

FINAL INVESTIGATION REPORT



SERIOUS INCIDENT OF M/S. DHL CARGO FLIGHT DHX-556
(SECTOR KHI – BAH) BOEING-762, REG. NO. A9-CDHJ
ON 01-11-2017

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Synopsis

The serious incident was reported to Safety Investigation Board (SIB), Pakistan by the Area Control Centre, JIAP, Karachi through Telex (**Appendix 'A'**). The incident was notified in accordance with ICAO Annex-13 (**Appendix 'B'**). Aviation Division, Government of Pakistan issued memorandum vide letter No. HQCAA/1901/400/SIB/658 dated 16th November, 2017 (**Appendix 'C'**) authorizing SIB, Pakistan to investigate the incident and investigation was conducted by SIB.

When aircraft was 90 NM West of Karachi, the cockpit crew reported Right Engine Failure (Engine No. 2) and a distress call was also given. The aircraft diverted back to Karachi, requested longer vector and no assistance required on arrival. Aircraft landed safely.

1. FACTUAL INFORMATION

- 1.1 **History of the Flight.** M/s DHL B-762 aircraft, Reg. No. A9-CDHJ was scheduled for a Cargo Flight DHX-556 from Karachi to Bahrain on 1st November, 2017. When aircraft was 90 NM West of Karachi, the cockpit crew reported Engine No. 2 Failure and a distress call was also given. The aircraft diverted back to Karachi, requested longer vector and no assistance required on arrival. Aircraft landed safely.
- 1.2 **Injuries to Persons.** There were no injuries to any person during the incident.
- 1.3 **Damage to Aircraft.** There was no apparent damage to the aircraft.
- 1.4 **Other Damages.** None.
- 1.5 **Personnel information.** Not applicable.
- 1.6 **Aircraft and Engines Information.**

Aircraft Information	
Aircraft Registration	A9-CDHJ
Aircraft Make and Model	BOEING 762
Last C-Check of aircraft	Performed on 39686 TSN / 22815 CSN on 30 th August, 2015 at Abu Dhabi
Last A-Check of aircraft	Performed on 41700 TSN / 23639 CSN on 26 th May, 2016 at Karachi

No. 2 Engine Information	
Pt No.	CF6-80A
S No.	V10209
TSN / TSO	41977 / 3698
CSN / CSO	32677 / 2169

Fuel Pump Information installed on No. 2 Engine	
Pt No.	9280-18A6
S No.	CGW70204
<u>TSN / TSO</u>	<u>Un-known / Un-known</u>
<u>CSN / CSO</u>	<u>Un-known / Un-known</u>

- 1.6.1 The aircraft was being maintained in accordance with approved maintenance schedule.
- 1.7 **Meteorological Information.** Not applicable.
- 1.8 **Aids to Navigation.** Not applicable.
- 1.9 **Communications.** Not applicable.
- 1.10 **Flight Recorders.** The Flight Data Recorder (FDR) data and Cockpit Voice Recorder (CVR) were successfully downloaded and utilized for the purpose of investigation.
- 1.11 **Wreckage and Impact Information.** Not applicable.
- 1.12 **Medical and Pathological Information.** Not applicable.
- 1.13 **Fire.** Not applicable.
- 1.14 **Survival Aspects.** Not applicable.
- 1.15 **Test and Research.** The faulty fuel pump was subjected to tear down examination at two MROs namely Team Accessories, Ireland and Triumph Engine Control Systems, USA. The reports are attached as **Appendix 'D'** and **Appendix 'E'** respectively.
- 1.16 **Organisational and Management Information.** Not applicable.
- 1.17 **Additional Information.** Not applicable.
- 1.18 **Use of Effective Investigation Techniques.** Standard investigation procedure and techniques were used.

2. ANALYSIS

2.1 Technical Analysis

- 2.1.1 Post incident, there were no signs of bird hit, FOD or fire on No. 2 Engine.
- 2.1.2 Using the applicable Troubleshooting & Maintenance Manual, the fuel pump installed on No. 2 Engine was isolated to be the only faulty component leading to the reported in flight shut down of No. 2 Engine.
- 2.1.3 FDR data was downloaded and its read out has also confirmed that N2 dropped suddenly after approximately 15 minutes of flight with no anomaly with the Engine No. 1 (**Appendix 'F'**).
- 2.1.4 The aircraft was returned to service after replacing the faulty fuel pump on Engine No. 2. The aircraft kept on operating with no repetition of the earlier reported problem.
- 2.1.5 In the light of Engine OEM (M/s GE, USA), this fuel pump was required to be subjected to a Bench check at 6000 FH and overhaul at 15,000 FH as part of Soft Life (**Appendix 'G'**).
- 2.1.6 The Operator (M/s DHL, Bahrain) was asked to provide complete maintenance and life history of the fuel pump, however, it was learnt that the required logging of operational life and maintenance was not being done by the operator. Consequent to this

non-tracking of the life, the OEM's recommended maintenance schedule for the Fuel Pump was not being tracked / adhered to by the operator.

- 2.1.7 The faulty fuel pump was firstly dispatched to M/s Team Accessories, Ireland thru the operator for tear down examination and a detailed technical report. Same was received (Appendix 'D') which declared that :-

"Team accessories doesn't have a previous maintenance history of this fuel pump but the condition of the pump would suggest that the failure in service is, in our opinion, due to a lack of regular shop maintenance on this pump in the past".

- 2.1.8 Owing to a limited report generated by M/s Team Accessories, Ireland, the fuel pump was then dispatched to M/s Triumph Engine Control Systems, USA on the advice of NTSB ACCREP.

- 2.1.9 M/s Triumph Engine Control Systems, USA carried out a detailed tear down examination of the fuel pump and delivered a report thru NTSB. Salient findings of this report are as mentioned below :-

- 2.1.9.1 The main pump bearings show wear through the electro-film coating and into the bronze substrate; there is locally severe cavitations as well. There is no evidence of scoring or seizure, though. These observations suggest the bearings are past their useful design life and should have been replaced but that they had not yet failed.

- 2.1.9.2 The pumping gears show journal heat damage, heavy tooth cavitations and wear but no evidence of actual seizure / failure. Again, very high service life is indicated.

- 2.1.9.3 All internal splined connections show heavy wear. The impeller drive shaft shows spline wear essentially across the entire tooth of the smaller spline and evidence that the shaft had spun. The main drive shaft fuel-side spline is heavily worn to the point that the shaft had spun. The main pump housing bores showed moderate wear.

- 2.1.9.4 Finally, gouges were noted at two locations on the bearing retaining plate (reference figure 6), indicating the use of improper tooling and poor maintenance practices at some point in the pump's service life. The above observations indicate likely cause of pump malfunction was excessive service life in the absence of overhaul to replace worn components.

- 2.1.9.5 No destructive analysis was performed to verify as metallurgical properties were acceptable.

- 2.1.9.6 The extent of the wear suffered by multiple moving parts subject to wear under normal conditions supports both our and TEAM accessories' conclusion. After hardware review, TECS engineering concurs with the Team Accessories conclusion that the pump failure is due to lack of proper and regularly scheduled maintenance. The pump hardware is not in serviceable condition.

- 2.1.10 In short, both the reports from two different expert agencies indicate that :-

- 2.1.10.1 Proper maintenance schedule as recommended by the OEM was not adhered to by the operator (M/s DHL, Bahrain).

- 2.1.10.2 At an un-known stage of life of the fuel pump, improper tools were utilized on the fuel pump.

3. CONCLUSION

3.1 Findings

- 3.1.1 Post incident, there were no signs of bird hit, FOD or fire on No. 2 Engine.
- 3.1.2 Using the applicable Troubleshooting & Maintenance Manual, the fuel pump installed on No. 2 Engine was isolated to be the only faulty component leading to the reported in flight shut down of No. 2 Engine.
- 3.1.3 FDR data was downloaded and its read out has also confirmed that N2 dropped suddenly after approximately 15 minutes of flight with no anomaly with the Engine No. 1.
- 3.1.4 The aircraft was returned to service after replacing the faulty fuel pump on Engine No. 2. The aircraft kept on operating with no repetition of the earlier reported problem.
- 3.1.5 In the light of Engine OEM (M/s GE, USA), this fuel pump was required to be subjected to a Bench check at 6000 FH and overhaul at 15,000 FH as part of Soft Life.
- 3.1.6 The Operator (M/s DHL, Bahrain) was asked to provide complete maintenance and life history of the fuel pump, however, it was learnt that the required logging of operational life and maintenance was not being done by the operator. Consequent to this non-tracking of the life, the OEM's recommended maintenance schedule for the Fuel Pump was not being tracked / adhered by the operator.
- 3.1.7 The faulty fuel pump was firstly dispatched to M/s Team Accessories, Ireland thru the operator for tear down examination and a detailed technical report. Same was received which declared that :-
"Team accessories doesn't have a previous maintenance history of this fuel pump but the condition of the pump would suggest that the failure in service is, in our opinion, due to a lack of regular shop maintenance on this pump in the past".
- 3.1.8 Owing to a limited report generated by M/s Team Accessories, Ireland, the fuel pump was then dispatched to M/s Triumph Engine Control Systems, USA on the advice of NTSB ACCREP.
- 3.1.9 M/s Triumph Engine Control Systems, USA carried out a detailed tear down examination of the fuel pump and delivered a report thru NTSB. Salient findings of this report are as mentioned below :-
 - 3.1.9.1 The main pump bearings show wear through the electro-film coating and into the bronze substrate; there is locally severe cavitation as well. There is no evidence of scoring or seizure, though. These observations suggest the bearings are past their useful design life and should have been replaced but that they had not yet failed.
 - 3.1.9.2 The pumping gears show journal heat damage, heavy tooth cavitations and wear but no evidence of actual seizure/failure. Again, very high service life is indicated.
 - 3.1.9.3 All internal splined connections show heavy wear. The impeller drive shaft shows spline wear essentially across the entire tooth of the smaller spline and evidence that the shaft had spun. The main drive shaft fuel-side spline is heavily worn to the point that the shaft had spun. The main pump housing bores showed moderate wear.
 - 3.1.9.4 Finally, gouges were noted at two locations on the bearing retaining plate (reference figure 6), indicating the use of improper tooling and poor maintenance practices at some point in the pump's service life. The above observations indicate likely cause of pump malfunction was excessive service life in the absence of overhaul to replace worn components.
 - 3.1.9.5 No destructive analysis was performed to verify as metallurgical properties were acceptable.

- 3.1.9.6 The extent of the wear suffered by multiple moving parts subject to wear under normal conditions supports both our and TEAM accessories' conclusion. After hardware review, TECS engineering concurs with the Team Accessories conclusion that the pump failure is due to lack of proper and regularly scheduled maintenance. The pump hardware is not in serviceable condition.
- 3.1.10 In short, both the reports from two different expert agencies indicate that :-
- 3.1.11 Proper maintenance schedule as recommended by the OEM was not adhered by the operator (M/s DHL, Bahrain).
- 3.1.12 At an un-known stage of life of the fuel pump, improper tools were utilized on the fuel pump.
- 3.2 **Cause of the Occurrence.** The occurrence was caused due to sudden failure of Fuel Pump installed on No. 2 Engine after 15 minutes of the flight. This failure of the fuel pump was a consequence of non-adherence to the OEM's specified maintenance schedule by the operator M/s DHL, Bahrain.

4. SAFETY RECOMMENDATIONS

- 4.1 It is recommended that the Operator M/s DHL, Bahrain should carry out a complete technical audit of the fleet to ensure that all aircraft, engines and its accessories are being logged, tracked and maintained as per OEMs' approved maintenance schedule.
- 4.2 The Operator M/s DHL, Bahrain should conduct regular workshops & refresher training for her maintenance personnel for use of proper tools while performing routine scheduled / un-scheduled maintenance / servicing.
- 4.3 Bahrain Ministry of Transportation is requested to have an oversight of the abovementioned technical audit by the operator M/s DHL, Bahrain and scope of the same may be expanded to other operators in Bahrain (if deemed appropriate).


(MIAN TAHIR AFTAB)
Group Captain
AdID Technical Investigation SIB
Investigation In-charge

Dated: 12 November, 2018.