HQCAA/1901/326/SIB

PAKISTAN CIVIL AVIATION AUTHORITY
(SAFETY & INVESTIGATION BOARD)

INVESTIGATION REPORT
SERIOUS INCIDENT – M/S. SHAHEEN AIR
AIRCRAFT BOEING – 737-200, REG. NO. AP-BHB
ON 17 NOVEMBER 2008
JINNAH INTERNATIONAL AIRPORT, KARACHI

FINAL REPORT

INCIDENT TO SHAHEEN AIR BOEING-737-200, REG. NO. AP-BHB AT AIIAP, LAHORE ON 17-11-2008

SYNOPSIS:

The investigation was authorized by the Director General Civil Aviation Authority Memorandum No.HQCAA/1901/327/SIB dated 11 November 2008 **(Appendix 'A')**. On 17 November 2008 at 1446 LT, a scheduled passenger flight No. SAI-766, Boeing 737-200, Reg. No. AP-BHB, Lahore to Dubai was parked on stand No. 04. After the boarding was completed, pilot requested for push back but immediately reported problem as aircraft was not being pushed back. At 1554, a rep of Shaheen Air informed Air Traffic Control Tower that aircraft "Nose Landing Gear" (NLG) had collapsed / broken and it would not be pushed back / taxi. The same was confirmed by Manager Air Side after necessary inspection. Aircraft was switched off and passengers were disembarked. Inspection revealed NLG shifted rearward and pushed inside the wheel well as only portion of nose wheel was visible on which the nose was on rest.

1. FACTUAL INFORMATION

1.1 **History of the Flight**: Lahore – Dubai

1.2 **Injuries to Persons**: Nil

1.3 **Damage to Aircraft**: During pushback of the subject airplane, the "Nose Landing Gear" collapsed and shifted rearward causing damage to Nose Gear itself and to station 294 bulk head and skin around. The details of damage are given at **Appendix 'B'.**

1.4 **Crew Information**:

1.4.1 Capt. Schamesul Haq, ATPL No. 1043, Experience on B-737 1462:02 hrs, Grand Total 4746:00 hrs

1.4.2 First Officer Owais, ATPL No. 2705, Experience on B-737, 1462:02 hrs, Grand Total 3498:10 hrs

1.5 **Aircraft Information:** Aircraft information is as follows:

1.5.1	Manufacturer	:	Boeing Company
1.5.2	Aircraft Reg. No.	:	AP-BHB
1.5.3	Model No.	:	737-200
1.5.4	Line Position No.	:	872
1.5.5	Flight Hours	:	72,996 at the time of incident.
1.5.6	No. of landings	:	56,122 at the time of incident.

1.6 **Technical Information of Nose Landing Gear:** The details of Nose Landing Gear installed on AP-BHB are as below:

1.6.1	Date of last overhaul	:	16-02-2001
1.6.2	Date of installation of MSN-22651	:	07-03-2001
1.6.3	Date of induction of aircraft SAI	:	30-11-2004
1.6.4	MSN 22651 (AP-BHB) to SAI		

1.7 **Drag Brace Assembly – Upper, Nose Landing Gear Details:**

1.7.1	Part No. 65-80051-13	ATA Index: 3220-20
1.7.2	Serial No.: 265/L6669	
1.7.3	Responsible Design Group - Landing Gear Design Centre	

1.8 **Flight Data Recorder / CVR**: Flight Data Recorder (FDR) and Cockpit Voice Recorder (CVR) were removed for the purpose of analysis and investigation.

1.9 **Details of Tug Master used:**

1.9.1	S. No.	:	SAPS No. 096
1.9.2	Manufacturer (local or branded)	:	Branded SCHOPF
1.9.3	Date of manufacturer	:	1989
1.9.4	Specs / capability / strength etc.	:	43000 Kgs
1.9.5	HP	:	245 KW
1.9.6	Last inspection date	:	08.10.2008 (initial inspection after overhauling / serviceability)
1.9.7	Operator / company	:	SAPS Lahore

1.10 **Fire:** Not observed / reported.

1.11 **Impact Information**: No damage found on apron surface or it's surrounding. However, both the lugs of tow bar being used for push back were found broken.

1.12 **History of Pushback incident:** As of Jan 2008, six similar cases of nose collapse during push back or towing on B737 airplanes between years 2004 – 2006 were reported. In all the cases, the upper or lower drag brace either fractured in tension or buckled in compression. Service letter along with a brief summary of nose gear collapse cases is attached as **Appendix 'C'.**

2. ANALYSIS

2.1 **Flight Data Recorder:** AP-BHB (737-277 MSN 22655 Variable Number PL-561). FDR P/N 980-4120-GXUS S/N 4052. The decoding grid sent by the NTSB was found not working properly. Raw data file was burnt on a CD, hence FDR data could not be analysed.

2.2 **Cockpit Voice Recorder:** CVR P/N 980-6005-076 S/N 11316. Direct read out was not satisfactory. Tape extraction indicated some old recording not particular to this incident. Four wav files were burned on a CD, hence CVR data could also not be analysed.

2.3 **Trim Sheet:** Details of Trim sheet / load sheet is placed at **Appendix 'D'.**

2.4 **Analysis of Events:** Boarding of passengers and aircraft declaration by Engg Staff was event less. As stated, after ATC clearance and completion of 'check call' or brakes off 'A' pumps off cleared for push back facing south, facing south "block off "45" was given to ground technician. Immediately on initiation of push back a loud thud was heard, on inquiry by aircrew, technician said nose gear has collapsed. Further actions for push back by aircrew were terminated and shutdown check list was initiated.

2.5 During the push back Drag Brace Assembly – upper Nose Landing Gear shifted rearward because of which the wheel assembly got pushed into the wheel well. At the same time the lugs of the tow bar being used for push back gave way. The shear pin used into the Tow bar, however, could not be traced either by the Ground Handlers, the Operators or the Airside Management.

2.6 **Analysis of broken parts:** For the purpose of detailed analysis of fracture of Drag Brace Assembly – upper Nose Landing Gear, NTSB-USA, and Material and Process Technology (M & PT), Boeing Air Safety Investigation, and for failure analysis of fractured surface of two Lugs of Tow Bar, PN Dockyard Laboratory were approached and consulted.

2.7 **Fracture Analysis of Drag Brace Assembly – Upper Nose Landing Gear:** Drag brace fracture was caused due to a fatigue crack, developed at the transition radius of the door operator linkage lug, fitted to 737-100/200 model aircraft. The crack initiation occurred at a corner radius feature where multiple surface and corner radii converge. Unfortunately, there is post fracture mechanical damage in the origin areas which has obliterated some of the surface features. However, the corner radius near the origin was measured to be 0.31-1.047 inches which is below the minimum required value of 0.090 inches. This sharp corner would act as a stress raiser and could have contributed to fatigue crack initiation.

2.8 Poor adhesion of the primer / enamel on the part reflects the condition and preparation of the base metal during any recent overhaul activity. There may be abrasions or sanding marks on the base metal surface which may have contributed to the crack initiation as well.

2.9 **Failure Analysis of Fracture Surfaces of Tow Bar lugs:** Feractographic study revealed that fractures of the both the lugs bear ductile features comprising of elongated voids & dimples, shear lips and plastic deformations at edges. **(Figure 2 of Appendix 'E').**

2.10 No other surface and sub-surface flaws observed during non destructive testing except multiple cracks at vicinity of fractures **(Figure 4 of Appendix 'E').**

2.11 During metallographic study material of lugs found heat-treated to hardened condition (to the depth of 1.5 mm), while core material exhibits normalized condition. Micro-cracks found originating from heat-treated zone at surface and penetrating towards the inner side / core **(Figure 5 & 6of Appendix 'E').**

2.12 Fractographic study indicates scaly layers at periphery of both fractures which depicts that micro cracks had earlier been developed on lugs surface due possibly to heat-treatment process and assembly remained in services while possessing cracks till occurrence of final fracture.

2.13 The incident report states that the gear shifted rearwards during pushback. The orientation of the gear after the event was not what the tow bar is designed to connect to and as such, it is possible that the angle that the gear made with the tow bar forced it to fracture.

2.14 With the known condition of the radius on the drag brace which caused the fatigue crack, indicates that the drag brace was at fault primarily.

2.15 There is a fuse pin on the tow bar designed to shear in the event that excessive force is applied by the tow lug, but as noted, the existing fatigue crack was already 0.44 inches in length.

2.16 Fracture of Tow Bar lugs initiated from one of the quench cracks developed by heat-treatment process to tow bar/lugs.

2.17 The fact that, whether the Drag Brace Assembly-Upper NLG broke first or the Lugs of Tow bar could not be determined. However, the likely scenario is that the Drag Brace fractured first, as fatigue crack was already well developed at the time of this event and was approximately .5 inches at the time of fracture, and the Tow bar was a secondary fracture. The Tow bar is not designed to work with a landing gear which has translated rearward. The orientation of the gear that after the event was not what the Tow bar is designed to connect to and as such, it is possible that the angle that the gear made with the Tow bar forced it to fracture from already present cracks. Though, there are not many reports of this incident with known condition of the radius on the drag brace which caused the fracture crack, there is a possibility that the drag brace was at fault primarily.

2.18 **Tow bar shear pins:** The fuse pin on the Tow bar is designed to shear in the event of excessive force is applied by the Tow Tug. If during the incident event this pin did not fuse / shear, or it was a wrong specs pin, then there was a possibility of overloading the landing gear. However, as per the fracture analysis of Drag brace assembly Upper NLG, there already existed a fatigue crack of 0.44 inches in length in transition radius of the door operator linkage lug. Due to loss of two shear pins of the Tow Bar used for push back from the incident site, required analysis could not be undertaken.

2.19 **Operational Analysis:** There was no apparent lapse on the part of aircrew while aircraft commenced push back and the NLG collapsed.

2.20 **Observations**

2.20.1 Preservation of evidence is an obligation for all the personnel of airlines, ground handling organisations, CAA and other organisations involved in recovery of aircraft after an occurrence. The loss of two shear pins of the Tow Bar is a serious issue and reflects aviation personnel awareness regarding preservation of evidence.

2.20.2 After the incident, shifting of incident aircraft (with NLG collapsed) to maintenance Bay by SAI/Ground handler displayed inadequacy of resources and specialised equipment.

2.21 **Accident investigation support by Operator**

Adequate support was extended by the operator and airport management; however, broken / damaged shear pins were misplaced by the airline engineering staff / ground handlers and could not be reproduced.

3. CONCLUSION

3.1 Fracture surface separated the left hand side lug from the body of the brace. The fracture initiated in the area where the edge of the door operator linkage lug blended into the side rail of the brace. **(Figure 2 of Appendix 'F').** Initiation occurred by fatigue at the lug-to-brace transition radius, and propagated by the same mechanism to a depth of ~0.44", before final fracture occurred by ductile separation. **(Figure 3A & 3B of Appendix 'F').**

3.2 Fracture of Tow Bar lugs initiated from one of the quench cracks which developed by heat-treatment process to tow bar/lugs. Final fracture, however, took place instantaneously as a result of sudden over loading to the assembly.

3.3 **Cause of Incident.** The drag brace fractured due to a fatigue crack developed at the transition radius of the door operator linkage lug which caused the occurrence.

4. FINDINGS

4.1.1 Aircrew procedures during push back were in line with FCOM, and did not contribute towards the causation of the occurrence.

4.1.2 The Drag Brace fractured first due to a fatigue crack developed at the transition radius of the door operator linkage lug. Fracture of Tow Bar lugs was secondary which took place instantaneously as a result of sudden over loading.

4.1.3 Fracture of Tow Bar lugs initiated from one of the quench cracks developed by heat-treatment process to tow bar/lugs.

4.1.4 Shear pin is suspected to be of improper specification, which could not be confirmed due to absence / loss of Shear pin from the site of incident, thus an important evidence was lost and analysis were denied.

5. SAFETY RECOMMENDATIONS

5.1 Monitoring and timely inspections of Drag Brace Assembly – upper Nose Landing Gear be ensured.

5.2 Lug-to-brace transition radius of all parts be checked for correct radius.

5.3 Usage of standard tow bar Shear pin and its preservation for investigation / analysis purposes be ensured by the Operator as well as the Ground handler.

5.4 Preservation of onsite evidences be ensured by the Operators and the Handlers, as the case may be.