

FINAL INVESTIGATION REPORT



**SERIOUS INCIDENT OF REJECTED TAKEOFF M/S
SHAHEEN AIR INTERNATIONAL FLIGHT NO. NL-766,
A-320 AIRCRAFT, REG NO. AP-BLH AT AIIAP LAHORE
ON 2ND JUNE, 2016**

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SERIOUS INCIDENT OF REJECTED TAKEOFF M/S SHAHEEN AIR INTERNATIONAL
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Synopsis

The serious incident was reported to Safety Investigation Board (SIB), Pakistan by the operator through Mandatory Occurrence Report (MOR) (**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/1901/381/SIB/366 dated 15th June, 2016 (**Appendix 'C'**) authorizing SIB, Pakistan to investigate the incident and investigation was conducted by SIB.

During takeoff procedure Pilot Monitoring (PM) called thrust not set at 80 knots (as per SOP). At this stage Pilot Flying (PF) applied TOGA thrust in reaction to PM call. On selection of TOGA thrust by PF, PM again called thrust not set while monitoring the EPR gauges and suggested second time to reject takeoff. PF complied to PM call and rejected takeoff procedure was applied. Once aircraft came under control, runway was cleared and engines were switched off on taxiway "U". Due to high brake temperatures, three main tyres got deflated, however No. 2 tyre got burst. ATC was informed and all passengers disembarked safely.

1. FACTUAL INFORMATION

- 1.1 **History of the Flight.** M/s Shaheen Air International (SAI) A-320-232 aircraft Reg. No. AP-BLH was scheduled for a routine flight NL-766 from Lahore to Dubai on 2nd June, 2016. At approximately 0625 hrs UTC during takeoff, the required thrust did not develop and aircraft rejected take off. Once aircraft became under control, runway was cleared and engines were switched off on taxiway "U". Due to high brake temperatures, three main tyres got deflated, however No. 2 tyre got burst approximately 30 minutes after the aircraft was stopped.
- 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 except its main wheels.
- 1.4 **Other Damages.** None.
- 1.5 **Personnel information.**

Captain

- | | | |
|---------------------------------|---|------------------------------|
| • Date of Birth | : | 29 th March, 1961 |
| • ATPL No. | : | ATPL 914 |
| • Medical Validity Date | : | 31 st July, 2016 |
| • Total Flying Experience | : | 9500 Hrs |
| • Total Hrs In command on A-320 | : | 640 Hrs |
| • Total in command (All types) | : | 4735 Hrs |

First Officer

- Date of Birth : 18th March, 1974
- CPL No. : CPL 2732
- Medical Validity Date : 31st July, 2016
- Total Flying Experience : 2958 Hrs
- Total On Type Hrs (P-2) : 770 Hrs

1.6 Aircraft and Engines Information.

Aircraft Information	
Aircraft Registration	AP-BLH
Aircraft Make and Model	Airbus A320-232
Aircraft Manufacturer Serial No. (MSN)	0542
Aircraft Manufacturing Year	1997
Aircraft C of A	Valid till 13 th October, 2016
Aircraft Flight Hours (FH) / Aircraft Flight Cycles (FC)	41750 Hours / 23660 Cycles
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

Engine No.1 Information		Engine No.2 Information	
Type	IAE V2527-A5	Type	IAE V2527-A5
Engine SN	V10209	Engine SN	V10211
Flight Hours (FH)	40613 Hours	Flight Hours (FH)	39532 Hours
Time Since Last Shop Visit for Performance Restoration	7426 Hours	Time Since Last Shop Visit for Performance Restoration	14500 hours

- 1.6.1 The aircraft was maintained in accordance with approved maintenance schedule. The daily inspection of the aircraft was carried out on 1st June, 2016 at Lahore and transit check was carried out at Karachi on 2nd June, 2016.

- 1.7 **Meteorological Information.** On 02nd June, 2016 the weather of Allama Iqbal International Airport (AllAP), Lahore at the time of incident are as follows:

Outlook	Visibility	Clouds	Wind	Temp	QNH
Fair	8 Km	SKC (Sky Clear)	CALM	39° C	1005

- 1.8 **Aids to Navigation.** Aircraft was equipped with serviceable VOR / DME and ILS equipment. Also, all required navigation aids were available and serviceable at AllAP.

- 1.9 **Communications.** Following communication aids were available and found serviceable at AllAP, Lahore at the time of incident.

OPLA AD 2.18 ATS COMMUNICATION FACILITIES

Service designation	Call sign	Frequency	Hours of operation	Remarks
1	2	3	4	5
TWR	Lahore Tower	118.1 MHz	H24	Primary
TWR	Lahore Tower	118.875 MHz	H24	Secondary
Apron	Lahore Ground	118.4 MHz	H24	Primary
Apron	Lahore Ground	121.8 MHz	H24	Secondary
ATIS	ATIS	125.3 MHz	H24	
APP	Lahore APP	121.3 MHz	H24	Primary
	Lahore APP	125.3 MHz	H24	Secondary
	Lahore APP	121.5 MHz	H24	Emergency
BS	Radio	630 KHz	HX	0130-1900 HR
BS	Pakistan	1090 KHz	HX	Variable SKED

- 1.9.1 **Aerodrome Information.** The AllAP, Lahore detailed aerodrome data is appended below:-

OPLA AD 2.12 RUNWAY PHYSICAL CHARACTERISTICS

Designations RWY NR	True bearing	Dimensions of RWY (M)	Strength (PCN) and surface of RWY and SWY	THR coordinates	THR elevation and highest elevation of TDZ of precision APP RWY
1	2	3	4	5	6
15L	180°	3360 x 46	PCN 55/R/B/X/U (concrete)	313211.94N 0742417.44E	THR: 216.9M / 712 FT
36R	360°			313023.30N 0742415.49E	THR: 215.1M / 706 FT
15R	180°	2743 x 46	PCN 55/F/C/X/T	313202.14N 0742410.18E	THR: 216.5M / 710 FT
36L	360°			313033.13N 0742408.60E	THR: 214.8M / 705 FT

- 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. The FDR report (Appendix 'D') and CVR recording were effectively utilized for the investigation.

- 1.11 **Wreckage and Impact Information.** Not applicable.

- 1.12 **Medical and Pathological Information.** Not applicable.

- 1.13 **Fire.** No fire was reported by the cockpit crew members.

- 1.14 **Survival Aspects.** Not applicable.
- 1.15 **Test and Research.** Examination of the Wheel No.1 & 2 and Brake Assembly No. 2 was carried out at Safran Landing Gear Systems, France. The report is placed as **Appendix 'E'**.
- 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 Operational Analysis

- 2.1.1 This was a scheduled passenger flight from Lahore to Dubai.
- 2.1.2 When the crew reported on the aircraft, duty engineer briefed the Captain that the aircraft Engine No. 1, bearing No. 4 ECAM may appear after engine start. According to the duty engineer the bearing was not available in the stock and an order had been placed for its replacement.
- 2.1.3 The duty engineer further added that this ECAM would have no effect during the flight. The same entry was also not mentioned in the Tech Log.
- 2.1.4 The Captain also did not further inquire about the implication of this abnormality and accepted the aircraft for the flight. This is a violation of the standard procedures (refer **Appendix 'F'**) as the Captain had to ask for mentioning of snag in Tech Log and it was to be cleared before acceptance of the aircraft for flight.
- 2.1.5 The crew reported that during taxi, the idle RPMs of No.1 and No.2 engines were 68% and 70.2 % respectively, which was not an anomaly as mentioned in Directorate of Flight Standards letter No. HQCAA/1076/067/FSAC/7190 attached as **Appendix 'F'**. Most probably, the excessive use of brakes during taxi increased brake temperature which, however, remained within limit.
- 2.1.6 The captain initiated takeoff by advancing the thrust levers to flex detent for takeoff. During initial takeoff roll at speed 80 kts, the First Officer (Pilot Monitoring) observed the difference in N₁ RPM values (No. 1 Engine 84.6% & No. 2 Engine 93.9%) and announced 'thrust not set reject takeoff'. The difference is No. 1 & No. 2 Engines RPMs required to reject the takeoff which was not done by the captain. The captain instead applied TOGA thrust which was not a normal procedure (refer **Appendix 'F'**). The required thrust did not build up even with the TOGA power. The FO again called 'thrust not set' while monitoring the EPR values difference (EPR₁1.32 & EPR₂1.42) after application of TOGA suggesting to reject takeoff.
- 2.1.7 The FDR data indicated that the asymmetric thrust caused the aircraft to turn to the left and the captain had to use appropriate right rudder to keep the aircraft on centerline.
- 2.1.8 By this time the aircraft was crossing 130 kts of speed and the captain decided to reject takeoff. The aircraft accelerated to a maximum speed 138 kts before decelerating. The

captain applied standard rejected takeoff procedure 17" seconds after the FO's first call to reject takeoff. The applicable procedure given in FCOM / QRH is appended below :-

● **Above 100 knots and below V1 :**

Rejecting the takeoff at these speeds is a more serious matter, particularly on slippery runways. It could lead to a hazardous situation, if the speed is approaching V1. Very few situations should lead to the decision to reject the takeoff. The main ones are:

1. Fire warning or severe damage.
2. Sudden loss of engine thrust.
3. Malfunctions or conditions that give unambiguous indications that the aircraft will not fly safely.
4. ECAM warnings such as :
 - ENG or APU FIRE
 - ENG FAIL
 - CONFIG. (MAIN WARNINGS ONLY)
 - ENG OIL LO PR
 - ENG REV UNLOCKED
 - L + R ELEV FAULT

Nose gear vibration should not lead to an RTO above 100 knots.

In case of tire failure between V1 minus 20 knots and V1 :

Unless debris from the tires has caused serious engine anomalies, it is far better to get airborne, reduce the fuel load, and land with a full runway length available.

The V1 call has precedence over any other call.

2.1.9 The PF decision to reject takeoff below V₁ (156 kts) due to insufficient engine thrusts of No. 1 Engine is considered correct. Once aircraft decelerated, runway was cleared and engines were switched off.

2.1.10 After sometime, wheel temperature rose due to use of Max Auto braking during rejected takeoff and resulted into deflation of three tyres at position 1, 3 and 4 as their fuse plugs melted. However, No. 2 tyre fuse plugs did not melt and the tyre bursted after about 30 minutes of stopping of the aircraft.

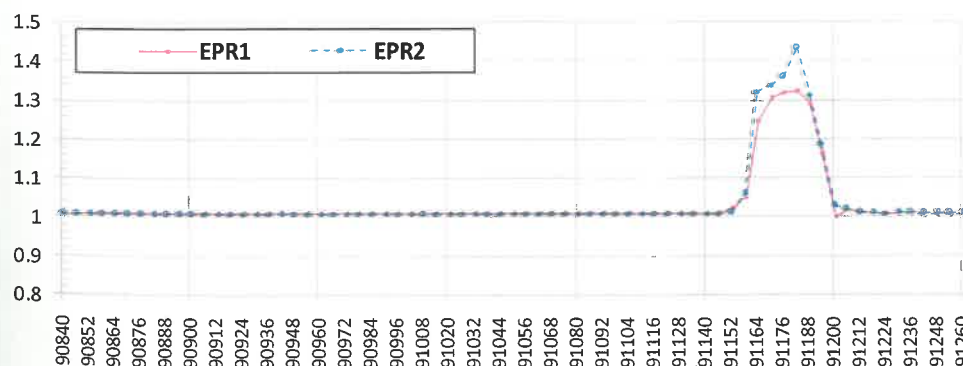
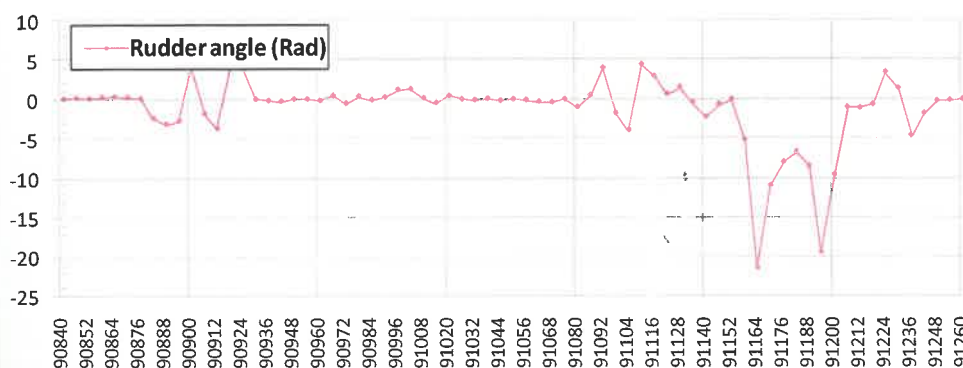
2.2 Technical Analysis

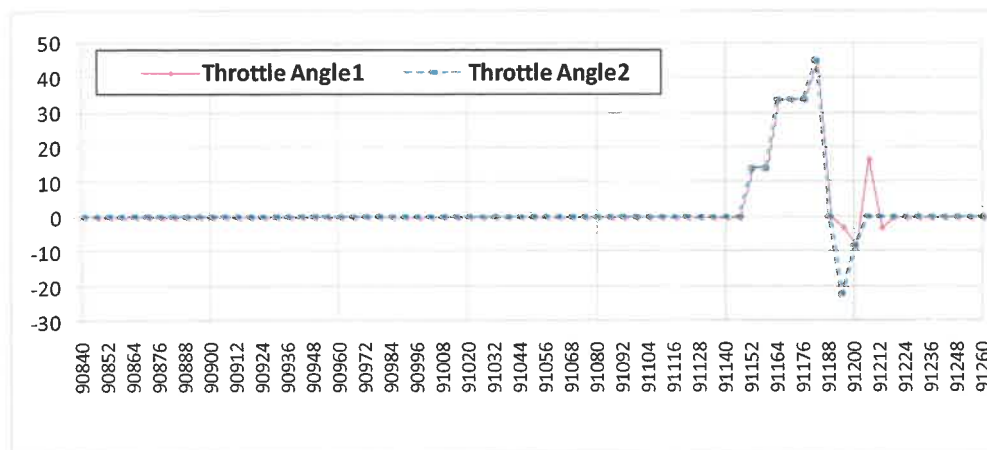
2.2.1 The post incident Borescope Inspection (BSI) of No. 1 engine was carried out by the operator SAI and no internal damage or abnormality was reported.

2.2.2 The crew reported that during taxi, the idle RPMs of No. 1 and No. 2 engines were 68% and 70.2 % respectively. Because of this high idle RPM, the crew reportedly used more braking during taxi and, therefore, brakes' temperature became relatively higher (but remained below the specified limit) than normal during taxi.

2.2.3 PM called thrust not set at 80 knots as per SOP while observing that the EPR values did not match the desired EPR calculated by the FMGC and suggested to reject takeoff. At this stage, PF, also Pilot in Command (PIC) did not reject the takeoff as per the procedure, and instead applied TOGA. PM again called thrust not set while monitoring the EPR values difference after TOGA thrust was materialized. PF observed asymmetric thrust and then decided to reject the takeoff.

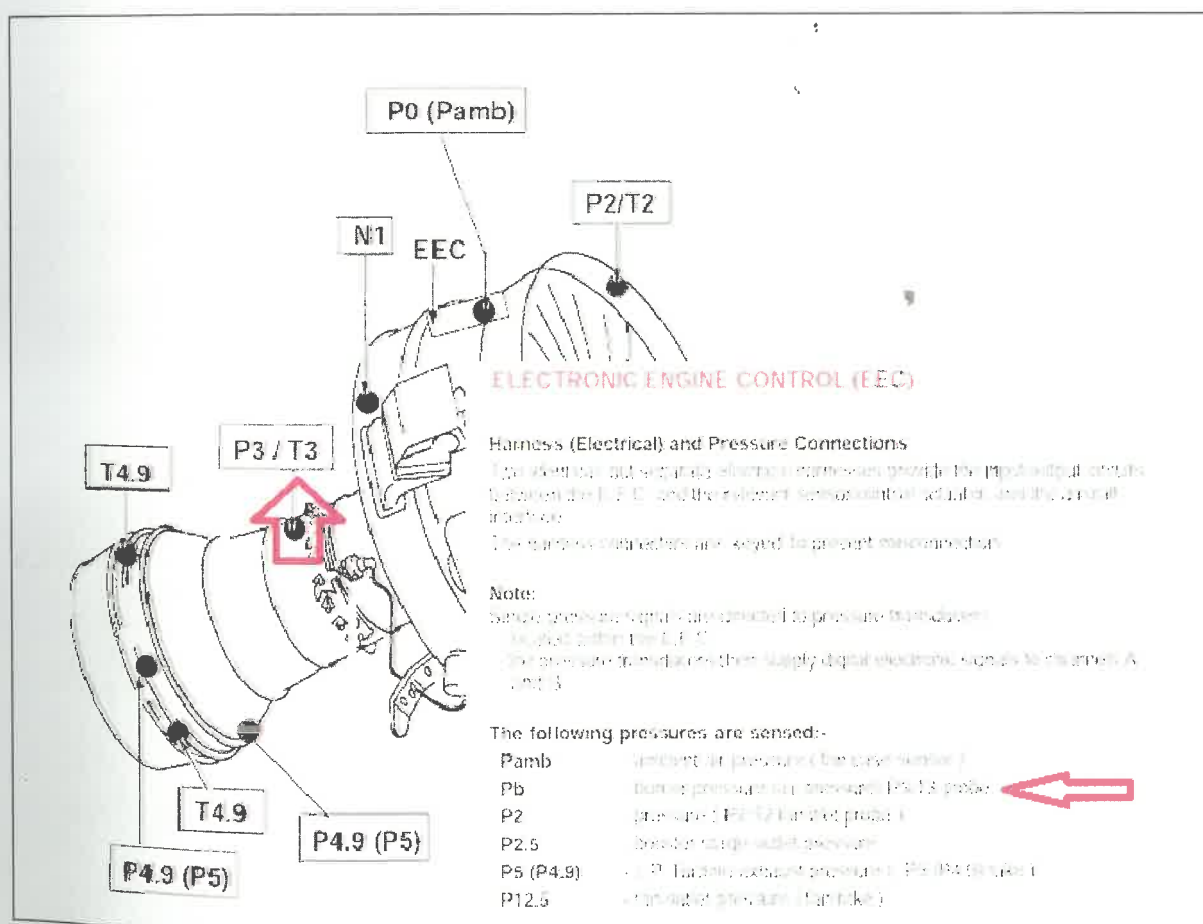
2.2.4 The plots of relevant FDR parameters vs. FDR subframe count (one second interval between subframes) is shown below. FDR data showed that aircraft ground speed peaked to 138 kts and application of rudder to counter the asymmetric thrust before Thrust Levers were retarded for rejecting the takeoff.





Thrust Lever Angle

- 2.2.5 The post incident troubleshooting checks by the operator revealed that Engine No. 1 thrust did not develop due leak in the Burner Pressure (PB) line.
- 2.2.6 In order to control different parameters of the engine, one of the inputs is taken in from P3 (Pressure from HP Compressor) and fed to Engine Electronic Control (EEC). This pressure is called Pressure Burner (Pb) as shown in the figure below :-

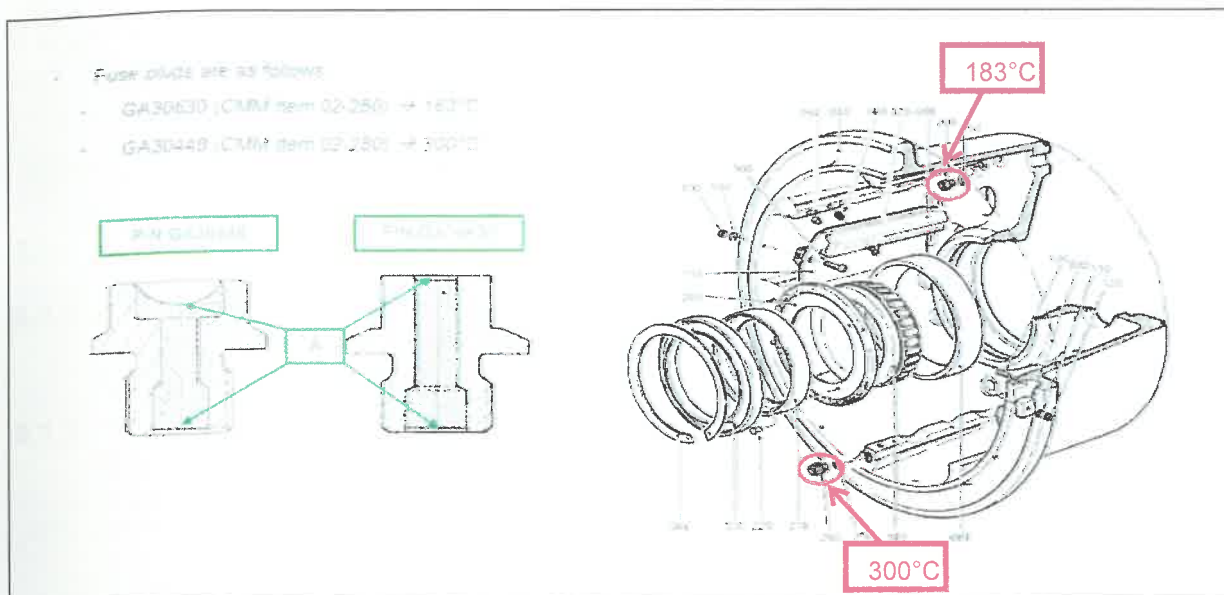


- 2.2.7 The P3 or Pb is transferred to the EEC thru Pressure Burner line. The defective PB line Part No. 6A9039 is removed & re-installed at every A-check for water wash of the engine. The last water wash was carried out on 26th May, 2016 at A-check at Karachi. The aircraft flew 20 cycles after water wash before the incident. During leak check of the faulty PB line by the operator, the leakage was found at the swaged end as pointed out with PEN in picture below. The defective line was dispatched to the engine manufacturer, International Aero Engines (IAE) for further investigation. The OEM has informed that process of redesigning the PB line is under consideration at their end in collaboration with the Vendor who provides material for this line. This indicate that :-
- 2.2.7.1 The leakage of air pressure from PB line lead to a reduced pressure signal to EEC of No. 1 engine. Accordingly, the EEC reduced the fuel flow rate to the combustion chamber leading to a lesser thrust during takeoff role.
- 2.2.7.2 There being no pressure leakage from the ends of PB line indicates that there was no maintenance error on part of the operator.
- 2.2.7.3 The OEM's update after analysis that the design of PB line is being reviewed including review of the vendor provided material indicate that the leakage was due to some material flaw in the line.



Location of the leakage on PB Line

- 2.2.8 In order to prevent the tyre burst, the main wheel hubs are fitted with 02 sets (each set containing Qty-03 fuses). The first set (Pt No. GA30630) operates if the temperature of wheel reaches between 180-186°C and deflate the tyre. The second set (Pt No. GA30448) operates if the temperature of wheel reaches 300°C and deflates the tyre.



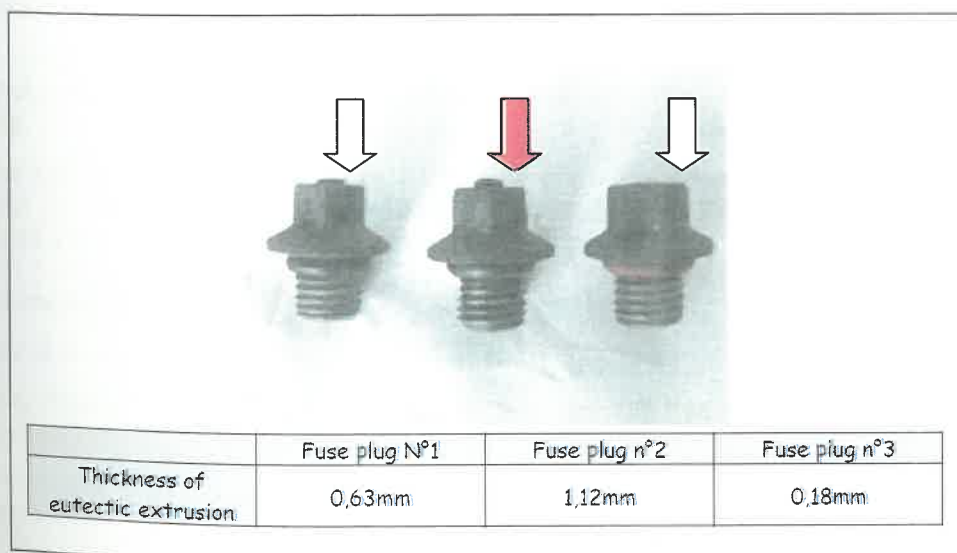
2.2.9 The brake temperature rose due to Max Auto braking after high speed rejected take off and resulted into deflation of three tyres as fuse plugs melted. However, the No. 2 tyre fuse plugs did not melt and it bursted after about 30 minutes of stopping of the aircraft. In order to investigate this anomaly, No. 1 & 2 wheels and No. 2 Brake assembly were investigated by Safran Landing Gear Systems, France. The pertinent findings of Safran Report (**Appendix 'E'**) are summarized below.

2.2.10 Brake was inspected visually but no disassembly was performed as the brake was found in satisfactory condition. The Brake Assembly only shows signs of overheat (thrust plate bend by thermal effect). This is not abnormal as A/C performed high speed RTO.

2.2.11 During visual inspection of No. 1 Wheel (C20195162, SER 32143) confirmed that all 03 fuse plugs (GA30630) are melted and Fuse plugs (GA30448) are not melted.

2.2.12 On the other hand, during visual inspection of No. 2 Wheel (C20225510, SER 07304), none out of the six fuse plugs (**GA30630 Qty-03 and GA30448 Qty-03**) are melted.

2.2.13 The three GA30630 fuse plugs installed on wheel No. 2 present a partial eutectic extrusion at the screw head.



- 2.2.14 Measurement of eutectic alloy melting temperature for fuse plug GA 30630 No. 2 demonstrated an average melting temperature started at 182.98°C. Exposition at this temperature would partially melt the eutectic as observed in this case.

3. CONCLUSION

3.1 Findings

- 3.1.1 The Captain accepted the aircraft with an anomaly, verbally briefed to him by the duty engineer. However, the anomaly briefed to the captain had no contribution in the occurrence.
- 3.1.2 The crew reported that during taxi, the idle RPMs of No. 1 and No. 2 engines were 68% and 70.2 % respectively, which is not an anomaly as opinioned by Directorate of Flight Standards letter No. HQCAA/1076/067/FSAC/7190. Because of this high idle RPM, the crew reportedly used more braking during taxi and, therefore, brakes' temperature became relatively higher (but remained below the specified limit) than normal during taxi.
- 3.1.3 The captain's decision to reject takeoff below V_1 due to decreased No. 1 Engine thrust was in accordance with the OEM recommended procedure. However this action was to be initiated at first call of First Officer, engaging TOGA during takeoff run to obtain extra thrust (when one engine is already producing less power) was not substantiated by the OEM recommended procedures.
- 3.1.4 The Engine No. 1 did not develop desired power due to leak in its PB line.
- 3.1.5 There was no maintenance error on part of the operator which led to the leakage of Air Pressure from the PB line.
- 3.1.6 The investigation of defective PB line is still under investigation by the Engine OEM, IAE (International Aero Engines) and has updated that the design of PB line is under review indicating some flaw in the material of the PB line.
- 3.1.7 During investigation it was found that defect about ECAM of No. 4 bearing of Engine No. 1 was not documented and was verbally briefed to the Captain indicating a culture of poor work ethics at the organizational level.
- 3.1.8 Owing to high speed abort, the temperature of main wheels raised which deflated No. 1, 3 and 4 tyres. However, No. 2 tyre didn't deflate and got burst.
- 3.1.9 Investigation of No. 1 & No. 2 Wheels and No. 2 Break Assembly at the OEM premises confirmed that all these three assemblies were serviceable and performed their desired role.
- 3.1.10 The Lab analysis of the fuses indicated that the average temperature of the No. 2 wheel rose to 182.98°C (Range 180-186°C). Accordingly, at this transient temperature, the fuses extruded partially, hence not deflating the tyre.

3.2 Cause of Occurrence

- 3.2.1 Non adherence of FCOM/QRH rejected takeoff procedure by the captain.
- 3.2.2 The Engine No. 1 did not develop desired power due to leak in its PB line as a consequence of its material failure.
- 3.2.3 The fuses of No. 2 tyre were exposed to a closed but below the melting temperature, which was not enough to deflate the concerned tyre.

4. SAFETY RECOMMENDATIONS

- 4.1 The involved Captain is to undergo a simulator training session followed by a Sim Check monitored by the CAA Inspector focusing on the procedures related to rejected takeoff.
- 4.2 The involved Captain and First Officer are to undergo complete VACBI refresher, especially focusing on engine related abnormalities and pre flight aircraft acceptance procedures.
- 4.3 The involved Captain and First Officer are to undergo CRM refresher training.
- 4.4 All operators are to ensure that their aircrew follows OEM recommended procedures after encountering a non normal situation. Any deviation / experimentation at critical stages of flight must be avoided.
- 4.5 All operators are to ensure that their aircrew do not accept the aircraft for flight with a verbally briefed snag by the engineering staff.
- 4.6 All operators must ensure that technical malfunctions are mentioned in the Tech Log and no 'only verbal communication' about such anomalies is made with aircrew.
- 4.7 IAE (international Aero Engines) is requested to redesign and improve the material of PB line and intimate all users.
- 4.8 Airbus / SLS (Safran Landing Gear System) is requested to analyze the industry experience for similar cases where the tyres got burst due malfunction of the fuses. In case there are more number of similar cases, a design review of the tyre deflate system may be under taken.