paragraph 5)	*At 0408 UTC, the aircraft landed on runway 10 at ~~650~~ 557 meters from the beginning* *runway with speed ~~11~~ 9 knots above the target*	The QAR data reviewed by Boeing indicates touchdown occurred at 1810 feet and with at Vref + 9.	**Accepted**
2	1.3 Aircraft Information (page 11, paragraph 3)	*According to Boeing 737-800/900ER Flight Crew Operations Manual (FCOM) Chapter* *PI.20.5, the VRef landing with configuration flap 30 for landing weight of 64,562 kg was* *~~142~~ 141 knots.*	The QAR data reviewed by Boeing indicates a recorded Vref of 141 knots	accepted
3	Meteorological Information (pages 13 and 14, paragraph 1)	*0400 UTC* *Wind : 110 / ~~1~~04 knots* *Cloud : BKN 016 FEW ~~020~~ 018CB* *0430 UTC* *Wind : 140/06 knots.*	METAR data reviewed by Boeing indicates the wind at 0400 UTC on 20 February 2016 was reported as 110/04 knots. Also in the data reviewed by Boeing, clouds at 0400 UTC were reported as BKN 016 FEW018CB and at 0430 UTC as SCT018 FEW020CB.	accepted

No	Reference chapter, page, paragraph	Proposed amendment	Reason for proposed change	Remarks
		Cloud : SCT018 FEW~~018~~ 020CB…		
4	1.4 Meteorological Information (Page 14, flag note 4)	*The international unit for reporting cloud amount for Broken (BKN) is when the clouds* *cover more than half (5/8 up to 7/8) area of the sky, scattered (SCT) is when the clouds* *cover between ¾ 3/8 to 4/8 area of the sky and few (FEW) is when the clouds cover 1/8 to* *2/8 part of the sky.*	Boeing review of standard units used in METAR reports found that the cloud coverage amount for scattered (SCT) is between 3/8 to 4/8 area of the sky.	accepted
5	1.6 Flight Recorders (page 15, figure 7 and page 17, bullet 9)	*04:07:5~~1~~0 UTC, the aircraft touched down.*	The QAR data reviewed by Boeing indicates that touch down occurred about 0.5 seconds prior to the time indicated in the draft final report. A sudden decrease in longitudinal acceleration along with the main gear air/ground discrete transition to GROUND indicates that the gear had	**Accepted**

No	Reference chapter, page, paragraph	Proposed amendment	Reason for proposed change	Remarks
			contacted the runway and that the gear were already loaded prior to the peak normal load factor observed in Figure 7.	
6	1.6 Flight Recorders (page 16, CVR excerpt table)	*~~4:07:44 - 4:07:41~~ GPWS Altitude callout started from "Fifty" with interval ten feet until touch down.*	The time range indicated for GPWS altitude callouts appears to have a typographical error in that the starting time occurs after the ending time. Please review and revise as appropriate.	accepted
7	1.6 Flight Recorders (page 16, CVR excerpt table)	*4:08:12 - 4:08:15 ~~P1~~PIC ~~P1~~PIC instructed ~~P2~~SIC to assist ~~P1~~PIC in applying the brake*	The PIC and SIC designations change to the terms P1 and P2 at this point in the CVR excerpt table. Please consider revising terms P1 and P2 to PIC and SIC respectively for consistency with the terminology used in other areas of the report.	Accepted
8	1.6 Flight Recorders (page 17, bullet 2)	*04:07:015 UTC, aircraft passing altitude 500 feet and PIC statement that the runway in* *sight was ~~not~~ confirmed by SIC.*	The CVR excerpt table above this area indicates that the SIC did confirm that the runway was in sight at 04:07:15.	Accepted
9	1.6 Flight	*04:07:24 UTC, the ~~SIC~~PIC confirmed that the*	The CVR excerpt table above this area	Accepted

No	Reference chapter, page, paragraph	Proposed amendment	Reason for proposed change	Remarks
	Recorders (page 17, bullet 3)	*runway in sight.*	indicates that the PIC did confirm that the runway was in sight and the SIC did not respond at 04:07:24.	
10	1.6 Flight Recorders (page 17, bullet 7)	*~~04:07:45~~ UTC, the aircraft passed altitude 50 feet and speed was 153 knots.*	The time noted here does not coincide with the CVR excerpt table time of the GPWS callout of "Fifty" that was documented as 4:07:44 – 4:07:41. Please review and revise as appropriate.	Accepted
11	1.6 Flight Recorders (page 17, bullet 9)	*04:07:51 UTC, the aircraft touched down.* *- Aircraft speed was 153~~0~~ knots.* *- Speed brake handle stayed at armed position, speed brake armed light illuminated* *and the spoilers did not deploy for 10 seconds.* *- The brake pressures relatively constant at 25 Psi for ~~13~~ 9 seconds.* *- Throttle ~~lever~~ Resolver ~~a~~Angle~~s~~ positions were at 41.3° and the engine N1s values* *were 47% and 42% respectively for left and right engines.*	The QAR data reviewed by Boeing indicates touch down airspeed was approximately 150 knots, a brake pressure delay of 9 seconds, and Throttle Resolver Angle positions of 41.3 degrees at touch down. The use of the term Throttle Resolver Angle is a more accurate term for these recorded parameters.	**accepted**

<table>
<tr><th>No</th><th>Reference chapter, page, paragraph</th><th>Proposed amendment</th><th>Reason for proposed change</th><th>Remarks</th></tr>
<tr><td>12</td><td>1.7.2 Boeing 737 Flight Crew Operation Manual- Advisory Information (page 19,

paragraph 1)</td><td>Refer to the Boeing FCOM, chapter Performance Inflight, Advisory Information, the

factors affecting the landing distance for the existing conditions in ~~good and medium~~ poor

and good runway braking action, are as follows:</td><td>Review of QAR data and analysis by Boeing in letter 66-ZB-H200-ASI-18964 shows that the pilot reported braking action was Poor at initial braking but on average was Good during the rollout. Please review and consider including Poor runway braking action in the runway length and landing distance calculations based upon this information.</td><td>Rejected. The increased of deceleration corelated with the deployment of spoiler. KNKT considered that during the initial braking the deceleration was not affected by runway condition.</td></tr>
<tr><td>13</td><td>1.7.2 Boeing 737 Flight Crew Operation Manual- Advisory Information (page 19, runway

length table)</td><td><table><tr><th rowspan="2">Condition</th><th colspan="2">Runway Length Required</th></tr><tr><th>Runway Braking Action Good</th><th>Runway Braking Action Medium</th></tr><tr><td>Tail~~W~~ wind ~~020°~~/~~17~~8 kts</td><td>~~17 x Cos 80° x (240) = 17 x 0.174 x (240) = 708~~ 8/10 x 820 = 656</td><td>~~17 x Cos 80° x (320) = 17 x 0.174 x (320) = 944~~ 8/10 x 1140 = 912</td></tr></table></td><td>The wind conditions noted in the table appear to be the reported winds available to the flight crew. Review of QAR data and analysis by Boeing calculated the presence of an 8 knot tailwind at touch down. Please review and consider including the runway length calculations based upon calculated winds at touch down as shown in the revised calculations above since this could have a significant effect on landing distance calculations due to the positive wind adjustment from a tailwind. If Poor braking action was included the wind adjustment due to an</td><td>Refer to the FDR data recorded, the tailwind at the time of aircraft touched down was 3.39 knot. KNKT considered to change the wind condition based on the FDR data.</td></tr>
</table>

<table>
<tr><th>No</th><th>Reference chapter, page, paragraph</th><th>Proposed amendment</th><th>Reason for proposed change</th><th>Remarks</th></tr>
<tr><td></td><td></td><td></td><td>8 knot tailwind would be: 8/10 * 1750 = 1400</td><td></td></tr>
<tr><td>14</td><td>2.1 Factors Affecting Landing Distance (page 21, landing distance table)</td><td><table>
<tr><th>Component</th><th>Good Braking Action Adjustment (feet)</th><th>Medium Braking Adjustment (feet)</th></tr>
<tr><td>Tail~~W~~ wind ~~020°//17~~8 kts</td><td>~~708~~ 656</td><td>~~944~~ 912</td></tr>
<tr><td>Total</td><td>~~6,820 feet (2,078 m)~~ 8,184 feet (2,494 m)</td><td>~~8,263 feet (2,518 m)~~ 10,119 feet (3,084 m)</td></tr>
</table></td><td>The wind conditions noted in the table appear to be the reported winds available to the flight crew. Review of QAR data and analysis by Boeing calculated the presence of an 8 knot tailwind at touch down. The revised calculations above

show this has a significant effect on landing distance (8,184 feet for Good and 10,119 feet for Medium) due to the positive wind adjustment from a tailwind. Please review and consider including the landing distance calculations based upon calculated winds at touch down as well as the statement regarding available runway length based upon this information.</td><td>Refer to the FDR data recorded, the tailwind at the time of aircraft touched down was 3.39 knot. KNKT considered to change the wind condition based on the FDR data.</td></tr>
</table>

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