AIRCRAFT SERIOUS INCIDENT

FINAL REPORT

SI 04/18

Air Accident Investigation Bureau (AAIB)

Ministry of Transport, Malaysia

Serious Incident involving Fixed wing aircraft Boeing B737-900

Registration 9M-LNJ

Runway Excursion at Tribhuvan International Airport,

Kathmandu, Nepal

on the 19th April 2018

AIR ACCIDENT INVESTIGATION BUREAU (AAIB)

MALAYSIA

SERIOUS INCIDENT REPORT NO. : SI 04/18

OPERATOR	**:**	**MALINDO AIRWAYS SDN. BHD**
AIRCRAFT TYPE	**:**	**BOEING B737-900**
NATIONALITY	**:**	**MALAYSIAN**
REGISTRATION	**:**	**9M-LNJ**
PLACE OF OCCURRENCE	**:**	**TRIBHUVAN INTERNATIONAL AIRPORT, KATHMANDU, NEPAL**
DATE AND TIME	**:**	**19th APRIL 2018 AT 1621Z**

This report contains a statement of facts which have been determined up to the time of issue. It must be regarded as tentative, and is subjected to alteration or correction if additional evidence becomes available.

This investigation is carried out to determine the circumstances and causes of the accident with a view to the preservation of life and the avoidance of accident in the future: It is not the purpose to apportion blame or liability (Annex 13 to the Chicago Convention and Civil Aviation Regulations 2016).

INTRODUCTION

The Air Accident Investigation Bureau of Malaysia

The Air Accident Investigation Bureau (AAIB) is the air accident and serious incident investigation authority in Malaysia and is responsible to the Ministry of Transport. Its mission is to promote aviation safety through the conduct of independent and objective investigations into air accidents and serious incidents.

The AAIB conducts the investigations in accordance with Annex 13 to the Chicago Convention and Civil Aviation Regulations of Malaysia 2016.

In carrying out the investigations, the AAIB will adhere to ICAO's stated objective, which is as follows:

"The sole objective of the investigation of an accident or incident shall be the prevention of accidents and incidents. It is not the purpose of this activity to apportion blame or liability".

Accordingly, it is inappropriate that AAIB reports should be used to assign fault or blame or determine liability, since neither the investigation nor the reporting process has been undertaken for that purpose.

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GLOSSARY OF ABBREVIATION

AMM	Aircraft Maintenance Manual
AMSL	Above Mean Sea Level
APU	Auxiliary Power Unit
CB	Circuit Breaker
CPT	Captain
DFO	Director of Flight Operation
FDR/CVR	Flight Data Recorder/Cockpit Voice Recorder
FO	First Officer
FON	Flight Operation Notices
KTM	Kathmandu
KUL	Kuala Lumpur
MSA	Minimum Safe Altitude
OCC	Operations Control Center
OD	Malindo Airways
OM-A	Operating Manual Part A
PF	Pilot Flying
PM	Pilot Monitoring
PIC	Pilot in Command
QRH	Quick Reference Handbook
RTO	Reject Take-Off
RWY	Runway
SOP	Standard Operating Procedure
TO	Take-Off
V1	Take-Off Decision Speed
VOR	VHF Omnidirectional Radio
Z	Zulu Time

Synopsis

On 19th April 2018, flight OD181 operated by Malindo Airways departing KTM bound for KUL using RWY20. Wind was calm but it was drizzling. According to the pilot, during take-off roll at approximately V1 speed, 'Take-Off Configuration' aural warning came on. Captain decided to 'Reject the Take-off' taking consideration of high terrain and bad weather all around KTM. However the aircraft was not able to stop on the runway and skidded off at the end of runway around 50m after the threshold of RWY02. After liaising with KTM tower, ground crew, fire rescue services, and the authority, the crew was instructed to open door 2R in armed mode and disembark the passengers using the slide. No injuries to all crew and passengers. After the maintenance inspection, there was no damage found on the aircraft structures, flight controls, engines and landing gears. However, number 2 main wheel found deflated. All wheels were replaced by maintenance personnel as per AMM requirement.

1.0 Factual Information

1.1 History of Flight

A Boeing B737-900, registration 9M-LNJ belongs to Malindo Airways (OD) was scheduled to depart KTM bound for KUL on the 19th April 2018 at 2145hrs LT, with 7 crew and 132 passengers on board.

On ground prior to departure, the flight crew briefing was focused on the impact of the bad weather, the fuel to be considered and particularly Engine Out Procedures in KTM. There was no briefing carried out with the Cabin Crew. During the departure review, the First Officer (FO) confirmed he physically checked speed brake at down detent.

Take off was initiated normally by doing rolling take off after the back track. Approximately at V1, the TO Configuration warning came up both visual and aural. At that point aircraft captain as Pilot Flying (PF) confirms he physically checked again the speed brake at down detent but the warning did not disappear. Immediately afterward he decided to reject the take-off, the PF applied pressure on the brake pedals. After a few seconds the PF asked the FO as Pilot Monitoring (PM) also to apply pressure on the brake pedals, however they did not manage to stop the aircraft on the runway and it skidded off and overrun about 50 meters after the threshold.

The decision of rejecting the take-off was well taken since it was unsafe to continue considering the airport surrounding high terrain and bad weather conditions.

PF wanted to start the evacuation immediately after the aircraft came to a stop, however, the PM suggested that it was not necessary since there's no indication of fire or malfunctions apart from the TO Configuration warning. PF contacted the Cabin Crew ordering them to remain seated. The flight crew started the APU and shut down both engines.

Communication with the tower was done by the PM, and he switched on all the external lights. Airport authorities came a few minutes later. After 30 minutes in communication with the crew, the airport authorities instructed the crew to disembark the passengers using the slide from door 2R, because the steps could not be placed due to aircraft position and soft ground. The PF was authorised to leave the aircraft when all passengers and cabin crew were off the aircraft. The PF left the APU ON and no circuit breaker (CB) was pulled out when he left the aircraft.

1.2 Injuries to Persons

Injuries	Pilot	Cabin Crew	Passenger	Others
Fatal	-	-	-	-
Serious	-	-	-	-
Minor	-	-	-	-
None	**02**	**05**	**132**	-

1.3 Damage to Aircraft

No damage on the aircraft structures, flight controls, engines and landing gears. Number 2 main wheel found deflated. All wheels replaced as per AMM requirement.

1.4 Other Damages

Nil.

1.5 Personnel Information

1.5.1 Flight Crew

	Captain	Co-pilot
Age	45	30
License Type	ATPL 2140	ATPL 5068
License Validity	3rd January 2019	30th September 2018
Ratings	B737 NG	B737 NG
Certificate of Test Conducted	9th November 2017	27th October 2017
Instrument Rating Conducted	9th November 2017	27th October 2017
Instructor Rating	Yes	No
Medical Limitation	Shall wear corrective lenses	Nil
Medical Class	One	One
Total Hours	14,349:24hrs	3,022:22hrs

Total Hours on Type	6,473:20hrs	2,822:22hrs
Previous Rest Hours	23:25hrs	23:25hrs
Hours in 28 Days	76:36hrs	76:40hrs
Hours in 12 Months	736:48hrs	876:17hrs
Hours in 12 Months	736:48hrs	876:17

1.6 Aircraft Information

Manufacturer	The Boeing Company
Model	B737-900 ER
Date of Manufacture	17th June 2013
Manufacture Serial Number	38690
Nationality	Malaysia
Registration Number	9M-LNJ
Certificate of Airworthiness Number	M.1559
Date of Issue	16th June 2017
Date of Expiry	15th June 2018
Certificate of Registration Number	AR/16/230
Date of Issue	19th October 2016
Date of Expiry	18th October 2019
Total Hours Since New	21,443:38hrs
Last Inspection Date	30th November 2017 (3C+2A)
Type of Fuel Used	Jet-A1

1.7 Meteorological Information

According to the pilot report, it was drizzling but no rain. Calm wind.

19/04/2018 08:30->	METAR VNKT NIL=
19/04/2018 08:20->	METAR VNKT 190820Z 25005KT 7000 FEW020 FEW025TCU SCT030 25/15 Q1011 NOSIG=
19/04/2018 08:05->	METAR VNKT NIL=
19/04/2018 08:00->	METAR VNKT 190800Z NIL=

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19/04/2018 07:20->	METAR VNKT 190720Z 24003KT 6000 FEW020 FEW025TCU SCT030 26/15 Q1012 NOSIG=
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19/04/2018 07:00->	METAR VNKT 190700Z NIL=
19/04/2018 06:50->	METAR VNKT 190650Z 36005KT 6000 FEW015 SCT030 25/15 Q1012 NOSIG=
19/04/2018 06:30->	METAR VNKT NIL=
19/04/2018 06:20->	METAR VNKT 190620Z 26005KT 6000 FEW015 SCT030 BKN100 25/14 Q1013 NOSIG=
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19/04/2018 06:00->	METAR VNKT 190600Z NIL=
19/04/2018 05:50->	METAR VNKT 190550Z 24004KT 6000 FEW015 SCT030 25/14 Q1013 NOSIG=
19/04/2018 05:30->	METAR VNKT 190530Z NIL=
19/04/2018 05:20->	METAR VNKT 190520Z 14004KT 120V230 6000 FEW015 SCT030 24/14 Q1013 NOSIG=
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19/04/2018 05:00->	METAR VNKT 190500Z NIL=
19/04/2018 04:50->	METAR VNKT 190450Z 29004KT 6000 FEW015 SCT030 24/15 Q1014 NOSIG=
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19/04/2018 04:20->	METAR VNKT 190420Z 05006KT 5000 HZ FEW015 SCT030 23/15 Q1014 NOSIG=
19/04/2018 04:05->	METAR VNKT NIL=
19/04/2018 04:00->	METAR VNKT 190400Z NIL=
19/04/2018 03:50->	METAR VNKT 190350Z 07003KT 4000 BR FEW015 SCT030 23/16 Q1014 NOSIG=

1.8 Navigation Aids

Not Applicable.

1.9 Communication

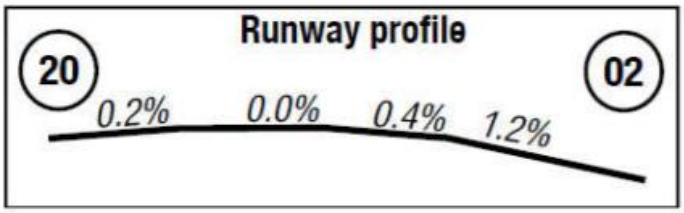
Communication was done with the tower and the OCC after the event. Both CPT and FO stated no communication issues during the coordination of the disembarkation. However, the company contact numbers in the aircraft were not updated and the CPT called the former DFO.

1.10 Aerodrome Information

Tribhuvan International Airport, Kathmandu is located in Kathmandu Valley 6km east of Kathmandu city and surrounded with significant high terrain in all quadrants, with the highest MSA of KTM VOR 21,100ft in the northern sector. The airport elevation is 4,395ft.

The 25NM Minimum Safe Altitude reflects the nature of the surrounding terrain. Beyond 35NM northwest clockwise through southeast lies the Himalayan mountain range with peaks of 25,000ft AMSL to more than 29,000ft AMSL (Mount. Everest).

Runway



Avg slope 0.74%

1.11 Flight Recorders

Both of the FDR and CVR were removed from the aircraft for downloading of the data and to be analysed for the investigation. A pair of spare FDR and CVR have been installed into the aircraft to replace the previous ones before the aircraft is allowed to fly back to KUL.

However no information of the event could have been found. CB were not pulled out after the event. CPT informs the company that he did not pull out the CB after the incident and before he left the aircraft.

1.12 Wreckage and Impact Information

The aircraft was found on soft ground about 50 meters after the runway threshold.

Picture 1: Take-off direction and aircraft stops location.

1.13 Medical and Pathological Information

To be included in Final report.

1.14 Fire

There was no fire during and after the occurrence.

1.15 Survival Aspects

No evacuation was carried out. However, the Airport Authorities instructed the crew to disembark the passengers through 1 slide (door 2R) due to unavailability to use stairs on soft and uneven ground. No injuries recorded during the disembarkation. The incident was survivable.

1.16 Tests and Research

Not applicable.

1.17 Organisational and Management Information

Not applicable.

1.18 Additional Information

Pre-flight briefing with the Cabin Crew

Flight Crew stayed-over in KTM before this flight, however the Cabin Crew did the KUL-KTM first with another Flight Crew. This flight is paired in such way in accordance with the CAAM Flight Time Limitations. According to the ICC the Cabin Crew did not receive the pre-flight briefing from the entering CPT as stated in MXD OM-A 8.3.14.

Actions taken after the event

Right after the event and with the aircraft stopped the PIC made the announcement "Remain calm, cabin crew and passengers remain seated". ICC repeated the announcement to the passengers. According to the cabin crew interviewed the passengers were calmed, did not panic and remained seated, except for one passenger who went to aft galley to request for a glass of water. The cabin lights remained switched off until the disembarkation was initiated.

Precautionary Disembarkation

Due to the soft and uneven terrain mobile stairs were not possible to be placed in order to disembark the passengers. Crew was instructed by the Airport Authorities to deploy slide at Door 2R and disembark the passengers by it. According to the crew interviewed, the PIC made an announcement to inform the passengers that this was not an evacuation. Cabin lights were switched on and cabin crew instructed passengers to sit and slide at Door 2R. After all passengers exited, crew members were instructed to remain on-board for at least 30 minutes before exiting the aircraft. The last to leave the aircraft was the CPT who left the APU ON and all CB's untouched.

1.19 Useful of Effective Investigation Techniques

Bowtie Analysis: The Bowtie Analysis proved to be effective on describing the impact on the preventive and recovery barriers before and after the Rejected Take-Off by the decisions taken during the Take-off roll. Actions resulting from the investigation are pointed to reduce the vulnerability of these barriers

Runway Excursion Risk Assessment Diagram: This diagram has allowed the investigation team to assess the impact on the safety margin by every action taken during the Take-Off roll and Rejected Take-Off.

2.0 Analysis

Flight Data Analysis

Flight data analysis provides a comprehensive description of the sequence of events, as shown in Diagram 2 and 3. A Bowtie of the event is detailed in Diagram 1.

According to the flight data the RTO was initiated 4 seconds after V1, at a CAS 154kts. There is no evidence of TO Warning during the take-off roll recorded. The RTO was performed initially with autobrake, and it was disconnected immediately after by applying pressure on the brake pedals by the CPT. Flight data shows a progressive movement of the braking pedals from 30% to close to 90% in 10 seconds (see Figure 3). After that point, constant maximum pressure was applied until aircraft came to stop. Runway excursion occurred at Groundspeed 30kts, and the aircraft was stop close to 50m after the RWY02 threshold.

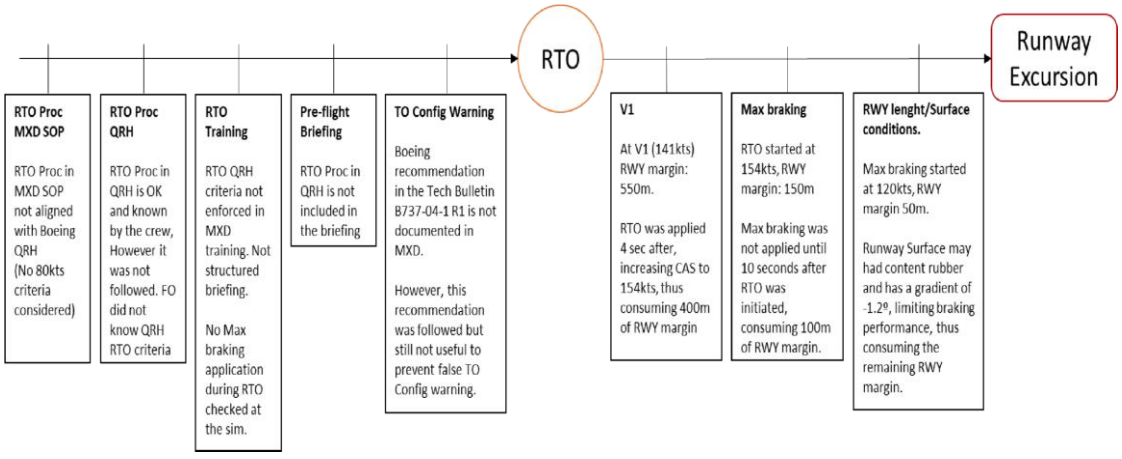


Diagram 1: Bowtie analysis of the incident.

Diagram 2: Sequence of events during take-off roll and RTO

(Source FDA/Google Earth)

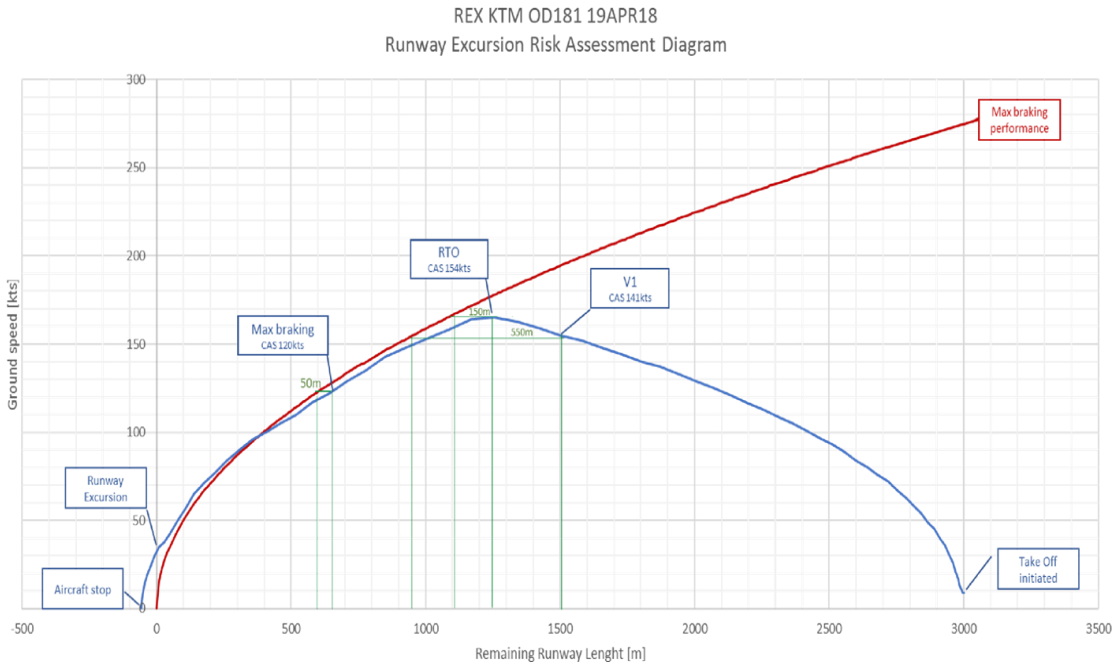


Diagram 3: Runway Excursion Risk Assessment Diagram (Source: FDA)

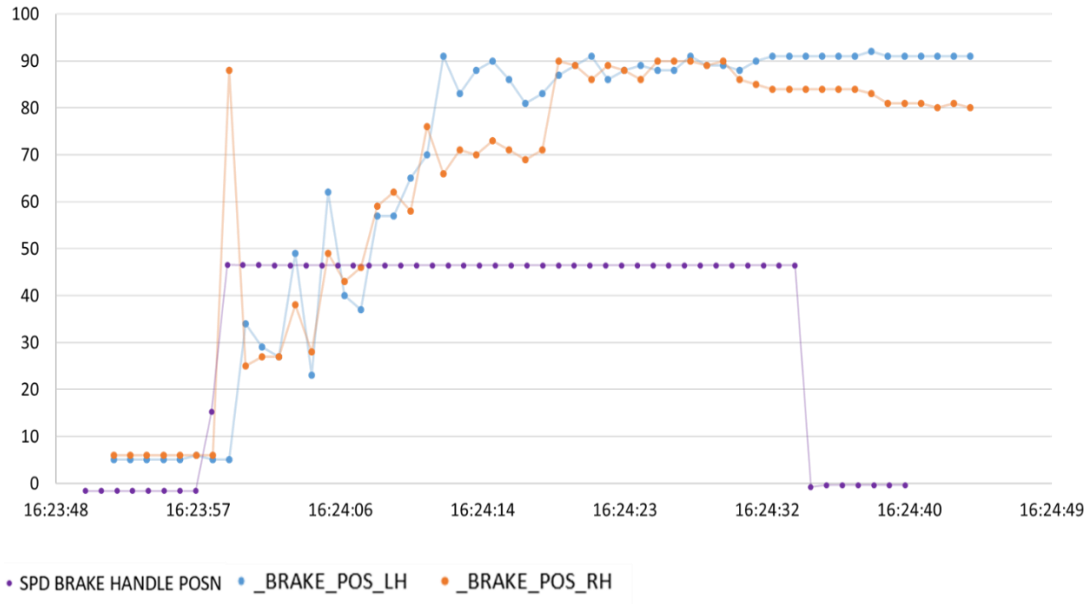


Diagram 4: Braking pedal and speed brake handle position during RTO (Source: FDA)

CPT and FO interview

According to the interviews both pilots were aware of the bad weather conditions of KTM. Briefing done was focused on the impact of the bad weather on the fuel to be considered and the particular Engine Out Procedures in KTM. There was no briefing with the Cabin Crew. During the departure review the FO confirms he physically checked speed brake at down detent.

Take-off was initiated normally by doing rolling take-off after the back track. Approximately at V1 (cannot be confirmed in FDA) the TO Configuration Warning came up both visual and aural. At that point CPT confirms he physically checked again the speed brake at down detent but the warning did not disappear. Immediately after he decided to reject the take-off. After a few seconds the CPT states he asked the FO also to apply pressure on the braking pedals, however they did not manage to stop the aircraft before the threshold. During the interview the CPT remembers the 11 items to be considered to reject the take-off below 80kts as documented in the QRH, however he declares that the decision of rejecting the take-off was well taken since it was unsafe to continue considering the airport surrounding high terrain and bad weather conditions.

CPT confirms he considered to start the evacuation immediately after the aircraft came to stop, however, the FO suggested not to start it since there was no indication of fire or malfunctions apart from the TO Configuration Warning. CPT contacted the Cabin

Crew ordering Cabin Crew remain seated. The flight crew started the APU and switched off both engines. Communication with the tower was done by the FO, and he switched on all the external lights. Airport authorities came a few minutes later. After 30 minutes in communication with the crew, the airport authorities instructed the crew to proceed the passengers disembark by the slide on door 2R, because the steps could not be placed due to aircraft position and soft ground. The CPT was authorized to leave the aircraft once all passengers and cabin crew were off the aircraft. The CPT confirms he left the APU ON and no CB was pulled out when he left the aircraft.

Maintenance first check on the Take-off Configuration Warning

Full test performed found nil current faults. Take-off warning reports indicate that speed brake lever was not in down position. Troubleshooting carried out found that speed brake lever switch was out of range and giving an intermittent signal. Adjustment carried out on the switch found satisfactory. Aircraft take-off warning test carried out found satisfactory. EGR carried out found all parameter reads normal. See Appendix 1 for the details in the AFML.

Boeing Technical Bulletin: Speed Brake initiated Take-off Configuration Warning

On 7th August 2015 Boeing issued the Technical Bulletin number 737-04-1 R1 (See Appendix 2). This bulletin was issued to address several reports received at Boeing of take-off configuration warnings because the speed brake handle was not in the DOWN detent (not stowed). According to this bulletin, the Boeing 737 Pre-flight procedure and checklist include the step to check the Speed Brake in the "DOWN DETENT". Speed brake cable friction and/or speed brake lever spring back force may prevent the handle from dropping completely into the detent by causing the handle to catch securely in the detent. In this bulletin Boeing recommends the technique to ensure the speed brake is properly stowed by pushing down firmly on top of the speed brake handle. Additionally it is mentioned that this technique will not prevent a false warning if the speed brake warning switch is not adjusted correctly, but it should prevent a warning due to the handle not being fully stowed.

According to the information gathered during the interviews, the FO check firmly the Speed brake handle at the down detent, and the CPT check it again once the take-off

configuration warning sounded, however both actions were not enough to prevent this warning.

Additionally, the bulletin emphasises the fact that if the take-off configuration warning occurs during the take-off roll before 80kts, the flight crew should accomplish the Rejected Take Off non-normal manoeuvre as described in the Manoeuvres chapter of the QRH.

3.0 Conclusion

3.1 Findings

3.1.1 No briefing with the Cabin Crew was carried out by the aircraft Captain.

3.1.2 Boeing recommendation included in the Boeing Technical Bulletin 737-04-1 R1 is not included in the MXD B737 normal checklist nor being considered during the briefing. However, despite following the recommendation, it was still not useful to prevent the TO Config. Warning to trigger during the take-off roll.

3.1.3 The decision of the CPT to initiate the RTO above V1 is not in accordance with Boeing QRH RTO criteria (TO Config. Warning to initiate a RTO below 80kts).

3.1.4 Malindo Air B737 SOP Issue 5 1.9 Standard take-off briefing did not specify details as stated in with Boeing QRH RTO criteria. It is not specified what action to be taken when speed below 80kts, or above 80kts and below V1.

3.1.5 Autobrake was disconnected immediately after the RTO was initiated. However, no maximum braking was applied during manual braking until 10 seconds after the RTO was initiated.

3.1.6 CVR/DFDR CB was not pulled out by the PIC after the incident and even before he left the aircraft, and thus not preserving the recording as required by OM-A.

3.2 Cause

The probable cause of the runway excursion was due to the PIC attempted to reject the take-off at high speed, following take-off Configuration Warning. The rejected TO was

initiated at the speed of 154kts, which is above V1. In addition, the maximum braking was not applied throughout the stopping.

4.0 Safety Recommendations

It is recommended that the operator:

4.1 To ensure the B737 SOP STANDARD TAKE-OFF BRIEFING to be aligned with Boeing QRH RTO criteria, and specify what items may trigger a RTO below 80kts, and above 80kts.

4.2 To ensure the FON to be issued to communicate the new take-off briefing and to enforce its review during all pre-flight briefings, to enforce the recommendations stated in the Boeing Technical Bulletin 737-04-1 R1 and to enforce the importance of Captain's briefing to the Cabin Crew prior the flight.

4.3 To ensure the RTO criteria detailed in Boeing QRH to be structured in the Simulator briefing and Line Training. Communicate the need of emphasising this criteria to all instructors.

4.4 To check with Boeing the recommended/best practice on the use of the Autobrake during the RTO. Review the MXD RTO procedure accordingly, and emphasise the use of the simulator sessions to assess pilots' compliance with it.

4.5 To ensure the OM-A (Ref 11.1.3) to specify the responsibility of Flight Crew - to include the preservation of the CVR/DFDR after an incident/accident. To consider the in case of a pilot incapacitation and to define a proper back up that can ensure CVR/FDR preservation.

4.6 To check with Boeing Tech. Rep. whether there is a new revision of the Bulletin and to check whether there is further actions to be taken in case the recommendations are followed but not enough to prevent the false TO Configuration Warning to be triggered.

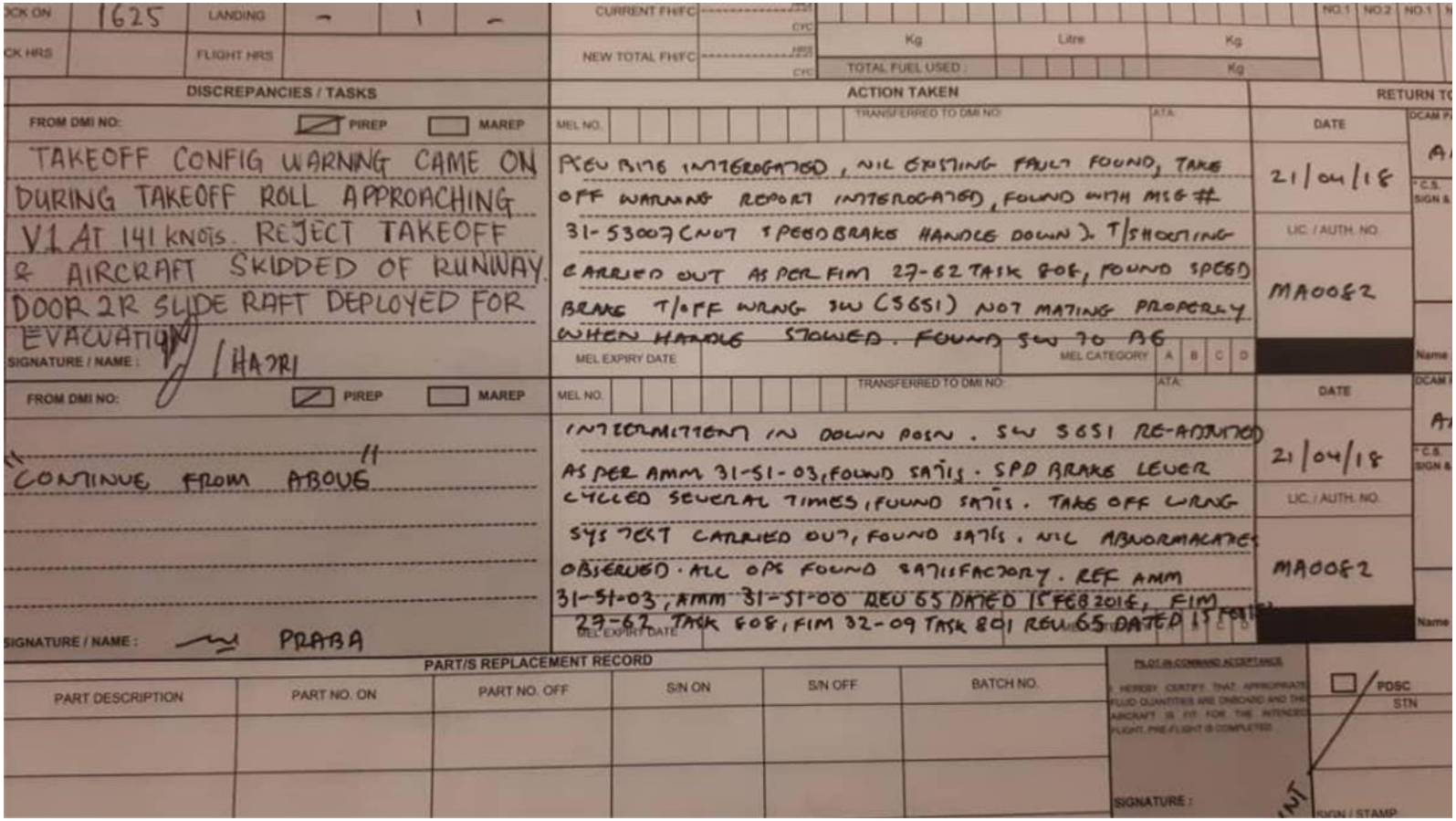
4.7 To issue FON to enforce the recommendations stated in the Boeing Technical Bulletin 737-04-1 R1,

4.8 The operator is to issue FON to enforce the importance of Captain's briefing to the Cabin Crew prior to the flight.

Chief Inspector
Air Accident Investigation Bureau (AAIB)
MALAYSIA
03rd June 2019

Appendices

Appendix 1: AFML. TO CONFIG. WARNING CHECK



CK ON 1625 LANDING – 1 –
CK HRS FLIGHT HRS
CURRENT FH/FC ----------
NEW TOTAL FH/FC ----------
Kg Litre Kg
TOTAL FUEL USED : Kg
NO.1 NO.2 NO.1

DISCREPANCIES / TASKS

FROM DMI NO: ☒ PIREP ☐ MAREP

TAKEOFF CONFIG WARNING CAME ON DURING TAKEOFF ROLL APPROACHING V1 AT 141 KNOTS. REJECT TAKEOFF & AIRCRAFT SKIDDED OF RUNWAY. DOOR 2R SLIDE RAFT DEPLOYED FOR EVACUATION

SIGNATURE / NAME : HAZRI

ACTION TAKEN

MEL NO. TRANSFERRED TO DMI NO: ATA:

PERFORMED BITE INTERROGATED, NIL EXISTING FAULT FOUND, TAKE OFF WARNING REPORT INTERROGATED, FOUND WITH MSG # 31-53007 (NOT SPEEDBRAKE HANDLE DOWN). T/SHOOTING CARRIED OUT AS PER FIM 27-62 TASK 808, FOUND SPEED BRAKE T/OFF WRNG SW (S651) NOT MATING PROPERLY WHEN HANDLE STOWED. FOUND SW TO BE

MEL EXPIRY DATE MEL CATEGORY A B C D

RETURN TO

DATE 21/04/18

LIC. / AUTH. NO. MA0082

DCAM P A

C.S. SIGN &

Name

FROM DMI NO: ☒ PIREP ☐ MAREP

MEL NO. TRANSFERRED TO DMI NO: ATA:

CONTINUE FROM ABOVE

INTERMITTENT IN DOWN POSN. SW S651 RE-ADJUSTED AS PER AMM 31-51-03, FOUND SATIS. SPD BRAKE LEVER CYCLED SEVERAL TIMES, FOUND SATIS. TAKE OFF WRNG SYS TEST CARRIED OUT, FOUND SATIS. NIL ABNORMALITIES OBSERVED. ALL OPS FOUND SATISFACTORY. REF AMM 31-51-03, AMM 31-51-00 REV 65 DATED 15 FEB 2016, FIM 27-62 TASK 808, FIM 32-09 TASK 801 REV 65 DATED 15 FEB

MEL EXPIRY DATE MEL CATEGORY A B C D

DATE 21/04/18

LIC. / AUTH. NO. MA0082

DCAM A

C.S. SIGN &

Name

SIGNATURE / NAME : PRABA

PART/S REPLACEMENT RECORD

PART DESCRIPTION	PART NO. ON	PART NO. OFF	S/N ON	S/N OFF	BATCH NO.

PILOT-IN-COMMAND ACCEPTANCE

I HEREBY CERTIFY THAT APPROPRIATE FLUID QUANTITIES ARE ONBOARD AND THE AIRCRAFT IS FIT FOR THE INTENDED FLIGHT. PRE-FLIGHT IS COMPLETED

SIGNATURE :

☐ POSC STN

SIGN / STAMP

Appendix 2: Boeing Technical Bulletin 737-04-1 R1 (Source: Boeing)

BOEING COMMERCIAL AIRPLANE GROUP FLIGHT OPERATIONS

TECHNICAL BULLETIN

NUMBER: 737-04-1 R1

DATE: August 7, 2015

These bulletins provide information which may prove useful in airline operations or airline training. This information will remain in effect depending on production changes, customer-originated modifications, and Service Bulletin incorporation. Information in these bulletins is supplied by the Boeing Company and may not be approved or endorsed by the FAA at the time of writing. Applicable documentation will be revised, as necessary to reflect the information contained in these bulletins. For further information, contact Boeing Commercial Airplane Group, Chief Pilot, Flight Technical, through the Service Requests Application (SR APP) on the MyBoeingFleet home page.

SUBJECT: Speed Brake Initiated Takeoff Configuration Warning

ATA NO: 27-00

APPLIES TO: 737-ALL

REASON: Revised the last paragraph to reflect the correct crew response for the Takeoff Configuration Warning during takeoff roll.

The speed brake handle position is one of the airplane components monitored by the Takeoff Configuration Warning System. If the speed brake handle is not in the down detent or the speed brake warning switch is not properly adjusted, the intermittent Takeoff Configuration Warning horn sounds.

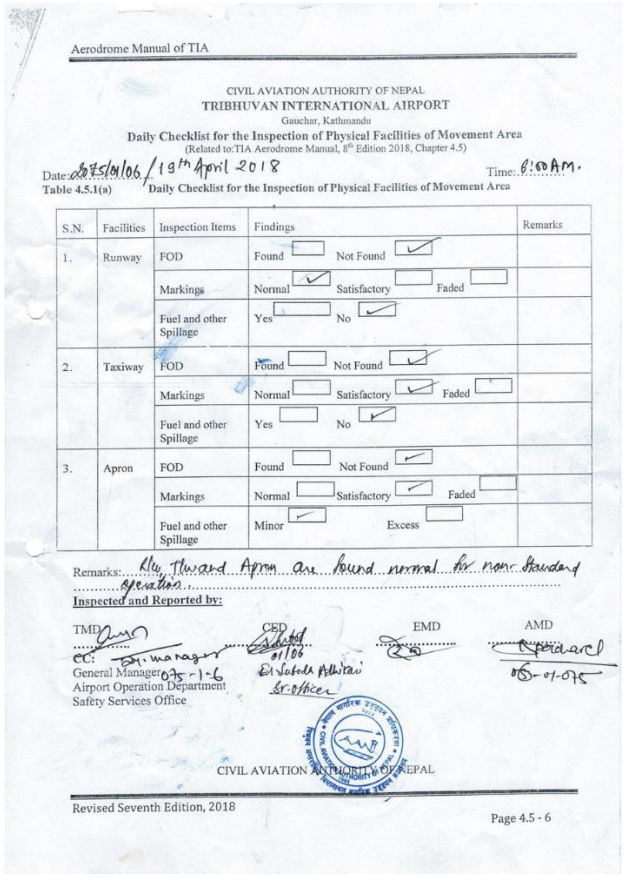
Boeing has received a number of reports of takeoff configuration warnings because the speed brake handle was not in the DOWN detent (not stowed). The Boeing 737 Preflight procedure and checklist include the step to check the Speed Brake in the "DOWN DETENT". Speed brake cable friction and/or speed brake lever spring back force may prevent the handle from dropping completely into the detent by causing the handle to catch on the aft face of the speed brake detent.
Therefore simply pushing forward on the speed brake handle does not ensure it is securely in the detent.

The recommended technique to ensure the speed brake is properly stowed is to push down firmly on top of the speed brake handle. This technique will not prevent a false warning if the speed brake warning switch is not adjusted correctly but it should prevent a warning due to the handle not being fully stowed. Boeing recommend pilots check the speed brake for proper stowing during Preflight as mentioned above.

If the takeoff configuration warning occurs during the takeoff roll before 80 knots, the flight crew should accomplish the Rejected Takeoff non-normal maneuver as described in the Maneuvers chapter of the QRH.

CS3 3379

Appendix 3: KTM RUNWAY CHECK AND RUBBER DEPOSIT REMOVAL REPORT



Aerodrome Manual of TIA

CIVIL AVIATION AUTHORITY OF NEPAL
TRIBHUVAN INTERNATIONAL AIRPORT
Gauchar, Kathmandu
Daily Checklist for the Inspection of Physical Facilities of Movement Area
(Related to:TIA Aerodrome Manual, 8th Edition 2018, Chapter 4.5)

Date: 2075/01/06 / 19th April 2018 Time: 6:00 AM.

Table 4.5.1(a) Daily Checklist for the Inspection of Physical Facilities of Movement Area

S.N.	Facilities	Inspection Items	Findings	Remarks
1.	Runway	FOD	Found ☐ Not Found ☑	
		Markings	Normal ☑ Satisfactory ☐ Faded ☐	
		Fuel and other Spillage	Yes ☐ No ☑	
2.	Taxiway	FOD	Found ☐ Not Found ☑	
		Markings	Normal ☐ Satisfactory ☑ Faded ☐	
		Fuel and other Spillage	Yes ☐ No ☑	
3.	Apron	FOD	Found ☐ Not Found ☑	
		Markings	Normal ☐ Satisfactory ☑ Faded ☐	
		Fuel and other Spillage	Minor ☑ Excess ☐	

Remarks: Rly, Thward Apron are found normal for navr Standard operation.

Inspected and Reported by:

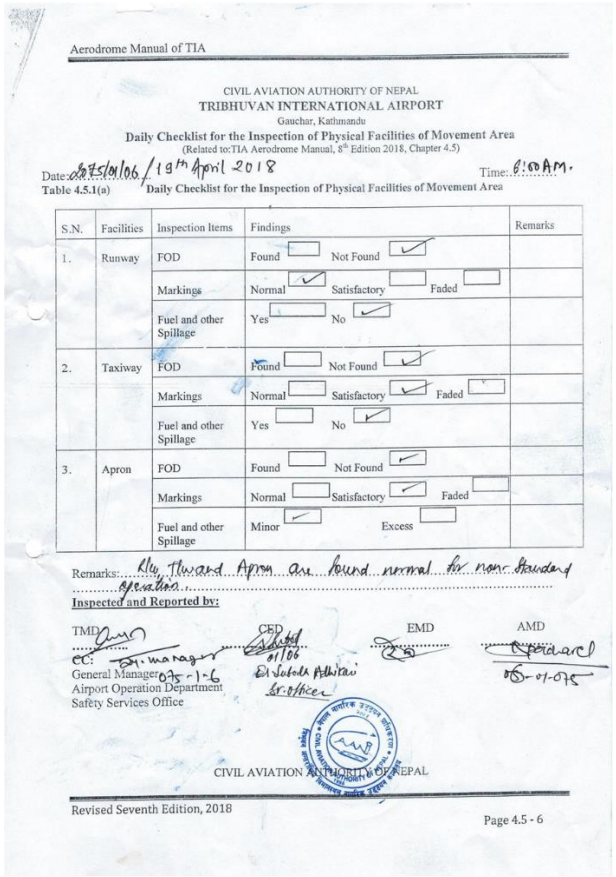
TMD CED EMD AMD

CC: Dy. manager
General Manager 075-1-6
Airport Operation Department
Safety Services Office

Dr Sobodh Adhikari
Sr. Officer
01/06

CIVIL AVIATION AUTHORITY OF NEPAL

Revised Seventh Edition, 2018 Page 4.5 - 6



Aerodrome Manual of TIA

CIVIL AVIATION AUTHORITY OF NEPAL
TRIBHUVAN INTERNATIONAL AIRPORT
Gauchar, Kathmandu
Daily Checklist for the Inspection of Physical Facilities of Movement Area
(Related to:TIA Aerodrome Manual, 8th Edition 2018, Chapter 4.5)

Date: 2075/01/06 / 19th April 2018 Time: 6:00 AM.

Table 4.5.1(a) Daily Checklist for the Inspection of Physical Facilities of Movement Area

S.N.	Facilities	Inspection Items	Findings	Remarks
1.	Runway	FOD	Found ☐ Not Found ☑	
		Markings	Normal ☑ Satisfactory ☐ Faded ☐	
		Fuel and other Spillage	Yes ☐ No ☑	
2.	Taxiway	FOD	Found ☐ Not Found ☑	
		Markings	Normal ☐ Satisfactory ☑ Faded ☐	
		Fuel and other Spillage	Yes ☐ No ☑	
3.	Apron	FOD	Found ☐ Not Found ☑	
		Markings	Normal ☐ Satisfactory ☑ Faded ☐	
		Fuel and other Spillage	Minor ☑ Excess ☐	

Remarks: Rly, Thward Apron are found normal for navr Standard operation.

Inspected and Reported by:

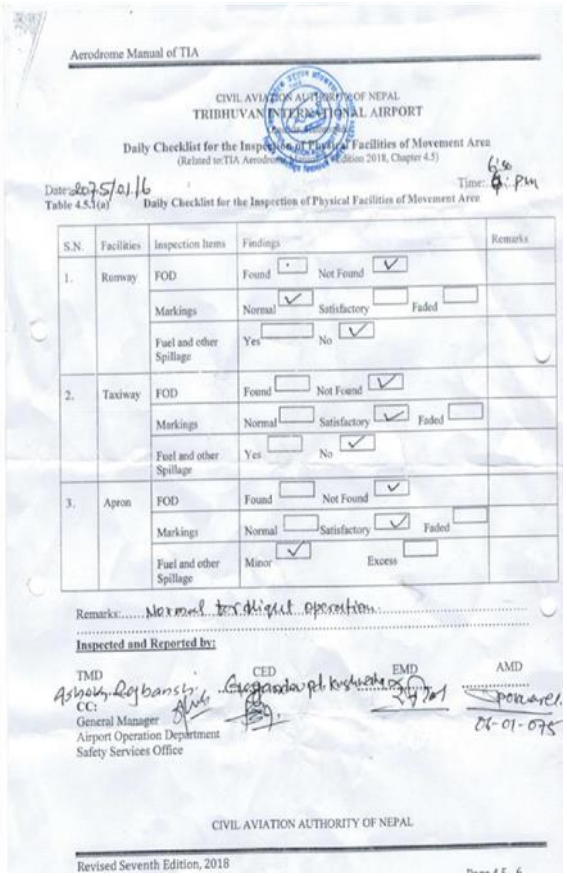
TMD CED EMD AMD

CC: Dy. manager
General Manager 075-1-6
Airport Operation Department
Safety Services Office

Dr Sobodh Adhikari
Sr. Officer
01/06

CIVIL AVIATION AUTHORITY OF NEPAL

Revised Seventh Edition, 2018 Page 4.5 - 6



Aerodrome Manual of TIA

CIVIL AVIATION AUTHORITY OF NEPAL
TRIBHUVAN INTERNATIONAL AIRPORT
Daily Checklist for the Inspection of Physical Facilities of Movement Area
(Related to:TIA Aerodrome Manual, 8th Edition 2018, Chapter 4.5)

Date: 2075/01/16 Time: 6:30 P.M.

Table 4.5.1(a) Daily Checklist for the Inspection of Physical Facilities of Movement Area

S.N.	Facilities	Inspection Items	Findings	Remarks
1.	Runway	FOD	Found ☐ Not Found ☑	
		Markings	Normal ☑ Satisfactory ☐ Faded ☐	
		Fuel and other Spillage	Yes ☐ No ☑	
2.	Taxiway	FOD	Found ☐ Not Found ☑	
		Markings	Normal ☐ Satisfactory ☑ Faded ☐	
		Fuel and other Spillage	Yes ☐ No ☑	
3.	Apron	FOD	Found ☐ Not Found ☑	
		Markings	Normal ☐ Satisfactory ☑ Faded ☐	
		Fuel and other Spillage	Minor ☑ Excess ☐	

Remarks: Normal torchlight operation.

Inspected and Reported by:

TMD CED EMD AMD

CC:
General Manager
Airport Operation Department
Safety Services Office

CIVIL AVIATION AUTHORITY OF NEPAL

Revised Seventh Edition, 2018

(Note: The rubber deposit removal report was requested to KTM Airport Authorities. However, after several requests, the report was not provided to Malindo Air)

Appendix 4: Pictures taken after the event


BOEING 737-800ER
9M-LNJ

Appendix 5: Boeing Investigation Report

Boeing Proprietary June 5, 2018
Aero-B-BBA1-C-18-059

COORDINATION SHEET

To:	King, Leroy	437435	66-CQ-EC2B	Rechenmacher, A E	1670419	66-CQ-EC8L
Cc:	Anderson, Richard J	110461	66-CB-H220	Badger, Kevin	1830801	66-CB-BBA1
	Block, Jonathan C	1710681	66-CB-BBA1	Brenci, Christopher J	2194193	66-CB-BBA1
	Dodt, Thomas K	21337	66-CB-B001	East, Eric J	1692309	66-CB-H220
	Gardner, Kyle J	205619	66-CB-BA00	Goodwill, Sam	1641064	76-PT-P433
	Lie, Simon	43958	66-CB-H220	Mazzitelli, Timothy	3702	66-CB-BA00
	Moskalik, Steven J	207791	66-CB-BBA5	Muehlhausen, Matthew R	30133	66-CB-BBA6
	Torrez-Zuniga, Eddy A	1970227	66-CB-BBA1	Wires, Lance J	109841	66-CB-H210
	Yingling, David A	332641	66-CQ-DLPB	Zimmerman, David L	124313	66-CR-GFD3

Group Index: **FLIGHT SCIENCES – AIRPLANE CHARACTERISTICS: Job No. SC18737A-005**

Model No.: **737-900ER / C.F.M.I**

Subject: **Analysis of Malindo Airways (MLO) 737-900ER (YH538/9M-LNJ) Rejected Takeoff and Runway Overrun on April 19, 2018**

Reference:
a) *Service Request 4-4034672425, <<AOG>> 9M-LNJ Runway Excursion- ARD Further Explaination., dated April 20, 2018*
b) *Service Request 4-4045754445, 9M-LNJ RTO at KTM via OD181, dated April 25, 2018*
c) *737 NG Flight Crew Training Manual (FCTM), The Boeing Company, Revision Date: June 30, 2017*
d) *737-800/-900ER Flight Crew Operations Manual (FCOM) Malindo Airways, The Boeing Company, Revision Date: March 15, 2018*
e) *Airplane Flight Manual (AFM) Performance Data for the 737-900ER with CFM56-7B26*

Abstract: MLO reported that a 737-900ER experienced a runway excursion following a rejected takeoff after receiving a takeoff configuration warning at Tribhuvan International Airport in Kathmandu, Nepal on April 19, 2018. The initial request was to confirm the inspections and repairs necessary since the airplane went off the runway into rough ground. In a follow up message, it was communicated that the event was under investigation by the local authorities. Analysis of the data show that the airplane overran the end of the runway by approximately 218 feet and came to a stop on soft ground due to the delayed initiation of the RTO as the airplane accelerated through V1. The timing of the takeoff configuration warning received by the crew could not be determined from the QAR data.

Action: *Please share content with the appropriate parties.*

Prepared By:
eSigned on 6/4/2018
Graves, Patricia M
204391 425-387-4954 66-CB-BBA1

Concurred By:
eSigned on 6/5/2018
Desmond, Kristina J
1599399 425-234-6662 66-CB-BBA5

Approved By:
eSigned on 6/5/2018
Lunde, Scott E
413243 425-931-8589 66-CB-BBA1

Enclosure:	Enclosure Description:	Number of Pages:
A	Aero-B-BBA1-C-18-059 Figures	3

Discussion:

Event Report
In the Reference (a) Service Request (SR), Malindo Airways (MLO) reported that a 737-900ER (YH538/9M-LNJ) experienced a runway excursion following a rejected takeoff (RTO) at Tribhuvan International Airport (KTM/VNKT), Kathmandu, Nepal on April 19, 2018. The report from MLO stated the following:

Dear Sir/Madam,

Please be informed that 9M-LNJ MSN 38690 experienced runway excursion during RTO at KTM airport.This request was requested under AOG since the aircraft is currently under ARD phase and performing applicable AMM 05 task to make the aircraft serviceable as soon as ossible.

Recovery plan is currently in progress to recover the aircraft for operation.

During Ref/Al evaluation, we figured out that we need to perform the inspection for the landing gear fuse pin due to the aircraft moves along rough ground (off the runway) during the incident.

As per Ref/Al, we need to ensure the all fuse pin are good and replace the bad fuses.

With respect to this matter, kindly advise the criteria/inspection required to ensure the fuse pin in good condition. Please advise if in-situ NDT inspection for the fuse pin is suitable method to ensure the fuse pin in good condition.

Futhermore, kindly advise any inspection required for NLG pin since Ref/Al only mentioned about MLG.

Moreover, kindly need your assistance to provide removal and installation reference for the all fuse pins related to task as per Ref/Al in case we need to perform the fuse pin replacement.

DESIRED ACTION:
==========
Kindly advise the criteria/inspection required to ensure the fuse pin in good condition. Please advise if in-situ NDT inspection for the fuse pin is suitable method to ensure the fuse pin in good condition.

Kindly advise any inspection required for NLG pin since Ref/Al only mentioned about MLG pin.

Kindly need your assistance to provide removal and installation reference for the all fuse pins related to task as per Ref/Al in case we need to perform the fuse pin replacement.

In the Reference (b) SR, it was communicated that the event is under investigation by the local authorities. However, as of this writing, Boeing has not been informed by the National Transportation Safety Board (NTSB) of an official investigation per the International Civil Aviation Organization (ICAO) Annex 13 accident investigation guidelines. The quick access recorder (QAR) data were provided to Boeing for analysis. The event was reported to have occurred on April 20, 2018. However, after evaluating the time and date parameters in the QAR, along with the location of the event, the event date was determined to be April 19, 2018 (local time).

Weather Report
A publicly available Aviation Routine Weather Report (METAR) was posted at 10:05 PM local time which was concurrent with the time of the event. The METAR stated the following:

METAR VNKT 191620Z 15004KT 7000 FEW015 SCT100 18/14 Q1014 NOSIG

The METAR indicates that the winds were out of the southeast at 150 degrees with a magnitude of 4 knots. The temperature was 18 degrees Celsius and sea-level pressure was 29.94 inches of Mercury. In an attachment provided within the SR, it was reported that the runway was wet during the RTO.

QAR Data Analysis

Time history plots of the pertinent longitudinal and lateral-directional parameters are attached as Figures 1 and 2, respectively. The QAR data show the airplane configured for a flaps 5 takeoff from Runway (RWY) 20 at KTM (Figures 1 and 2, location verified by latitude and longitude data, not shown). The airplane gross weight at takeoff was 160,640 pounds (LB); the operational maximum takeoff weight for the subject airplane is 185,000 LB. The crew performed a rolling takeoff after completing a turn to align with the runway heading of 202 degrees at time 512 seconds (Figures 1 and 2). The throttles were set at 45 degrees then advanced to 78 degrees with the press of the takeoff/go-around (TO/GA) switch to initiate the takeoff roll (Figure 1). The engines spooled up to an engine %N1 of 100.25% which was the maximum takeoff thrust setting as indicated by the derate parameters recorded in the data. Early in the takeoff roll, rudder pedal was input to the right, then slightly to the left, before maintaining approximately neutral deflection for the majority of the takeoff roll (Figure 2). The airplane accelerated and passed through the recorded decision speed (V1) of 141 knots at time 548 seconds (Figure 1). At time 551 seconds, at a computed airspeed of 151 knots, a RTO was initiated with the reduction of thrust to forward idle and activation of the autobrake system. The commanded brake pressures momentarily increased to the maximum capability of 3000 pounds/inch^2 (psi) before disengagement. The crew momentarily deflected the control wheel 5.7 degrees to the left as the RTO was initiated (Figure 2). The logic to automatically extend the speedbrakes was satisfied and the speedbrakes started to extend at about time 552 seconds. The throttles were positioned at reverse idle (25 degrees) at time 552 seconds and then positioned at reverse detent 2 (10 degrees) just before time 555 seconds. After the autobrakes were deactivated the wheel brakes were commanded manually. The commanded brake pressures decreased from the autobrake commanded levels of 3000 psi to approximately 800 psi before gradually increasing. Both the left and right commanded brake pressures reached 3000 psi at about time 571.5 seconds, approximately 20 seconds after the RTO was initiated. As the airplane decelerated, the throttles were positioned at forward idle at time 574.5 seconds at a ground speed of 37 knots (estimated computed airspeed of 27 knots). A change in characteristics can be observed in the acceleration data after time 575 seconds which is an indication that the airplane most likely departed the paved surface of the runway at that time with a ground speed of 35 knots. This also corresponds to a sudden and momentary wheel input to the right to 7 degrees (Figure 2). The airplane came to a stop at time 581.5 seconds with the airplane magnetic heading at 210 degrees, 8 degrees to the right of the runway heading. During the RTO, the computed airspeed reached a maximum of 154 knots at time 551.8 seconds before decreasing due to the application of the deceleration devices.

There was no indication in the data that a takeoff configuration (config) warning triggered during the takeoff roll; however, based on the information provided by MLO as to the source of the takeoff config warning, which was a misrigged spoiler handle down switch (S651), the takeoff config parameter present in the QAR data would not have been triggered. The S651 switch signal is provided to the proximity sensor electronics unit (PSEU) which then provides outputs for the takeoff config lights and aural warning module. The takeoff config warning parameter recorded by the QAR is sourced from the flap-slat electronics unit (FSEU). It could not be determined from the QAR data when the takeoff config warning was presented to the crew.

Ground Track Analysis

A ground track was generated to show the airplane's path from taxi, through takeoff roll and RTO, until coming to rest beyond the end of the runway (Figure 3). RWY 20 at KNT has a defined accelerate stop distance available (ASDA) of 10,007 feet and a width of 151 feet. The ASDA includes the length of RWY 20 (9603 feet) and the displaced threshold (404 feet). Longitudinal and lateral distances were calculated using the inertial data (ground speed, drift angle, heading) recorded by the QAR. The distances were then referenced to the runway based on the airplane's estimated final resting location. The airplane's actual resting position was not provided.

The ground track analysis results indicate that a rolling takeoff was initiated approximately 228 feet into the displaced threshold with a press of the TO/GA switch which advanced the throttles. Initiating the takeoff at that location effectively reduced the amount of ASDA to 9779 feet. The airplane accelerated down the runway and reached V1 at 4950 feet into the ASDA and the RTO was initiated at 5650 feet. The speedbrakes were fully extended by 6150 feet and the throttles were positioned at reverse detent 2 by 6750 feet into the ASDA. The autobrakes applied maximum commanded braking of 3000 psi momentarily just after the initiation of the RTO, then manual braking was applied and the commanded brake pressures were allowed to decrease to 800 psi before gradually increasing in both left and right brakes to maximum pressure by 9750 feet into the ASDA. The center of gravity (CG) of the airplane departed the paved surface of the runway at 10,007 feet at a ground speed of 35 knots. The final location of the airplane was estimated to be 10,225 feet past the start of the ASDA with the CG aligned with the extended runway centerline. It is estimated that the airplane came to rest approximately 218 feet beyond the end of the paved surface of the runway with all gear in soft ground.

Operational Guidance

The Reference (c) Flight Crew Training Manual (FCTM) contains the following recommendations that are applicable to this event:

> ***Go/Stop Decision Near V1***
> *It was determined when the aviation industry produced the Takeoff Safety Training Aid in 1992 that the existing definition of V1 might have caused confusion because they did not make it clear that V1 is the maximum speed at which the flight crew must take the first action to reject a takeoff. The U.S. National Transportation Safety Board (NTSB) also noted in their 1990 study of rejected takeoff accidents, that the late initiation of rejected takeoffs was the leading cause of runway overrun accidents. As a result, the FAA has changed the definition of V1 in 14 CFR Part 25 to read as follows:*
> - *V1 means the maximum speed in the takeoff at which the pilot must take the first action (e.g., apply brakes, reduce thrust, deploy speedbrakes) to stop the airplane within the accelerate-stop distance and*
> - *V1 also means the minimum speed in the takeoff, following a failure of an engine at which the pilot can continue the takeoff and achieve the required height above the takeoff surface within the takeoff distance.*
>
> *Pilots know that V1 is fundamental to making the Go/Stop decision. Under runway limited conditions, if the reject procedure is initiated at V1, the airplane can be stopped before reaching the end of the runway. See RTO Execution Operational Margins diagrams for the consequences of initiating a reject after V1 and/or using improper procedures.*

The QAR data show that the RTO was initiated approximately 3 seconds after accelerating through V1. As described by the FCTM, V1 has been defined as the maximum speed in which the first action should be taken to decelerate the airplane and stop within the ASDA. Initiating the RTO at 151 knots (10 knots faster than the V1 of 141 knots) increased the stopping distance not only due to the additional 700 feet of runway that was utilized but also due to additional stopping distance needed to decelerate from the faster speed.

The Quick Reference Handbook (QRH), located within the Reference (d) 737-800/-900ER Flight Crew Operations Manual (FCOM), contains the following non-normal maneuver procedure for initiating an RTO above 80 knots and before V1:

Captain	First Officer
Without delay:	Verify actions as follows:
Simultaneously close the thrust levers, disengage the autothrottles and apply maximum manual wheel brakes or verify operation of RTO autobrake.	Thrust levers closed.
	Autothrottles disengaged.
	Maximum brakes applied.
If RTO autobrake is selected, monitor system performance and apply manual wheel brakes if the AUTO BRAKE DISARM light illuminates or deceleration is not adequate.	Verify SPEED BRAKE lever UP and call "SPEEDBRAKES UP." If SPEED BRAKE lever is not UP, call "SPEEDBRAKES NOT UP."
Raise SPEED BRAKE lever.	Reverse thrust applied. When both REV indications are green, call "REVERSERS NORMAL."
Apply reverse thrust up to the maximum amount consistent with conditions.	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".
Continue maximum braking until certain the airplane can stop on the runway.	Call out omitted action items.

During the RTO, reverse thrust, wheel brakes, and speedbrakes were utilized; however not to their maximum capability which would have aided in reducing the airplane speed even further. Reverse detent 2 was utilized, instead of maximum reverse thrust which would be expected on a wet runway, and commanded brake pressures were reduced from the autobrake applied pressure of 3000 psi to 800 psi and gradually increased back to maximum brake pressures over 20 seconds.

Performance Analysis

A performance analysis was conducted, using the Airplane Flight Manual-Digital Performance Information (AFM-DPI) software located within Reference (e) to calculate the accelerate-stop distance (ASD). To better understand the effect of the specific conditions surrounding the event, a few scenarios were calculated to quantify the effects on stopping distance of initiating a RTO at a speed higher than V1. The distances calculated using the AFM-DPI assumptions have conservatism built in which includes a 2-second distance pad at V1 along with deceleration device activation times which provide reaction time for the crew to take action. The deceleration device activation timing assumption for a wet runway is: maximum brake application at V1, throttle chop 0.15 seconds after V1, speedbrake deployment 0.49 seconds after throttle chop, and set maximum reverse thrust 1.0 second after speedbrake deployment.

The following is a chart that shows the runway ASDA, estimated event stopping distance, along with the ASD calculations assuming RTO initiation at a V1 of 141 knots and RTO initiation at the event RTO speed of 151 knots. Along with the ASD calculations, the stopping distance is included at both speeds without the 2 second margin that the AFM-DPI includes. The assumptions that went into these calculations were based on the event conditions which were: maximum takeoff thrust, outside air temperature of 18 degrees Celsius, airport pressure altitude of 4350 feet, average runway slope of -0.75%, and a wet runway surface.

The ASDA of RWY 20 is defined as 10,007 feet. Based on the assumptions defined above, the dispatch ASD that would have been provided to the crew for an RTO at V1 is 9438 feet, which includes the AFM-DPI 2-second distance pad. The takeoff roll began at approximately 228 feet. The data show that had the RTO been initiated at V1, using the deceleration device utilization assumptions without the 2-second margin, the airplane would have stopped on the runway by approximately 9190 feet, leaving 817 feet of runway remaining. Initiation of the RTO at 151 knots, 10 knots faster than V1, would have required 10,289 feet to accelerate and stop, without the added margin included in the ASD calculations. Given that the takeoff roll started at 228 feet, the airplane would have stopped at 10,517 feet had there been available runway to accommodate that distance. The estimated stopping location of the airplane was 10,225 feet, 218 feet beyond the ASDA for RWY 20 and 292 feet shorter than the calculated AFM-DPI distance of 10,517 feet. The 292-foot difference between the calculated distance and the actual estimated location of the airplane can be accounted for by the increased friction provided by the soft ground that the airplane encountered after overrunning the end of RWY 20. Figure 3 shows the location of the AFM-DPI accelerate-stop distance if the RTO had been initiated at V1, red "X," using the takeoff initiation as the starting point.

The QAR data indicated that maximum takeoff thrust was used during the takeoff run; however the engine performance that resulted from the operational condition assumptions resulted in an engine %N1 that was approximately 1.0% higher than what was recorded (recorded engine %N1 = 100.25%). The stopping distances were produced using the higher AFM-DPI engine %N1. Using the recorded engine %N1 increases the distances by 400 to 500 feet.

Conclusion

Analysis of the QAR data indicates that the RTO was initiated approximately 3 seconds after accelerating through V1. The RTO was initiated at 151 knots and the maximum computed airspeed reached was 154 knots. Reverse thrust, wheel brakes, and speedbrakes were activated during the RTO procedure; however not to their maximum capability which would have reduced the airplane speed but would not have prevented the overrun. The airplane overran the end of the runway by approximately 218 feet and came to a stop on soft ground due to the delayed initiation of the RTO as the airplane accelerated through V1. The timing of the takeoff config warning received by the crew could not be determined from the QAR data.