

FINAL INVESTIGATION REPORT



**SERIOUS INCIDENT OF PIA FLIGHT PK-311 (QUETTA TO KARACHI)
ATR 42-500 REG NO AP-BHM NO 1 ENGINE IN-FLIGHT SHUT DOWN
DURING FINAL APPROACH AT JIAP KARACHI ON 09-06-2017**

SCOPE

Safety Investigation Board (SIB), Pakistan investigations are conducted in accordance with Annex-13 to the ICAO Convention on International Civil Aviation and Civil Aviation Authority (CAA), Pakistan Rules 1994 (CARs 94).

The sole objective of the investigation of an accident or incident under above stated regulations is the prevention of future accidents and incidents of similar nature. It is not the purpose of such an investigation to apportion blame or liability. Accordingly, it is inappropriate that SIB 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.

This report contains facts which have been determined up to the time of publication. This information is published to inform the aviation industry and the public of the general circumstances of civil aviation accidents and incidents.

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THE SIB PAKISTAN ICAO ANNEX 13 SAFETY INVESTIGATION BOARD TEAM

| Sr No | Name | Designation |
|--------------|--------------------------------|--|
| 1. | Air Commodore M Usman Ghani | President SIB Investigation In-charge |
| 2. | Group Captain Mian Tahir Aftab | Additional Director Tech Investigator SIB |

FINAL REPORT

SERIOUS INCIDENT OF M/S. PIAC FLIGHT PK-311 (SECTOR UET – KHI) ATR42-500 REG NO AP-BHM AT JIAP KARACHI ON 09-06-2017

Synopsis

On 09 June 2017, AP-BHM ATR-42-500 aircraft operated by Pakistan International Airlines was on a flight from Quetta to Karachi Jinnah International Airport. While on final approach for Runway 25L at Karachi, an un-commanded in-flight shutdown of the number 1 engine occurred. The aircraft landed safely out of same approach.

This serious incident was reported to Safety Investigation Board (SIB) Pakistan by the operator through Mandatory Occurrence Report. The incident was notified in accordance with ICAO Annex-13. Aviation Division Government of Pakistan issued memorandum vide letter No HQCAA/1901/396/SIB dated 15 June, 2017 authorizing SIB Pakistan to investigate the incident.

1. FACTUAL INFORMATION

- 1.1 **History of the Flight.** On 09 June 2017, PIAC aircraft AP-BHM ATR-42-500 took off from Quetta for Karachi. The weather was fit to undertake the flight. The aircraft followed standard route. After establishing localizer for the final approach the first officer (Pilot Flying) felt a dissymmetry in the flight conditions. The Captain took over the controls. Master caution light along with EEC light and subsequently PEC light of No 1 Engine came on. Followed by unwinding of all parameters / un-commanded in-flight shutdown of No 1 Engine. Checklist actions were taken and the aircraft landed safely out of same approach. There were 41 passengers and 04 crew members on board. The aircraft landed safely with no injuries.
- 1.2 **Injuries to Persons.** Nil.
- 1.3 **Damage to Aircraft.** Nil.
- 1.4 **Other Damages.** None.
- 1.5 **Personnel information.** The aircraft was flown by Captain Furrukh Azam Chohan and First Officer Uzair Ansari. Both the pilots were qualified, held valid licences and were adequately experienced to undertake the said flight.
- 1.6 **Aircraft and Engine Information.**

| AIRCRAFT INFORMATION | |
|--|--------------------------|
| Aircraft Make & Model | ATR42-500 |
| Registration Marking | AP-BHM |
| Manufacturer Serial No | 659 |
| Year of Manufacture | March 2007 |
| Daily inspection prior to 09-06-2017 occurrence (date, location) | 09-06-17 (KHI) |
| Total Aircraft hours / cycles / landings | 22049:13 / 21799 / 21945 |

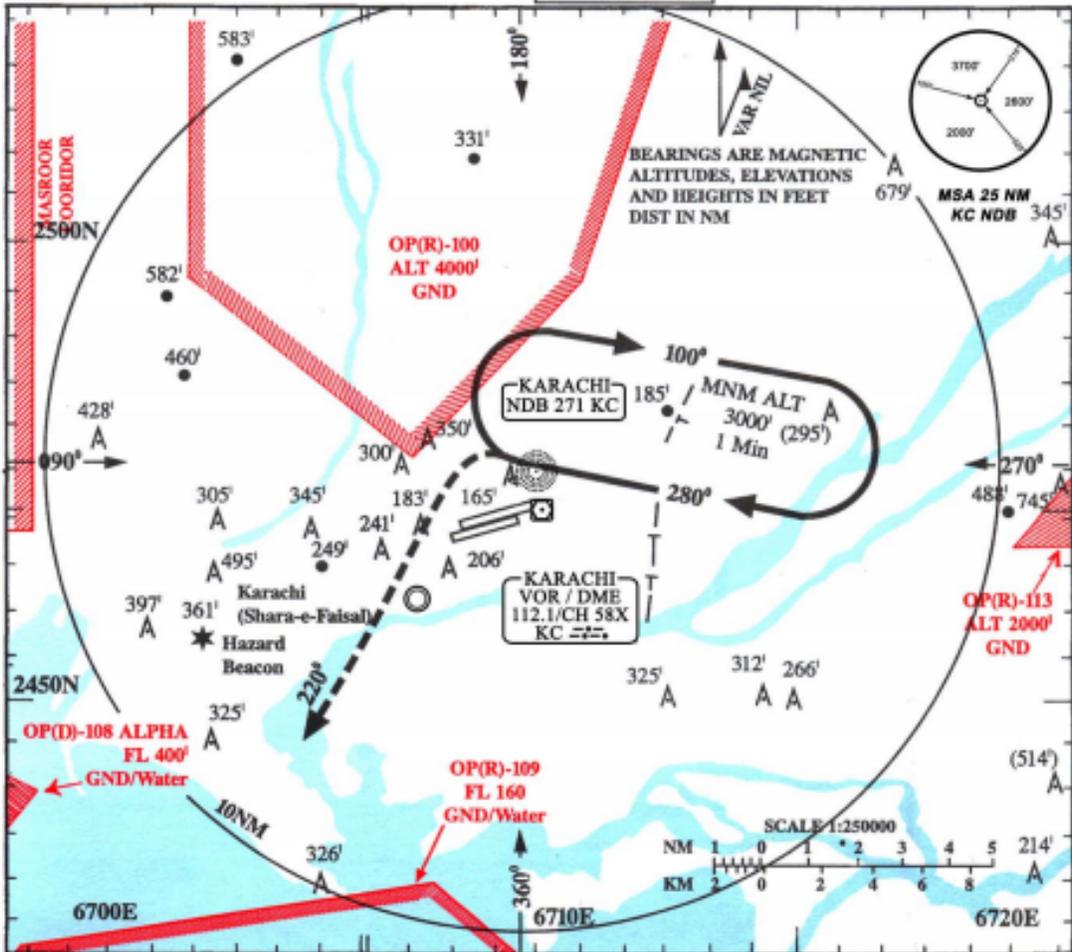
| NO 1 ENGINE INFORMATION | | |
|---|-----------------|--------------------------------------|
| Part No | | PW127E |
| S No | | EB0284 |
| Manufacturer's Details | | Pratt & Whitney Canada |
| Time Since New (TSN) / CSN | | 14346/13242 |
| Time Since Installed | | 1772 Hrs |
| Next Overhaul Due at TSN / CSN | | 25262 /18058 |
| Details of recent scheduled / un-scheduled maintenance performed on this engine | | |
| S No | Date / Location | Details of Sch / Un-sch maintenance |
| 1 | 03/06/17(KHI) | HP vane damage BSI |
| 2 | 28/05/17(KHI) | Handling bleed Valve filter cleaning |
| 3 | 18/04/17(ISB) | HPT NGVs inspection |

- 1.7 The aircraft was being maintained in accordance with the approved maintenance schedule. Recent maintenance record for the past over two years (March, 2015 ~ June, 2017) of the engine S No EB0284 was reviewed from it's Log book which revealed that :
- 1.7.1 This engine has flown 2337 hours in last 28 months and 1772 hour since installation on this aircraft AP-BHM.
- 1.7.2 The engine has not gone thru any maintenance which could have a direct impact towards this occurrence.
- 1.8 **Meteorological Information.** Weather was fit to undertake said flight.
- 1.9 **Aids to Navigation.** All onboard aircraft & ground navigation aids and related equipment were serviceable.
- 1.10 **Communications.** Radio communication services i.e. primary and emergency frequencies were serviceable at the time of incident. Similarly, the onboard aircraft radio equipment was also serviceable.
- 1.11 **Aerodrome Information.** Detailed aerodrome data of Jinnah International Airport, Karachi is appended below:-

INSTRUMENT APPROACH CHART - ICAO
AD ELEV 100'
HEIGHTS RELATED TO AERODROME ELEV

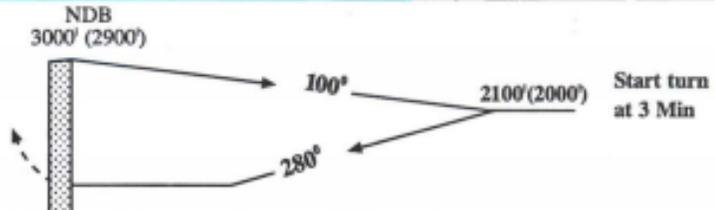
| | |
|------|-------|
| TWR | 118.3 |
| APP | 125.5 |
| ATIS | 126.7 |

KARACHI/Jinnah Int'l
NDB A RWY 25R/25L



TRANSITION LEVEL FL 50
TRANSITION ALT 3000'

MISSED APPROACH
Turn left and climb to 2000' AMSL on track 220 and contact ATC.



Military airfield with RWY-08/26 exists 2.5 NM SW of AD. Pilots should exercise caution in identification of correct RWY before making approach to land RWY-07L or 07R of Karach International

| OCA/H | | A | B | C | D |
|----------------------|----------|----------------|---|-------------|---|
| Straight in Approach | NDB | NOT APPLICABLE | | | |
| | Circling | 750'(650') | | 890' (790') | |

OPKC 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 |
| 07L | 074.29 | 3200 x 46 | 54/R/C/X/U CONCRETE ACFT upto A310 are permitted | 245416.90N | THR23.50M/77FT |
| 25R | 254.29 | | | 0670851.02E | |
| 07R | 074.29 | 3400 x 45 | 87/R/B/W/T CONCRETE SWY bitumen | 245402.15N | THR21.62M / 71FT |
| 25L | 254.29 | | | 0670833.56E | |
| | | | | 245431.79N | THR27.25M / 89FT |
| | | | | 0671030.20E | |

| Designations RWY NR | Slope of RWY/SWY | SWY dimension (M) | CWY dimension (M) | Strip dimension (M) | Obstacle Free Zone |
|------------------------|---------------------|----------------------|-------------------|------------------------|--------------------|
| 7 | 8 | 9 | 10 | 11 | 12 |
| 07L | 0.2% UP | 305 x 46 | 914 | 3930 x 300 | - |
| 25R | | 305 x 46 | 580 | 3930 x 300 | |
| 07R | 0.168% UP | 305 x 45 | 870x150 | 4130 x 300 | - |
| 25L | | 301 x 45 | 483X150 | 4126 x 300 | |

➔ **Remarks:** RWY07R RESA – 180M X 120M & RESA RWY 25L 150M X 150 M.

OPKC AD 2.13 DECLARED DISTANCES (M)

| Designations RWY NR | TORA | ASDA | TODA | LDA | Remarks |
|------------------------|------|------|------|------|---------|
| 1 | 2 | 3 | 4 | 5 | 6 |
| 07L | 3200 | 3500 | 4114 | 3200 | - |
| 25R | 3200 | 3505 | 3780 | 3200 | - |
| 07R | 3400 | 3705 | 4270 | 3400 | - |
| 25L | 3400 | 3701 | 3883 | 3400 | - |

OPKC AD 2.14 APPROACH AND RUNWAY LIGHTS

| Designations RWY NR | APCH LGT type LEN INTST | THRLGT colourW BAR | VASIS (MEH) PAPI | TDZMLGT LEN | RWY Centre line LGT Length, spacing, colour, INTST | RWY EDGE line LGT Length, spacing, colour, INTST | RWY End LGT spacing colourWBAR | SWY LGT LEN (M) colour | Remarks |
|------------------------|-------------------------------|--------------------------|------------------------------|----------------|--|---|--------------------------------------|------------------------------|------------|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| 07L | SALS LIH | GREEN | PAPI/ Left 3° | - | - | 3200 M, 60 M, | RED | - | Strobe LGT |
| 25R | PALS LIH | GREEN | PAPI/ Left 3° | - | - | WHITE LIH | RED | - | - |
| 07R | SALS LIH 300 M | GREEN | PAPI/ Both sides 2.91° | - | 3400M 30 M white LIH | 3400 M, 60 M, white LIH | RED | - | - |
| 25L | PALS LIH900M | GREEN | PAPI/ Both sides 2.98° | 900 M | Last 900 M alternate white/red | Last 600 M yellow | RED | - | Flashers |

Civil Aviation Authority

AMDT 01/17

OPKC AD 2.18 ATS COMMUNICATION FACILITIES

| Service designation | Call sign | Frequency | Hours of operation | Remarks |
|---------------------|---------------------|-------------|--------------------|---------------|
| TWR | KARACHI Tower | 118.3 MHZ | H24 | Primary |
| | | 118.8 MHZ | H24 | Secondary |
| | | 121.5 MHZ | H24 | Emergency |
| APRON | Karachi Ground | 121.6 MHZ | H24 | Primary |
| | | 118.4 MHZ | H24 | Secondary |
| | | 121.8 MHZ | H24 | Vehicle |
| | | 123.0 MHZ | H24 | |
| | | 126.7 MHZ | H24 | |
| ATIS APP | ATIS Karachi APP | 125.5 MHZ | H24 | Primary |
| | | Karachi APP | H24 | Secondary |
| | | Karachi APP | H24 | Emergency |
| | | Karachi APP | H24 | Emergency |
| BS | Radio Pakistan | 830 KHZ | HX | 0130-1900 HR |
| | | 1450 KHZ | HX | Variable SKED |

OPKC AD 2.19 RADIO NAVIGATION AND LANDING AIDS

| Type of aid. CAT of ILS (VAR VOR/ILS) | ID | Frequency | Hours of operation | Site of transmitting antenna coordinates | Elevation of DME transmitting antenna | Remarks |
|--|--------------------|---------------------|-----------------------|--|--|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| GP 25R LLZ 25R ILS CAT I (1°E/1995) | Dots/Dashes IKC | 334.4 MHZ | H24 | 245448.11N 0671029.32E | - | - |
| | | 110.1MHZ | H24 | 245413.64N0670837.68E | - | - |
| LOM MM | KO | 235 KHZ | H24 | *245547.51N 0671449.66E | - | 3.9 NM FM THRRWY 25R |
| | | 75 MHZ | H24 | *245454.06N 0671117.40E | - | 0.43 NM FM THRRWY 25R |
| GP/TDME 25L LLZ25L ILS CAT1 (1°E/1995) | Dots/Dashes | 333.2 MHZ CH34X | H24 | 245433.50N 0671017.88E | 30.90M | 2.98° RDH55 FT |
| NDB | IQA | 109.7 MHZ | H24 | 245359.09N0670820.434E | - | - |
| | | 271 KHZ | H24 | 245523.80N 0670936.28E | - | Coverage 500NM |
| VOR / DME | KC | 112.1 MHZ CH 58X | H24 | 245443.06N 0671053.91E | 40.84M | Coverage 200NM Radial 300 un-reliable |

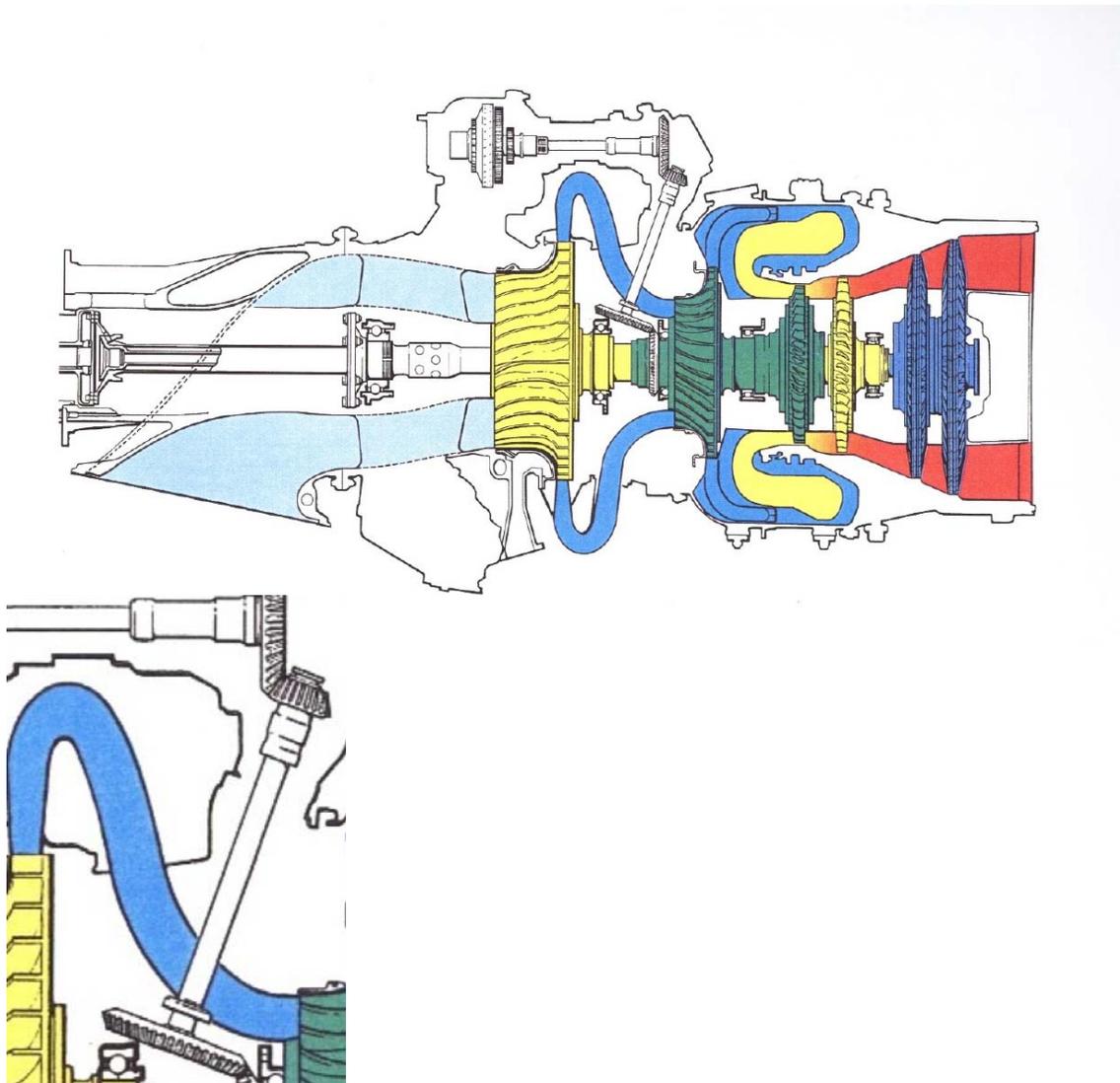
- 1.12 **Flight Recorders.** The Flight Data Recorder (FDR) and Cockpit Voice Recorder (CVR) were successfully downloaded and utilized for the purpose of investigation.
- 1.13 **Wreckage and Impact Information.** Not applicable.
- 1.14 **Medical and Pathological Information.** Not applicable.
- 1.15 **Fire.** There was no evidence of fire available after the occurrence.
- 1.16 **Survival Aspects.** Not applicable.
- 1.17 **Test and Research.** The No 1 engine S No EB-0284 was sent to the OEM Pratt & Whitney Canada for a tear down examination.
- 1.18 **Organisational and Management Information.** Not applicable.
- 1.19 **Additional Information.** Not applicable.
- 1.20 **Use of Effective Investigation Techniques.** Standard investigation procedure and techniques were used.

2. ANALYSIS

- 2.1 The aircraft followed standard route to Karachi. After establishing localizer for the final approach the first officer (Pilot Flying) felt a dissymmetry in the flight condition.
- 2.2 The captain took over the controls. Master caution light along with EEC light and subsequently PEC light of No 1 Engine came on. Followed by unwinding of all parameters / un-commanded in-flight shutdown of No 1 Engine.
- 2.3 Checklist actions were taken and the aircraft landed safely out of same approach.
- 2.4 Immediately after the reported incident, SIB's team arrived Karachi and the initial investigation was conducted in the presence of representatives from ATR France & Pratt & Whitney Canada (who were incidentally available at PIAC Karachi on that day).
- 2.5 Engine No1 Inlet and exhaust were checked, found no abnormality.
- 2.6 The Magnetic Chip Detector (MCD) of Turbo-machinery was found with metal particles as shown below:



- 2.7 Abnormal sound and irregular movement of the Accessory Gear Box (AGB) was observed in Engine No 1. In order to avoid any damage to the evidence, the initial investigation at Karachi was stopped and the engine was sent to the OEM for a detailed tear down examination and investigation.
- 2.8 Pratt & Whitney Canada conducted the tear down examination in the presence of representatives from SIB Pakistan and Transport Safety Board Canada.
- 2.9 During tear down examination of the engine, it was established that the event was a result of failure of No. 30 bearing which is installed on tower shaft of Accessory Gear Box (AGB). Owing to this failure, drive from the engine was lost which lead to IFSD due stopping of all driven components (Oil & Fuel Pumps etc).





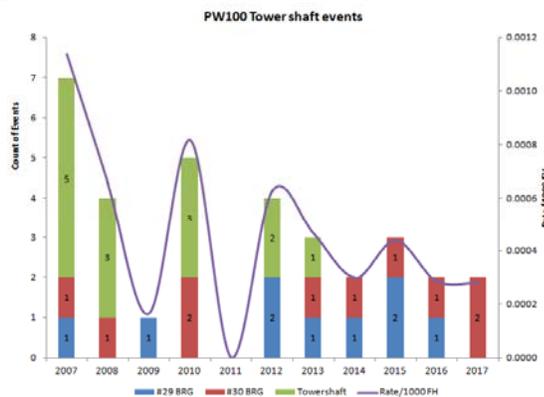
2.10 The failed No 30 bearing was sent to the Engineering Lab of TSB for a failure mode analysis which concluded that :

“The bearing failed due to bearing cage cracking. The mode of failure of the cage could not be determined due to the extensive rubbing damage observed on the fracture surfaces and the rivets”

2.11 A review of the engine maintenance history of past over two years revealed that no maintenance was performed by the operator (M/s PIAC) in the area of tower shaft or its bearings.

2.12 Industry data on failure rate of No 29 / 30 bearings and Tower Shaft (on which these two bearings are installed) was sought from the OEM which is as given below :

FIELD EXPERIENCE



Design and distress mode of the tower shaft components are consider similar across platform and all PW100. All Small, medium, Large) are included in this review.

10 year review revealed 34* tower shaft deterioration events

7 unscheduled removal following MIO
26 low oil pressure resulting in IFSD

Last 10 year rate for Towershaft "area"
0.0005/1000hrs considering 70.8MHRS

#29 bearing 1 event per 7.9MHRS
#30 bearing 1 event per 7.1MHRS
shaft 1 Event per 4.7MHRS

Cumulative rate of 1 event per 2.15MHRS

IFSD Overall rate = 1event per 2.2MHRS

*including events related with change incorporate in 2005 (bevel gear and tower shaft replacement as a set)

Cumulative combine UR/IFSD rate; 1 event per 2.15MHRS

3

2.13 The above data for the period 2007 ~ 2017 reveals that there have been failure cases related to tower shaft and its two bearings (No 29 & No 30 bearings). There's overall a decreasing trend of such failures on the entire fleet. Based on the above failures, the OEM (Pratt & Whitney Canada) is already working on re-designing / modification of the tower shaft and bearing No 29. These modifications

are currently undergoing hardware testing and validation phases. The details are as given below :

DESIGN IMPROVEMENT



In a pursue to improve Towershaft area, changes are made to prevent similar deterioration mode. hardware testing and validation currently ongoing.

Modification highlight;

- Tower shaft;
 - incorporate new spline layout
 - Improved wear resistance
 - improve fit and hardness
 - improved #29 bearing inner race hardness
 - increase assembly load
- #29 bearing
 - increase roller and cage size
 - increase tolerances for better roller stability
 - minimise damage induce assembly risk

3. CONCLUSIONS

3.1 Findings

- 3.1.1 The Magnetic Chip Detector (MCD) of Turbo-machinery was found with heavy metal particles once checked after the incident.
 - 3.1.2 The tear down examination and investigation at the OEM premises revealed that the engine shut down process was due to failure of No 30 bearing installed on the tower shaft inside AGB.
 - 3.1.3 Industry data revealed that during 2007~2017, there had been failure cases pertaining to tower shaft and the two bearings (bearing Nos 29 & 30) installed at its both ends, however there is a decreasing trend of such failures.
 - 3.1.4 The OEM (Pratt & Whitney Canada) has already re-designed Bearing No 29 and the tower shaft which is currently under trials.
 - 3.1.5 A review of the engine maintenance history of past over two years revealed that no maintenance was performed by the operator (M/s PIAC) in the area of tower shaft or its bearings.
- 3.2 **Cause of the Occurrence.** The occurrence was caused due to failure of No 30 Bearing of the engine however the exact cause of No 30 Bearing failure couldn't be established due to excessive damage.

4. SAFETY RECOMMENDATIONS

- 4.1 The OEM (Pratt & Whitney Canada) is recommended to accelerate their already initiated efforts to re-design / re-shape the Tower Shaft and its bearings so as to eliminate the chances of failures triggering from this area.