FINAL
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NATIONAL TRANSPORTATION SAFETY COMMITTEE

Aircraft Accident Investigation Report

PT. Lion Mentari Airline (Lion Air)
PK-LHH
Boeing 737-900ER
Sultan Kasim Syarif II Airport, Pekanbaru
Riau
Republic of Indonesia

15 Februari 2011

NATIONAL TRANSPORTATION SAFETY COMMITTEE
MINISTRY OF TRANSPORTATION
REPUBLIC OF INDONESIA
2013

This Final report was produced by the National Transportation Safety Committee (NTSC), 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 NTSC in accordance with Annex 13 to the Convention on International Civil Aviation, the Indonesian Aviation Act (UU No.1/2009), and Government Regulation (PP No. 3/2001).

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GLOSSARY OF ABBREVIATIONS

AFM	:	Airplane Flight Manual
AGL	:	Above Ground Level
ALAR	:	Approach-and-Landing Accident Reduction
AMSL	:	Above Mean Sea Level
AOC	:	Air Operator Certificate
ATC	:	Air Traffic Control
ATPL	:	Air Transport Pilot License
ATS	:	Air Traffic Service
BMKG	:	*Badan Meterologi Klimatologi dan Geofisika* (Metrological Climatologically and Geophysical Agency)
°C	:	Degrees Celsius
CASO	:	Civil Aviation Safety Officer
CASR	:	Civil Aviation Safety Regulation
CPL	:	Commercial Pilot License
COM	:	Company Operation Manual
CRM	:	Cockpit Recourses Management
CSN	:	Cycles Since New
CVR	:	Cockpit Voice Recorder
DFDAU	:	Digital Flight Data Acquisition Unit
DFDR	:	Digital Flight Data Recorder
DGCA	:	Directorate General of Civil Aviation
FL	:	Flight Level
F/O	:	First officer or Copilot
FDR	:	Flight Data Recorder
hPa	:	Hectopascals
Hrs	:	Hours
ICAO	:	International Civil Aviation Organizationn
IFR	:	Instrument Flight Rules
IIC	:	Investigator in Charge
ILS	:	Instrument Landing System
Kg	:	Kilogram(s)
Km	:	Kilometer(s)
Kt	:	Knots (nm/hours)
Mm	:	Millimeter(s)
MTOW	:	Maximum Take-off Weight

NM	:	Nautical mile(s)
NOTAM	:	Notice to Airman
KNKT (NTSC)	:	*Komite Nasional Keselamatan Transportasi* (National Transportation Safety Committee)
PIC	:	Pilot in Command
PIREP	:	Pilot Report
QFE	:	Height above airport elevation (or runway threshold elevation) based on local station pressure
RESA	:	Runway End Safety Area
RPM	:	Revolution per Minutes
R/W	:	Runway
S/N	:	Serial Number
SSCVR	:	Solid State Cockpit Voice Recorder
SSFDR	:	Solid State Flight Data Recorder
TS/RA	:	Thunderstorm and rain
TSN	:	Time since New
TT/TD	:	Ambient Temperature/Dew Point
TTIS	:	Total Time in Service
UTC	:	Universal Time Coordinate
VFR	:	Visual Flight Rules
VMC	:	Visual Meteorological Conditions

INTRODUCTION

SYNOPSIS

On 15 February 2011, a Boeing 737-900 aircraft Registration PK-LHH operated by PT. Lion Mentari Airlines as a passenger service flight with flight number LNI 295 departed from Polonia International Airport, Medan (MES / WIMM) to Sultan Syarif Kasim II Airport, Pekanbaru (PKU/ WIBB). On board in this flight was 226 person, consist of two pilots, one observer pilot, five flight attendants and 218 passengers (212 adults and six infant). The PIC acted as Pilot Flying on this flight

At 10.55 UTC (17.55 LT) the aircraft landed at Sultan Syarif Kasim II Airport, Pekanbaru. Prior to land, the Tower controller informed that the wind was calm. There was also a PIREP[1] informed that the runway was slippery. The weather condition slight rain and landed runway 36. While the aircraft on final approach after passed 500 feet until touched down, the FDR data revealed that there was tail wind with average component of 15 knots.

The passengers evacuated normally via passenger stair and no one injured.

The performance calculation based on the aircraft landing weight, approach speed, temperature, tail wind component and assumption of braking action medium indicated that the runway length available was not sufficient for the aircraft to stop on the runway.

The examination on the runway found rubber deposit and several spots of standing water up to 3 cm depth.

The investigation concluded that combination of tail wind component and runway skid resistant might have contributed to this serious incident.

One day before this serious incident, there was another runway excursion serious incident in Sultan Syarif Kasin II Airport involving same type of aircraft of the same aircraft operator while landed on runway 36 during raining.

Following this investigation, NTSC issued safety recommendations to address additional safety issues to be added to the NTSC report of the previous serious incident to the DGCA, and the aircraft operator.

1 PIREP = Pilot report

1 FACTUAL INFORMATION

1.1 History of the Flight

On 15 February 2011, a Boeing 737-900 aircraft Registration PK-LHH operated by PT. Lion Mentari Airline as passenger service flight from Polonia International Airport, Medan (MES/ WIMM) to Sultan Syarif Kasim II Airport, Pekanbaru (PKU / WIBB) with the flight number LNI 295. The aircraft departed from Medan at 10.00 UTC

On board in this flight was 226 person, consist of two pilots, one observer pilot, five flight attendants and 218 passengers (212 adults and six infant). The PIC acted as Pilot Flying on this flight.

During on route to Pekanbaru, the pilot received weather information from the ATIS informed that the wind was calm, ground visibility 6 km, weather slight rain.

The aircraft was vectored to intercept the ILS approach runway 36.

There was information to the Tower controller from the pilot who just landed and informed that the runway was slippery. After heard this information the PIC changed the auto-brake selection to MAX which was previously set to 3.

The aircraft landing weight was 65,467 kg and land with flap 40 with Vref[2] 136 knots.

At 800 feet the pilot could see the runway.

At final approach, the Tower controller gave clearance to land and informed that the wind was calm. At aircraft altitude below 500 feet, the FDR recorded the tail wind component average of 15 knots. The pilot did not see the wind information in the Computer Display Unit (CDU).

The FDR also revealed that the aircraft was flown below the glide path at aircraft altitude below 300 feet and back to the glide slope at about 50 feet from touchdown. FDR recorded the tail wind component during touch down was 17 knot.

At 10.55 UTC (17.55 LT) the aircraft landed. The pilot intended to make positive touch down, however both pilots felt that the touch down was smooth. The speed brake, auto-brake and thrust reverser were operated normally. Both pilots felt that the aircraft decelerated normally.

At approximately aircraft speed 60 knots, the PIC applied manual brake and stow the thrust reverser, afterward both pilots felt that the deceleration was decreasing. Considered that the deceleration was decreasing, the pilot then applied manual braking to maximum and reapplied the thrust reversers until the aircraft stop.

The aircraft stop approximately 12 meters at the right side from the end of the runway 36.

The passengers disembarked normally through passenger stair. No one injured in this serious incident.

A day before there was a similar aircraft type serious incident of runway excursion during landing on runway 36 Sultan Syarif Kasim II Airport.

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2 Vref is landing reference speed or threshold crossing speed

Figure 1: The aircraft position after the serious incident.

1.2 Injuries to Persons

Table 1: Injuries to persons

Injuries	Flight crew	Passengers	Total in Aircraft	Others
Fatal	-	-	-	-
Serious	-	-	-	-
Minor/none	8	218	226	-
TOTAL	8	218	226	-

1.3 Damage to Aircraft

There was no damage to the aircraft in this serious incident.

1.4 Other Damage

There was no other damage in this serious incident.

1.5 Personnel information

1.5.1 Pilot in Command

Gender	:	Male
Date of birth	:	20 June 1974
Nationality	:	Indonesia
License	:	Airline Transport Pilot
Date of issue	:	30 August 2002
Valid to	:	31 May 2011
Aircraft type rating	:	B737-200/300/400/500; B737-900 E
Medical certificate	:	First Class (Class 1)
Date of medical	:	09 November 2010
Valid to	:	09 May 2011
Last proficiency check	:	11 November 2010
Flying experience		
Total hours	:	11,000 hours
Total on type	:	1,709 hours
Last 90 days	:	188 hours 25 minutes
Last 30 days	:	105 hours 07 Minutes
Last 24 hours	:	50 minutes

1.5.2 Co-pilot

Gender	:	Male
Date of birth	:	05 December 1978
Nationality	:	Italy
License	:	Commercial Pilot
Date of validation	:	17 January 2011
Valid to	:	17 January 2012
Aircraft type rating	:	Boeing 737-900 ER
Medical certificate	:	First Class (Class 1)
Date of medical	:	02 November 2010
Valid to	:	02 May 2011

Last proficiency check	:	15 November 2010
Flying experience		
Total hours	:	*not provided by operator*
Total on this type	:	*not provided by operator*
Last 90 days	:	*not provided by operator*
Last 30 days	:	75 hours 52 minutes
Last 24 hours	:	50 minutes

1.6 Aircraft information

1.6.1 Aircraft Data

Aircraft manufacturer	:	Boeing Company
Aircraft model/type	:	Boeing / 737 - 9GP
Serial number	:	37275
Year of manufacture	:	August 2010
Aircraft registration	:	PK-LHH
Certificate of Registration	:	25 August 2010
Valid to	:	24 August 2011
Certificate of Airworthiness	:	25 August 2010
Valid to	:	24 August 2011
Total time since new (TSN)	:	1382 hours 11 minutes
Cycles Since New (CSN)	:	1105 cycles

1.6.2 Engines

Engine type	:	Turbofan Engine
Manufacturer	:	General Electric
Model / Part number	:	CFM56-7B26/3
Serial Number #1	:	804359
TSN	:	1382 hours 11 minutes
CSN	:	1105 cycles
Serial Number #2	:	805373
TSN	:	1382 hours 11 minutes
CSN	:	1105 cycles

1.7 Meteorological Information

The weather information at Sultan Syarif Kasim II Airport, Pekanbaru reported on 15 February 2010 at 10: 55 UTC was:

Surface wind	:	Calm
Visibility	:	5 Km
Present weather	:	Rain
Cloud	:	SCT 1500 ft
Temperature	:	29° C
Due Point	:	25° C
QNH	:	1008 Mbs / 29.76 Inch Hg
QFE	:	1004 Mbs / 29.64 Inch Hg

1.8 Aids to Navigation

Not relevant to this serious incident.

1.9 Communications

At the time of the occurrence all the communication between the pilot of LNI 295 and Tower controller was performed normally and consider not relevant to this serious incident.

1.10 Aerodrome Information

Aerodrome Code	:	WIBB / PKU
Airport Name	:	Sultan Syarif Kasim II Airport
Airport Address	:	Pekanbaru International Airport
Airport Authority	:	PT. Persero Angkasa Pura II
Coordinates	:	0° 27’47.6” N / 101°26’47.5”E
Elevation	:	102 feet (31 m)
Runway Length	:	2,240 meters
Runway Width	:	30 meters
Azimuth	:	18 – 36

Figure 2: Rubber deposit on the touchdown zone runway 18.

The airport operator scheduled for rubber deposit removal on six month interval bases. The last runway rubber deposit removal was performed on 31 December 2010 on the end of runway 36 and the result was good. (refer to letter number BAC.14.09.04/12/2010/330)

The last runway overlay was performed at 2010. After the overlay, the runway skid resistance was measured by Mu meter. The measurement found that the skid resistance was 0.55 to 0.59. According to the DGCA Advisory Circular number SE.04 issued in 2012, the minimum skid resistance was 0.6.

At the day of the serious incident, the rubber deposit was found on the runway especially between the thresholds up to touch down zone runway 18 (see figure 2).

The inspections of the runway friction were performed monthly uses sand patch method. The last inspection was on 1 January 2011 which found that the condition of

station B5 runway 36 was “smooth”.

After the serious incident, the runway was examined for existing of standing water. It found several water spots on the runway up to 3 cm depth.

Figure 3: standing water examination performed 1 hour after rain.

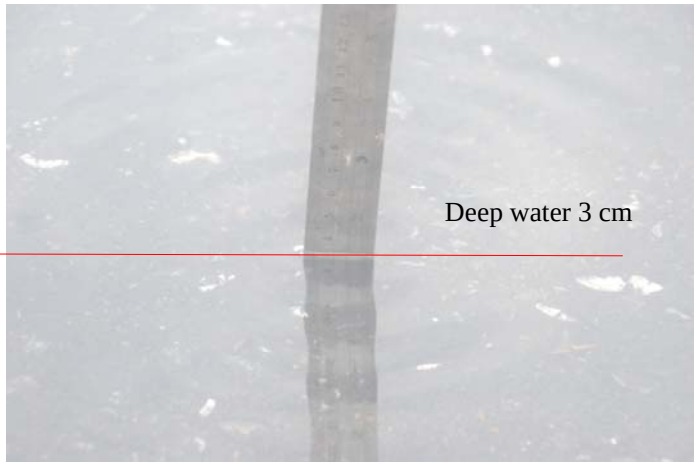

Figure 4: Standing water up to 3 cm.

1.11 Flight Recorders

1.11.1 Digital Flight Recorder

The aircraft was equipped with a Digital Flight Data Recorder (DFDR).

Manufacturer	:	Honey Well
Model	:	SSFDR
Part Number	:	980-4700-042
Serial Number	:	13895

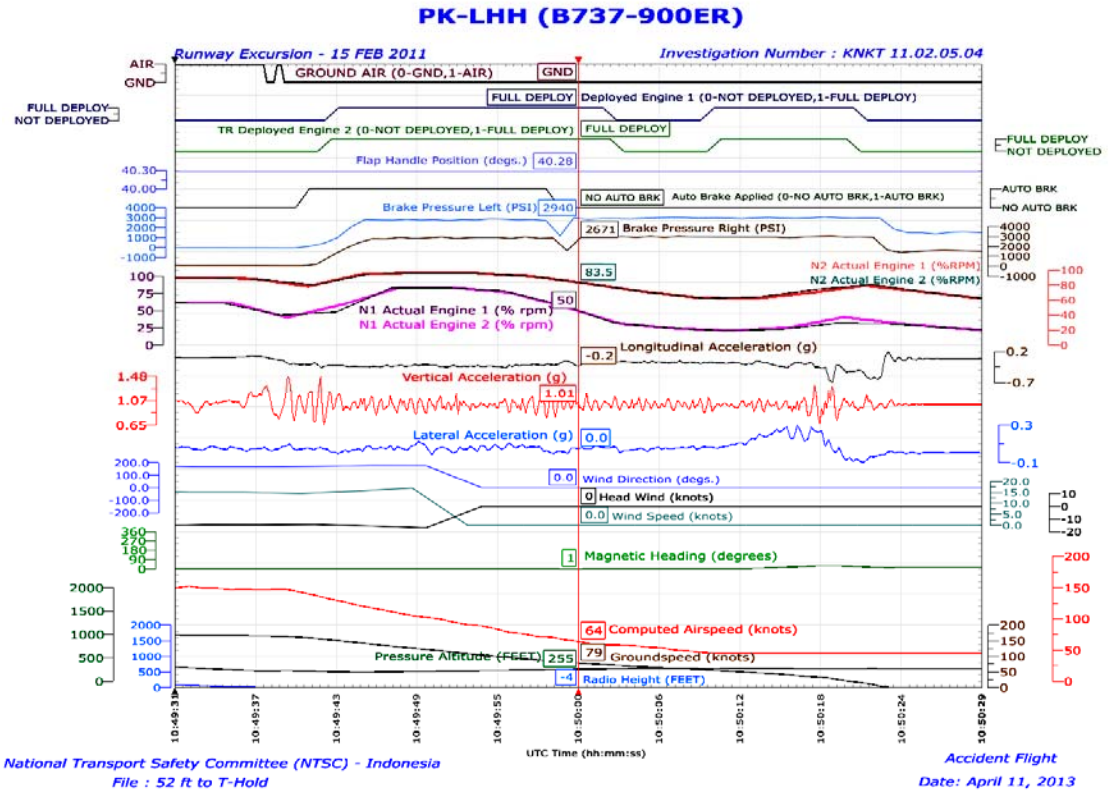

Figure 5: FDR data with special information during landing roll

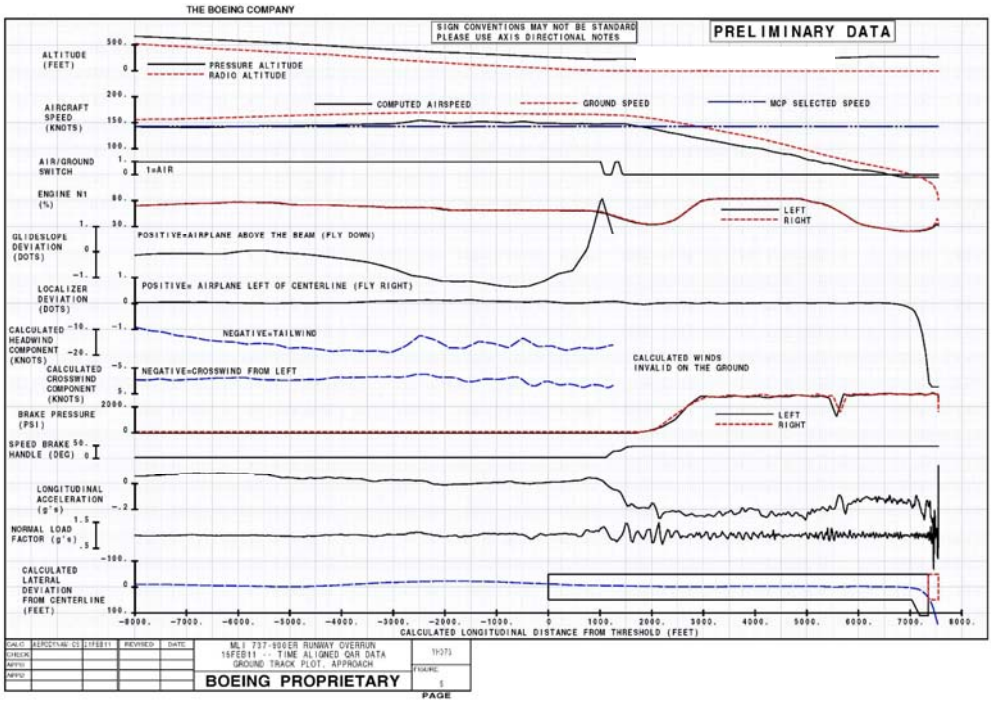

Figure 6: DFDAU data approach to land

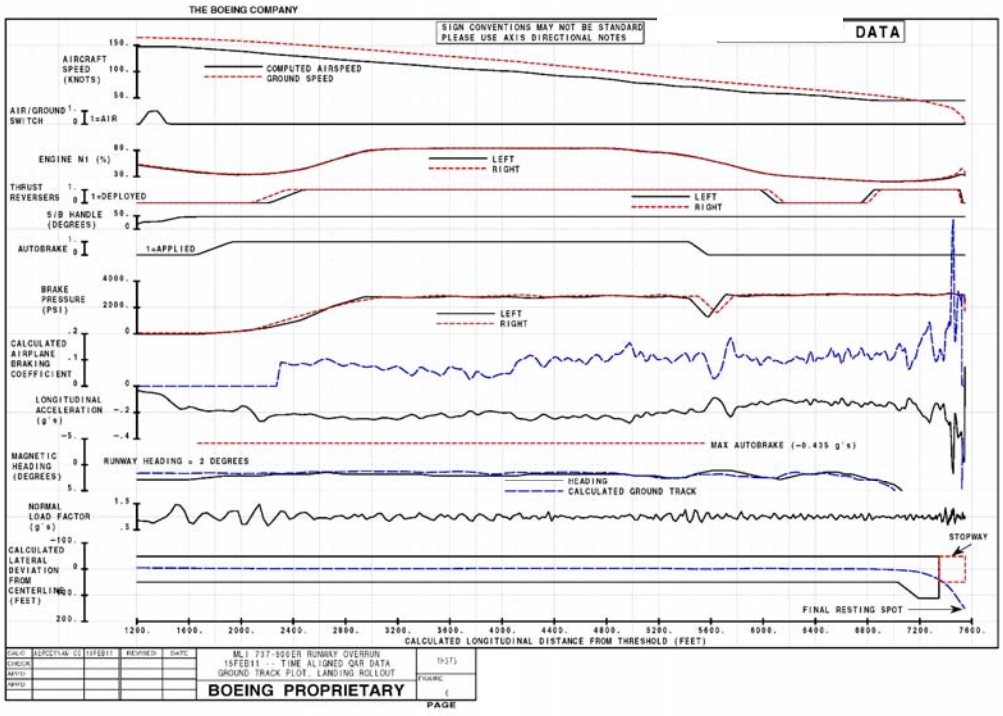

Figure 7: DFDAU data on landing roll

1.11.2 Cockpit Voice Recorder

The aircraft was equipped with a Cockpit Voice Recorder (CVR) with a 30 minutes recording time.

Manufacturer	:	Honey Well
Model		SSCVR
Part number	:	980-6022-001
Serial Number	:	18309

1.12 Wreckage and Impact lnformation

The investigation found several marks on the runway after the serious incident. The illustration below is based on the marks found on the runway

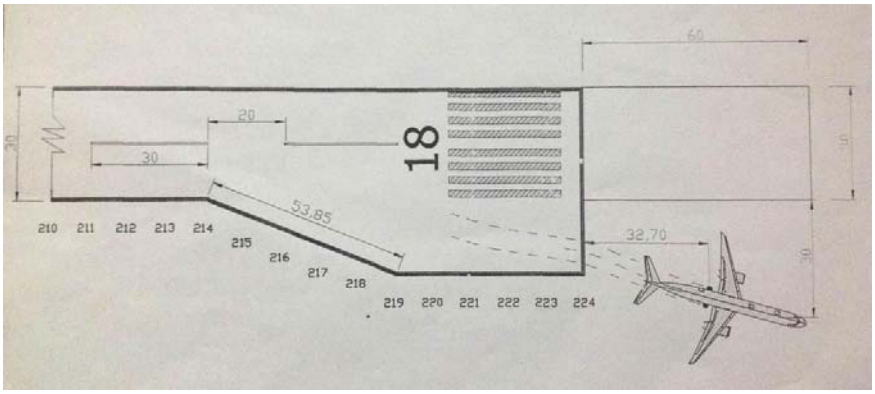

Figure 8: Illustration on the last part of aircraft movement

Figure 9: Aircraft position after serious incident

1.13 Medical and Pathological Information

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

1.14 Fire

There was no pre- or post- impact fire.

1.15 Survival Aspects

Not relevant to this Serious Incident.

1.16 Tests and Research

Not relevant to this serious incident.

1.17 Organisational and Management Information

Aircraft Owner	:	Celestial Aviation Trading 12 Limited
Aircraft Operator	:	PT. Lion Mentari Airlines Gajah Mada Street No: 7, Jakarta 10130, Republic of Indonesia.
AOC Number	:	121-010

1.18 Additional Information

The following information is related to auto-brake system which was taken from the Boeing manuals.

Auto-brake System (FCOM 14.20.4)
The auto-brake system uses hydraulic system B pressure to provide maximum deceleration for rejected takeoff and automatic braking at preselected deceleration rates immediately after touchdown. The system operates only when the normal brake system is functioning. Antiskid system protection is provided during auto-brake operation.

Factors Affecting Landing Distance (FCTM 6.32)
Advisory information for normal and non-normal configuration landing distances is contained in the PI section of the QRH. Actual stopping distances for a maximum effort stop are approximately 60% of the dry runway field length requirement. Factors that affect stopping distance include: height and speed over the threshold, glide slope angle, landing flare, lowering the nose to the runway, use of reverse thrust, speed brakes, wheel brakes and surface conditions of the runway.

Note: *Reverse thrust and speed-brake drag are most effective during the high speed portion of the landing. Deploy the speed-brake lever and activate reverse thrust with as little time delay as possible.*

Note: *Speed-brakes fully deployed, in conjunction with maximum reverse thrust and maximum manual antiskid braking provides the minimum stopping distance.*

Automatic Brakes (FCTM 6.36)
Immediate initiation of reverse thrust at main gear touchdown and full reverse thrust allow the auto-brake system to reduce brake pressure to the minimum level.

Since the auto-brake system senses deceleration and modulates brake pressure accordingly, the proper application of reverse thrust results in reduced braking for a large portion of the landing roll.

1.19 Useful or Effective Investigation Technique

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

2 ANALYSIS

The FDR recorded that the aircraft touched down at touchdown point with correct speed. This indicated that the approach phase of the flight was not a factor to this serious incident. The analysis focused on the deceleration process.

2.1 Landing performance

The aircraft landing weight was 65,467 kg. Aircraft configuration was flaps 40 and auto brake was selected at auto brake MAX According to the Boeing report the preselected rate of the longitudinal acceleration on auto brake MAX was - 0.435 G. The FDR data shown that on the high speed portion of landing roll, the average longitudinal acceleration was -0.2 G and the brake pressure was maximum (3000 psi).

The aircraft auto-brake system provides automatic braking at preselected deceleration rates. Based on the Boeing data, the preselected longitudinal acceleration for auto-brake MAX was -0.435 G.

The longitudinal acceleration of -0.435 G did not achieve with application of both engine thrust reversers and wheel brakes up to maximum.

The calculation base on Boeing Performance in flight with existing weight and temperature and assume braking action was at medium are as follow:

Required landing distance for existing weight	5480 feet
Tail wind component 8 knot	1470 feet
Temperature (ISA + 6)	130 feet
Approach speed 17 knot above target	430 feet

Base on this calculation the required runway length (total of those four factors) = 7510 feet.

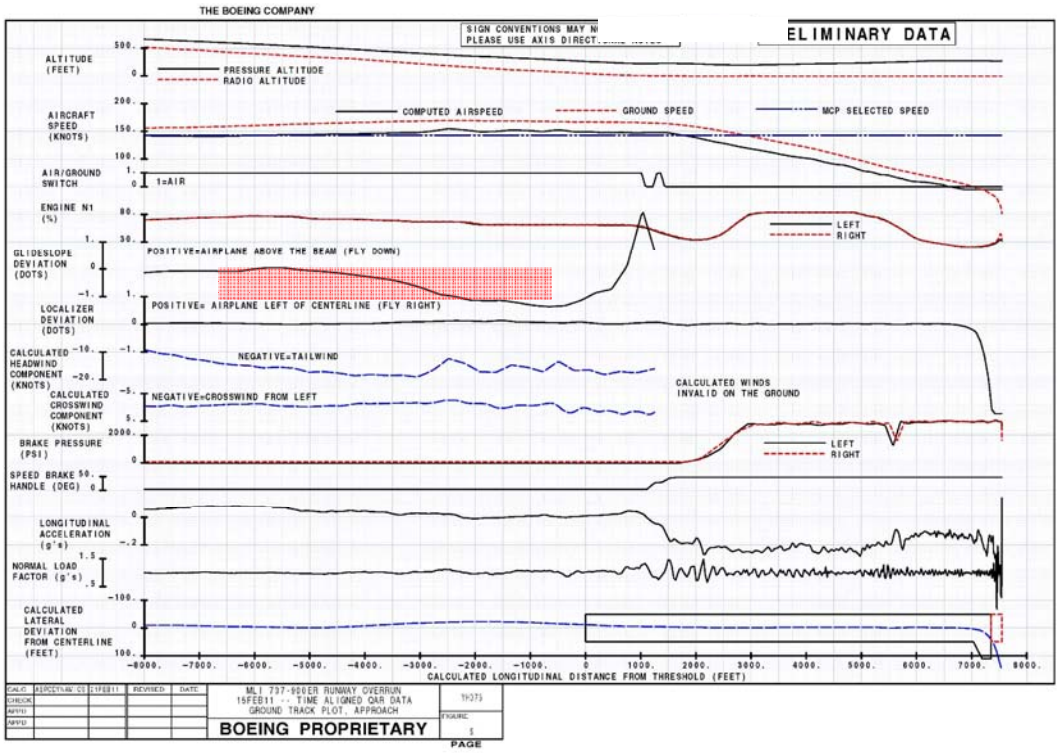

Figure 10: Tail wind information on the DFDAU data

2.2 Factors affecting deceleration

The FDR data showed that the aircraft touched down at 1440 feet from the beginning runway at speed of Vref + 8 knot. There was also tail wind component of 17 knot. After touchdown, the thrust reversers, spoilers, brake pressure worked normally.

The longitudinal acceleration for auto brake MAX was preselected at -0.435 G. The FDR data showed that the average longitudinal acceleration reached only – 0.2 G. The thrust reversers up to 80 % N1 and brake pressure up to 3000 psi was unable to reached preselected longitudinal acceleration of -0.435 G.

The Boeing data base on DFDAU showed that the average calculated airplane braking coefficient was – 1.5 instead of 0. This condition means that the friction between the wheel and runway surface was not sufficiently supporting the aircraft deceleration.

There are two possibilities affecting the wheel and runway surface friction, which are hydroplaning and runway skid resistance.

Hydroplaning indicates by reverted rubber on the aircraft tire. The investigation did not find any reverted rubber on the aircraft tires.

The runway skid resistance was found 0.55 to 0.59 which was measured after the overlay on 2010. The minimum runway skid resistance was 0.60. Runway examination found rubber deposit on the runway especially between the thresholds up to touch down zone runway 18. The runway skid resistance will decrease with the existing of rubber deposit.

The aircraft landed when the runway was wet.

This can be concluded that the ineffective of calculated airplane braking coefficient most probably due to the combination of low skid resistance, rubber deposit and wet runway.

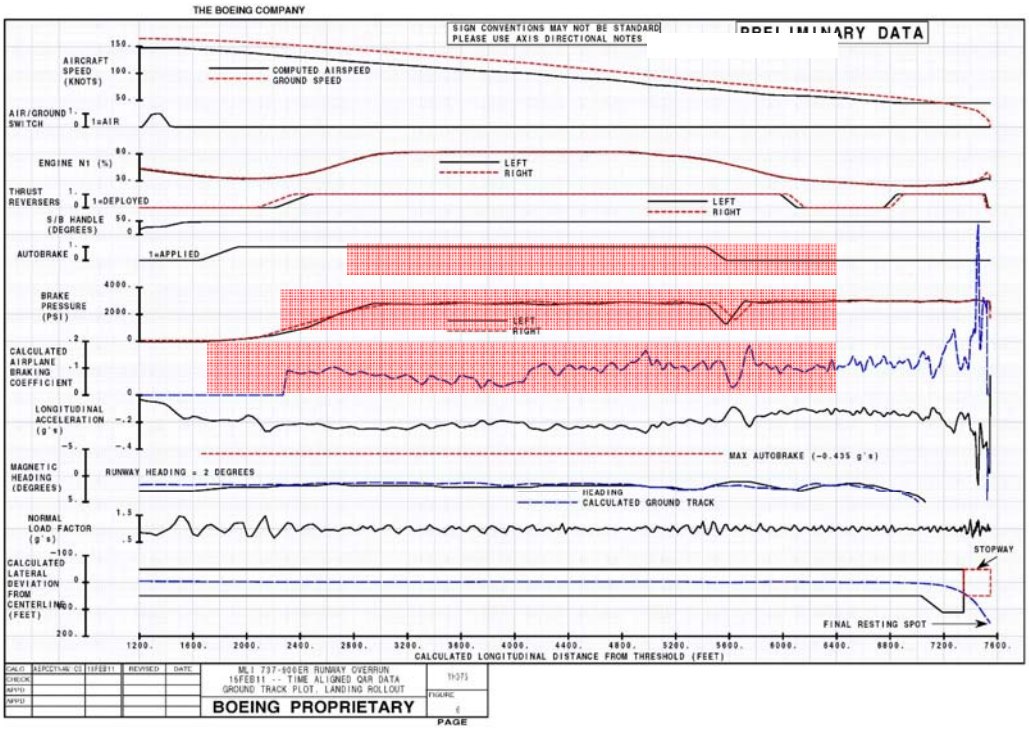

Figure 11: Factors contributed to the deceleration

2.3 Discrepancy of Wind Data

Prior to land the pilot received information from the Tower controller that the surface wind was calm. The FDR data retrieved that the surface wind condition was tail wind up to 17 knots.

The discrepancy of the surface wind data might arise from the fact that the location of the anemometer was surrounded by vegetation and building which might generates turbulence that might cause reading inaccuracy. Based on this condition it can be concluded that the wind speed report from the Tower controller might be incorrect.

The incorrect wind information to the pilots may affect to the pilot decision and flying technique.

2.4 Procedure

Refer to Operator Standard Operating Procedure (SOP) page 1.3 stated that : during approach the pilot flying should be set the CDU on PROGRESS PAGE 2 and the pilot monitoring should set the CDU on APPROACH REF PAGE. The progress page 2 contains information including cross wind and head/ tail wind.

During the approach the pilot did not see the wind information on the CDU and rely on information given by the ATC. The data revealed that the wind condition informed by the ATC was calm; while the FDR recorded that average tail wind from 500 feet to touchdown was 15 knots.

The aircraft operation limitation on the operator SOP stated maximum tail wind component for takeoff and landing was 10 knots. The existing tail wind component was higher than the maximum.

The missing information of the existing tail wind above maximum might have made the pilot decided to continue landing.

3 CONCLUSION

3.1 Findings

a) The aircraft was airworthy and there was no evidence that the aircraft has any system malfunction prior to the serious incident.

b) Both pilots have valid license and medical certificates.

c) The aircraft was within the correct weight and balance limitation.

d) The PIC acted as pilot flying.

e) The weather condition was raining and the runway was wet.

f) Aircraft landing weight was 65,467 kg. Auto brake was selected at MAX, thrust reversers were applied up to 80 % N1, and brake pressure 3000 psi, however the preselected longitudinal acceleration of – 0.435 G (deceleration) did not achieved.

g) Based on performance calculation refer to the Boeing manuals the runway was not sufficient to stop the aircraft with existing weight and temperature with additional factor of 17 knots tail wind component, with assumption of runway braking action was medium.

h) The FDR recorded that at 500 feet final approach until touch down the average tail wind component was 15 knots while the Tower controller reported that the wind was calm. The consequences for tail wind 17 knots would be additional 1470 feet to the stopping distance. (FCOM page 12.3).

i) During the approach the pilot did not see the wind information on the CDU and rely on information given by the ATC.

j) The calculation base on the Boeing Performance in flight for the existing weight, temperature and tail wind component with assume braking action was medium the required runway length was 7510 feet.

k) The test for runway skid resistance found 0.55 up to 0.59 below the minimum requirement of 0.60. The runway examination found rubber deposit and water spots up to 3 cm depth on the runway along 1000 feet to the end of runway 36.

l) The combination of low skid resistance, rubber deposit and wet runway would significantly reduce the runway friction; hence reduce the calculated airplane braking coefficient.

m) The last runway rubber deposit removal was performed on 31 December 2010 on the end of runway 36 and the result was good.

n) Prior to land, the Tower controller informed that the wind was calm. This incorrect information was result of the location of anemometer.

3.2 Causes

The following issues are the significant findings that most probably contribute to this serious incident.

The aircraft did not decelerate according to the preselected value of –0.435 G from the beginning touch down until the aircraft stop due to the decreasing of the calculated airplane braking coefficient that might caused by low skid resistance, rubber deposit and wet runway.

The existing weight, temperature and additional factor of 17 knots tail wind component, with assumption of runway braking action medium would require landing distance longer than the available runway.

4 SAFETY ACTION

Following the two serious incident of runway excursion in Sultan Syarif Kasim II Airport, involving B 737 900 which occurred on 14 February 2011 and 15 February 2011, the DGCA, PT Angkasa Pura II and airport authority of Sultan Syarif Kasim II held a meeting on 3 May 2011. The meeting was agreed that:

1. The airport authority of Sultan Syarif Kasim II was revised the interval schedule for the rubber deposit cleaning. The previous cleaning schedule was 6 (six) months, the revised schedule became "*On Condition*", depends on the inspection result;

2. The airport authority of Sultan Syarif Kasim II was conducted some repair on runway surface to ensure the standing water will be eliminate;

3. The airport authority of Sultan Syarif Kasim II shall issue a notam[3] to inform that the runway skid resistance was 0.55 and was below the minimum requirements of 0.60. This condition may result in poor braking action when the runway is wet.

3 Notam : Notice to airmen

5 RECOMMENDATION

The National Transport Safety Committee has issued safety recommendations following the investigation serious incident of runway excursion which occurred at Sultan Syarif Kasim II Airport involving same type of aircraft. As a result of this serious incident investigation, the National Transportation Safety Committee issued safety recommendation to address additional safety issues identified in this report.

5.1 Directorate General of Civil Aviation

The National Transportation Safety Committee recommends to the Directorate General of Civil Aviation to ensure that the aircraft operator implement company Standard Operating Procedure in relation of CDU set up during approach.

5.2 PT. Lion Mentari Airlines

The National Transportation Safety Committee recommends to the Directorate General of Civil Aviation to ensure the implementation of company Standard Operating Procedure in relation of CDU set up during approach.

6 APPENDICES

6.1 Boeing Performance In-Flight Table

ADVISORY INFORMATION

Normal Configuration Landing Distances
Flaps 40

	LANDING DISTANCE AND ADJUSTMENTS (FT)											
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ PER 10 KTS		SLOPE ADJ PER 1%		TEMP ADJ PER 10°C		APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	60000 KG LANDING WEIGHT	PER 5000 KG ABOVE/ BELOW 60000 KG	PER 1000 FT STD/ HIGH*	HEAD WIND	TAIL WIND	DOWN HILL	UP HILL	ABV ISA	BLW ISA	PER 10 KTS ABOVE VREF40	ONE REV	NO REV
Dry Runway												
MAX MANUAL	2690	180/-130	70/80	-100	340	30	-30	50	-50	200	50	80
MAX AUTO	3380	200/-180	80/110	-130	430	0	0	70	-70	330	0	0
AUTOBRAKE 3	4660	310/-300	150/200	-210	720	0	-20	110	-110	510	0	0
AUTOBRAKE 2	5950	430/-410	200/260	-280	980	80	-110	160	-160	490	0	130
AUTOBRAKE 1	6580	490/-480	230/310	-330	1160	160	-200	180	-180	480	230	690
Good Reported Braking Action												
MAX MANUAL	3690	230/-210	100/150	-160	590	80	-80	80	-80	280	200	360
MAX AUTO	4040	250/-230	110/150	-180	620	70	-70	80	-100	340	230	410
AUTOBRAKE 3	4660	310/-300	150/200	-210	720	20	-20	110	-110	510	30	50
AUTOBRAKE 2	5950	430/-410	200/260	-280	980	80	-110	160	-160	490	0	130
Medium Reported Braking Action												
MAX MANUAL	4990	360/-330	160/230	-260	980	210	-180	130	-130	380	620	1070
MAX AUTO	5120	360/-340	160/230	-260	980	200	-150	130	-130	430	620	1080
AUTOBRAKE 3	5200	380/-340	180/250	-280	1020	160	-110	130	-150	510	640	1000
AUTOBRAKE 2	6000	440/-430	200/280	-310	1120	160	-160	160	-160	490	300	560
Poor Reported Braking Action												
MAX MANUAL	6450	510/-460	230/330	-410	1570	540	-340	160	-180	440	1570	2540
MAX AUTO	6710	510/-460	230/330	-410	1560	540	-340	160	-180	460	1590	2580
AUTOBRAKE 3	6710	510/-480	250/330	-410	1560	510	-330	160	-200	480	1590	2590
AUTOBRAKE 2	6870	520/-490	250/340	-410	1610	490	-330	180	-200	490	1460	2280

Reference distance is for sea level, standard day, no wind or slope, VREF40 approach speed and two engine detent reverse thrust.
Max manual braking data valid for auto speedbrakes. Autobrake data valid for both auto and manual speedbrakes.
For max manual braking and manual speedbrakes, increase reference landing distance by 220 ft.
Actual (unfactored) distances are shown.
Includes distance from 50 ft above threshold (1000 ft of air distance).
***For landing distance at or below 8000 ft pressure altitude, apply the STD adjustment. For altitudes higher than 8000 ft, first apply the STD adjustment to derive a new reference landing distance for 8000 ft then apply the HIGH adjustment to this new reference distance.**

6.2 Standard Operating Procedure

Normal procedures show who does a step by crew position (C, F/O, PF, or PM):

- in the procedure title, or
- in the far right column, or
- in the column heading of a table

The mode control panel is the PF's responsibility. When flying 'Manual/ CWS Flight Operation', the PF directs the PM to make the changes on the mode control panel.

The captain is the final authority for all tasks directed and done.

1.4 CONTROL DISPLAY UNIT (CDU) PROCEDURES

Before taxi, the captain or first officer may make CDU entries. The other pilot must verify the entries.

Make CDU entries before taxi or when stopped, when possible. If CDU entries must be made during taxi, the PM makes the entries. The PF must verify the entries before they are executed.

In flight, the PM usually makes the CDU entries. The PF may also make simple, CDU entries when the workload allows. The pilot making the entries executes the change only after the other pilot verifies the entries.

During high workload times, for example departure or arrival, try to reduce the need for CDU entries. Do this by using the MCP heading, altitude, and speed control modes. The MCP can be easier to use than entering complex route modifications into the CDU.

For next pilot convenient, do not touch DU's screen because it will leave finger print mark. Keeping the screen clean is recommended.

1.5 FMC/CDU SELECTION

PHASE OF FLIGHT	PILOT FLYING	PILOT MONITORING
Takeoff	Takeoff Ref	Legs
Climb	Climb	Progress 1
Cruise	Cruise	Progress 1
Descent	Descent	Progress 1
Landing	Progress 2*	Approach Ref

Note : Page duplication are not recommended.

1.6 NAVIGATION

Pilots must be aware that any error in the FMC position will affect not only the aircraft position, but also the position of all navaids displayed on the ND MAP. Periodic independent cross checks of FMC position should be made, particularly in areas of sparse radio aids.