

ORIGINAL

HQ CAA/1901/240/SIB



**TYRE BURST INCIDENT TO M/S PIAC
A-310 REG NO AP-BEQ**

ON 5TH APRIL 1999

AT

QUAID-E-AZAM INTERNATIONAL AIRPORT

KARACHI.

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FINAL REPORT

INCIDENT REPORT ON PIAC A-310 PAKISTAN REGISTRATION AP-BEQ AT KARACHI AIRPORT ON 5TH APRIL, 1999.

Synopsis

On being notified of the incident relating to PIAC A- 310 Flight PK-268 at Karachi Airport on 5th April, 1999, SIB was asked to carry out the investigation vide Director General Civil Aviation Authority Memorandum No. HQ CAA/1901/238/SIB dated 6th April 1999 (Appendix 'A'). The investigation team was composed of Air Commodore Hashim Yamin, Investigator In-charge, Lt. Col. (Retd) Saleem Khan, Ops Investigator, and Wing Commander (Retd) Zia ul Haque, Tech Investigator. This report is being released under the authority of DG CAA.

Brief Resume

On 5th April 1999 at 0745 UTC, an Airbus 310, Flight PK-268, Pakistan Registered AP-BEQ was scheduled for a Regular Public Transport (RPT) Flight from Karachi to Kathmandu (Nepal). The First Officer/Co-Pilot was pilot flying (PF). During take off run, at 100 knots, the Captain, who was pilot not flying (PNF), called out the speed. The PF checked his speed on Primary Flight Display (PFD) and found it reading about 45 Knots. For about 15 seconds, decision to abort or continue take off was not taken. During this time the speed went from 100 knots to about 170 knots. At that stage the Captain aborted take off. The aircraft came to a stop about 276 feet before the end of the R/W. The temperature of the brakes soared to about 700°C. Resultantly, seven of the eight tyres of the main landing gears deflated. As smoke was reported from the tyres by the ATC, the aircraft was switched off on the Runway. After 3 hours 15 minutes the aircraft was removed from the R/W and the R/W was opened for normal traffic. Seven flights bound for Karachi were diverted to other airports and fourteen flights were delayed during the period the R/W remained blocked. No member of the crew or passenger was injured.

1. FACTUAL INFORMATION

- 1.1. History of the Flight: The flight PK-268 was scheduled to depart from Karachi for Kathmandu at 1245 hours (local time) on a RPT operation. The aircraft commenced take off roll at 0757:48 UTC. At the speed crosscheck point, when the Captain called out 100 knots, the First Officer's primary ASI was reading about 45 knots. Delayed abort resulted in heated brakes and seven deflated tyres, and the aircraft had to be switched off on the runway.
- 1.2. Injuries to Persons: Nil.
- 1.3. Damage to Aircraft: There was no damage to the aircraft; however, eight main wheels and brake assemblies were scrapped. The forward axle of bogie beam assembly was also replaced due to diffusion/melting of cadmium plating.
- 1.4. Other Damage: Nil.
- 1.5. Personal Information:
 - 1.5.1 Captain Shahid Jamil, P-35211 was the pilot in command of PK-268. His personal information is as appended below: -
 - i) Age : 45 years (DOB 29-6-53)
 - ii) Validity of Licence : Valid ATPL # 600
 - iii) Rating : Valid A-310 rating
 - iv) Medical : Class-I
 - v) Flying : Total command hours on type 1200
Grand Total Hours 11,700
 - vi) Mandatory Checks : Simulator, IR & route check carried out.

1.5.2 First Officer Tahir Yousuf P-49256 was the Co-pilot on PK-268.
His personal details are as follows:

- i) Age : 41 years
- ii) Validity of Licence: Valid CPL # 1078
- iii) Rating : Valid rating on A 310
- iv) Medical : Class-I
- v) Flying : Total hours on type 1205
Grand Total Hours 3960
- vi) Mandatory Checks: Simulator, IR and Route check carried out.

1.5.3. For Statements of Witnesses, please refer Appendix 'B'.

1.6. Aircraft Information:

1.6.1. The technical log showed that at the time of incident the A/C was air worthy and being maintained according to the maintenance schedule. A review of the technical log of the aircraft did not reveal any significant maintenance activity or shortfall related to the incident.

1.6.2. The aircraft mass and CG were within limits. These did not have any bearing on the incident. The trim sheet is placed as Appendix 'C'.

1.6.3. Fuel used was Jet A-1.

1.7. Meteorological Information: It was a bright sunny afternoon with no significant weather development. Aerodrome weather reports are placed at Appendix D. The temperature at the time of incident was 38° Centigrade.

1.8. Aids to Navigation: Non-factor in this incident.

- 1.9. Communications: ATC tape extracts placed at Appendices 'E' & 'F'.
- 1.10. Aerodrome Information: Presently Karachi does not have a secondary runway or a high speed turn off point.
- 1.11. Flight Recorders: Transcript of Digital Flight Data Recorder (DFR) is placed at Appendix 'G'. Relevant extract of Cockpit Voice Recorder (CVR) is placed as Appendix 'H'.
- 1.12. Wreckage and Impact Information: Not relevant to this incident.
- 1.13. Medical and Pathological Information: Post-incident medical test results showed satisfactory condition of aircrew (Appendices 'J' & 'K').
- 1.14. Fire: No fire occurred as a result of the incident. Fire fighting equipment was, however, used as a fire preventive measure and for cooling of the brake assemblies.
- 1.15. Survival Aspects: No member of the crew and no passenger received any injury. There was no reported failure of either the seats or the seat belts.
- 1.16. Tests and Research: Nil.
- 1.17. Organizational and Management Information: Nothing of significance to the incident was either observed or reported vis-à-vis the organization and the management.
- 1.18. Additional Information: Correspondence related to expeditious removal of the aircraft from the runway is placed as Appendices 'L1' to 'L7'.
- 1.19. Useful or Effective Investigation Techniques: Nil.

2. ANALYSIS

2.1. The following aspects have been analysed:

2.1.1. Operational.

2.1.2. Human Factor.

2.1.3. Technical.

2.1.4. Miscellaneous.

2.2. Operational

2.2.1. Before the take off roll, the aircraft was fully serviceable. Airbus 310 is equipped with a pitot static system that is fed by three probes. One probe each feeds the PFD through the Air Data Computer (ADC), while the third probe is connected directly to the two standby air speed indicators (ASI), which are of the conventional type. In the cockpit the speed display available to the pilots is from two PFDs and two standby ASIs. Both the Captain and the First Officer have their respective PFD screens and standby ASIs directly in front of them. Each PFD also has a speed trend arrow giving indication of aircraft acceleration. The standby ASIs display the speed on a dial. In case of a malfunction of one PFD (Captain's or First Officer's), the conventional ASI can be immediately referred to for verification. A blockage of any one of the probes does not affect the inputs of the other probes.

2.2.2. In this incident, only one probe, feeding the First Officer's PFD, was partially blocked by a leaf. This means that Captain's primary and standby and Co-pilot's standby ASIs were all serviceable. The aircrew could not decide whether to abort or to continue take off for about 15 seconds after the speed difference on the two PFD was detected. During this time the aircraft speed went up from about 100 KT to about 170 KT. Finally, the Captain decided to abort.

2.2.3. As per the A-310 Flight Crew Training Manual (Appendix 'M'), the procedure outlined for such a disparity of Airspeeds in PFDs of the

Captain and the First Officer should have been followed. This was not done. The procedure did not call for a rejection of take off. Note 1 of A-310/300-600 Flight Crew Manual (Abnormal Operation Briefings) states:

'The loss of both ADC above 100 Kts should not lead to a rejected take off since standby instruments are still available'.

2.2.4. While this was a case of only one PFD giving an erroneous reading, the manual emphasizes on 'not rejecting a take off' even if both the PFDs were to fail. Technically, therefore, the rejection of take off in this case was in violation of the 'Flight Crew Training Manual'.

2.3. Human Factor

2.3.1. The following human factor aspects have been analyzed:

2.3.1.1. Role of the Aircraft Captain

2.3.1.2. Role of the First Officer

2.3.2. Role of the Aircraft Captain

2.3.2.1. Fitness for the Flight. Captain Shahid Jamil is an experienced A-310 Captain with a grand total of 11700 hours and on type 1200 hours. He has a valid Class-I medical category. A brief look at his past 72 hours duty-rest record shows that there was no undue stress on him due to official workload. The results of his post incident blood and urine samples are also satisfactory. He is considered fit for flight.

2.3.2.2. Awareness. The fact that there was a disparity in the readings of the two PFDs was evident when he (PNF) called out 100 KT and the First Officer reported the speed to be about 45 KT. The Captain verified the speed with his own standby ASI yet he took considerable time (about 15 seconds) to accept that there was a problem. From the CVR read out it is quite clear that the Captain was attempting to physically look at the First

Officer's air speed indication on his PFD, yet he neither advised the First Officer to cross-check his PFD airspeed with his standby ASI nor looked at it himself. The Captain's knowledge of the aircraft pitot system and the related abort criteria on take off are both less than adequate.

2.3.2.3. Decision - Making. The decision whether or not to abort take off is to be made by the Captain irrespective of who is the PF. The Captain took too long to make a decision on a simple matter i.e. he was not required to interpret a complex situation and then make a decision. He was to simply act in accordance with well defined instructions given in the Flight Crew Training Manual along with a Note to clear any ambiguity. Let alone partial failure of one PFD, even in case of complete failure of both the PFDs, abort was not to be done above 100 KT. Hence the Captain's decision, besides being inordinately delayed (beyond V1, for calculations refer Appendix 'N') was also incorrect.

2.3.2.4. Aircraft Handling. At the speed crosscheck point, the First Officer's speed as indicated on PFD was different than that indicated on Captain's PFD. The Captain verified his PFD speed indication with the standby ASI. Knowing that PFD indication is independent of the standby indication, he should have been sure that his airspeed indications were reliable. As such, it was most appropriate for him to have taken over the aircraft control from his First Officer. He did not do so. Moreover, he got so distracted by the malfunction

that he forgot to keep track of important reference speeds like V1, VR and V2 and also did not check the speed while aborting.

- 2.3.2.5. Correspondence between CFS and SIB, in this regard, is placed as Appendix 'O'.

2.4. Role of the First Officer

- 2.4.1. **Fitness for the Flight.** First Officer Tahir Yousuf is an experienced A-310 First Officer with a grand total of 3960 hours and on type 1205 hours. He has a valid Class-I medical category. A brief look at his past 72 hours duty-rest record shows that there was no undue stress on him due to official workload. The results of his post incident blood and urine samples are also satisfactory. He is considered fit for flight.
- 2.4.2. **Awareness.** From the CVR it appears that the First Officer was very concerned about the speed problem. He, however, did not cross refer his PFD speed with that on his standby ASI. This reflects on his knowledge of the A-310 pitot system. It could also be due to insufficient emphasis laid during training on cross checking the PFD ASI indication with standby ASI indication in case of malfunction in the former indication. Had he quickly correlated the two, he would have found out that the malfunction was specific to only the PFD and hence not a cause of much concern.
- 2.4.3. **Decision Making.** His lack of knowledge of the procedures laid down in the A-310 Flight Crew Training Manual is evident from the fact that at no stage did he suggest to the Captain that the procedure required them to continue take off.
- 2.4.4. **Aircraft Handling.** On becoming aware of the airspeed disparity between his and the Captain's indications, he should have handed over the aircraft control to the Captain. He did not do so.

2.5. Technical

2.5.1. The following technical aspects were analyzed:

2.5.1.1. Cause of Malfunction of First Officer's ASI.

2.5.1.2. Brakes Function and Overheating.

2.5.2. Cause of Malfunction of First Officer's ASI.

2.5.2.1. The pitot system has two independent systems for Captain and First Officer separately. In addition there is an independent standby system also, which provides the aircraft related information on separate indicators. Detailed description of systems along with Aircraft Maintenance Engineer statement is placed at Appendix 'P'.

2.5.2.2. A test for the pitot static system was carried out by flushing the system. It was found that the First Officer's (F/O) pitot tube contained FOD. This FOD consisted of dry leaves stuck in the pitot tube, allowing only partial dynamic pressure to reach the system. Thus the F/O indicator was under-reading the speed of the aircraft.

2.5.2.3. The whole pitot static system was tested for proper functioning of the indicators and sensing components. Indicators and sensing component were normal and working satisfactorily.

2.5.2.4. The aircraft maintenance history for the period from 20th March 1999 to 5th April 1999 was studied. It did not indicate any such snag or work carried out in the area of pitot tube. Thus the possibility of maintenance related error was eliminated.

- 2.5.2.5. This is not an isolated case of FOD. In fact FOD is a known problem in A-310s. The cause of FOD in A-310s pitot tube has been identified by PIA as a possible weakness in its design. Most of the time tiny flowers, leaves etc, constitute the FOD. It seems that when the aircraft is parked, small insects pluck up these leaves from the plants nearby and take small pieces of these leaves into the pitot tubes. In regard to this FOD problem, correspondence between Airbus Industrie and PIA is referred, which is placed as Appendix 'Q'. The Airbus Industrie have declined to make any changes in the pitot tube design but have suggested the use of pitot covers. Even though PIA claim to be using the pitot covers as suggested, yet the incident highlights that the present system being used by PIA does not ensure adequate protection against FOD.
- 2.5.2.6. The build up of FOD appears to be cumulative in nature. Most probably, it takes place when the aircraft is parked on the ground for a comparatively long duration without pitot covers. Even though it may be a difficult exercise to install pitot covers when the aircraft is parked for a relatively smaller duration e.g. two to three hours, yet it is important to formulate a procedure such that the chances of FOD are minimised.
- 2.5.2.7. Presently, when the pitot system is flushed during 'B' check inspection, the extracts are not collected or observed to note a trend or to form a data base. Making such an observation could help in formulation of a viable procedure to preclude the chances of FOD in future.

2.5.3. Brakes Function and Overheating

2.5.3.1. The main wheel and brake assemblies were checked for their proper functioning. Although the main wheels were deflated and rubbed, no abnormality was observed in them. The brake assemblies were affected by the high temperatures but did not show any signs of abnormality in brake assemblies. The cause of overheating has been determined as high speed abort (above V1), necessitating maximum application of brakes at high speed. PIAC's Shop Report on Brakes, Main Wheel Assembly and Boggie Beam Assembly is placed as Appendix 'R'.

2.5.3.2. For Photographs, please refer Appendix 'V'.

2.6. Miscellaneous Factor

2.6.1. Runway Clearances: As a result of this incident, Karachi runway remained blocked for three hours 15 minutes (for ATC Journal and Sequence of Events, refer Appendices 'S' and 'T'). During this time, seven aircraft had to divert to other airports while the departure of 14 flights was delayed (for details, please refer Appendix 'U'). The investigation team therefore thought it appropriate to look at the aspect of expeditious removal of the aircraft from the runway. This study was also necessary for working out a strategy whereby runway closure time could be reduced to a minimum. Consequently, all Pakistani major airlines were approached vide our letter No.HQCAA/1901/240/SIB dated 15 May 1999, Appendix 'L1', to determine their capability of removal of a disabled aircraft from the runway expeditiously keeping in view the equipment/man- power available with them. Responses of the airlines in this regard are placed at Appendices 'L2' to 'L5'. From their replies it seems quite evident that out of

the airlines operating in country, PIAC has the bulk of equipment required for clearing aircraft from the runway with major disabilities. It can handle all aircraft in PIAC inventory starting from Cessna to B-747. The list of equipment is given as Appendix 'L6'. Recovery is conducted by forming groups of personnel. These personnel are not permanent but deployed as required. So far 23 aircraft have been recovered. This includes cases of Belly Landing, Landing Gear Collapse and Aircraft Overshooting the Runway. Minimum time taken was two hours in case of removal of B-707 which has overshoot the runway by 800 feet at Peshawar and maximum time taken was five days in case of B-747 belly landing at Islamabad and B-747 overshooting the runway at Lahore. PIAC's major facilities in this connection are available only at Karachi.

- 2.6.2. A study of some similar past cases in which runways were blocked due to disabled aircraft was also undertaken. It revealed that as a result of an investigation in the case of a belly landing of PIAC's B-747 aircraft at Islamabad, a recommendation had been made that PIAC should handle all removals of aircraft with major disabilities from the runways (Appendix 'L7'). So far no formal action on the recommendation has been taken.

3. CONCLUSIONS

3.1. Findings

- 3.1.1. On 5th April 1999, Captain Shahid Jamil P-36211 and First Officer Tahir Yousuf P-49256 were scheduled to fly A-310 Reg AP-BEQ Flight, PK-268, from Karachi to Kathmandu with scheduled departure time of 0745UTC(1245 PST).

- 3.1.2. As per the evidence available, the aircraft was serviceable before flight. The aircraft mass and CG were within limits. The brakes and wheel assemblies were also serviceable. There had been no report of an airspeed read-out malfunction in the recent past.
- 3.1.3. The Captain and First Officer were adequately experienced and, as per the available evidence, fit for flight.
- 3.1.4. The First Officer was the Pilot Flying (PF) while the Captain was the Pilot Not Flying (PNF) for the Karachi – Kathmandu Sector.
- 3.1.5. The calculated V1, and V2 speeds were 158, 162 and 165KT respectively.
- 3.1.6. The start-up, taxi and line up (on Runway 25R) phases of the flight were uneventful.
- 3.1.7. At 0757:48 UTC, take off roll was initiated.
- 3.1.8. Twenty six seconds later, at 0758:14 UTC, when the speed reached 100 knots on his PFD, the PNF (the Captain in this case) called out '100 knots' as part of the airspeed cross check procedure.
- 3.1.9. On this call, the PF (First Officer in this case) checked the speed on his PFD and found it to be reading about 45 knots. He gave a call to this effect at 0758:16 UTC.
- 3.1.10. The Captain cross checked his PFD speed with his standby ASI.
- 3.1.11. The First Officer did not cross check his PFD speed with his standby ASI.
- 3.1.12. On identification of the problem, the First Officer did not hand over the controls to the Captain.
- 3.1.13. The Captain should have taken over the controls but did not do so.

- 3.1.14. The Captain and First Officer got involved in a dialogue to verify the airspeed problem.
- 3.1.15. The decision whether to continue take off or to abort is the exclusive prerogative of the Captain of the aircraft irrespective of who has the controls.
- 3.1.16. The Captain took about 15 seconds to decide whether or not to abort. During this time, the aircraft accelerated to 169 KT.
- 3.1.17. ^{At} 0758:32 UTC, take off abort was initiated.
- 3.1.18. The decision to reject the take off by the Captain of the aircraft was incorrect according to the Flight Crew Training Manual.
- 3.1.19. During the abort process, the aircraft accelerated to 173 KT before slowing down.
- 3.1.20. The aircraft stopped about 276 feet short of the end of runway.
- 3.1.21. High-speed abort (about 10 KT above V1) caused seven of the eight main wheels to deflate and the brake temperature soared to over 700 degrees Celsius.
- 3.1.22. The aircraft engines were switched off on the runway because of smoke and sparks emanating from the wheels and brake assemblies.
- 3.1.23. The runway remained closed to normal traffic for about 3 hours and 15 minutes till the aircraft was finally cleared by PIAC personnel.
- 3.1.24. During the period that the runway remained closed, seven flights bound for Karachi International were diverted and 14 flights awaiting departure from Karachi International were delayed.
- 3.1.25. The cause of the airspeed display malfunction in First Officer's PFD was found to be FOD.

- 3.1.26. The FOD was found to comprise Bougainvillea leaves and an insect.
- 3.1.27. PIA had suggested to the Airbus Industrie to modify the design of the pitot tube to minimise the chances of FOD. The Airbus Industrie have declined to make any change in the existing design and suggested that pitot covers be used as a preventive measure.
- 3.1.28. Even though PIA claim to have instituted a system whereby pitot covers are installed on their aircraft on the ground, it is evident that the protection provided by their system is less than adequate.
- 3.1.29. Presently, pitot tubes are flushed during 'B' check but their extracts are not observed or recorded for trend analysis.
- 3.1.30. The Captain:
- a) Displayed poor knowledge of the aircraft pitot system and related abort criteria.
 - b) Took a late and incorrect decision to abort take off in case of a simple emergency.
 - c) Did not monitor the V1, VR and V2 speeds. He also did not monitor the speed at which he initiated abort.
 - d) On discovery of the problem, should have taken over controls of the aircraft but did not do so.
- 3.1.31. The First Officer:
- a) Displayed poor knowledge of the aircraft pitot system and related abort criteria.
 - b) On discovery of the problem, did not hand over the controls of the aircraft to the Captain.

3.1.32. Presently, during simulator training, times taken by the pilots to analyse the emergency and to complete the emergency actions are not recorded. As such, there is no data base for comparative analysis.

3.1.33. A look at old records indicated that after the incident to PIAC's B-747 Reg AP-AYW at Islamabad International Airport on 04 Feb 86, it had been recommended that 'PIA in co-ordination with other airlines operating through Pakistan should review its requirements for obtaining and maintaining recovery equipment in Pakistan to facilitate early recovery of crashed aircraft'. No policy / procedure has so far been documented in this regard.

3.2. Cause

3.2.1. The cause of the incident was Captain's decision to reject take off at a very high speed for a malfunction, which is not an abort criteria as per the Flight Crew Training Manual.

4. SAFETY RECOMMENDATIONS

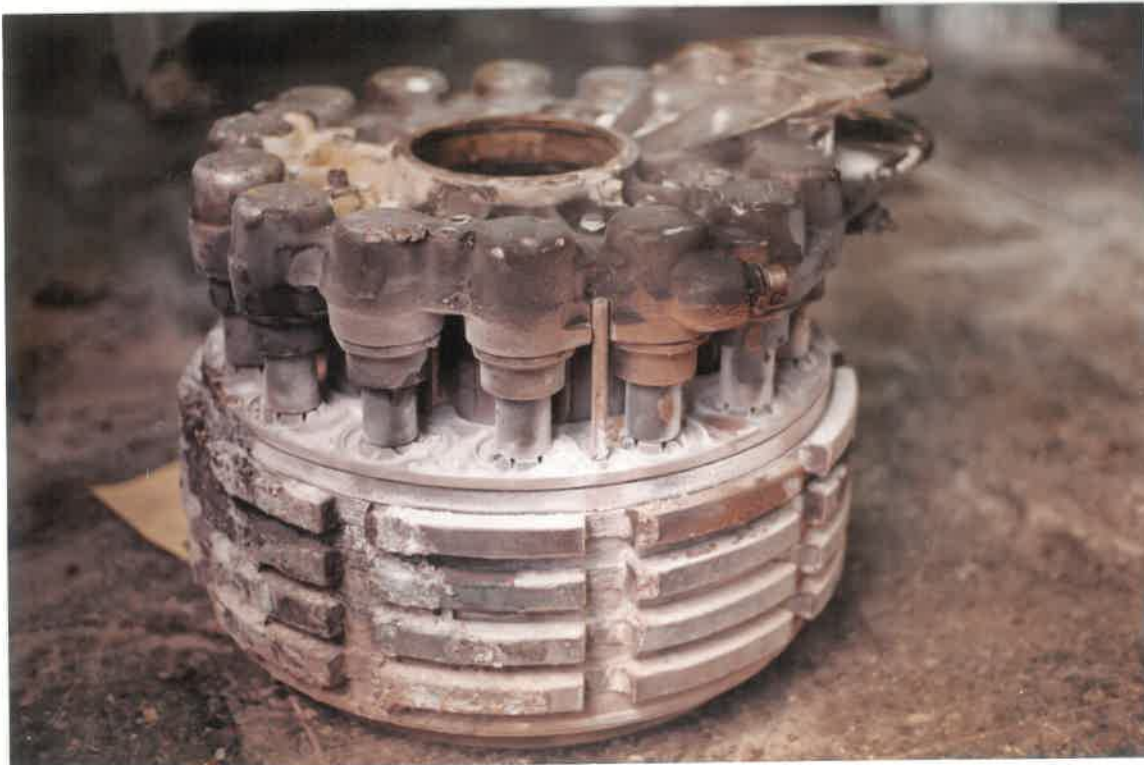
- 4.1. Captain Shahid Jamil, P-35211, be appropriately assessed for his ability to react in an emergency situation and his knowledge of the aircraft systems and procedures before he is cleared to fly as an independent Captain.
- 4.2. First Officer Tahir Yousuf, P-49256, be checked out for his knowledge of the aircraft systems and procedures before he is cleared for further flying.
- 4.3. An Operational Engineering Technical Bulletin be issued stressing on the aircrew that in case of failure of primary instruments, they must refer to standby instruments, if available, before taking further action.
- 4.4. During simulator training, besides noting the correctness of procedures, the times taken for the following also ^{be} observed and recorded so as to form a comprehensive data base for future comparative analysis.

- a) Time taken to assess the emergency (decision making).
 - b) Time taken to complete the emergency action.
- 4.5. Any weakness discovered in any of the areas mentioned above be appropriately addressed through additional training.
- 4.6. PIA may develop a procedure to minimise recurrence of FOD blocking the pitot system. Procedure(s) so developed be reviewed periodically to establish its effectiveness. SIB be kept abreast of the developments and review results.
- 4.7. D. ATS CAA may develop a procedure for assigning the responsibility of removing crashed / disabled aircraft from the runway to PIAC. A system of recovering the cost of such operations from the crashed / disabled aircraft's owner for PIAC be also worked out.
- 4.8. In keeping with their finances, PIAC may periodically modernise / upgrade its aircraft recovery / removal equipment.

APP. V



BRAKE ASSEMBLIES SHOWING HEAT EFFECT



BRAKE ASSEMBLIES SHOWING HEAT EFFECT



FOD EXTRACTED FROM PITOT TUBE



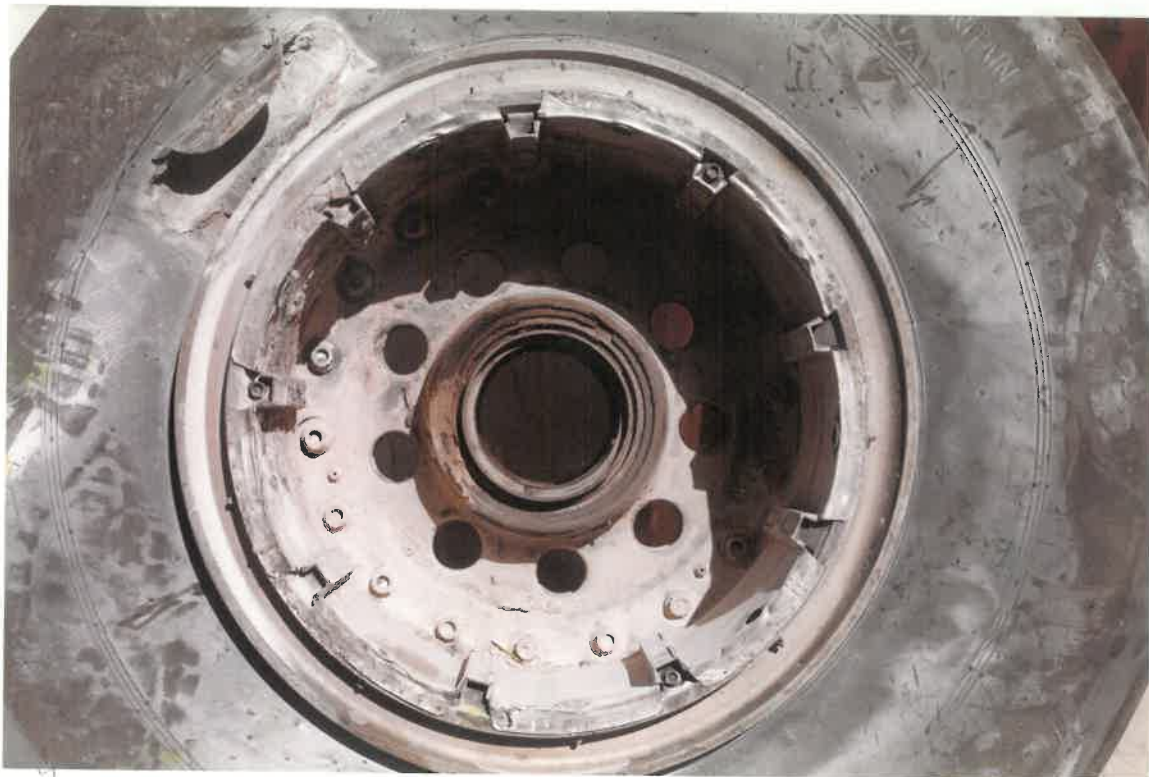
PITOT TUBE



PITOT TUBE



RUNWAY TYRE MARKINGS



WHEEL ASSEMBLY



WHEEL ASSEMBLY