


# FINAL INVESTIGATION REPORT

# ON ACCIDENT TO

# JET AIRWAYS BOEING B-737-800 AIRCRAFT VT- JBG

# AT GOA ON 27.12.2016

Rajinder Singh Passi
Chairman, Committee of Inquiry

Jasbir Singh Larhga
Member, Committee of Inquiry

Capt Nitin Anand
Member, Committee of Inquiry

# *Foreword*

*In accordance with Annex 13 to the Convention on International Civil Aviation Organization (ICAO) and Rule 3 of Aircraft (Investigation of Accidents and Incidents), Rules 2012, the sole objective of the investigation of an accident shall be the prevention of accidents and incidents and not apportion blame or liability.*

*This document has been prepared based upon the evidences collected during the investigation, opinion obtained from the experts and laboratory examination of various components. Consequently, the use of this report for any purpose other than for the prevention of future accidents or incidents could lead to erroneous interpretations.*

## INDEX


| Para | Content | Page No. |
|---|---|---|
| | SUMMARY | |
| 1 | FACTUAL INFORMATION | 02 |
| 1.1 | HISTORY OF THE FLIGHT | 02 |
| 1.2 | INJURIES TO PERSONS | 06 |
| 1.3 | DAMAGE TO AIRCRAFT | 06 |
| 1.4 | OTHER DAMAGE | 10 |
| 1.5 | PERSONNEL INFORMATION | 11 |
| 1.6 | AIRCRAFT INFORMATION | 13 |
| 1.7 | METEOROLOGICAL INFORMATION | 14 |
| 1.8 | AIDS TO NAVIGATION | 14 |
| 1.9 | COMMUNICATIONS | 15 |
| 1.10 | AERODROME INFORMATION | 15 |
| 1.11 | FLIGHT RECORDERS | 15 |
| 1.12 | WRECKAGE AND IMPACT INFORMATION | 16 |
| 1.13 | MEDICAL AND PATHOLOGICAL INFORMATION | 18 |
| 1.14 | FIRE | 18 |
| 1.15 | SURVIVAL ASPECTS | 18 |
| 1.16 | TESTS AND RESEARCH | 18 |
| 1.17 | ORGANISATIONAL & MANAGEMENT INFORMATION | 20 |
| 1.18 | ADDITIONAL INFORMATION | 30 |
| 1.19 | USEFUL AND EFFECTIVE TECHNIQUES | 35 |
| | | |

| | | |
|---|---|---|
| 2 | ANALYSIS | 36 |
| 2.1 | SERVICEABILITY OF AIRCRAFT | 36 |
| 2.2 | WEATHER | 36 |
| 2.3 | POST ACCIDENT CONTINGENCY ACTION/ ERP OF AIRLINE | 36 |
| 2.4 | COMMAND TRAINING – TRANSITION FROM TURBOPROP TO TURBOJET | 37 |
| 2.5 | ANALYSIS OF PREVIOUS FLIGHTS (AIRCRAFT & PIC) | 38 |
| 2.6 | CIRCUMSTANCES LEADING TO THE ACCIDENT | 38 |
| | | |
| 3 | CONCLUSIONS | 42 |
| 3.1 | FINDINGS | 42 |
| 3.2 | PROBABLE CAUSE OF THE INCIDENT | 43 |
| | | |
| 4 | SAFETY RECOMMENDATIONS | 43 |

# FINAL INVESTIGATION REPORT ON ACCIDENT TO JET AIRWAYS BOEING B-737-800 AIRCRAFT VT- JBG AT GOA ON 27.12.2016

| | | |
|---|---|---|
| 1. | Aircraft Type | BOEING 737 - 800 |
| 2. | Nationality | INDIAN |
| 3. | Registration | VT - JBG |
| 4. | Owner | PENGUIN LEASING LIMITED, IRELAND |
| 5. | Operator | JET AIRWAYS |
| 6. | Pilot – in –Command | ATPL holder |
| | Extent of Injuries | Nil |
| 7. | Co-Pilot | CPL Holder |
| | Extent of Injuries | Nil |
| 8. | Place of Accident | Goa |
| 9. | Co-ordinates of accident Site | 15° 22' 47.42" N, 73° 49' 40.17" E |
| 10. | Last point of Departure | Goa |
| 11. | Intended place of Landing | Delhi |
| 12. | Date & Time of Accident | 27.12.2016 & 23:34 UTC |
| 13. | Passengers on Board | 138 |
| 14. | Extent of Injuries | Minor to 16 passengers |
| 15. | Crew on Board | 7 |
| 16. | Extent of Injuries | Nil |
| 17. | Phase of Operation | Take-off Roll |
| 18. | Type of accident: | Runway excursion during take-off roll |

(ALL TIMINGS IN THE REPORT ARE IN UTC)

## 1.0 FACTUAL INFORMATION

### 1.1 History of Flight

On 27.12.2016, during take-off a Boeing B-737-800 aircraft, operating a scheduled flight from Goa to Mumbai was involved in an accident at Goa. The flight was under the command of an ALTP holder with a CPL holder acting as First Officer. In addition to the cockpit crew, there were 154 passengers on board with five cabin crew manning the cabin.

The schedule departure of the flight was at 2310 UTC. The cockpit crew had reported for duty at 2220 UTC. The pre flight medical of the flight crew was carried out including the breath-analyser test. The test was satisfactory and the breath analysis was negative for alcohol. The flight crew then proceeded to aircraft after self briefing and collection of the flight documents.

On the aircraft, the Cabin crew was briefed by the flight crew including the information that they will carry out a short taxi. Flight crew had requested ATC for a pushback clearance at 2322UTC. ATC cleared the flight to line up on Rwy 26 by entering Taxiway N1 and backtracking. Crew had requested for intersection departure, but intersection departure was not allowed by the ATC. At 23:22:54 UTC, the starboard engine was started followed by start of port engine at 23:23:54 UTC.

At 2331 UTC, when the aircraft was carrying out taxi, ATC gave departure clearance to the aircraft. The aircraft was cleared to Mumbai at FL220. Aircraft thereafter lined up on Rwy 26 after making a 180° turn at the dumbbell. At 23:32:13 ATC clarified the departure clearance was through airway R461 via waypoint Okila to Mumbai. At 2333 UTC, aircraft was cleared for take-off.

The aircraft was configured for a flaps 5 departure. The calculated takeoff speeds for 64.6 tons were V1 as 135, VR as 141 and V2 as 146. The crew completed the before take-off checklist and at 23:33:04 crew started pushing TLA to increase the thrust. As per the statement of crew, after taking TLA ahead of 40%, PIC pressed TOGA for takeoff.

As soon as TOGA was pressed, the aircraft started drifting towards right. Within 10 to 12 seconds of pressing TOGA, the aircraft went into unpaved surface. As per the crew, they tried to apply brakes, rudder and use NWS to

steer the aircraft, but due to heavy bumps could not apply control effectively. The aircraft went out of control and continued into unpaved surface.



TRAJECTORY FOLLOWED BY THE AIRCRAFT

The aircraft stopped at a distance of 219 m from the runway edge and just short of periphery road. During this trail it had hit PAPI lights.



PAPI LIGHTS

Engine had hit vertical pillar of 2.3 m height, located at 92.3 m abeam center line of Runway 26. The pillar has also damaged the left bottom portion of the fuselage.



PILLARS (after aircraft impact)



Engine damaged due hitting pillar

As per statement of Cabin Supervisor who was seated at L1 position, cabin crew had observed aircraft drifting to right very vigorously and shaking badly. Noticing the abnormal situation, cabin crew started shouting brace commands. Cabin supervisor was also informed of smoke like dust in cabin by the cabin crew seated at R1. As soon as the aircraft came to stop, Cabin crew in charge of aft galley made an announcement on PA system asking passengers to remain seated.

In the meanwhile at 2235 UTC crew declared MAYDAY. Captain then came on PA and gave EVACUATE command. All cabin crew checked the external condition and opened the door, inflating the emergency chutes. After ascertaining the external condition, evacuation was initiated. The cabin crew seated at R3 position was instructed by the Aft galley in-charge to rush towards over wing exit. The cabin crew tried to run to over-wing exits, but due to rush of passengers towards aft doors, she could not go ahead of 38$^{th}$ row. She was then instructed to evacuate from R2 door and assist passengers on ground.



FINAL POSITION OF THE AIRCRAFT

At 22:39 UTC crew informed ATC of having evacuated all passengers. L1, L2, R1 and R2 cabin crew evacuated after evacuating all passengers, taking along the safety and medical kits. Co-pilot and subsequently Captain also evacuated the aircraft.



The passengers were taken away from the aircraft by the cabin crew and made to gather close to a nearby post. A few passengers who were going towards tarmac were stopped and also instructed to gather at one place. Megaphone was used to pass instructions to the passengers. In view of the

absence of emergency services, cabin crew assisted the passengers and provided first aid to passengers who had sustained injuries during the evacuation. Emergency services arrived after approximately 20 minutes as per the statement of crew. On arrival of ambulances and buses, headcount was carried out and passengers were moved to terminal building. Total of 16 passengers received injuries during evacuation.

### 1.2 Injuries to persons

| INJURIES | CREW | PASSENGERS | OTHERS |
|---|---|---|---|
| FATAL | Nil | Nil | Nil |
| SERIOUS | Nil | Nil | Nil |
| MINOR/ NONE | 0/7 | 16/138 | Nil |

### 1.3 Damage to the aircraft

The aircraft suffered substantial damage during the accident. Some of the major damages are as follows:

- Nose landing gear oleo got damaged and found completely buried under the aircraft nose.



- Damage to LH side fuselage rearwards of aft of the front LH main door.



- Damage to LH engine cowling.



- LH engine pylon attachment broken.



- Damage to LH engine fan blades.



- Damage to LH landing gear wheel &Tyre.



- Damage to RH engine.



- Damage to RH Wheel &Tyre.



### 1.4 Other damages

The aircraft had hit a PAPI light and damaged glass of another PAPI light.



Broken PAPI Light



Broken glass of other PAPI Light

## 1.5 Personnel information

### 1.5.1 Pilot – in – Command

| | | |
|---|---|---|
| AGE | : | 36 years |
| License | : | ALTP Holder |
| Validity of License | : | 29.08.2020 |
| Category | : | Aeroplane |
| Endorsements as PIC | : | ATR72-500, B737 NGs |
| Date of Med. Exam. | : | 30.05.2016 |
| Med. Exam valid upto | : | 29.05.2017 |
| FRTO License Validity | : | 30.09.2017 |
| Total flying experience | : | 5741:54 Hrs |
| Experience on type | : | 491:18 Hrs |
| Experience as PIC on type | : | 368:26 Hrs |
| Total flying experience during | | |
| last 180 days | : | 305:14Hrs |
| last 90 days | : | 213:42Hrs |
| last 30 days | : | 47:16 Hrs |
| last 07 Days | : | 08:38 Hrs |
| last 24 Hours | : | 03:07 Hrs |

### 1.5.2 Co-Pilot

| | | |
|---|---|---|
| AGE | : | 33 years |
| License | : | CPL Holder |
| License Validity | : | 08.06.2019 |
| Category | : | Aeroplane |
| Endorsements as First Officer | : | B737 NGs |
| Date of Med. Exam | : | 21.07.2016 |
| Med. Exam valid upto | : | 20.07.2016 |
| Total flying experience | : | 723:40 Hrs |
| Experience on type | : | 472:35 Hrs |
| Total flying experience during | | |
| last 180 days | : | 265:17 Hrs |
| last 90 days | : | 113:47 Hrs |
| last 30 days | : | 19:19 Hrs |
| last 07 Days | : | 11:48 Hrs |
| last 24 Hours | : | 03:07 Hrs |

Neither the First Officer nor the Pilot in Command was earlier involved in any occurrence.

## 1.6 Aircraft Information

The aircraft was manufactured on 5th March 2008 (Aircraft Manufacturers Serial Number - 35083) and is presently registered with DGCA India under Category 'A' and the Certificate of registration No. 3719/3 valid upto 10.03.2022. The ownership of the aircraft as per the Certificate of Registration is with M/s Penguin Leasing Limited, Ireland.

The Certificate of Airworthiness Number 4028 under "Normal category" was issued by DGCA and was valid on the date of accident subject to validity of ARC. ARC was issued on 03.03.2017 and was valid upto 05.03.2017. The specified minimum operating crew is two and the maximum all up weight of the aircraft is 79,015 Kgs.

The last major inspection on aircraft was “C” check carried out at 26700 Hrs and 11709 cycles on 11th Oct 2014 at Mumbai. Subsequently all lower inspections (Pre-flight checks, Service Checks, Weekly Checks) were carried out as and when due before the incident.

The aircraft was last weighed on 27.02.2013 at Mumbai and the weight schedule was prepared and duly approved by the office of DGCA. As per the approved weight schedule the Empty weight of the aircraft is 42553Kg. Maximum Usable fuel Quantity is 20446 Kgs. Maximum payload with fuel tanks full is 14966 Kgs. Empty weight CG is 657.23 inches aft of datum. As there has not been any major modification affecting weight & balance since last weighing, hence the next weighing was due on 28.02.2018. Prior to the accident flight the weight and balance of the aircraft was well within the operating limits.

After last check „C", there was no major repair carried out on the aircraft. Left hand outboard aft flap de-lamination, inlet cowl sunk rivet damage & slat dent damage were repaired as per the SRM. Last “A“ check was carried out at Mumbai on 12th Sept 2016 at 34930:12 Hrs /15382 Cycles. Last Layover inspection was carried out at Mumbai on 25th Dec 2016 at 36256:21 Hrs /15997 Cycles.

The aircraft was fitted with two CFM 56-7B engines. LH Engine S/N 890668 was manufactured in Nov 2003 and had logged 40262 Hrsand 23911 cycles on the date of accident. Last major inspection was Core Performance

Restoration which was carried on 14th Jan 2014. There were no repairs carried out thereafter.

RH Engine S/N 894893 was manufactured in Aug 2007 and had logged 28553 Hrs and 18908 cycles on the date of accident. Last major inspection was Core Performance Restoration which was carried on 02nd Nov 2015. There were no repairs carried out thereafter.

The Nose landing Gear (P/N: 162A1100-13 S/N : MAL01730Y2535), LH main landing Gear (P/N: 161A1100-53 S/N : MAL05235Y2535) and RH main landing Gear (P/N: 161A1100-54 S/N : MAL05236Y2535) were original installation and had logged 36266 hours since new & 16004 cycles since new.

Aircraft was under MEL 36-5-2 for LH engine bleed inoperative which was invoked at Abu Dhabi while operating the previous flight (Abu Dhabi- Goa). All the concerned Airworthiness Directive, mandatory Service Bulletins, DGCA Mandatory Modifications on this aircraft and its engine has been complied with as on date of accident.

## 1.7 Meteorological information

The ATIS services were not available and weather was obtained by the First Officer. The weather information provided for takeoff was as follows:

| | |
|---|---|
| Winds | Variable 3 knots |
| Visibility | 4000 meters in haze |
| Temperature | 21° C |
| Dew Point | 01° C |
| QNH | 1010.2 hPa |

There were no significant clouds

## 1.8 Aids to navigation

The aids to navigation for runway 26 at Dabolim Airport Goa consist of an Instrument Landing System (ILS) and Distance Measuring Equipment (DME).

Global Positioning System, ME receivers, ILS receivers, ATC transponders, VHF Omni Directional Radio receivers, ADF, auto-pilot& Flight Director System were installed on the aircraft.

## 1.9 Communication

There was proper two way communication between the aircraft and the ATC/ Ground facilities

## 1.10 Aerodrome Information

Dabolim airport is a defence airfield where civil terminal services are provided by Airport Authority of India and Airport Operations are handled by the Indian Navy. The ICAO aerodrome code for this aerodrome is VOGO. The Geographical Co-ordinates of the airport are 15° 22' 47.42" N, 73° 49' 40.17" E and elevation is 45.8 m.

The details of the runway are as below:

Orientation - 08/26

Dimension - 3430MX45M

| Runway | Elevation ( Ft.) | LDA | TORA | TODA | ASDA |
|---|---|---|---|---|---|
| 08 | 111.5 | 3430M | 3430M | 3580M | 3580M |
| 26 | 185 | 3430M | 3430M | 3635M | 3635M |

Runway re-carpeting was done in June 2015.

## 1.11 Flight recorders:

Aircraft was fitted with SSFDR and SSCVR.

**SSFDR** Part No. 2100-4043-00/ S.No. 000501540

**SSCVR** Part No. 980-6022-001/ S.No. CVK120-04456

Both the units were removed after the accident. Readout of the SSCVR and downloading of the SSFDR was carried out for investigation purposes.

The relevant details of the readout and the correlation for the circumstances leading to the accident are discussed in the analysis portion of this report.

### 1.12 Wreckage and impact information

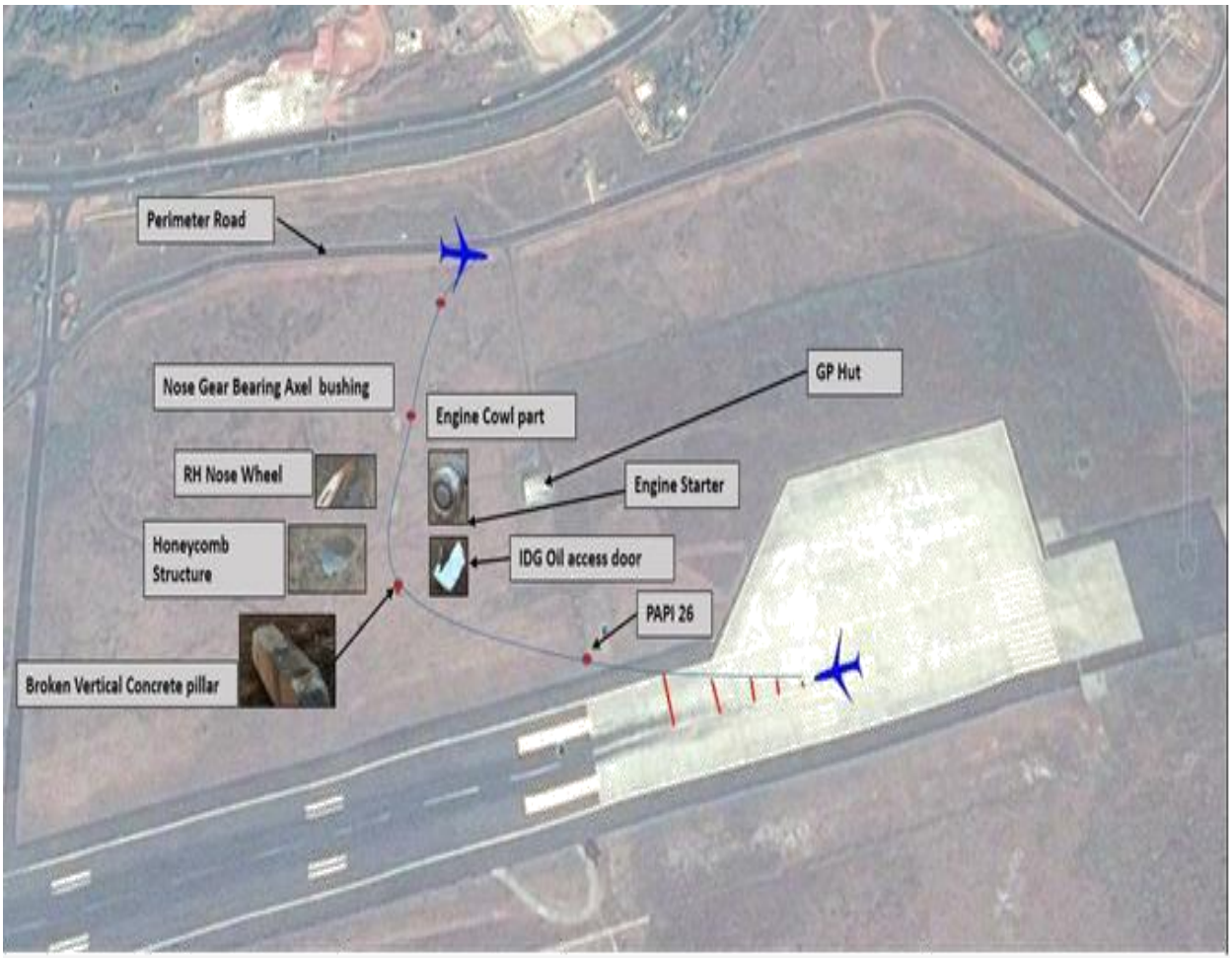



The crew after getting approval for push back and startup, started engine number 2 followed by engine no 1. Taxi was then commenced and the aircraft backtracked runway 26 for departure. The aircraft heading was 256 prior to commencement of take-off roll. The flight crew rejected take-off as the aircraft was drifting towards right after the TOGA was pressed.

The crew could not control the aircraft and it went into kutcha. The aircraft stopped at a distance of approximately 219 m from the Rwy centre-line, just short of periphery road. There were some unused RVR observation vertical cement pillars of approx 2.3 m height in the path traversed by the aircraft. Though the aircraft stopped and the wreckage was self contained, there were following structural damages due high speed travel on the undulatedground

surface and impact with the above mentioned vertical cement pillars.

- LH and RH forward lower fuselage (from STN 360 to forward lower Nose compartment)
- LH engine
- Tread and sidewall of both tyres of RH MLG were badly scrapped.
- Nose gear was folded backward into area between E/E compartment and wheel bay.
- RH Engine inboard side
- LH MLG No. 1 wheel hub and both tyres.




WRECKAGE DIAGRAM

## 1.13 Medical and pathological Information

Both the flight crew and 05 cabin crew have undergone pre-flight medical including the breathanalyzer test. The medical was satisfactory and breathanalyzer test results were negative. Both the flight crew has also given the blood and urine samples post flight as per the requirements.

## 1.14 Fire

There was no fire barring that one of the flap track fairing had burn marks.



## 1.15 Survival aspects

The accident was survivable.

## 1.16 Tests and research

Both the engines of the aircraft were damaged during the accident. The engines were sent for strip examination to Manufacturer‟s approved facility ST Aerospace, Singapore. The initial boroscope examination of the engines indicated significant internal damage to the **LH engine, ESN 890668** and substantial damage to the **RH engine, ESN 894893**.

The observations and findings of boroscopic examination and detailed examination of the **LH Engine, ESN: 890668** are as follows:

- HP Compressor stator vane shrouds had minor rubbing marks.
- Dirt and debris were noticed at No. 4 swivel nozzle in Combustion Chamber.
- Dirt and deposits were also noticed on HPT shrouds.
- LPT blades were found melted
- There were debris at 6 o'clock Position in the engine exhaust area
- Engine thrust link was bent at the middle.
- Oil tank was cracked and mounting bolts were sheared off. The holes for mounting bolts were elongated.
- Air starter housing had a dent and crack.
- All the fan blades had nicks and tears. The fan Case lining was completely missing with parent metal exposed.
- Fan case Drain Tubes were found dented.
- FAN OGV"s had Multiple Nicks and Dents.
- Outer Metallic and Rubber Braids of J7 and J8 harness had got damaged due to impact with the hard ground.
- Gear box lower mounting lugs had scratch marks and were damaged.
- Engine driven Hydraulic Pump housing was found broken.
- HMU had dent on body.
- Fuel Filter , Oil Supply Filter and Scavenge filter condition was satisfactory/normal
- All Magnetic Chip detectors and Scavenge screens were removed and inspected. Composite material debris were found on FWD MCD and Silver filament on FWD Screen.
- Booster was found in a good condition, Nil Defects were observed.
- On HPC one blade had had a minor nick in stage 1 & 2 each.
- Minor rub marks were noticed on stator vane shrouds of stage 4.
- 01 blade of Stage 9 was found with nick marks in area A.
- Discoloration &Carbon accumulation observed in Combustion Chamber.
- Material blockage was observed at no.4 secondary swirl nozzle of the combustion chamber. The material probably appears to be the debris sucked in during the accident.
- Axial Crack was noted at outer liners.

- HPT NGV Leading edge convex and concave surfaces found with Unknown material (external Debris)
- HPT Blades were found melted, with HPT shroud having material deposit (debris)
- LPT Blades were found melted, with unknown material on Leading edge convex and concave surfaces.

The observations and findings of boroscopic examination and detailed examination of the **RH Engine, ESN: 894893** are as follows:

- Impact damage was seen on the IDG.
- AGB was broken
- Servo Fuel Heater was broken.
- TGB shaft housing was bent.
- Leading edge distortion was observed on one of the Fan Blades.
- Fuel Filter, Oil Supply Filter and Scavenge filter condition was satisfactory.
- All Magnetic Chip detectors and Scavenge screens were removed, inspected and found satisfactory.

## 1.17 Organizational and management information

### 1.17.1 Aircraft Operator – The Airline

#### 1.17.1.1 Operations & Training

The aircraft was operated by scheduled airline. It has got divisions of flight operations, Engineering (145 organisation), both engineering and flight training, In-flight Services and Flight Safety including Safety Management System etc.

The operations department has got fleet offices which issues the Standard Operating Procedures, Operations Manual including the Training Manual for training of the crew. It also co-ordinates with the Flight Safety Department regarding the changes in the procedures or callouts etc. based on the findings/ recommendations from the various proactive and reactive activities. The flight crew training department plans the training including the upgrade training of Captain, Instructor examiner etc. A captain on the turbo prop fleet can

shift to the Captain on turbojet fleet by undergoing the requisite training and flying experience as per the laid down regulations on the subject.

As per the Operations Manual Part „D" Training, ground training& simulator training/ checks syllabus for conversion from Captain ATR to Captain B737 is as given below (highlighted):

| JET AIRWAYS | OM PART D : TRAINING | JA/OPS/004 | |
|---|---|---|---|
| | CONVERSION TRAINING AND CHECKING | SECTION 1 - CHP 3 | |
| | TRAINING COURSE SYLLABUS B737 NG | REV 8.2 | 01 OCT 2016 |

| No | Course | Ground Training (hrs) | SIMULATOR TRAINING & CHECKING | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | FBS | FFS | FFS LOFT | SKILL TEST | | IRPPC (CA 41) | AWO | LVTO | ZFTT |
| | | | Sessions | | | DAY (CA 40) | NIGHT (CA 40) | | | | |
| 6 | Operator's Conversion Course (OCC 738 - P1/P2) | | | | | | | | | | |
| Recency Upto 90 days | | 52 | X | 2 | X | X | X | ✓ | ✓ # | ✓ | X |
| Recency 90 days to 12 Months | | 59 | X | 2 | X | X | X | ✓ | ✓ # | ✓ | X |
| Recency 12 Months to 24 Months | | 59 | X | 4 | X | X | X | ✓ | ✓ # | ✓ | X |
| Recency 24 Months to 36 Months | | 59 | X | 6 | X | X | X | ✓ | ✓ # | ✓ | X |
| 7 | Captain ATR to Captain B737 | | | | | | | | | | |
| Adapted Transition Course (ATC 738-P1) | | 180 | 5 | 8 | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ |

For line training syllabus for conversion from Captain ATR to Captain B737 is as given below (highlighted):

| JET AIRWAYS | OM PART D : TRAINING | JA/OPS/004 | |
|---|---|---|---|
| | CONVERSION TRAINING AND CHECKING | SECTION 1 - CHP 3 | |
| | TRAINING COURSE SYLLABUS B737 NG | REV 8.2 | 01 OCT 2016 |

| No | Course | LINE TRAINING | | | | | |
|---|---|---|---|---|---|---|---|
| | | Supernumerary | *Base Trg | 01 Sector Initial Route Check | SLF | **10 PIC Route Check | ***Line Release Route Check |
| 3 | **Non- Rated Co-Pilot ATR/A330/B777 to Captain B737** | | | | | | |
| Non-Rated Command Upgrade **(NCU 738)** | | 25 hours or 15 Sectors whichever is later | X | ✓ Without Safety Pilot | 100 hrs or 12 sectors (whichever is later) from LHS | ✓ | ✓ |
| 4 | **Rated B737 Co-Pilot to Captain B737** | | | | | | |
| Rated Command Upgrade **(RCU 738)** | | X | X | ✓ Without Safety Pilot | 75 hrs or 10 sectors (whichever is later) from LHS | ✓ | ✓ |
| 5 | **JetLite to Jet Airways** | | | | | | |
| **(JOCC 738)** | | 02 Sectors | X | X | 06 Sectors | X | ✓ |
| 6 | **Operator's Conversion Course (OCC - P1/P2)** | | | | | | |
| Recency Upto 90 days | | 04 Sectors | X | X | 06 sectors | X | ✓ |
| Recency 90 days to 12 Months | | | | | | | |
| Recency 12 to 24 Months | | | | | | | |
| Recency 24 to 36 Months | | | | ✓ | | | |
| 7 | **Captain ATR to Captain B737** | | | | | | |
| Adapted Transition Course **(ATC738-P1)** | | 25 hours or 15 Sectors whichever is later | X | ✓ Without Safety Pilot | 100 hrs or 12 sectors (whichever is later) from LHS | ✓ | ✓ |

**Non Normal Procedures for B-737**

Following are the contents of the B-737 Flight Crew Operations Manual (FCOM) regarding Non Normal Procedure – Reject Take-off.



**WARNING: ** Excessive use of pitch trim or rudder may aggravate the condition, or may result in loss of control or in high structural loads.**

## Rejected Takeoff

The captain has the sole responsibility for the decision to reject the takeoff. The decision must be made in time to start the rejected takeoff maneuver by V1. If the decision is to reject the takeoff, the captain must clearly announce "REJECT," immediately start the rejected takeoff maneuver and assume control of the airplane. If the first officer is making the takeoff, the first officer must maintain control of the airplane until the captain makes a positive input to the controls.

Prior to 80 knots, the takeoff should be rejected for any of the following:

- activation of the master caution system
- system failure(s)
- unusual noise or vibration
- tire failure
- abnormally slow acceleration
- takeoff configuration warning
- fire or fire warning
- engine failure
- predictive windshear warning
- if a side window opens
- if the airplane is unsafe or unable to fly.

Above 80 knots and prior to V1, the takeoff should be rejected for any of the following:

- fire or fire warning
- engine failure
- predictive windshear warning
- if the airplane is unsafe or unable to fly.

During the takeoff, the crewmember observing the non-normal situation will immediately call it out as clearly as possible.

Actions to be taken by the flight crew during reject takeoff are as follows:

| Captain | First Officer |
|---|---|
| Without delay:<br>Simultaneously close the thrust levers, disengage the autothrottles and apply maximum manual wheel brakes or verify operation of RTO autobrake.<br>If RTO autobrake is selected, monitor system performance and apply manual wheel brakes if the AUTO BRAKE DISARM light illuminates or deceleration is not adequate.<br>Raise SPEED BRAKE lever.<br>Apply reverse thrust up to the maximum amount consistent with conditions.<br>Continue maximum braking until certain the airplane will stop on the runway. | Verify actions as follows:<br>Thrust levers closed.<br>Autothrottles disengaged.<br>Maximum brakes applied.<br>Verify SPEED BRAKE lever UP and call "SPEEDBRAKES UP." If SPEED BRAKE lever is not UP, call "SPEEDBRAKES NOT UP."<br>Reverse thrust applied. When both REV indications are green, call "REVERSERS NORMAL."<br>If there is no REV indication(s) or the indication(s) stays amber, call "NO REVERSER ENGINE NUMBER 1", or "NO REVERSER ENGINE NUMBER 2", or "NO REVERSERS".<br>Call out omitted action items. |

As per the Minimum Equipment List for B-737, following Maintenance procedure is to be followed for Engine Bleed Air Shut Off Valve inoperative:

**B-737 MINIMUM EQUIPMENT LIST & DISPATCH DEVIATIONS PROCEDURES GUIDE**

***PNEUMATICS*** ***ATA 36***

**36-5 Engine Bleed Air Shutoff Valves (PRSOV)**

**2) (-700/-800/-900/-900ER)**

| Interval | Installed | Required | Procedure |
|---|---|---|---|
| C | 2 | 0 | (M) (O) |

Except for ER operations beyond 120 minutes, may be inoperative provided :

a. Valve is secured closed before engine start, and
b. Airplane is not operated in known or forecast icing conditions.

***Dispatch Deviations Procedures Guide (DDPG)***

***MAINTENANCE (M) PROCEDURES***

***For (- 700 / - 800 / - 900):***
*Lock the associated engine bleed air valve in the closed position (AMM 36-00-00 / 901).*

***For All Models:***
*1. Deactivate the leading edge slats in the retracted position (AMM 27-81-00/201).*
*2. Deactivate the associated thrust reverser (AMM 78-31-00/201).*
*3. Gain access to the engine bleed air valve by opening the appropriate fan cowl panel (AMM 71-11-02/201) and thrust reverser (AMM 78-31-00/201).*
*4. Lock the engine bleed air valve in the CLOSED position.*
*A. Turn the override nut to align the position indicator with the CLOSED position.*
*B. Loosen the lock screw / knob bolt and push in locking knob to lock valve in closed position.*
*C. Retighten lock screw / knob bolt.*
*5. Close fan cowl panel (AMM 71-11-02/201) and thrust reverser (AMM 78-31-00/201).*
*6. Activate the thrust reverser (AMM 78-31-00/201).*
*7. Activate the leading edge slats (AMM 27-81-00/201).*

The Operational Procedures are as given below:

***OPERATIONAL (O) PROCEDURES***

***NOTE 1** : Operating two air conditioning packs with one engine bleed is not recommended. Use of the APU bleed air is limited to 17,000 feet. One air conditioning pack will be unusable when dispatching with :*

*(1) the right engine bleed inoperative,*
*(2) the left engine bleed inoperative and flight altitude greater than 17,000 feet, or*
*(3) both engine bleeds inoperative.*

*NOTE 2:When dispatching with a single engine bleed on for takeoff (airplane pressurized), Carry out Supplementary procedure – Air systems "No Engine Bleed Takeoff and Landing".*

*1. Do not dispatch into known or forecast icing conditions.*
*2. Associated engine bleed switch is selected to the OFF position.*
*3. For left engine bleed inoperative :*

*A. At altitudes 17,000 feet and below, operate the left pack using the APU bleed air, the right pack using the right engine bleed and the isolation valve CLOSE.*

*B. At altitudes above 17,000 feet, operate with the APU bleed air OFF.*
*1) Limit altitude to FL 250.*
*2) Operate the left pack using the right engine bleed, the right pack OFF and isolation valve OPEN.*

*4. For right engine bleed inoperative :*
*A. Limit altitude to FL 250.*
*B. Operate the left pack using the left engine bleed, right pack OFF, and isolation valve CLOSE.*

### 1.17.1.2 Emergency Response Plan of Airline

The airlines have issued new Emergency Response Manual in March 2015 which was further amended in July 2015. The relevant portions of the Manual are:

The Airlines Emergency Response Planning Section (the „Section") shall continually strive to ensure that all other appropriate departments, business units and individuals within the airline, having (specific and / or implicit) roles and responsibilities requiring response during a catastrophic aircraft accident type emergency (or similar impact emergency), are always fully prepared, trained and exercised accordingly. This shall also apply, where appropriate, to any third parties supplying emergency response services to the airline, insofar as is possible, practicable and permissible so to do.

The Section shall plan for, procure, establish, maintain, review and enhance appropriate personnel, equipment, infrastructure, IT /

Telecommunications, budgetary and similar resources required to effectively, efficiently and expediently conduct any such emergency response preparation, implementation and response.

Finally, the Section shall demonstrate its ability to consistently provide an emergency response service which meets or exceeds all stakeholder requirements, by demonstrating continual improvement of said service.

All of the above shall be accomplished in order to attain the ultimate goal of achieving successful emergency response solutions and conclusions - from Humanitarian, Safety, Crisis Communications, Operational, Regulatory, Corporate and any other appropriate viewpoints.

As per para 7.7.2 of the ERP Manual, in the event of an aircraft accident, the Airport Manager at the Station Nearest is responsible for handling all details, until the arrival of the Jet Airways Field Team.The Airport Manager is the primary person at the airport of the accident. His prime responsibilities are:

- Provision of welfare and support to the passengers, crew members, relatives and friends of passengers;
- Provision of information to the Airport Emergency Control Centre;
- Protection of property belonging to passengers, crewmembers and Jet Airways;
- Telephone call to the Jet Airways ERC thirty minutes after the initial alarm call to Jet Airways IOCC.

In coordination with airport authorities, following should be planned for the airport:

- Local / national laws and regulations should be clarified.
- Plans should be updated regularly.
- Plans, priorities and restrictions of the ground handling agents who act on behalf of the airline.
- Emergency response facilities and organisational elements. Local abbreviations should also be defined.
- Regular programme of visits by airline and handling agent personnel to the emergency centres of the airport and local authorities.

- Plans should include the airport annual exercise programme.
- Due consideration should be given to the plans, priorities and restrictions of the ground handling agents who act on behalf of the airlines.
- Plans should be openly shared with airports and handling agents.
- Plans should include the airline station annual exercise.

**Take-off Procedure**

The actions of the flight crew during take-off as per the Standard Operating Procedure given in FCOM is as follows:

| JET AIRWAYS | B737 FLIGHT CREW OPERATIONAL MANUAL | JA/OPS/199 | |
|---|---|---|---|
| | STANDARD OPERATING PROCEDURE – AMPLIFIED PROCEDURE | CHAPTER 1 | |
| | TAKEOFF PROCEDURE | REV 16.0 | 15 JAN 2016 |

**1.14 TAKEOFF PROCEDURE**

| Pilot Flying | Pilot Monitoring |
|---|---|
| Align the airplane with the runway. | ARM the A/T. |
| Captain: Advance the thrust levers to approximately 40% N1.<br>Allow the engines to stabilize.<br>Push the TO/GA switch | First officer: Start the elapsed timer on the clock. |
| Verify that the correct takeoff thrust is set. | |
| | Monitor the engine instruments during the takeoff. Call out any abnormal indications.<br>Adjust takeoff thrust before 60 knots as needed.<br>During strong headwinds, if the thrust levers do not advance to the planned takeoff thrust, manually advance the thrust levers before 60 knots.<br>Call "THRUST SET". |
| After takeoff thrust is set, the captain's hand must be on the thrust levers until V1. | |
| Monitor airspeed.<br>Maintain light forward pressure on the control column up to 80 knots. | Monitor airspeed and call out any abnormal indications. |
| Verify 80 knots and call "CHECK." | Call "80 KNOTS." |

#### 1.17.1.3 Evacuation

The actions taken by the cabin crew for carrying out the evacuation after the evacuation command was given by the flight deck were carried out as per SOP defined by cabin safety training team.

In the present case, the above was followed barring that the crew at R3 position could not reach the over wing exit due to push by the guests backwards. Some of the guests were blocking the evacuation path on ground by standing next to the slide. She evacuated through R2 door, moved the passengers away from the slide and carried out the ground duties as per SOP.

After all the crew have evacuated, the guests were moved away from the aircraft and were assembled near a small hut which was away from the aircraft as there was some light at that place. Immediately first aid and other medical assistance was given with simultaneous head count of the guest. After the passengers have left the site for terminal building, the crew also left the place and as desired waited at the terminal building.

As per the Cabin crew, when all passengers moved from the left hand side of the aircraft to the right hand side of the aircraft and first aid was being administrated, the airline supervisor came and inquired about the accident and she told the cabin crew that she had been given half the information i.e. the aircraft had skidded off the runway. She then started coordinating the facilitation of the guests. However the cabin crew have not seen station manager at the accident site.

### 1.17.2 Aerodrome Operator – ATC & Operations

The aerodrome is a Defence Aerodrome. The ATC and Operations is with the Defence authorities and the civil terminal including passenger facilitation and apron is with the Airports Authority of India. The aerodrome operator has prepared a contingency plan to deal with the Civil Aircraft crash.

The relevant portion of the plan is reproduced below:

**CONTINGENCY PLAN TO DEAL WITH CIVIL AIRCRAFT CRASH**

The purpose of an airport contingency plan is to ensure that there is:-

- Orderly and efficient transition from normal to emergency operations.
- Delegation of airport emergency authority.
- Assignment of emergency responsibilities.
- Authorization by key personnel for actions continued in the plan.
- Co-ordination of efforts to cope with the emergency.
- Safe continuation of aircraft operation or return to normal operation as soon as possible.

As per the contingency plan available with the airport authorities (Goa),

"The responsibility of civil aircraft accident investigation is with the inspector of accident or the Director General Civil Aviation (DGCA) or in his absence an officer from the Air Safety Directorate of the Civil Aviation Department (CAD). The removal of the wreckage is to be undertaken only after the investigation team accords approval. All agencies are to render maximum assistance to the investigation team in order to enable them to arrive at the exact cause of the accident."

Further the document contains the action to be taken for medical check upfor crew members (alive), i.e.

"the duty medical Officer shall conduct a comprehensive physiological and physical check-up compromising of General and systematic medical examination, especially in status of CNS and higher centers, of each air crew presented to him. The detailed finding along with special remarks, if any recorded in three copies. Each copy should be countersigned by the individual examined and the official who has been presented the air crew to the duty Medical Officer for the check-up. The time and date of the check-up must be noted.

The responsibility of bringing the concerned Captain & Co-pilot to the medical officer shall rest with airline operators. Hence, Airline shall bring the Captain and Co-pilot to Medical Officer without any delay."

## 1.18 Additional information

### 1.18.1 Chronology of events at the site of accident

As per the chronology submitted by the operator about the events, at 2320 Z the Chocks were taken off for the aircraft to operate the flight. At 2337 Z Duty Officer received call from Ramp staff that there was a large sound and flight was not airborne. At 2340 Z Duty Officer spoke to ATC to check and ATC informed, that the flight has skidded off the runway. At 2343 Z hrs Duty Officer spoke to ATC, who informed the duty officer to arrange ground equipment/ Coaches/ Ambulances/Tow bar/ Tow truck.Most of the equipment was arranged immediately as these were on ramp area.

However the hospitals which the operator contacted for Ambulancescould not provide as the ambulances were unserviceable. Other ambulance services like 108 ambulances were also called. AAI was informed to arrange for the AAI ambulance.These personnel could not proceed to the Site as they did not have the follow me vehicle. At 0000 Z reached the end of the runway but could not reach the site as it was too dark and no direct path to the site. At 0005 Z hrs reached the site with DO/ Engineers/ Security staff/ Loaders.

Two CFTs were activated during the crash. As per the CFT operators, at around 2330 Z they heard on Motorola "aircraft north side". The voice was very panicky. CFT 1 immediately rushed to dumbbell 26. After reaching dumbbell 26, they could not find the aircraft there but came to know that it was on extreme north of runway abeam glide path hut. There was no flame or smoke. Fire crew rushed towards the crash site and CFT 1 after finding way reached as close as possible to the aircraft. CFT 2 had followed the CFT 1 and after reaching near runway controller‟s hut got the location of the aircraft. The vehicle was parked on the runway shoulder and fire crew rushed to the crash site. The aircraft crew had by the time evacuated all the passengers which were confirmed by the fire crew verbally from the aircraft crew and passed on to the tower. As there were

some injuries during evacuation, the ambulance was instructed to follow the perimeter road and reach the crash site.

The PIC in this regard had informed that the external assistance came after about 20 minutes. The flight crew was taken to the terminal building along with the cabin crew. Flight crew informed the APM about blood & urine test. The flight crew was taken to the Government hospital, the hospital however was not having the facilities to carry out the test. The crew was then taken to another hospital. The samples were taken approx. 6 hours after the accident.

### 1.18.2 Cockpit Summary



- The number two reverse thrust is fully deployed and the number one thrust lever is in the interlock stop position.
- The parking brake has been set and the speed brake lever is in the down detent




- The flaps lever is in the 40 position.
- The flaps indicator shows flaps 5.
- There is damage to the brake pressure indicator on the top right side




- Both start levers are moved to cutoff.
- The two engine fire switches and the APU fire switch have been pulled. These are in concurrence with the evacuation checklist

### 1.18.3 DFDR data

The DFDR data was downloaded and the time duration from arming of the auto-throttle and the beginning of the take-off roll till the aircraft comes to a stop is 40 seconds. Relevant parameters are given below in tabular form (3 tables):

**Table I** - Thrust lever advanced for take-off till pressing of TOGA.

| Time | N1 | | TLA | | Fuel flow/ Eng. lbs/hr | | Rudder |
|---|---|---|---|---|---|---|---|
| | Eng no.1 | Eng no. 2 | No.1 | No.2 | No.1 | No. 2 | L/R |
| 23:33:04 | 20.63 | 20.13 | 36 | 36 | 507 | 531 | -0.78 |
| 23:33:05 | 20.5 | 20.13 | 36 | 38 | 688 | 736 | -0.78 |
| 23:33:06 | 20.5 | 20.13 | 41 | 42 | 704 | 720 | -0.78 |
| 23:33:07 | 20.75 | 20.5 | 44 | 44 | 752 | 832 | -0.78 |
| 23:33:08 | 21.63 | 20.88 | 45 | 44 | 1024 | 896 | -0.78 |
| 23:33:09 | 22.75 | 21.38 | 45 | 44 | 1136 | 928 | -0.78 |
| 23:33:10 | 24.13 | 21.75 | 45 | 44 | 1184 | 984 | -0.85 |
| 23:33:11 | 25.75 | 22.25 | 45 | 44 | 1248 | 976 | -0.91 |
| 23:33:12 | 27.88 | 22.88 | 45 | 44 | 1360 | 992 | 2.35 |
| 23:33:13 | 31.25 | 23.5 | 45 | 44 | 1584 | 1024 | 3.13 |
| 23:33:14 | 37.38 | 24.38 | 45 | 44 | 2064 | 1072 | 2.48 |
| 23:33:15 | 44.5 | 25.38 | 45 | 44 | 2192 | 1120 | 0.72 |
| 23:33:16 | 42.63 | 26.75 | 45 | 44 | 1536 | 1184 | 3.32 |
| 23:33:17 | 42.63 | 28.25 | 45 | 47 | 1680 | 1280 | |

**Table II** – TOGA application and advancement of thrust levers till number 2 engine thrust lever is retarded.

| TIME | HDG. | G/S. | N1 | | TLA | | EGT | | F/F | | RUDDER | | BRAKE PRESS | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 | Left | Right | Left | Right |
| 23:33:17 | 257 | 5 | 46 | 28 | 45 | 47 | 538 | 579 | 1680 | 1280 | | 3 | 248 | 35 |
| 23:33:18 | 258 | 6 | 44 | 30 | 53 | 59 | 536 | 584 | 1728 | 1408 | 2 | | 248 | 35 |
| 23:33:19 | 259 | 7 | 60 | 32 | 63 | 69 | 568 | 590 | 3072 | 1536 | 9 | | 252 | 38 |
| 23:33:20 | 260 | 10 | 81 | 35 | 70 | 70 | 611 | 593 | 5200 | 1712 | 28 | | 248 | 38 |
| 23:33:21 | 262 | 13 | 90 | 43 | 71 | 71 | 659 | 601 | 7362 | 2112 | 30 | | 255 | 35 |
| 23:33:22 | 264 | 16 | 92 | 57 | 73 | 71 | 681 | 607 | 8336 | 2928 | 29 | | 255 | 35 |
| 23:33:23 | 268 | 20 | 95 | 74 | 75 | 71 | 706 | 627 | 8752 | 4320 | 29 | | 255 | 38 |
| 23:33:24 | 270 | 24 | 98 | 89 | 75 | 71 | 724 | 670 | 9280 | 6688 | 29 | | 248 | 38 |

## **Table III** – Retarding of number 2 thrust lever till both engines are cut-off

| . TIME | HDG. | G/S. | N1 | | TLA | | EGT | | F/F | | RUDDER | | BRAKE PRESS | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 | Left | Right | Left | Right |
| 23:33:25 | 272 | 29 | 95 | 87 | 75 | 37 | 738 | 684 | 9264 | 8000 | 29 | | 252 | 38 |
| 23:33:26 | 273 | 34 | 95 | 77 | 75 | 39 | 744 | 650 | 9168 | 6144 | 29 | | 252 | 40 |
| 23:33:27 | 275 | 38 | 95 | 66 | 75 | 39 | 750 | 611 | 9104 | 3856 | 29 | | 252 | 38 |
| 23:33:28 | 277 | 41 | 95 | 56 | 75 | 39 | 757 | 576 | 9056 | 2384 | 29 | | 252 | 38 |
| 23:33:29 | 281 | 44 | 95 | 41 | 75 | 36 | 761 | 550 | 9024 | 1520 | 29 | | 258 | 45 |
| 23:33:30 | 288 | 46 | 95 | 38 | 75 | 36 | 765 | 543 | 9008 | 1024 | 29 | | 241 | 380 |
| 23:33:31 | 291 | 47 | 95 | 33 | 75 | 36 | 769 | 538 | 9024 | 616 | 29 | | 739 | 255 |
| 23:33:32 | 298 | 47 | 96 | 36 | 76 | 36 | 772 | 531 | 9024 | 688 | 29 | | 770 | 770 |
| 23:33:33 | 306 | 47 | 96 | 28 | 76 | 36 | 780 | 525 | 9254 | 640 | 29 | | 922 | 604 |

| TIME | HDG. | G/S. | N1 | | TLA | | EGT | | F/F | | RUDDER | | BRAKE PRESS | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 | Left | Right | Left | Right |
| 23:33:34 | 314 | 44 | 97 | 25 | 77 | 36 | 787 | 518 | 9472 | 592 | 29 | | 1915 | 370 |
| 23:33:35 | 324 | 41 | 98 | 22 | 77 | 36 | 795 | 492 | 9648 | 192 | 29 | | 1495 | 221 |
| 23:33:36 | 334 | 39 | 98 | 19 | 77 | 36 | 808 | 472 | 9792 | 160 | 29 | | 1129 | 89 |
| 23:33:37 | 345 | 37 | 98 | 17 | 78 | 25 | 812 | 431 | 9874 | 192 | 29 | | 611 | 31 |
| 23:33:38 | 356 | 37 | 99 | 16 | 78 | 25 | 814 | 421 | 9952 | 224 | 29 | | 160 | 35 |
| 23:33:39 | 007 | 34 | 99 | 14 | 81 | 25 | 815 | 414 | 10000 | 272 | 29 | | 899 | 45 |
| 23:33:40 | 019 | 34 | 102 | 13 | 82 | 6 | 827 | 408 | 10208 | 304 | 29 | | 1071 | 28 |
| 23:33:41 | 032 | 37 | 102 | 12 | 84 | 6 | 835 | 403 | 10739 | 336 | 29 | | 970 | 15 |
| 23:33:42 | 046 | 32 | 102 | 11 | 84 | 6 | 838 | 399 | 10768 | 384 | 29 | | 844 | 31 |
| 23:33:43 | DFDR stops recording as both start levers are moved to cut-off. | | | | | | | | | | | | | |

**1.19 Useful or effective investigation techniques:** NIL

## 2.0 Analysis

### 2.1 Serviceability of the aircraft

Certificate of Registration, Certificate of Airworthiness, Aero Mobile Licence &Certificate of Release to Service in respect of the aircraft were valid. The aircraft and its Engines were being maintained as per the maintenance program consisting of calendar period/ flying Hours approved by DGCA. The Noise Certificate for the aircraft was current. The Centre of the Gravity (CG) of the aircraft was within limit.

Airworthiness Directive, Service Bulletins, DGCA Mandatory Modifications on this aircraft and its engine has been complied with. No snag was pending for rectification before the accident flight nor was any repetitive defect entered in the logbook of the aircraft.

Aircraft was under MEL 36-5-2 for LH engine bleed inoperative. The MEL required that the crew should perform a no engine bleed takeoff with reference to the supplementary procedures. The Flight crew had discussed the MEL with the engineer. However the engine bleed inoperative has not in any way contributed to the accident. There was no thrust asymmetry because of any system design or maintenance inactivity.

### 2.2 Weather

The ATIS services were not available and weather was obtained by the First Officer. The weather was fine and had not contributed to the accident in any manner

### 2.3 Post accident contingency action/ ERP of Airline

On the date of accident, two Crash Fire Tenders (CFT1 and CFT2) were on duty. The aircraft had stopped in an uneven and rocky area close to the perimeter road. The CFT1 operator was instructed to proceed to Dumbell 26 by the tower. On reaching Dumbell 26, operator noticed that aircraft was north of runway, abeam Glide Path Hut. Same was announced to tower on radio. The emergency personnel disembarked and rushed to the aircraft as CFT1 could not proceed towards the aircraft. The CFT2 had also followed the

CFT 1, however on listening to CFT1 transmission; it turned north towards the aircraft. CFT2 was parked on the runway shoulder and emergency personnel disembarked and rushed to the aircraft.

Both CFT1 and CFT2 proceeded to north and were than directed by the tower to follow the perimeter road, to reach the aircraft. In the meanwhile cabin crew provided assistance and first aid to the passengers.

In the present case, there was neither any serious injury to any person nor any fire had taken place. From the discussions with personnel; statements of the flight crew, cabin crew and fire/ CFT operators; and various documents it is inferred that there could have been better co-ordination among the various stake holders. Though the visibility was poor in the direction where the aircraft has finally stopped, the time of reaching the crash site could have been reduced with some proactive procedures in place. All stakeholders were not aware of their duties and responsibilities. The ERP of the airline was not integrated with the contingency plan of the aerodrome operator.

### 2.4 Command Training – Transition from Turboprop to Turbojet

Both the flight crew was having valid Licenses with appropriate endorsements of aircraft. They possessed all the necessary documents as required by the regulations. Their Medical check was valid and without any conditions.

The PIC had transitioned from turboprop commander to turbojet commander as per the CAR on the subject and training manual of the operator. As per the Manual, the „adapted transition course" provides 180 hours of ground training (self-study) followed by simulator training, LOFT and simulator checks. After the simulator checks, the pilot is subjected to line training which culminates with 100 hrs of SLF followed by release checks. PIC had about 5741 hrs of flying experience out of which about 368 hrs was as PIC on type.

As elaborated below in “Findings”, the flight crew (PIC) had not carried out certain actions which were either precursor to the unsafe acts or were unsafe acts themselves. Though the transition training „adapted transition course" was imparted to him, it appears that certain vital training aspects and

checks were not covered e.g. allow the engine to stabilize prior to pressing TOGA; effectiveness of rudder in a jet aircraft at low speeds etc.

The role of First Officer for safe conduct of flight in the present accident indicates lack of CRM training.

### 2.5 Analysis of previous flights (Aircraft & PIC)

The aircraft was involved in a reject takeoff incident on 22/10/2015 due to asymmetric thrust. However the thrust application prior to departure was incorrect. TOGA was engaged at 27 % N1 and 24 % N1 on engine no. 1 and no. 2 respectively. Heading in that case changed by 13 degrees on completion of reject actions.

Analysis was carried out of the previous ten departures by the subject aircraft. The difference in the N1 setting was in correspondence with the difference in the thrust lever angle.

The procedure followed by the PIC for setting takeoff thrust was also analysed for previous ten sectors operated by him. It was observed that at the time of pressing TOGA there was no significant difference between the thrust of the engines barring an instance where the difference was of 10 %.

### 2.6 Circumstances leading to the accident

#### 2.6.1 Engine Start-up & Taxiing

The detailed analysis of DFDR and its correlation with the CVR recording gives a clear picture of the circumstances which resulted into the present accident. The aircraft asked for pushback and startup. Engine number 2 was started followed by engine number 1.

The engine parameters prior to commencement of taxi were as follows:

| Engine | N1 | N2 | EGT | FF/ENG |
|---|---|---|---|---|
| **No. 1** | 20.63 | 60 | 501 | 688 |
| **No. 2** | 20.13 | 60 | 519 | 720 |

The PIC slowed the aircraft down to approximately 16kts, prior to commencing the turn on the runway dumbbell of Runway 26. The turn was commenced at approximately 13kts and during the turn speed was further slowed down. No differential thrust was used during the turn. The aircraft was stopped on heading of 256. The PIC applied brake pressure and held the aircraft on brakes. Left and right brake pressure indicated 479 and 458 psi. At 23:32:59,the auto throttle was armed.

During the above period of one minute or so, the flight crew were modifying the flight management computers and updating ATC clearance. The aircraft heading was 256 prior to commencement of takeoff roll. Air traffic control cleared the aircraft for takeoff on runway 26 and winds were reported as Variable/06kts.

### 2.6.2 Take-off roll & the Accident

The CVR summary is given in Section 1.18.2 & the relevant DFDR data is given in section 1.18.3 of this report. The DFDR data has been analysed in 3 different parts i.e. from the point of line-up, thrust levers movement for take-off; TOGA application and until the point the engine start levers are moved to cut-off. At this point the DFDR recording stopped.

Runway heading for Goa runway 26 is 261. The reference take-off N1 is 95.7%. The aircraft heading on line-up was 256 and TOGA was pressed at 23:33:17.

During the twelve second period from 23:33:05 to 23:33:17 both the thrust levers were advanced for take-off. The throttle resolver angle increased from idle thrust position which is 36/36and reached the position of 45/47. During this period the left brake pressure indicates 252psi and the right brake pressure 38psi.The rudder position is neutral.

At time 23:33:17, the N1 parameters on both engines are not symmetrical. The fuel flow on both engines has a difference of 400lbs/hr. Fuel flow for number one engine is higher as the thrust produced by number one engine is higher. The application of thrust for takeoff is not as per the Jet Airways documented procedure for take-off which states that both thrust

levers must be advanced till the N1 displayed is 40% and then TOGA must be pushed.

The asymmetry in the thrust setting prior to TOGA application caused the number one engine to increase thrust at a faster rate than the number 2 engine.

From time 23:33:17 to 23:33:34, as the thrust was increased there was an increase in heading from 257 to 270. There was left rudder application and constant left brake application. During this period at 23:33:20 the number 2 engine thrust increased but was lagging behind the number one engine by 46%. After a second, the number 2 engine thrust further increased but was lagging behind the number one engine by 47%. This was the maximum value in the difference of the N1 parameter between both the engines. 03 seconds later, the reference N1 was reached on number one engine and the number two engine was at 89%.

During this period it can also be seen that at 23:33:25, number 2 thrust lever is moved to the idle position. There is a continuous increase in heading and constant application of the left brake. The heading increases by 34 degrees in a period of 8 seconds. When the no. 2 thrust lever is moved to idle then there is decrease in EGT, fuel flow and N1. The values consistently reduce in the period of 8 seconds. The rudder had a fixed value indicating left deflection.

2 seconds later, auto-throttle is disconnected followed by an increase in right brake application. At 23:33:31, the aircraft has a ground speed of 47kts which was the maximum value of the ground speed during the accident. For 2 seconds at this point, there is an increase in application of brake pressure on both the brakes.

As can be seen the procedure for reject take-off was not as per the Boeing procedure for reject take-off.

At 23:33:34, there was an increase in the number one TLA by one degree and this caused the N1 to increase. There is an increase in the fuel and EGT of the number one engine. The number two engine thrust lever was

at the idle position with reduction in fuel flow and EGT. The ground speed of the aircraft accordingly was reducing. The maximum value of left brake pressure recorded during the accident was 1915. The rudder position showed left deflection. Thereafter for two seconds the engine parameters of the number one engine increased though the ground speed of the aircraft reduced. At 23:33:37, there was an increase in the TLA of the number one engine by one degree and this caused the N1 to increase. The initiation of the reverse thrust for the number two engine began as there was change in the TLA. The ground speed of the aircraft continued to reduce. After 2 seconds, again there was an increase in the TLA of the number one engine by three degrees which further caused the N1 to increase. A second later TLA of the number one engine was further increased by one degree which caused the N1 to increase further. The N1 for number one engine reached 102% which was the maximum value recorded during the accident. During this period the number two engine reverse thrust sleeve was still getting deployed. EGT and fuel flow for the number two engine continued to reduce with reduction in the ground speed of the aircraft. At 23:33:43, both start levers were moved to cut-off position and the DFDR had also stopped recording.

The CVR recording was downloaded and heard by the Committee. During the line up the aircraft was aligned on a heading of 256. The visual cross-check was carried out by the captain as the centre line markings passed thru the aircraft nose. The PIC did not allow the engine to stabilize as documented in the standard operating procedures prior to pressing TOGA.TOGA was pressed with the number one engine at 40% and the number two engine at 28%. Correlating the above DFDR analysis with the CVR, the PIC had a very small time frame to decide to reject to take-off. During the period of 23:33:34 till 23:33:42 the CVR clearly indicates that the PIC was not effective in controlling the aircraft. Increase in the TLA of the number one engine during this period was probably due to the fact that the aircraft was travelling over a rough surface and the PIC though tried to close the thrust levers but inadvertently moved number one forward thereby increasing the N1 on the number one engine.

DFDR data also indicates that as the aircraft started turning to the right during the take-off procedure PIC tried to correct it with the application of left brake. This is indicated by continuous left brake application during the take-off roll. During the entire phase of flight the speed-brakes lever was in the down detent.

## 3.0 Conclusions

## 3.1 Findings

- The operator was carrying out operation of aircraft under SOP and the maintenance of aircraft under CAR 145.
- The Certificate of Airworthiness, Certificate of Registration and Certificate of Release to Service of the aircraft was valid on the date of the accident.
- The defect records were scrutinized and there was no defect pending on the aircraft prior to the flight which could have contributed to the accident.
- The PIC & the co-pilot were holding a valid license on the type of aircraft. Both the crew members held valid medical certificates as per the requirement.
- The crew had undergone pre-flight medical examination and nothing abnormal was observed. The BA test was negative.
- All major modifications and Service Bulletins were complied with. There was no snag pending for rectification before the accident flight.
- The PIC did not allow the engines to stabilize as documented in the standard operating procedures prior to pressing TOGA. TOGA was pressed with the number one engine at 40% and the number two engine at 28% which is not as per the SOP.
- The flight crew did not follow Company standard operating procedures as required on the first flight of the day for the departure briefing. These include the actions for a reject, evacuation, single engine and configuration for departure.
- The path on the ground during the event was due to the asymmetry in the thrust. The number one engine at full thrust and the number two

engine at idle thrust. The number one thrust lever may have been moved forward inadvertently as the aircraft was travelling over a rough surface.

- The reject maneuver was incorrectly carried out. Only the number two thrust lever was retarded during the reject maneuver as verified in the DFDR and from the CVR.
- The speed brakes were not applied during the reject maneuver.

**3.2 Probable cause of the Accident**:

The PIC pressed TOGA when the thrust on no.1 engine was 40% and no.2 engine was 28% in deviation from SOP, which caused the No.1 engine thrust to increase at a faster rate than no.2 resulting in aircraft yawing towards right. In the absence of timely desired corrective actions including reject takeoff, the aircraft veered off the runway and continued to move in a semicircular arc on the undulated ground resulting in substantial damages to the aircraft.

**4.0 Recommendations**

**OPERATOR**

- The operator must reiterate the importance of all briefings to flight crew especially emergency briefings. First officers to be more assertive with regards to adherence to standard operating procedures.
- Stabilized callout by the PM may be introduced after the initial thrust application of 40% prior to application of TOGA. This callout should imply that both thrust setting are practically identical.
- The training department of the operator to incorporate defined failures for unstabilised thrust, uneven spool up of engines during low speed for reject and their corrective actions thereof.
- The importance of following the correct actions regarding evacuation and briefing for the same during all simulator training sessions be emphasized.

**DGCA**

- DGCA in co-ordination with the Defence authorities should make the standard „Aerodrome Emergency Plan‟ for all the Defence Airfield where

scheduled civil flights operate as per the latest framework of Safety Management System. AAI which is the custodian of the Civil Enclaves and apron area at these airports, now licensed by DGCA, should have a direct role to play in the procedures of contingency actions in case of an accident.

- As a onetime exercise, DGCA should check the practical implementation of the ERP of all airlines and ensure that it is rigidly integrated with the AEP of the aerodromes for better handling of the situation & passenger facilitation.

**AAIB**

- AAIB India must reiterate all the aspects of requirements of detailed Medical Examination of the Flight Crew whenever there is a serious incident or accident by clearly defining the responsibility of individuals involved in the process.

(Rajinder Singh Passi)
Chairman
Committee of Inquiry

(Capt. Nitin Anand)
Member
Committee of Inquiry

(Jasbir Singh Larhga)
Member
Committee of Inquiry

Place: New Delhi
Date: 13/11/2017