

Director General of Civil Aviation,
Opp. Safdarjung Airport,
New Delhi - 110 003

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Amended Report

INVESTIGATION
REPORT
ON INCIDENT TO M/s GO AIRLINES
A320N AIRCRAFT VT-WGB



DUE
IN-FLIGHT SHUT DOWN AT DELHI ON
08TH FEB 2017.

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INVESTIGATION REPORT

**REPORT ON INCIDENT TO M/s GO AIRLINES (INDIA) LTD AIRBUS A320N AIRCRAFT VT-WGB AT
DELHI ON 08TH FEB 2017.**

1. **Aircraft Type** : Airbus A320 NEO
Nationality : Indian
Registration : VT-WGB
2. **Owner** : SMBC Aviation Capital Limited
3. **Operator** : Go Airlines (India) Ltd.
4. **Pilot-in-Command** : ATPL holder on type
Extent of injuries : NIL
5. **First Officer** : CPL holder on type
Extent of injuries : NIL
6. **Place of Incident** : Delhi
7. **Date and Time of Incident** : 08th February 2017 1403 UTC
8. **Last point of Departures** : Delhi
9. **Point of Intended Landing** : Bengaluru
10. **Type of Operation** : Scheduled Operation
11. **Crew on Board** : 02+04
Extent of Injuries : NIL
12. **Passengers on Board** : 187
Extent of Injuries : NIL
13. **Phase of Operation** : Take off
14. **Type of Incident** : In-Flight Shutdown of #1 Engine

NOTE: ALL TIMINGS IN THE REPORT ARE IN UTC

SUMMARY

M/s Go Airlines (India) Limited A320 NEO aircraft VT-WGB operating the scheduled flight G8-557 (Delhi-Bengaluru) was involved in an incident at Delhi on 08/02/2017. There were 193 persons including six crew members on board the aircraft.

The flight was planned with FLX-MCT Take-off (56°) and the aircraft was appropriately configured.

The aircraft was dispatched with the following MELs

1. MEL# 79-09-06A – Eng#1 Oil Chip Detected alert. As per this MEL, in case of an actual alert on one engine, the aircraft may be dispatched for 10 flight hours even with one warning displayed on the EWD.
2. MEL# 36-00-01F – Air Bleed Maintenance Message

Engine levers were moved for take-off at 14:01:44. Just when the aircraft wheels lifted off the ground, Master Warning came ON along with the ECAM message of Low Oil Pressure (RED) followed by Engine #1 Fail. The crew followed the ECAM actions and gave a "Stand-by" call to Delhi ATC for receiving further instruction. Thereafter in 20 seconds a "PAN PAN PAN" call was given by the crew and informed ATC about their decision to return back.

The crew carried out a safe overweight single engine landing at Delhi airport on Runway 28 and taxied safely to the parking bay.

The incident was reported by M/s Go Airlines (India) Limited to DGCA immediately. DGCA ordered an Inquiry under rule 13 of Aircraft (Investigation of Accidents and Incidents), Rules 2012 to investigate into the cause of the incident.

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1. FACTUAL INFORMATION

1.1. History of the Flight

M/s Go Airlines (India) Limited A320 NEO aircraft VT-WGB while operating the scheduled flight G8-557 (Delhi-Bengaluru) was involved in an incident at Delhi on 08/02/2017. The flight was under the command of PIC holder of ATPL license with Co-Pilot holder of CPL license and both duly qualified on type. There were 187 passengers and 6 crew members on board the aircraft. The Flight crew had availed sufficient rest prior to commencement of flight for the sector Delhi – Bengaluru. The pre-flight medical test was carried out at Delhi which has found negative.

Prior to the incident flight, the aircraft VT-WGB had earlier operated the following sector BOM-DEL. During flight #1 engine chip warning came on and aircraft continued the flight to Delhi. Subsequently the aircraft was dispatched from Delhi by the AME with the following MELs

1. MEL# 79-09-06A – Eng#1 Oil Chip Detected alert. As per this MEL, in case of an actual alert on one engine, the aircraft may be dispatched for 10 flight hours even with one warning displayed on the EWD.
2. MEL# 36-00-01F – Air Bleed Maintenance Message.
3. Aircraft VT-WGB further operated the following sectors with above MELs

Flight Date	Flight No.	Sector	To	Remarks
08-Feb-2017	G8-710	DEL	DEL	Aircraft released under MEL for 10 flight hours for LEH. However returned back to Delhi due to weather at LEH.
08-Feb-2017	G8-151	DEL	GAU	Aircraft operated the flight under MEL for #1 Engine.
08-Feb-2017	G8-250	GAU	DEL	Aircraft operated the flight under MEL for #1 Engine.
08-Feb-2017	G8-557	DEL	BLR	The incident flight #1 Engine failed during takeoff and landed back at Delhi.

For the incident flight the aircraft was configured for Flex Take-off. Engine levers were moved for take-off at 14:01:44. At 14:02:25 the aircraft wheels lifted off the ground and in the next second the Master Warning Came ON along with the ECAM message of Low Oil Pressure (RED) followed by Engine No1 Fail. The crew followed the ECAM actions and requested ATC Delhi for standby. Thereafter in 20 seconds a "PAN PAN PAN" call was given by the crew and informed ATC about their decision to return back. Thereafter at 14:03 UTC, the Eng#1 stall warning came 'ON'. The crew shut down the engine#1 and carried out the ECAM Checklist.

The aircraft made a safe single engine landing at Delhi and taxied back to bay. There was no injury to any of the occupants and there was no fire on the aircraft.

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On Arrival of aircraft to the bay, during Initial inspection the following observation was made by the arrival AME:-

1. Oil leak was observed from Engine#1 Exhaust and oil quantity visually checked observed not within gaugable limit.
2. Found oil splashes on engine exhaust area.
3. Fan inlet/exhaust area visually checked no damage observed.
4. Chip detectors of No 1, 2, 3 and 4 bearing were checked and NO CHIP observed
5. Metal chips were found in MGB chip detector.
6. Upon` removal of MGB chip detector, oil drained out up to a bucket.

Subsequently the aircraft was grounded for detailed inspection.

1.2. Injuries to Persons

There was no injury to any crew member, passenger or any other personnel on board the aircraft or around it (see Table below).

Injuries	Crew	Passengers	Others
Fatal	Nil	Nil	Nil
Serious	Nil	Nil	Nil
Minor	Nil	Nil	---
None	6	187	---

1.3. Damage to Aircraft: NIL

There was no damage to the aircraft. However, ENG#1 was shut down due internal failure.

1.4. Other Damage

NIL

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1.5. Personnel Information.

Pilot-in-Command

Age	: 44 yrs. 8 months
License no	: Valid ATPL holder
Endorsement as PIC	: A320
Date Of Medical Exam	: 16 Sep 2016
Medical exam valid up to	: 15 Sep 2017
FRTO license valid up to	: 31 Dec 2019
Total flying experience	: 6777:08 hrs.
Experience on type	: 256:08 hrs.
Experience as PIC on type	: 97:54 hrs.
Total flying experience during last 365 days	: 256:08 hrs.
Total flying experience during last 180 days	: 240:47 hrs.
Total flying experience during last 90 days	: 99:00 hrs.
Total flying experience during last 30 days	: 49:40 hrs.
Total flying experience during last 07 days	: 14:30 hrs.
Total flying experience during last 24 hours	: 6:04 hrs.

First Officer

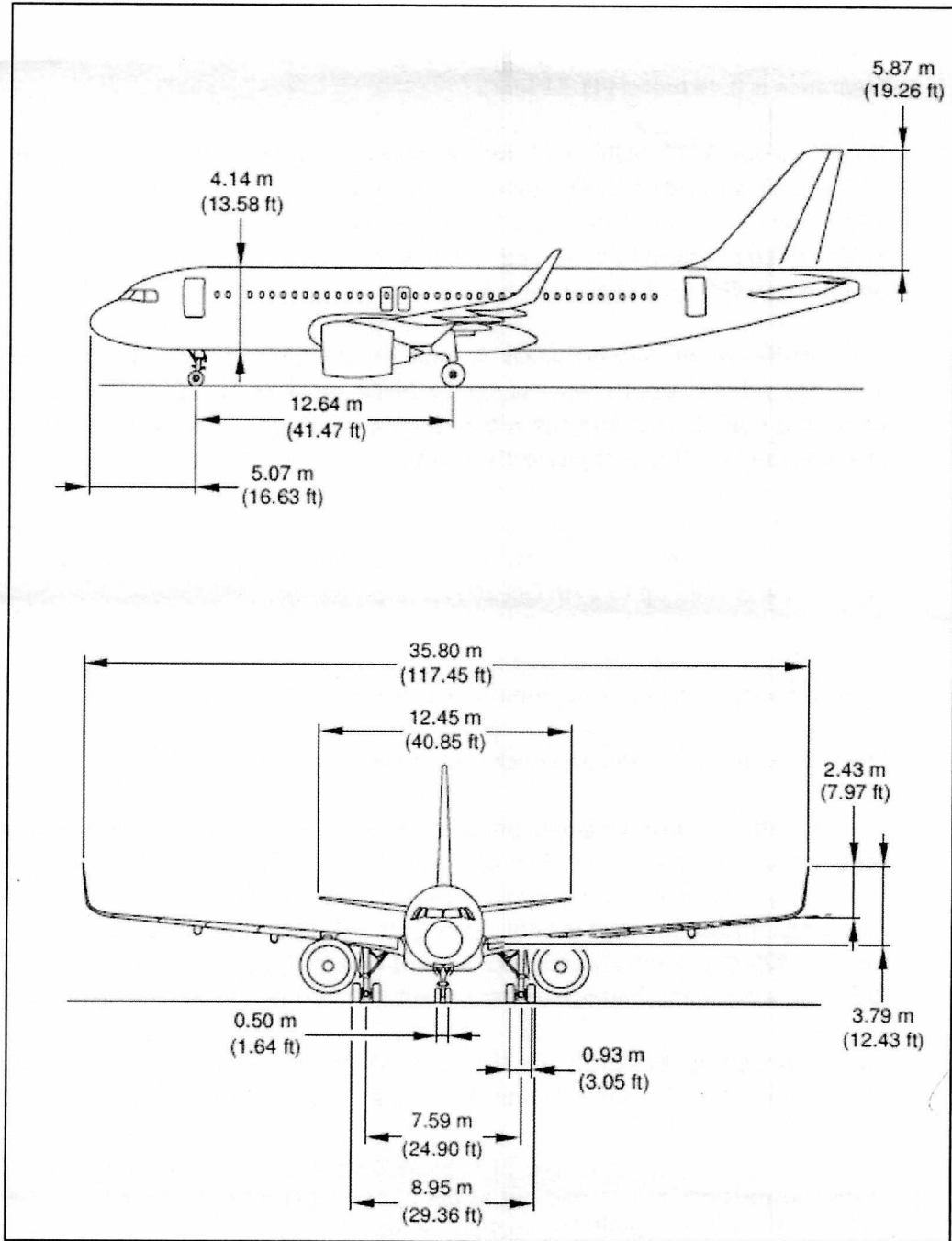
Age	: 26 yrs. 10 months
License no	: Valid CPL holder
Endorsement as F/o	: A320
Date Of Medical Exam	: 25 July 2016
Medical exam valid up to	: 15 Sep 2017
FRTO license valid up to	: 7 Dec 2019
Total flying experience	: 994:43hrs
Experience on type	: 693:38hrs
Experience as PIC on type	: Nil
Total flying experience during last 365 days	: 686:43 hrs.
Total flying experience during last 180 days	: 361:19 hrs.
Total flying experience during last 90 days	: 165:07 hrs.
Total flying experience during last 30 days	: 68:30 hrs.
Total flying experience during last 07 days	: 25:27 hrs.
Total flying experience during last 24 hours	: 09:03 hrs.

Both the operating crew were current in all training and was not involved in any serious incident/ accident in the past and had an adequate rest prior to roster for the incident flight.

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1.6. Aircraft information

The A320 is a subsonic, medium-range, civil transport aircraft. The aircraft has two high bypass geared turbofan PW 1100G engines manufactured by M/s Pratt and Whitney. The aircraft is designed for operation with two pilots and has passenger seating capacity of 186.



Dimensions of A320 Neo

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The aircraft is certified in Normal (Passenger) category, for day and night operation under VFR & IFR. The maximum operating altitude is 39,800 feet and maximum take-off weight is 73,500Kgs. The maximum landing weight is 64,500 Kgs. The aircraft length is 37.57 meters (123.27 feet), wingspan is 35.80 meters (117.45 feet) and height of the aircraft is 11.98 meters (39.30 feet). The distance between main wheel center is 7.59 meters (24.90 feet). The distance between the engines is 11.5 meters (37.72 feet) and Engine Ground Clearance is 0.46 meters (1.51 feet).

Go Air Airbus A320 MSN 7074, Indian Registration VT-WGB, was delivered on 27th June 2016 fitted with P&W 1100G Engines. The aircraft had logged 2410:56 FH and 1518 cycles since new till the incident. The aircraft was registered with DGCA under the ownership of SMBC Aviation Capital Ltd on 28th June 2016. The aircraft is registered under Category 'A' and the Certificate of Registration No is 4668.

The Certificate of Airworthiness Number 6778 under "Normal Category" sub-division Passenger/ Mail/ Goods was issued by DGCA on 01st Jul 2016. The specified minimum operating crew is two and the Maximum All Up Weight is 73,400kgs. At the time of the incident the Certificate of Airworthiness was current and valid.

The Aircraft was holding a valid Aero Mobile Station Licence No A-128/022-RLO (NR) at the time of the incident. The Aircraft was operated under Scheduled Operator's Permit No S-18 which was valid up to 27th Oct 2017.

The Airbus A320Neo aircraft and its engines are being maintained as per the maintenance program approved by the Regional Airworthiness Office, Mumbai.

The last major inspection 3A check was carried out on 10/01/2017

The aircraft was last weighed on 01st June 2016 at Toulouse, France and the Weight Schedule was prepared and duly approved by the office of the Director of Airworthiness, DGCA Mumbai. As per the approved weight schedule the Empty Weight of the aircraft is 42526 Kgs. Maximum usable Fuel Quantity is 18622 Kgs. Maximum Payload with fuel tanks full is 11429 Kgs. Empty weight CG is 18.91 meters aft of the datum. Prior to the incident flight the weight and balance of the aircraft was well within the operating limits.

All the concerned Airworthiness Directive, Mandatory Service Bulletins, DGCA Mandatory Modifications on this aircraft and its engines has been complied with as on day of the event.

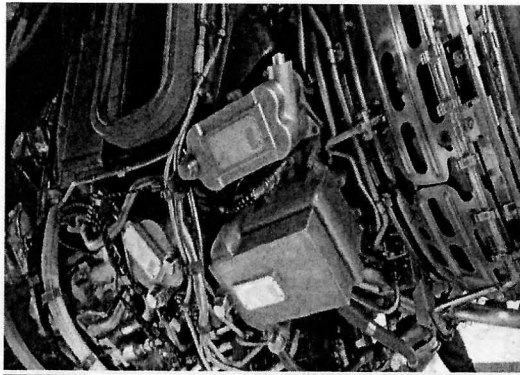
Transit inspections are carried out as per approved Transit Inspection schedules and all the higher inspection schedules include checks/ inspection as per the manufacturer's guidelines as specified in the Maintenance Program and are approved by the Continuing Airworthiness Manager (CAMO) – post holder for Continuous Airworthiness.

The aircraft has two Pratt & Whitney's Pure Power PW1100G-JM engines that supply power to the aircraft. The engines are high bypass (bypass ratio of 12.5:1) geared turbofan engines

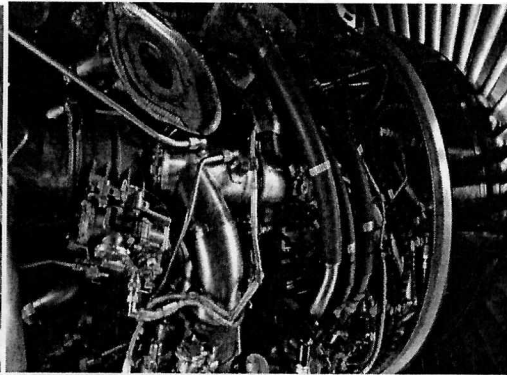
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Observations on Detailed Inspection of Failed Engine#1 at Delhi as follows:

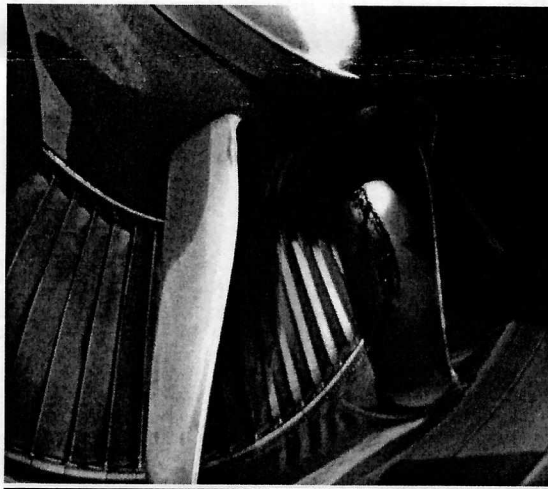
1. Fan and N2 rotation is OK. Not seized. Slight squeaky sound from N2
2. On removal of N2 drive pad for BSI facilitation. Abnormal quantity of Oil drained out (10 liters) from drive pad which is normally dry.
3. No external oil leaks seen in Core engine.
4. Oil seen at the last stage turbine with oil smeared on the aft center body. Coking seen on the 05:30 o' clock strut of ALF turbine.
5. Engine Air inlet area is clean.
6. The MCD except for MGB had nil findings. Also when the MGB MCD was pulled out, oil just poured out due to particles blocking the self-sealing feature.



RH Core



LH Core



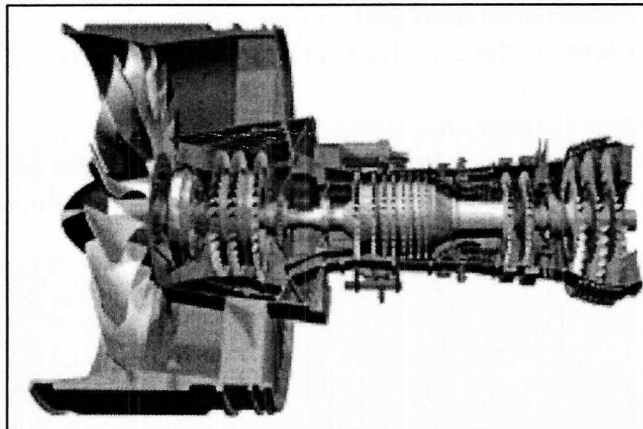
Oil from Turbine Section



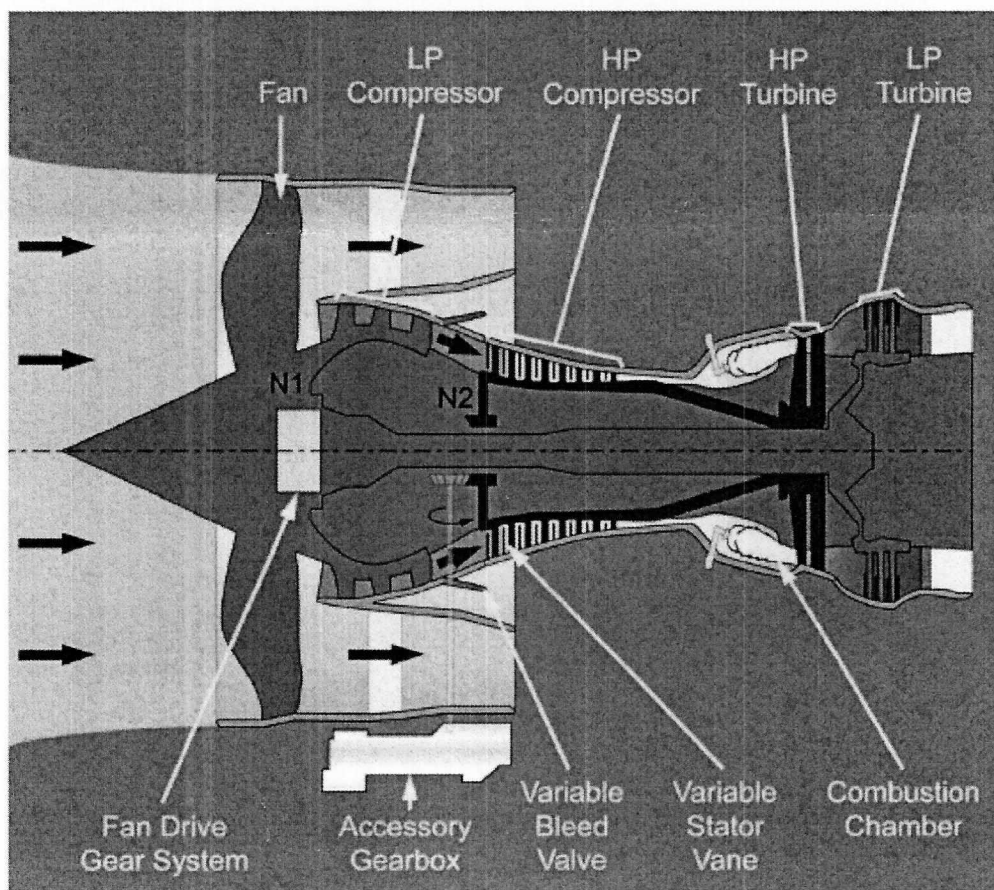
MGD Metal Chip Detector

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ENGINES:



Cut out view of PW1100G-JM Engine



Schematic of PW1100G-JM Engine

LP COMPRESSOR TURBINE ASSEMBLY

- The LP compressor turbine assembly has:
 - One LP compressor,
 - One Fan Drive Gear System (FDGS),
 - One LP shaft,
 - One LP turbine.
- The FDGS is a planetary gear reduction unit that connects the LP shaft to the LP compressor.
- The LP shaft connects the LP compressor to the LP turbine.
- The LP compressor has a fan and 3 stages, and the LP turbine has 3 stages.

HP COMPRESSOR TURBINE ASSEMBLY

- The HP compressor turbine assembly has:
 - One HP compressor,
 - One HP shaft,
 - One HP turbine.
- The HP shaft connects the HP compressor to the HP turbine.
- The HP compressor has a fan and 8 stages, and the HP turbine has 2 stages.

COMBUSTION CHAMBER

The combustion chamber burns a mixture of fuel and HP air. The FADEC controls the fuel/air mixture in accordance with the position of the thrust lever and the aircraft operating conditions. The combustion chamber is an annular assembly with fuel nozzles and two igniters. The combustion chamber is between the HP compressor and the HP turbine.

ACCESSORY GEARBOX

- The accessory gearbox drives various accessories with mechanical power via the HP shaft for the operation of the engine and the aircraft systems.
- The accessory gearbox of each engine operates:
 - The oil feed pump that provides the oil system with oil.
 - The main engine fuel pump that provides the combustion chamber with fuel.
 - The engine-driven hydraulic pumps that pressurize the GREEN and the YELLOW hydraulic systems.
- The engine-driven generators that are the primary source of electrical power.
- The FADEC alternator that provides the FADEC with electrical power.
- The pneumatic starter that enables the engine start.

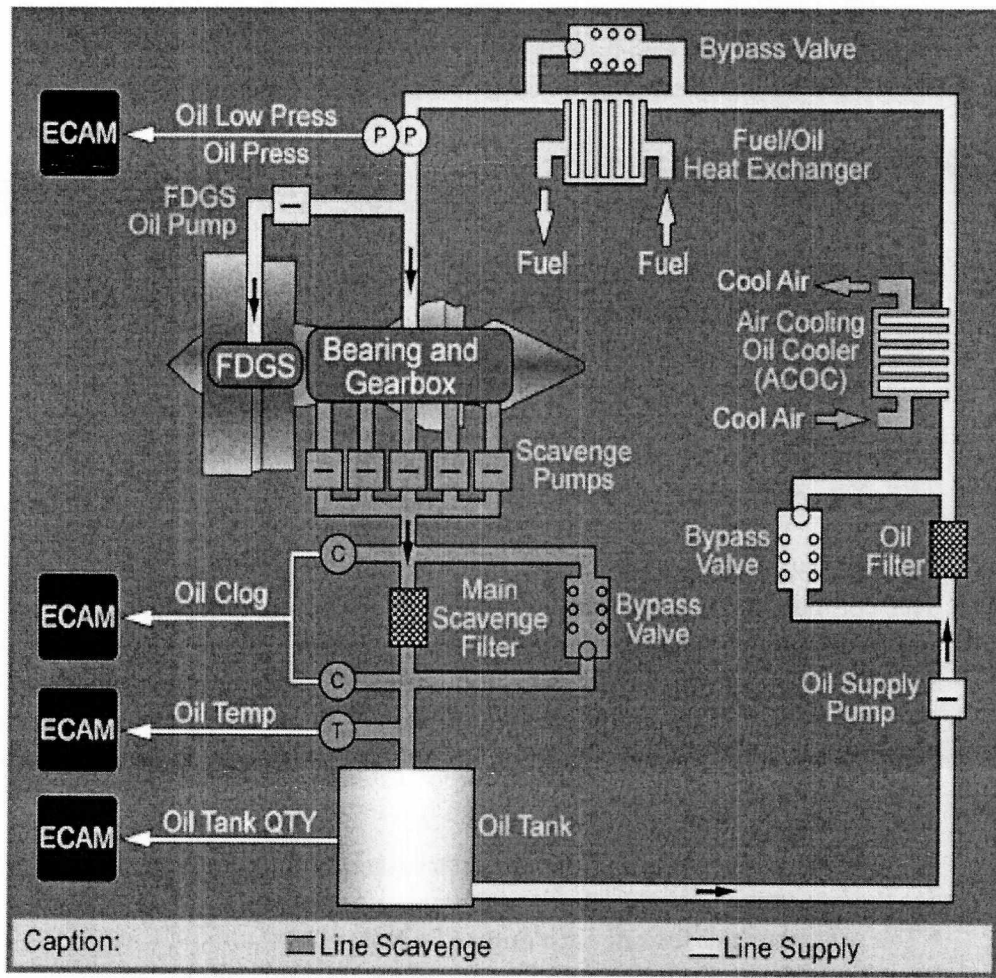
THE ENGINE OIL SYSTEM

The oil system lubricates the engine components.

The oil system includes the following:

- The oil tank
- The lube and scavenge pump modules
- The fuel/oil heat and air/oil heat exchangers
- The filters, chip detectors, pressure relief and bypass valves
- Oil pump for HP and LP rotors
- Oil pump for FDGS.

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Caption: Line Scavenge Line Supply

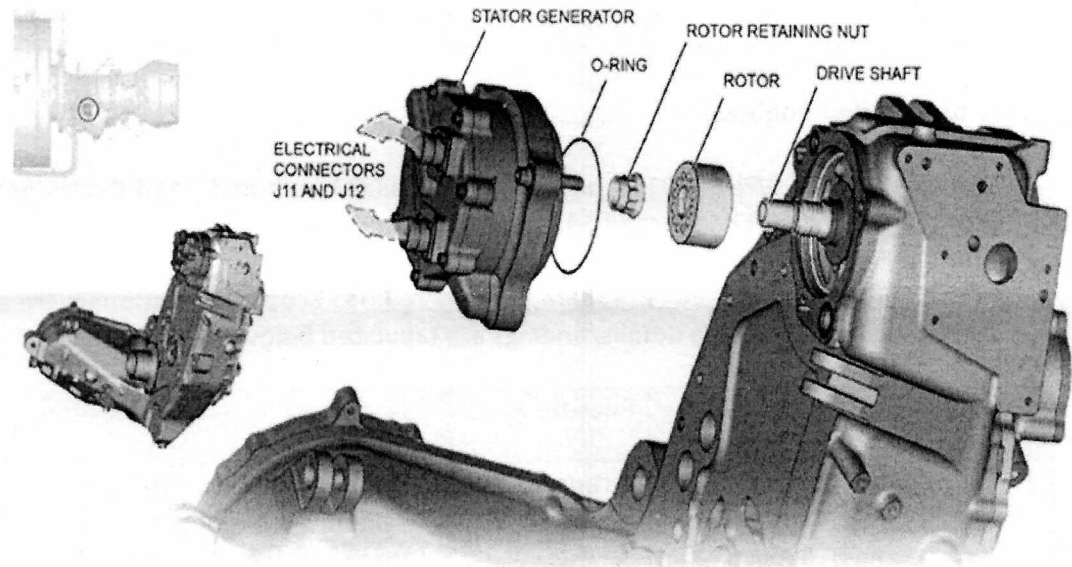
Schematic of Engine Oil System

PERMANENT MAGNETIC ALTERNATOR (PMA)

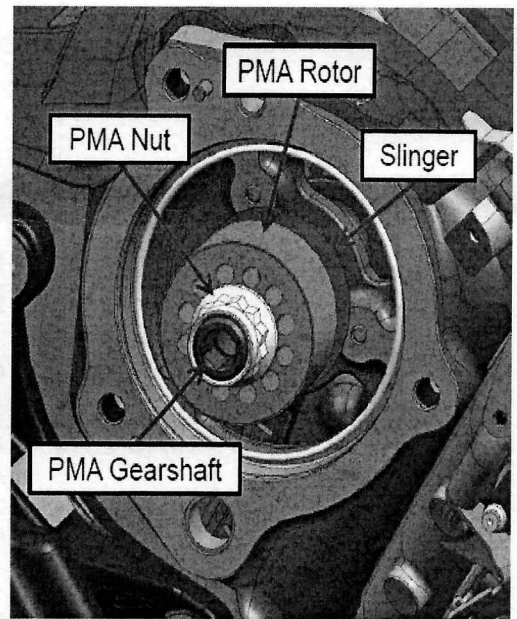
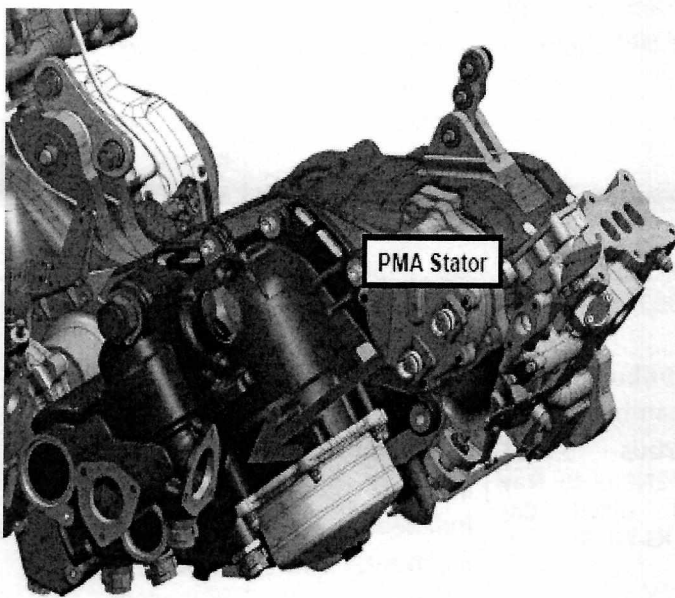
The PMA rotor consists of a high tensile steel magnet and an Inconel sleeve. The rotor is installed on the PMA drive shaft on the Main Gearbox. PMA driveshaft is used to transmit torque from the Main gearbox to the PMA rotor. A self-locking nut is installed to provide axial retention of the PMA rotor. As the motor is pun by the drive shaft, the magnet rotates and induces a current in both sets of windings of the stator. This current provides the voltage that is used to power the EEC.

The PMA rotor and stator generator provides electrical power to both channels of the EEC during engine operation. The PMA is attached to a dedicated mounting pad on the front left side of the Main Gearbox.

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Schematic of Permanent Magnet Alternator



Schematic of Permanent Magnet Alternator

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History of installed engines

The No1 Engine S/N P770153 had logged 2403:06 hours and 1514 Cycles and the No2 Engine S/N P770148 had logged 2410:56 hours and 1518 Cycles.

In line with the manufacturer recommendation, **Boro-Scopic Inspections** were carried out on both the engines. The details/findings are tabulated below:

SL	Engine SN	Date of BSI/ Hrs/ Cyc	Reason/ Area	Findings	Disposition by PW
1	P770153	11/10/2016 1080Hrs 723 Cyc	Airbus AOT A72N008-16 Rev 00 dated 04- AUG-2016 Combustion Chamber and 1 st HPT Vane	Engine shows evidence of thermal barrier coating missing on bulkhead liner segment which is acceptable for a regular inspection interval.	INITIAL Permitted for a inspection interval of 1,350 hours on 12/10/2016 UPDATED Permitted per EA 16CCE00 for a inspection interval of 1,500 hours (by 2580 hours). On 16/11/2016
2	P770153	31/01/2017 2301:36 Hrs 1455 Cyc	PW SB 72-00- 0062 Combustion chamber	OBL1/IBL1 Burn- back & Cracking	Permitted for 750- Hour Interval
3	P770148	12/10/2016 1088 Hrs 729 Cyc	Airbus AOT A72N008-16 Rev 00 dated 04- AUG-2016 Combustion Chamber and 1 st HPT Vane	Observed crack in single Bulkhead Liner Segment, located approximately 90° (Aft Looking Forward, CCW)	INITIAL (12/10/2016) Permitted per EA 13CCD69_D, re-inspect Combustion Chamber in 675 hours. FINAL (16/11/2016) Permitted per EA 16CCE00, re-inspect Combustion Chamber in 750 hours (by 1838 hours TSN).
4	P770148	15/12/2016 1814:11 Hrs	Airbus AOT A72N008-16 Rev 00 dated 04- AUG-2016	Single crack on the bulkhead (with associated	Applying the criteria for the bulkhead inspection per EA

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SL	Engine SN	Date of BSI/ Hrs/ Cyc	Reason/ Area	Findings	Disposition by PW
		1158 Cyc	Combustion Chamber and 1 st HPT Vane	material liberation of approximately 0.050 sq in)	16CCE00, the engine should be placed on a reduced BSI Interval of 750 FH.
5	P770148	31/01/2017 2309:26 Hrs 1459 Cyc	Airbus AOT A72N008-16 Rev 00 dated 04- AUG-2016 Combustion Chamber and 1 st HPT Vane	Bulkhead burn through	Permitted for inspection intervals of 375Hrs

On 8th Feb 2017, VT-WGB operated the following sectors-

Flight Date	Flight No.	Sector	To	Chocks OFF	Airborne	Touch Down	Chocks ON	Flight Hours
08-Feb-2017	G8-329	BOM	DEL	00:27	00:50	02:27	02:36	01:37
08-Feb-2017	G8-710	DEL	DEL	04:13	04:37	06:27	06:34	01:50
08-Feb-2017	G8-151	DEL	GAU	07:10	07:19	09:13	09:17	01:54
08-Feb-2017	G8-250	GAU	DEL	09:51	10:08	12:57	13:08	02:49
08-Feb-2017	G8-557	DEL	DEL	13:58	14:02	14:17	14:23	00:15

On the first sector of the day (BOM-DEL), the Engine Oil Chip Detected warning triggered 29 minutes after take-off. Since the warning is inhibited during this phase, there was no warning in the cockpit. However, the warning triggered after landing and crew reported accordingly in the PDR.

The aircraft was cleared under MEL 79-09-06A (CAT A) for 10 Flight Hours after landing at DEL prior to dispatch for flight G8-710 to Leh. The flight returned back to DEL due bad weather at Leh. Thereafter the aircraft operated to DEL – GAU – DEL with the same MEL. Subsequently the aircraft was schedule for DEL – BLR. The incident occurred on this sector. As per the approved MEL by DGCA the Flight Hours (FHs) are to be counted based on the definition of a flight, i.e. the period of time that begins the moment at which an aircraft begins to move by its own means in preparation for takeoff and ends when the aircraft lands and comes to a complete stop in its parking area. However as per the manufacturer Airbus A320 maintenance planning document the Flight Hours are defined as elapsed time

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between wheel lift off and touchdown. The AME while evaluating the flight hours had considered only the time period from takeoff to touch down and had not considered the overall engine run time as per the approved MEL.

If the AME would have evaluated the flight hours as per MEL the aircraft would have logged 10:15 Hours by the end of sector DEL-BLR which was above the restriction of MEL. Since the AME had only considered the time in air the aircraft would have logged 08:55Hours only after DEL – BLR sector.

1.7. Meteorological Information.

The met report at the time 13:30 UTC of take-off at Delhi was:-

Wind	:	300 ⁰ / 06 Knots
Visibility	:	3500meters - haze
QNH	:	1014

1.8. Aids to Navigation.

Delhi Airport has three near-parallel runways: runway 11/29 with CAT IIIB instrument landing system (ILS) on both sides, runway 10/28 and an auxiliary runway 09/27.

CAT IIIB Landing system is available on RWY 11, RWY 28 and RWY 29
CAT I Landing system is available on RWY 10, RWY 27

PAPI is available for all the runways.

The ATC is controlled and manned by Airport Authority of India.

1.9. Communications.

There was always two way communication between the aircraft and ATC.

1.10. Aerodrome Information.

ICAO : VIDP
Coordinates : 283407N 0770644E
Elevation : 777feet

Runway Declared Distances

RWY designator	TORA (M)	TODA (M)	ASDA (M)	LDA (M)	Remarks
10	3810	3810	3810	3810	Graded RESA: 240M X 150M
28	3810	4084	3810	3810	Graded RESA: 240M X 150M
11	4110	4110	4430	3465	THR displaced by 645M , Graded RESA: 240M X 90 M
29	4430	4430	4430	2970	THR displaced 1460M, RESA: 240 X 120 M
09	2813	3246	2813	2813	Graded RESA: 240M X 90M

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27	2813	3513	2813	2661	Threshold displaced by 152M RESA 240 x90 M
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APPROACH AND RUNWAY LIGHTING

Designation s RWY	APCH LGT TYPE LEN INTST	THR LGT COLOUR WBAR	PAPI (MEHT)	TDZ, LGT LEN	RWY centre line LGT Length, spacing, colour and intensity	RWY edge LGT Length, spacing, colour and intensity
09	SALS 420M LIH	Green	Left/ 3°	---	2813 M 15M White, LIH	2813M 60M White LIH
27	CAT-1 570M LIH	Green	Left/ 3°	---	2661 M 15M White, LIH	2813M 60M White LIH
10	CAT-1 600M LIH	Green	Left/ 3° 22M	---	3810M, 15M White, LIH	3810M, 60M White LIH
28	CATIIIB 900M LIH	Green	Left/ 3° 21M	900M, 30M (Spaci ng btn. Pairs and barrettes) White	3810M, 15M White, LIH	3810M, 60M White LIH
11	CAT IIIB 900M LIH	Green	LEFT & RIG HT/3 ° MEH T 20.8 4M	900M, 30M White	4430M, 15M White, LIH	4430M, 60M, WHITE LIH
29	CAT IIIB 900M LIH	Green	LEFT /3° MEH T 20.9 7M	900M, 30M White	4430M, 15M, White LIH	4430M, 60M WHITE LIH

MET SERVICES

Met Office hour of service is 24 Hrs. TAF, Trend Forecast and Briefing is available. Flight Documentation is provided in Chart and Tabular form in English language.

1.11. Flight Recorders.

The Flight Data Recorder and Cockpit Voice Recorder were downloaded.

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CVR Details		DFDR Details	
Make	: - Honeywell	Make	: - Honeywell
MODEL	: - HFR5	MODEL	: - HFR5
Serial No	: - 04689	Serial No	: - 04895
Part NO	: - 980-6023-001	Part NO	: - 980-4750-002

The following information is available from CVR & DFDR-

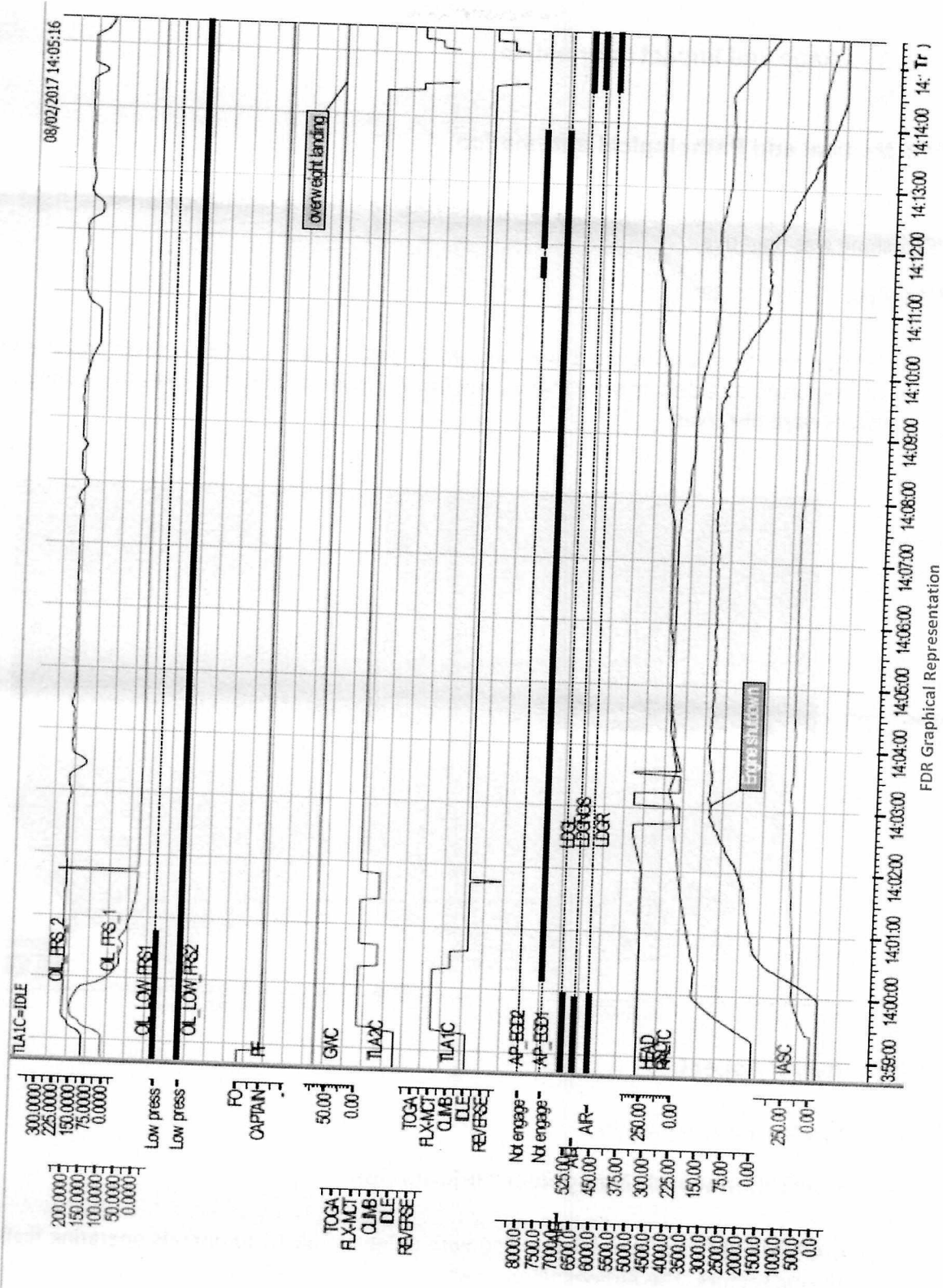
CVR.

1. As the aircraft got airborne master caution warning came on.
2. The crew identified as #1 engine failure and followed the ECAM actions and QRH checklist as per procedure.
3. The PAN PAN PAN call was made by the first officer.
4. Cabin crew reported to the cockpit that Tailpipe Fire from Engine No 1 was noticed by passengers.
5. The ATC vectored VT-WGB for priority landing on RWY28.
6. Checklist and callouts were standard.

DFDR

TIME (UTC)	EVENT
14:01:44	Take off Initiated; Oil Pressure E1/E2 – 163 psi/ 166 psi
14:02:05	Oil Pressure E1 starts to reduce; IAS – 108Knots
14:02:24	Lift off; IAS – 169 Knots; Oil Pressure E1/E2 – 97 psi/ 186 psi
14:02:26	Master Warning Triggered; Rad Alt 37 ft
14:03:03	Throttle E1 brought to Idle; E1N1/ E2N2 – 84%/85%; Rad Alt 1633 ft
14:03:11	Lo Oil Pressure (E1) triggered; Rad Alt 1787 ft
14:03:20	Eng#1 Shut Down; Eng#1 Master – ON; Rad Alt 1838 ft
14:03:35	Eng#1 Master – OFF; Rad Alt 1946 ft

The graphical representation of the flight is attached in the next page.



1.12. Wreckage and Impact Information.

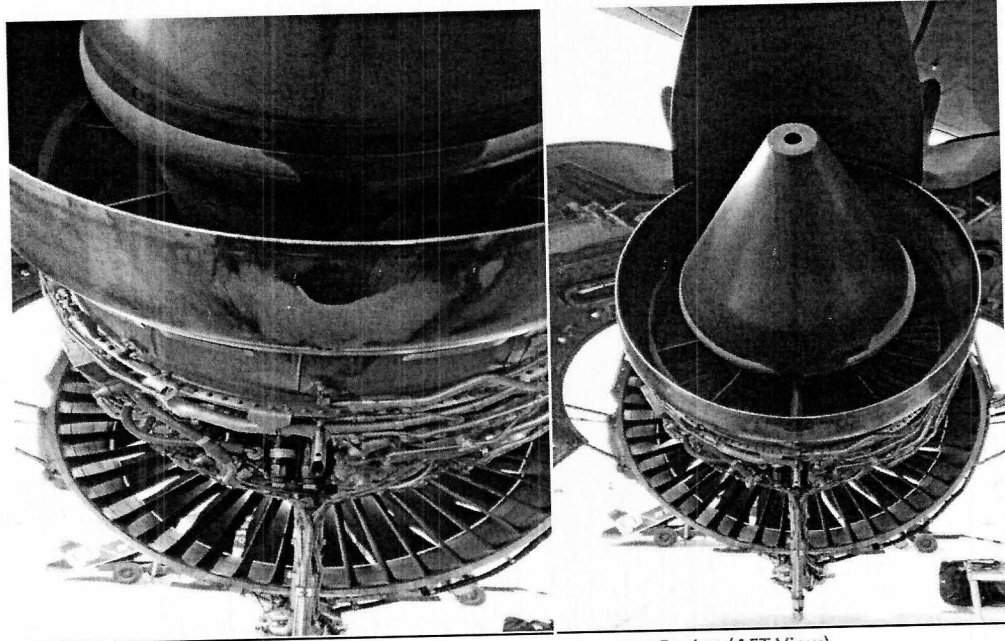
Nil

1.13. Medical and Pathological Information.

Both the cockpit crew had undergone pre-flight medical examination prior to flight and same was negative.

1.14. Fire

Tailpipe Fire from Engine No 1 was noticed by passengers and Cabin Crew and the same was reported by Cabin crew to the Cockpit Crew. However during strip examination no fire marks were observed.



Bottom view of Engine

Engine (AFT View)

1.15. Survival Aspect.

The incident was survivable.

1.16. Organizational and Management Information

M/s GO AIR Ltd. is a scheduled airline with a fleet of 31 A320 aircraft operating flights on domestic sectors. The Airlines Head Quarter is located at Mumbai. The Air operator permit of the Airlines is valid as on date. The Company is headed by Chief Executive Officer assisted by a team of professional of various departments. The Flight Safety Department is headed by Chief of Flight Safety approved by DGCA. The Chief of Safety is senior management official who reports directly to the CEO.

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M/s GO AIR has a full established Operations training facility for the pilots at Mumbai. The training facilities are headed by the Director Training who reports to CEO directly. The Engineering training facility is established at Mumbai. The Chief of flight safety overlooks the flight safety activities of the airline and reports directly to the airline.

1.17. Tests and Research.

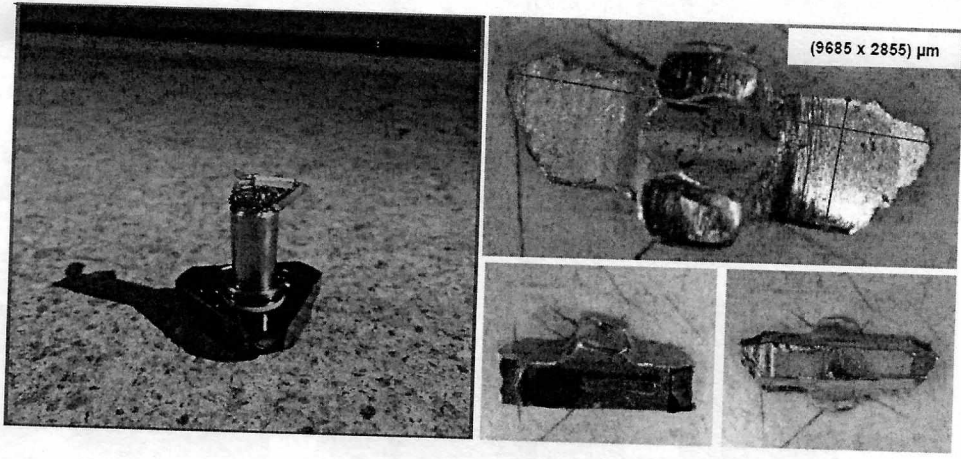
1.17.1. The Metal debris and oil samples sent for inspection to P&W

Oil Samples from MGB and starter along with debris found in MGB Magnetic chip collector were sent to Pratt & Whitney's Laboratory for inspection and investigation.

The oil samples were analyzed under PWCOAT methodology. After a visual observation under a microscope, three large particles were found in sample and they were measured and analyzed by Scanning Electron Microscopy (SEM-EDX). Some smaller particles were also collected from the tissue and analyzed by SEM-EDX.

After Inspection, following was inferred:

1. It was found that there is presence of M50 and low alloy steel particles similar to UNS G43400 (larger particles found with silver plating) observed in the oil samples and in the debris.
2. Presence of an interaction between low alloy steel particles and 300 stainless steel particles (best possible match is probably 17-7 PH). This interaction was observed in the previous oil samples from this engine.



a) Metal Particles of Main gear Box on Magnetic chip Detector
 b) Metal particles found in the oil samples.

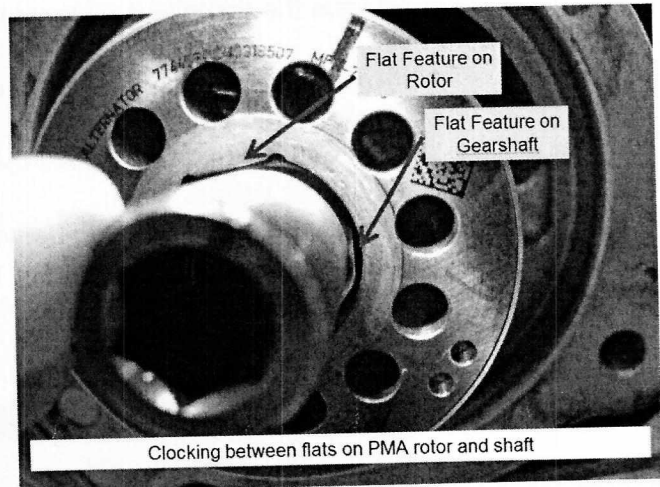
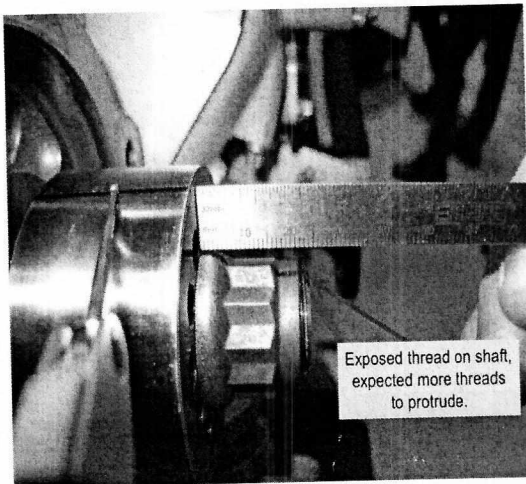
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INVESTIGATION REPORT

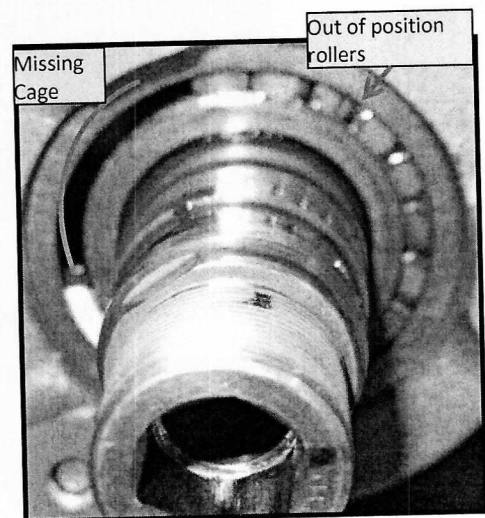
1.17.2. **Investigation of Failed Engine at Manufacturer Facility.**

The failed engine was returned to Pratt & Whitney's Columbus Engine Center, Columbus, Georgia for disassembly and investigation. The examination of the engine's magnetic chip detectors revealed metallic debris that was consistent with the gearbox's permanent magnet alternator's (PMA) forward bearing cage. During disassembly following observations were made:-

1. The Permanent Magnet Alternator (PMA) rotor was out-of-position axially and circumferentially on the PMA gear shaft. PMA Rotor was incorrectly installed on gearshift during assembly allowing slinger to spin freely on gearshaft.



2. Foreign Object Damage (FOD) from the loose nearby slinger initiated a spall on the PMA bearing race. Also increased vibration loads from the spall caused the cage to fracture.

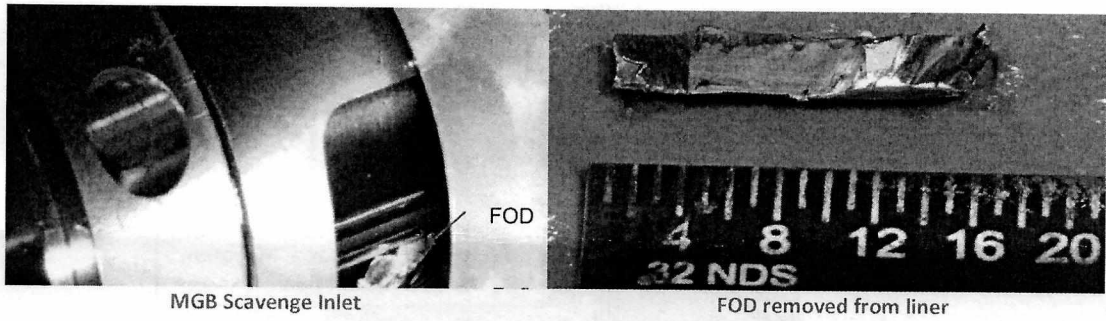


3. Large FOD found on the Chip Collector in the MGB Scavenge return and scavenge stack of Lube & Scavenge Oil Pump (LSOP) was seized and did not spin freely. It was

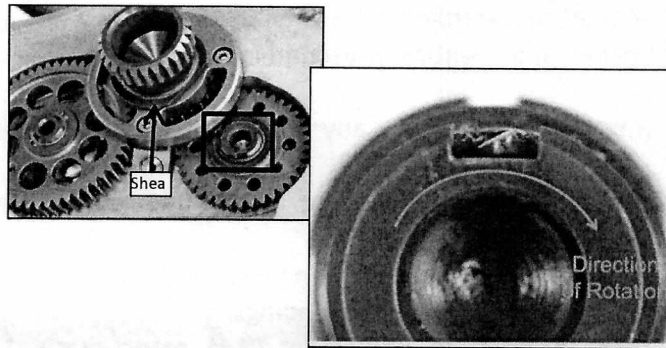
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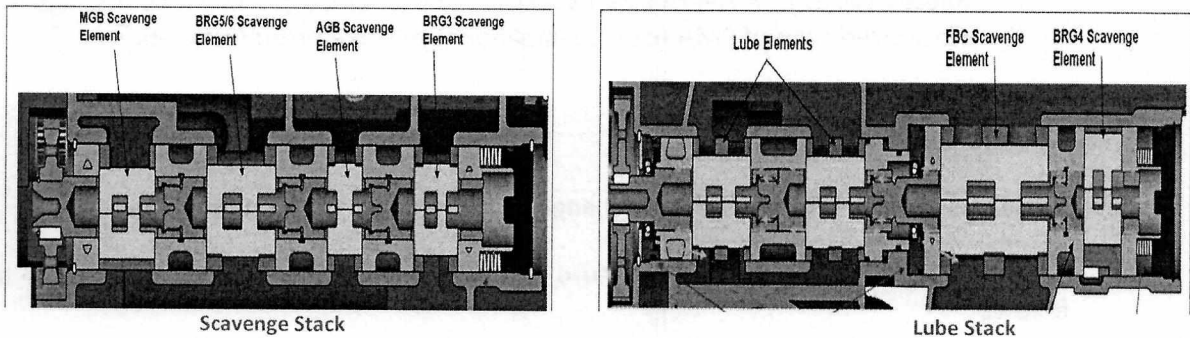
identified that last chance screen was not included on MGB Scavenge return due to design escape and missing screen allowed bearing cage FOD to be ingested into pump.



4. Input drive and Lube stack spun freely and the scavenge stack did not spin when the input drive was spun.

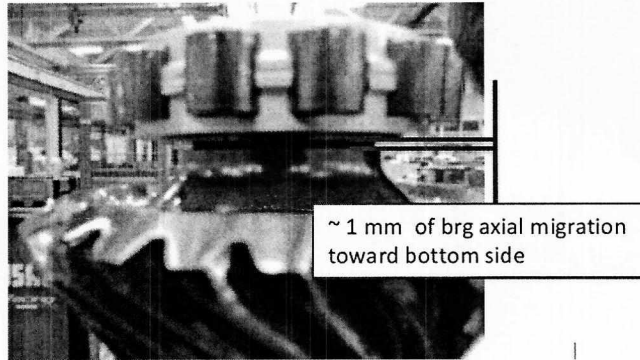


5. Scavenge stack seized prior to shear neck as intended and also the Lube stack continued to pump oil to the entire lube system. Hence MGB, AGB, #3BC, and #5/6 BC flooded due to loss of scavenge function.



6. Angle Gearbox unable to be rotated by hand due loss of backlash caused gears to go into tight mesh.

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The lube scavenge pump scavenge stack did not rotate when the input gear was turned by hand. During detailed examination it was identified that the PMA rotor was not completely seated on its gear shaft and fractured the PMA bearing cage which over the period of time generated metal debris and eventually resulted into chip warning.

P&W took following actions to prevent any work man ship error in this area:-

1. Revise engine assembly procedure to include over-inspection for PMA rotor installation; completed 5/5/2017.
2. Inspect PMA rotor seating on all engines at Pratt & Whitney assembly facilities; completed 5/8/2017. No negative findings.
3. Revise Engine Manual to implement PMA rotor seating inspection; completed 6/8/2017
4. PMA rotor seating inspected on all engines at Airbus Final Assembly Line; completed 8/4/2017. No negative findings.
5. Service Bulletin issued to inspect PMA rotor seating for all fielded engines before 4/1/2018;
6. Status as of 12/1 = 164 of 234 inspected (70% complete). 5 negative findings
7. Future redesign of PMA rotor to implement mistake proof installation

1.18. Additional Information.

1.18.1 Brief on Pratt & Whitney PW1100G engine failure fitted on A320 Neo Aircraft


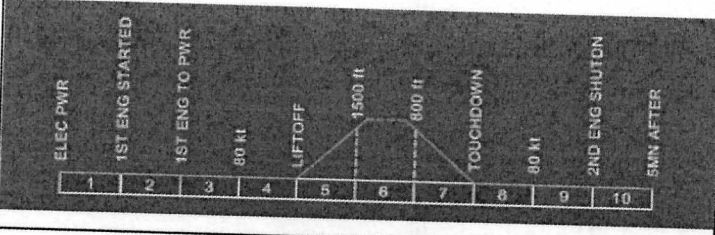
- As of 31st Jul 2017, details of premature removals of PW1100G engines worldwide are as follows-
 - 26 Premature removals of engine due combustion chamber distress
 - 77 Premature removals of engine due No.3 bearing distress
 - Two Premature removals of engine due Main Gear Box failure.

INVESTIGATION REPORT

- **COMBUSTION CHAMBER FAILURE:**
 - P&W has informed that their analysis suggests about 25% degradation of combustion chambers is due to operation of aircraft in coastal environment.
 - Improved combustion chambers are undergoing testing and will be delivered in Sep 2017, which will provide significant increase in life.
- **NO.3 BEARING FAILURE**
 - Detected as a metal chip warning. Root cause for seal failure is loss of film thickness between carbon seal and seal plate.
 - Bearing compartment has been redesigned and the retrofit will be available by Apr 2017.
- **MGB FAILURE**
 - Detected as a metal chip warning. Contrary instructions in manufacturer's Trouble Shooting Manual (TSM) and Master Minimum Equipment List (MMEL)/ Minimum Equipment List (MEL) regarding procedure to be followed.
 - Manufacturer agreed to revisit MMEL and propose amendments to FAA.

1.18.2 FCOM PROCEDURE FOR ENG 1(2) OIL CHIP DETECTED ECAM

As per the FCOM the Engine Oil Chip Detected warning is inhibited in phases 1 to 8. It is displayed only in Phases 9 and 10. The snapshot of the relevant page of FCOM is given below:

 A318/A319/A320/A321 FLIGHT CREW OPERATING MANUAL	PROCEDURES ABNORMAL AND EMERGENCY PROCEDURES POWER PLANT
ENG 1(2) OIL CHIP DETECTED	
Applicable to: MSN 7047-7507	
Ident. PRO-ABN-70-CE-00018171.0001001 / 21 MAR 16	
ANNUNCIATIONS	
<u>Triggering Conditions:</u> This alert triggers when a chip is detected by the EEC in the engine oil system.	
<u>Flight Phase Inhibition:</u>	
	
Ident. PRO-ABN-70-CE-00015577.0001001 / 18 AUG 14	
Crew awareness.	

FCOM Extract for Eng 1(2) Oil Chip Detected ECAM

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A/C ID	DATE	GMT	FLTN	CITY PAIR
VT-UGB	08FEB	1419	GOU557	VIDP VIDP

MAINTENANCE
POST FLIGHT REPORT

A/C ID	DATE	GMT	FLTN	CITY PAIR
VT-UGB	08FEB	1356/1419	GOU557	VIDP VIDP

WARNING/MAINT.STATUS MESSAGES

GMT	PH	ATA	MESSAGE
1400	02	36-00	AIR BLEED
1402	04	77-11	ENG 1 OIL LO PR
1403	06	77-11	ENG 1 FADEC
1403	06	77-11	ENG 1 STALL
1403	06	77-11	ENG 1 FAIL
1403	06	78-00	ENG 1 START FAULT (2)
1403	06	77-11	ENG 1 SHUT DOWN
1403	06	78-00	ENG 1 START FAULT (3)
1406	06	21-61	AIR PACK 1-2 FAULT

FAILURE MESSAGES

GMT	PH	ATA	MESSAGE	SOURCE	IDENT.
1401	02	36-22-15	ENG1 PYLON LOOP A INOP	BMC 1	
1402	05	79-33-00	ENG10-0640-OIL LO PRESS	EIU1FADEC	
			(RED)		
1403	06	23-12-33	VHF3(1RC3)	VHF 3	
1403	06	24-22-55	AFS-28V PUR 11KU1	AFS 1	
1403	06	34-12-34	ADIRU1(IFP1) IR BUS/	RADAR 1	
			WXRI(1SD1)		
1404	06	79-21-15	ENG18-0606- VOR VLV	EIU1FADEC	
			TRACK CHECK		
1404	06	79-21-15	ENG18-0604- VOR VLV	EIU1FADEC	
			TRACK CHECK		
1404	06	71-00-00	ENG10-0041-ENG SURGE	EIU1FADEC	
1405	06	73-25-34	EIU1(1KS1)/ADIRU1(IFP1)	ADR 1	ADR 3
					ADR 2
1405	06	73-22-34	EECCE1-4000KS)	EIS 1	
1417	08	73-25-00	EIU1-155-MACELLE FAILED	EIU1FADEC	
			OPEN FAULT		

PFR After the IFSD Incident

1.18.3 PREAMBLE OF MEL

As per the approved MEL of M/s Go Airlines following are the definitions to be considered for invoking MEL

Flight:- For the purpose of an MEL, one flight is defined as the period of time that begins the moment at which an aircraft begins to move by its own means in preparation for takeoff, continues during takeoff and the applicable flight phases and ends when the aircraft lands and comes to a complete stop in its parking area.

Flight Hours: - For the purpose of an MEL, the Flight Hours (FHs) are to be counted based on the definition of a flight, i.e. the period of time that begins the moment at which an aircraft begins to move by its own means in preparation for takeoff, continues during takeoff and the applicable flight phases, and ends when the aircraft lands and comes to a complete stop in its parking area.

Note:- Flight Hours as here defines are synonymous with the term "block to block" time or "chock to chock" time in general usage which is measured from the time an aeroplane first moves for the purpose of taking off until it finally stops at the end of the flight.

Flight day:- A flight day is a 24 hour from midnight to midnight either UTC or local time as established by the aircraft operator during which at least one flight is initiated for the affected aircraft.

1.18.4 Maintenance planning Document

As per the manufacturer Airbus A320 maintenance planning document following are the definitions to be considered

Flight Hours: - Elapsed time between wheel lift off and touchdown.

Flight Cycle: - A complete takeoff and landing sequence.

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Flight Day: - 24 calendar elapsed. "DY" interval may be counted from 00.00 o'clock of next day (has not to include remaining day time since task completion)

1.18.5 Useful or Effective Investigation Techniques.

NIL.

2. ANALYSIS

2.1. Serviceability of the aircraft:

M/s Go Air Airbus A320 aircraft MSN 7074, Indian Registration VT-WGB with P&W 1100G Engines, was registered with DGCA under the ownership of SMBC Aviation Capital Ltd on 28th June 2016. The aircraft is registered under Category 'A' and the Certificate of Registration No is 4668. As on 8th Feb 2017, the aircraft had logged 2410:56 Airframe Hours and 1518 Cycles. The Aircraft was operated under Scheduled Operator's Permit No S-18 which was valid as on date.

The Airbus A320Neo aircraft and its engines are being maintained as per the maintenance program approved by the Regional Airworthiness Office, Mumbai. The last major inspection 3A check was carried out on 10/01/2017. The aircraft was last weighed on 01st June 2016 at Toulouse, France and the Weight Schedule was prepared and duly approved by the office of the Director of Airworthiness, DGCA Mumbai. Prior to the incident flight the weight and balance of the aircraft was well within the operating limits.

All the concerned Airworthiness Directive, Mandatory Service Bulletins, DGCA Mandatory Modifications on this aircraft and its engines has been complied with as on day of the event.

Transit inspections are carried out as per approved Transit Inspection schedules and all the higher inspection schedules include checks/ inspection as per the manufacturer's guidelines as specified in the Maintenance Program and are approved by the Continuing Airworthiness Manager (CAMO) – post holder for Continuous Airworthiness.

A320 neo aircraft with P & W 1100 G engines had series of failures with their operations after their induction worldwide. As of 31st July, 2017, details of premature removals of PW1100G engines worldwide are as follows-

- 26 Premature removals of engine due combustion chamber distress
- 77 Premature removals of engine due No.3 bearing distress
- Two Premature removals of engine due Main Gear Box failure
- The failed Engine S/N P770153 had logged 2403:06 hours and 1514 Cycles and the No. 2 Engine S/N P770148 had logged 2410:56 hours and 1518 Cycles.
- On further investigation, it was observed that during Boro-Scopic inspection on 11th October 2016 engine S/N P770153 with 1080 Hrs. had evidences of thermal barrier coating missing on bulkhead liner segment. Initially P&W gave disposition and permitted for an inspection interval of 1,350 hours on 12th October 2016. Later on 16th

October 2016 they updated it and permitted as per EA 16CCE00 for an inspection interval of 1,500 hours.

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- On 31st January 2017, Engine S/N P770153 had logged 2301:36 Hrs. During Boro-Scopic inspection it was observed OBL1/IBL1 Burn-back & Cracking in combustion chamber. P&W gave disposition and permitted for 750 Hour interval.

Subsequently on 8th February 2017, engine S/N P770153 experienced an in – flight shut down shortly after takeoff. It was sent to manufacturer facility for investigation. During detailed examination it was identified that the PMA rotor was not completely seated on its gear shaft which resulted in the fracture of the PMA bearing cage generating FOD over the period of time which eventually resulted in to the incident.

During further investigation, it was known that the engine chip light warning came during flight while operating the sector (BOM – DEL). At DEL the aircraft was cleared under MEL 79-09-06A (CAT A) for 10 Flight Hours. As per the approved MEL by DGCA the Flight Hours (FHs) are to be counted based on the definition of a flight, i.e. the period of time that begins the moment at which an aircraft begins to move by its own means in preparation for takeoff and ends when the aircraft lands and comes to a complete stop in its parking area. However as per the manufacturer Airbus A320 maintenance planning document the Flight Hours are defined as elapsed time between wheel lift off and touchdown. The AME while evaluating the flight hours had considered only the time period from takeoff to touch down and had not considered the overall engine run time as per the approved MEL.

If the AME would have evaluated the flight hours as per MEL the aircraft would have logged 10:15 Hours by the end of sector DEL-BLR which was above the restriction of MEL. Since the AME had only considered the time in air the aircraft would have logged 08:55Hours only after DEL – BLR sector.

From the above it is inferred that incident occurred due to error at the assembly stage itself. Further, the misinterpretation by the operator regarding the MEL flight hours for the release of aircraft with chip warning caused the engine to fail inflight.

2.2. Weather

Prior to take off from Delhi, the weather was fine. The aircraft took off from Delhi at around 1402 UTC and weather reported for Delhi was within the crew operating minima. The weather reported was fine with visibility reported 3500 meters with haze.

From the foregoing, it is inferred that the weather conditions were within the operating minima and is not the contributory factor to the incident.

2.3. DFDR Analysis

The aircraft initiated take off run at time 14:01:44 UTC wherein the oil pressure for engine 1 and 2 was recorded as 163 psi and 166 psi respectively. During the takeoff run for about 20 seconds and speeds around 108 knots, the engine 1 oil quantity started reducing, however the oil pressure was normal. As per DFDR at 14:02:24 UTC during lift off, oil pressure had reduced to 97psi.

As per FCOM, the oil pressure warning is inhibited during the take-off phase. Even though the oil pressure on Engine#1 was falling, during the takeoff run the cockpit crew had no

means to monitor the same. Immediately after liftoff at around 37 feet the master warning came ON. The system is inhibited to give specific indication till

1500 feet. The crew observed loss of N1 on #1 engine and reduced throttle at 1658ft. Subsequently the warning for Low oil pressure came ON at 1787 ft. The crew followed ECAM actions and inflight shut down of engine#1 was carried out at 14:03:20 UTC at 1838 ft. The increase in fuel flow indicates that the power on the other engine was increased and carried out single engine landing.

From the above it is inferred that the crew actions were in line with the standard operating procedures as per FCOM.

2.4. Circumstances leading to the incident:

During the first sector, in G8 – 329 (BOM – DEL) the Eng#1 Oil chip warning was triggered inflight. The aircraft landed safely at Delhi and was released for the next sector under MEL #79-09-06A – Eng#1 Oil Chip Detected alert. As per this MEL, in case of an actual alert on one engine, the aircraft may be dispatched for 10 flight hours even with one warning displayed on the Engine warning display.

As per the Airbus, in case of chip warning the MEL released is for 10 flight hours wherein the time to be considered is the total engine run time. The operator however calculated 10 flight hours from takeoff to touch down only. If the aircraft would have operated the incident sector then it would have logged 10:15 Hours in total considering the engine total run time. However since the operator had only considered time from take-off to touchdown the aircraft would have logged 08:55 Hours after completing the incident sector. This ambiguity/ misinterpretation of MEL by the operator resulted in the In-flight shut down while operating the sector DEL-BLR.

3. CONCLUSIONS:

3.1. Findings:

- a) The Certificate of Airworthiness and the Certificate of Registration of the aircraft was valid on the date of incident.
- b) The certificate of flight release was valid on the day of incident.
- c) All the concerned Airworthiness Directive, Service Bulletins, DGCA Mandatory Modifications on this aircraft and its engine were found complied with.
- d) Both the Pilots were appropriately qualified to operate the flight.
- e) There was no snag reported prior to the incident flight except for MEL for #1 engine oil chip detected warning. As per MEL the aircraft was released for 10 flight hours.

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- f) The Engine#1 Oil Quantity started dropping in the take-off roll at 14:01:55 and reached zero at 14:02:05.
- g) At 14:02:25 the aircraft lifted off the ground and in the next second the Master Warning triggered along with the ECAM message of Low Oil Pressure (RED) followed by Engine No1 Fail.
- h) At 14:03 UTC the Eng#1 stall warning came 'ON'. The crew shut down the engine and carried out the ECAM Checklist.
- i) The aircraft made a safe single engine landing at Delhi and taxied to bay.
- j) No external damage was done to the aircraft.
- k) There was no fire in the aircraft.
- l) On arrival of aircraft at Delhi, Oil leak was observed from Engine#1 Exhaust and oil quantity visually checked observed not within gaugable limit.
- m) As per the approved MEL by DGCA the Flight Hours (FHs) are to be counted based on the definition of a flight, i.e. the period of time that begins the moment at which an aircraft begins to move by its own means in preparation for takeoff and ends when the aircraft lands and comes to a complete stop in its parking area. However as per the manufacturer Airbus A320 maintenance planning document the Flight Hours are defined as elapsed time between wheel lift off and touchdown. The AME while evaluating the flight hours had considered only the time period from takeoff to touch down and had not considered the overall engine run time as per the approved MEL.
- n) The aircraft would have logged 10:15 Hours if the total engine run time is considered and if only take off to touchdown is considered then the aircraft would have logged 08:55Hours only after DEL – BLR sector.
- o) The examination of the engine's magnetic chip detectors revealed metallic debris that was consistent with the gearbox's permanent magnet alternator's (PMA) forward bearing cage.
- p) During disassembly the PMA forward bearing cage was found broken. The PMA rotor was out-of-position axially and circumferentially on the PMA gear shaft.
- q) After the incident, the engine strip inspection was carried out at manufacture facility. The report reveals that PMA Rotor was incorrectly installed on gearshaft during assembly stage allowing slinger to spin freely on gearshaft.
- r) The PMA rotor was not completely seated on its gear shaft and fractured the PMA bearing cage which over the period of time generated metal debris and eventually resulted into chip warning.

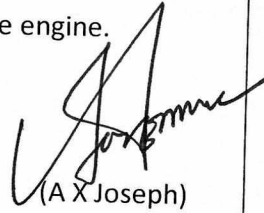
4. PROBABLE CAUSE

The cause of the incident was an error during assembly stage as the PMA Rotor was incorrectly installed on gearshift which over the period of time generated FOD and eventually resulted in to chip warning and subsequently engine shut down.

The misinterpretation of the MEL by the operator regarding flight hours for the release of aircraft with chip warning caused the engine to fail In-flight is a contributory factor.

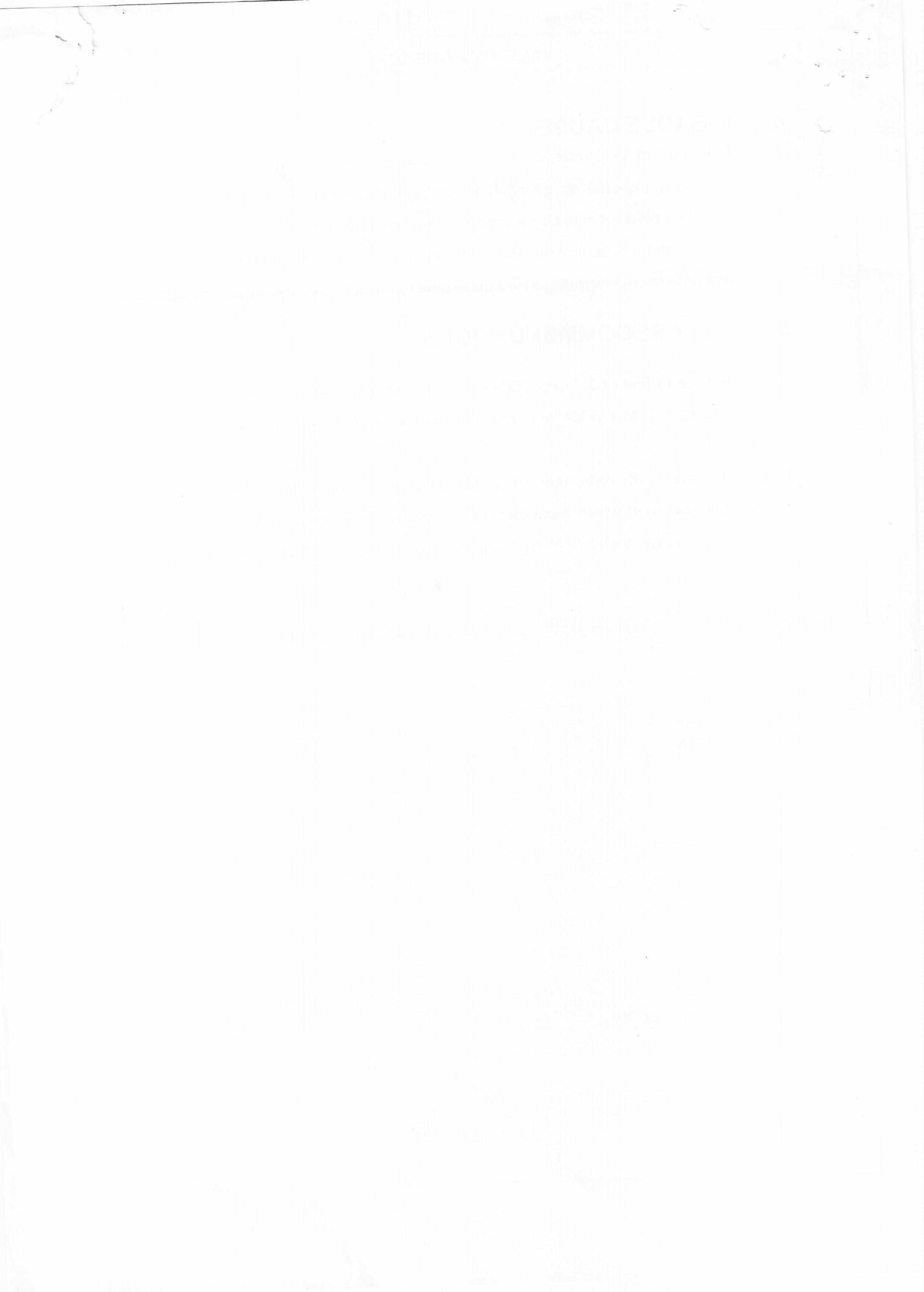
5. SAFETY RECOMMENDATIONS

1. In reference to finding 3.1. (m) DGCA may direct all operators to ensure that their certifying staff needs to follow DGCA approved documents/requirements strictly during certification work.
2. During assembly the PMA rotor was installed out-of-position axially and circumferentially on the PMA gear shaft which was observed during Strip examination of the engine. DGCA may take up the matter with P & W regarding the error during assembly stage of the engine.



(A X Joseph)
Dy. Director Air Safety
Inquiry Officer VT-WGB

Place: - New Delhi
Date:-15.06.2018



ABBREVIATIONS:-

DGCA	- DIRECTORATE GENERAL OF CIVIL AVIATION
FAA	- FEDERAL AVIATION ADMINISTRATION
P&W	-PRATT & WHITNEY
ECAM	- ELECTRONIC CENTRALIZED AIRCRAFT MONITOR
FLX-MCT	- FLEXIBLE TAKEOFF/MAXIMUM CONTINUOUS POWER
MEL	- MINIMUM EQUIPMENT LIST
EWD	- ENGINE WARNING DISPLAY
AME	- AIRCRAFT MAINTENANCE ENGINEER
ATPL	- AIR TRANSPORT PILOTS LICENSE
CPL	- COMMERCIAL PILOT LICENSE
CAMO	- CONTINUING AIRWORTHINESS MANAGER
MCD	- MAGNETIC CHIP DETECTOR
MGB	- MAIN GEAR BOX
LP	- LOW PRESSURE
HP	- HIGH PRESSURE
FADEC	- FULL AUTHORITY DIGITAL ENGINE CONTROL
FDGS	- FAN DRIVE GEAR SYSTEM
PMA	- PERMANENT MAGNETIC ALTERNATOR
EEC	- ELECTRONIC ENGINE CONTROLLER
PAPI	- PRECISION APPROACH PATH INDICATOR
TAF	- TERMINAL AERODROME FORECAST
CVR	- COCKPIT VOICE RECORDER
DFDR	- DIGITAL FLIGHT DATA RECORDER.
SEM-EDX	- SCANNING ELECTRON MICROSCOPE/ENERGY DISPERSIVE USING X-RAY
FOD	- FOREIGN OBJECT DAMAGE
LSOP	- LUBE & SCAVENGE OIL PUMP
MMEL	- MASTER MINIMUM EQUIPMENT LIST
TSM	- TROUBLE SHOOTING MANUAL
FCOM	- FLIGHT CREW OPERATIONS MANUAL
UTC	- UNIVERSAL TIME COORDINATED
HPT	- HIGH PRESSURE TURBINE