FINAL INVESTIGATION REPORT ON ACCIDENT TO BORDER SECURITY FORCE SKA B-200 AIRCRAFT VT-BSA NEAR IGI AIRPORT, DELHI ON 22.12.2015

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Foreword

In accordance with Annex 13 to the Convention on International Civil Aviation Organization (ICAO) and Rule 03 of Aircraft (Investigation of Accidents and Incidents), Rules 2012, the sole objective of the investigation of an accident/incident shall be the prevention of accidents/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 such future accidents/incidents could lead to erroneous interpretations.

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1.	Aircraft Type	Beechcraft Super King Air B 200
2.	Nationality	INDIAN
3.	Registration	VT - BSA
4.	Owner	Border Security Force
5.	Operator	Border Security Force
6.	Pilot – in –Command	CPL holder
	Extent of Injuries	Fatal
7.	Co-Pilot	CPL Holder
	Extent of Injuries	Fatal
8.	Place of Accident	Delhi
9.	Co-ordinates of accident Site	28^{o}33’ 45.5” N, 77^{o} 04’ 27.6” E
10.	Last point of Departure	Delhi
11.	Intended place of Landing	Ranchi
12.	Date & Time of Accident	22nd December 2015, 0400 UTC (Approx)
13.	Passengers on Board	06
14.	Extent of Injuries	Fatal
15.	Crew on Board	04 (02 Cockpit +01 AME + Cabin Attendant)
16.	Extent of Injuries	Fatal
17.	Phase of Operation	Take-off
18.	Type of accident:	Fatal, aircraft crashed soon after take-off

Synopsis

Beechcraft Super King Air B-200 aircraft, VT-BSA belonging to BSF Air Wing was involved in an accident on 22.12.2015 while operating a flight from IGI Airport, New Delhi to Ranchi. The flight was under the command of a CPL holder with another CPL holder as Second in Command. There were ten persons on board including two flight crew members.

The flight crew contacted ATC Delhi for clearance to operate the flight to Ranchi. The aircraft was cleared to Ranchi via R460 and FL210. Runway in use was given as 28. After the ATC had cleared the aircraft for taxi, it had stopped for some time while taxiing at taxiway E1. The pilot informed ATC that they will take 10 minutes delay for further taxi due to some administrative reasons. After a halt of about 6 to 7 minutes, the pilot again requested ATC for taxi clearance and the same was approved by the ATC. Thereafter, the aircraft was given take-off clearance from runway 28. Shortly after take-off, the aircraft progressively turned left with simultaneous loss of height. Finally it impacted terrain and came to final rest in the holding tank of the water treatment plant of the airport. There was post impact fire and the aircraft was destroyed. All passengers and flight crew were fatally injured.

Ministry of Civil Aviation constituted a Committee of Inquiry to investigate into the causes of the accident under Rule 11 of Aircraft (Investigation of Accidents and Incidents) Rules 2012 vide MoCA order no. AV-15018/215/2015-DG dated 22.12.2015.

1.0 FACTUAL INFORMATION

1.1 History of Flight

Beechcraft Super King Air B-200 aircraft, VT-BSA belonging to BSF Air Wing was involved in an accident on 22.12.2015 while operating a flight from IGI Airport, New Delhi to Ranchi. The flight was under the command of a CPL holder with another CPL holder as Second-in-Command. There were ten persons on board including two flight crew members.

As per the scheduling procedure of the Operator, the flying programme for 22.12.2015 was approved by the ADG (Logistics) on the recommendation of the DIG (Air) for VT-BSA on 21.12.2015. The programme included names of the flight crew along with the sectors as given below:

From	To	ETD	ETA
Delhi	Ranchi	0800 hrs.	1030 hrs.
Ranchi	Delhi	1300 hrs.	1600 hrs.

The task was as per instructions on the subject dated 23rd July 2015. As per the weight & load data sheet there were 8 passengers with 20 Kgs. of baggage in the aft cabin compartment. The actual take-off weight shown was 5668.85 Kgs as against the maximum take-off weight of 5669.9 Kgs. Fuel uplifted was 1085 Kgs.

The aircraft was taken out of hangar of the Operator at 0655 hrs on 22.12.2015 and parked outside the hangar for operating the subject flight. At around 0745 hrs, the passengers reached the aircraft who were mainly technical personnel supposed to carry out scheduled maintenance of Mi-17 helicopter of the Operator at Ranchi. They were carrying their personnel baggage alongwith tools and equipments required for the maintenance.

At around 0915 hrs the flight crew contacted ATC Delhi and requested for clearance to operate the flight to Ranchi. The aircraft was cleared to Ranchi via R460 and FL210. Runway in use was given as 28. At 0918 hrs the doors were

closed and the flight crew had started carrying out the check list. After the ATC issued taxi clearance, the aircraft had stopped for some time after commencing taxiing. The pilot informed the ATC that they will take 10 minutes delay for further taxi due to some administrative reasons. The taxi clearance was accordingly cancelled. After a halt of about 6 to 7 minutes, the pilot again requested the ATC for taxi clearance and the same was approved by the ATC. Thereafter, the aircraft was given take-off clearance from runway 28. The weather at the time of take-off was: Visibility 800 meters with Winds at 100^{o}/ 03 knots.

Shortly after take-off and attaining a height of approximately 400 feet AGL, the aircraft progressively turned left with simultaneous loss of height. It had taken a turn of approximately 180^{o} and impacted some trees before hitting the outside perimeter road of the airport in a left bank attitude. Thereafter, it impacted 'head on' with the outside boundary wall of the airport. After breaking the outside boundary wall, the wings impacted two trees and the aircraft hit the holding tank of the water treatment plant. The tail portion and part of the fuselage overturned and went into the water tank. There was post impact fire and the portion of the aircraft outside the water tank was destroyed by fire. All passengers and crew received fatal injuries due impact and fire. The ELT was operated at 0410 hours UTC (0940 hours IST). The fire fighting team reached the site and extinguished the fire. The bodies were then recovered from the accident site. 08 bodies were recovered from the holding tank of the water treatment plant and bodies of both pilots were recovered from the heavily burnt portion of the cockpit lying adjacent (outside) to the wall of the holding tank of the water treatment tank.

1.2 Injuries to Persons

INJURIES	CREW	PASSENGERS	OTHERS
FATAL	03	07	Nil
SERIOUS	Nil	Nil	Nil
MINOR/NONE	Nil	Nil	Nil

1.3 Damage to the aircraft

The aircraft was destroyed during the accident.

1.4 Other Damages

The boundary wall of the airport was broken due to the impact of the aircraft. Also the outer portion of the water tank was damaged.

1.5 Personnel Information

1.5.1 Pilot-in-Command

Pilot Flying (PF)	
Age	38 Years
Licence	CPL
Date of Initial Issue	29.10.2008
Valid upto	28.10.2018
Type endorsements/ Aircraft rating	King Air C-90 A, SKA B-200
Date of Medical Exam	26.08.2015
Validity of Medical Exam	25.08.2016
Date of last IR/PPC Simulator Check	19.04.2015
Total flying Experience	964:50 hours
Total Experience on Type	764:00 hours
Total Type Experience as PIC	77 hours
Hours flown in last 90 days	105:00
Hours flown in last 60 days	60:45
Hours flown in last 30 days	43:00
Hours flown in last 7 days	7:30
Hours flown in the last 24 hrs	00:00

1.5.2 Co-Pilot

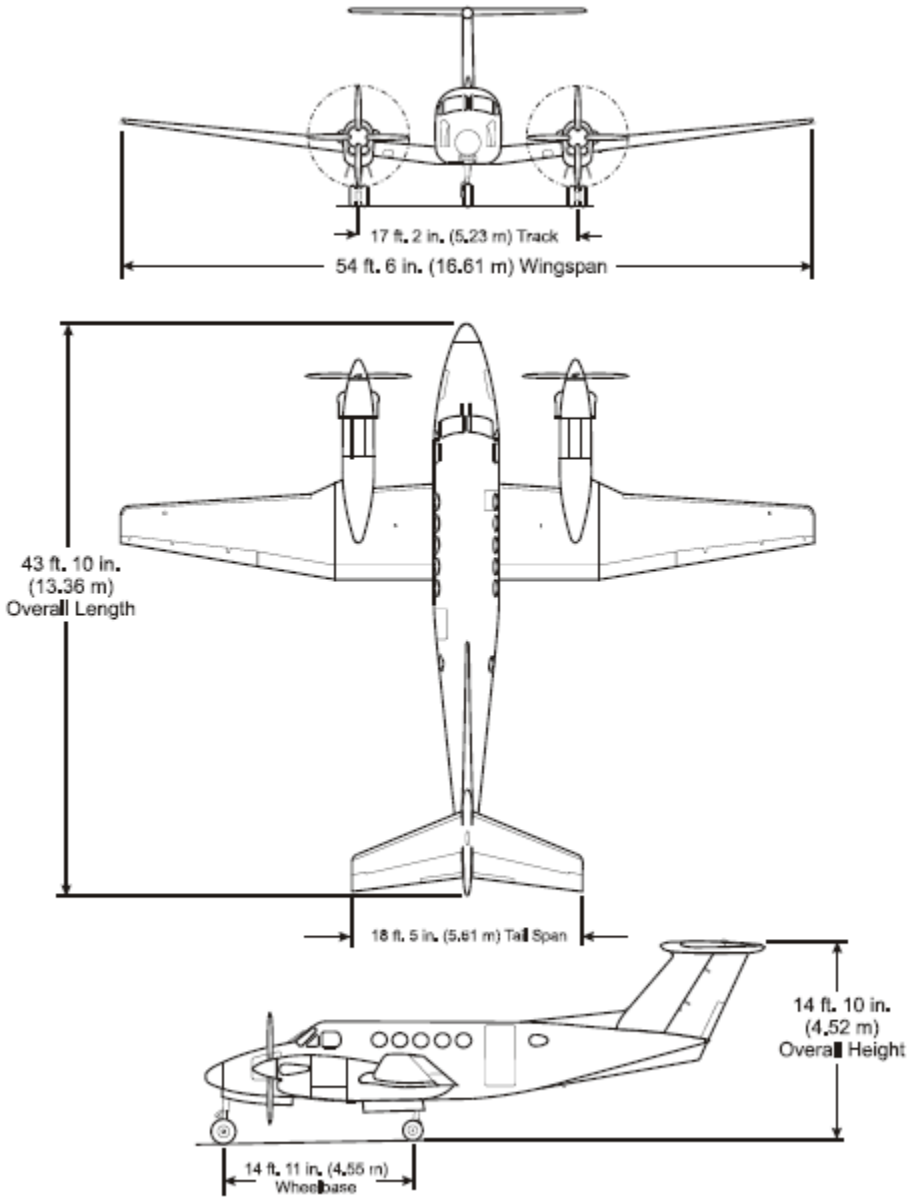
Pilot Monitoring (PM)	
Age	38 years
Licence	CPL
Date of Initial Issue	13.11.2009
Valid upto	01.12.2019
Type endorsements/ Aircraft rating	TB20, King Air C-90A, SKA B-200
Date of Medical Exam	17.10.2015
Validity of Medical Exam	16.10.2016
Date of last IR/PPC Simulator Check	18.04.2015
Total flying Experience	891 hrs
Total Experience on Type	691hrs
Total Type Experience as PIC	196:35 hrs
Hours flown in last 180 days	163:15 hrs
Hours flown in last 90 days	71:15 hrs
Hours flown in last 30 days	35:30
Hours flown in last 7 days	07:30
Hours flown in the last 24 hrs	00:00

1.6 Aircraft Information:

1.6.1 General Information

1.6.1.1 Aircraft Construction

Wing and fuselage of the aircraft are of conventional semi-monocoque construction. It has fully cantilevered wings and a T-tail empennage.



Fuselage

The fuselage is fabricated from high strength aluminium alloy, with appropriate use of steel and other materials. The structural design is based on damage tolerance (fail-safe) principles using multiple load paths, bonded doublers and small panel sizes on the primary structure. The fuselage is divided into three subsections; an unpressurized nose section, a pressurized flight deck and cabin section and an unpressurized tail section.

The aircraft is equipped with retractable tricycle landing gear. The main landing gear retracts forwards into each engine nacelle. The nose gear retracts aft into the nose section. The landing gear is electrically controlled and hydraulically actuated. It is enclosed by mechanically actuated doors.

1.6.1.2 Engines

The aircraft is powered by two nacelle mounted PT6A-42 turboprop engines rated to 850 SHP (on a standard day at sea level) manufactured by Pratt & Whitney, Canada. The engine is free turbine; therefore the power requirements during engine starting are relatively low. Engine starts may be made using the aircraft battery or external power.

1.6.1.3 Propellers

Each engine is equipped with a conventional Hartzell 93-inch diameter four blade, full feathering, constant speed, counterweighted, reversing, variable pitch propeller mounted on the output shaft of the reduction gearbox. The propeller pitch and speed are controlled by engine oil pressure, through single action, engine driven governors

1.6.2 VT-BSA Particulars

The Beechcraft Super King Air aircraft VT-BSA (MSN BB-1485) had been manufactured in the year 1994. The aircraft was registered with DGCA; India under category ‘A’ and the certificate of registration No. 2691 was issued on 03.08.1995.

The Certificate of Airworthiness Number 2179 under “Normal category” subdivision Passenger was issued by DGCA on 03/08/1995. The specified minimum operating crew was two and the maximum all up weight was 5670 Kgs. At the time of accident the Certificate of Airworthiness was valid with unlimited validity. The ARC was issued on 16.04.2015 and was valid till 15.04.2016.

The Aircraft was holding a valid Aero Mobile License No. A-073/006-RLO (NR) at the time of accident. As on 22.12.2015 the aircraft had logged 4766:05 Airframe hours and2745 landings.

The aircraft and its Engines are being maintained as per the maintenance program consisting of calendar period / flying Hours as per maintenance program approved by DGCA.

For the investigation purposes aircraft log book, Engine log book, Propeller log book, Journey Logbook and Radio log book were scrutinised for the period from 13.04.2014 till 22/12/2015. The organisation was approved to carry out Phase IV inspection (800 hours/24 months) and all lower inspections. The last major inspection Phase IV (800 Hours/24 months) was carried out at 4596:15 A/F Hours on 18.09.2015. Subsequently all lower inspection were carried out as and when due before the accident. The aircraft was grounded from 05.09.2014 to 13.04.2015 for Port engine change.

Left Hand Engine

Engine type	:	PT6A-42
Serial Number	:	94669
Hours Since New	:	3,364.15
Cycles Since New	:	1,973
Hours Since Overhaul	:	365
Cycles Since Overhaul	:	192

The engine was being maintained as per the Beechcraft phase inspection program. The last overhaul was carried out in December 2009.

Right Hand Engine

Engine Type	:	PT6A-42
Serial Number	:	93278
Hours Since New	:	4,757

Cycles Since New	:	2,303
Hours Since Overhaul	:	1,767
Cycles Since Overhaul	:	958

The engine was being maintained as per the Beechcraft phase inspection program. The last overhaul was performed at DGCA approved maintenance organisation under work order # 11-53-04-01-09. 1st stage RGB gears (Timken make) were installed during overhaul and were removed at 3,738 hrs since new as per applicable Airworthiness Directive. These were replaced with new P&WC gears.

The DGCA has issued two mandatory modifications on SKA B-200 aircraft which were complied with. DGCA has issued two Mandatory Modifications on Engines, out of which one is concerning Hot Section Inspection (HSI) and other Rotor Component Service Life. The HSI is to be carried out as per AMP every 1800 hours. Till the date of accident, HSI was not due on any engine. A Mandatory Modification on Propeller was also issued by DGCA which revises the Time Between Overhaul (TBO) for propeller. The same was also complied with. All the DGCA Mandatory Modifications pertaining to Aircraft, Engine and Propellers has been complied with, and proper Log book entry has been made.

1.6.3 Snags Summary

Following is the summary of snags reported from 18/04/2013 to 24/11/2015.

DATE	SNAG REPORTED	RECTIFICATION
18/04/2013	Port auto-feather is unserviceable. During auto-feather check port auto-feather light do not blink.	Low oil pressure switch P/N 50-389121-25 replaced with new one. Operation checked on ground. Engine ground run carried out and found satisfactory.
	When applying reverse after landing the aircraft swung towards the right side.	Reverser adjustment on port engine carried out. Operation checked and found satisfactory during ground run.
20/06/2013	During reverse thrust check it is	Reverse thrust adjusted,

	observed that reverse on port is faster than starboard engine.	operation checked, found satisfactory.
29/06/2013	Throttle staggering	RH engine control rigging carried out. Duplicate inspection carried out checked for safety and locking. Operation checked during ground run and found satisfactory.
08/07/2013	**1.** Port fuel flow gauge unserviceable.	Fuel flow indicator (PORT) replaced, operation checked during ground run and found satisfactory.
	2. During reverse thrust at VILK (Lucknow) & VIDP (Delhi) the aircraft swung towards right side after few seconds of normal reverse.	Reverse control adjusted, operation during ground checked and found satisfactory. Independent check of controls carried out and found satisfactory.
19/11/2013	Power lever movement is jerky	Centre console panel opened, lubricated, checked for freedom of movement and noise. Found serviceable.
23/12/2013	Starboard torque meter gauge needle is jerky.	Starboard torque meter indicator connection removed, contact cleaned and refitted. Operation checked during ground run and found satisfactory.
08/02/2014	1. During reverse thrust following observations are made: **a.** Starboard reverse thrust is higher than port reverse thrust. **b.** Thus overall reverse thrust is not stable.	Rigging of port & Starboard engine controls carried out, controls checked for proper dimension security. Locking operation checked during ground run, found satisfactory during reverse. Duplicate inspection of engine controls (Port & Starboard) checked and found satisfactory.
01/04/2014	Prop lever staggering	Prop control rigging carried out. Checked for security of attachment, clearance and operation during ground run and found satisfactory.
	Torque indicator (Starboard) jerky	Torque indicator (Starboard) connection removed, cleaned and refitted. Operation checked during ground run and Found

		satisfactory.
07/04/2014	**1.** Thorough rigging is required for both the engines to match the parameters.	Propeller Governor (Port) replaced (S/N 2346806). Rigging of engine controls (Port & Starboard) carried out as per approved procedure. Checked for proper attachment, locking and operation of engine controls and found satisfactory. Independent check of controls carried out and found satisfactory. Checked operation during ground run and found satisfactory.
07/08/2014	1. Power control lever and prop lever staggering.	Sang not confirmed during ground run. Aircraft cleared. Subject to next flight report.
	2. Right torque indicator flicker.	Torque indicator connector cleaned, refitted& checked during ground run and found satisfactory.
30/08/2014	Propeller lever staggering	Ground run carried out. Snag was not confirmed. However port propeller indicator found intermittent. Connection of Prop Governor and TachoGenerator refitted. Ground run carried out again and system found satisfactory.
19/05/2014	1. Starboard ITT gauge is unserviceable	Starboard ITT gauge removed, contact cleaned & refitted. Operation checked during ground run and found satisfactory.
	2. Humming sound in port engine is heard.	Port engine and its mounting bolts were checked visually for proper torque. During ground run no unusual sound was observed. All engine parameters were normal and found satisfactory.
24/11/2015	Port condition lever detent slip to fuel cut off may be checked	Checked the port side condition lever for proper operation and simultaneously the engine controls. Ground run carried out, operation and engine parameters found satisfactory.

There was a repetitive snag with respect to PROP lever and PROP Governor. Subsequent to the replacement of PROP Port Governor and PORT engine, the snag did not persist.

1.6.4Autopilot

The Aircraft was equipped with Collins FCS-65 Automatic Flight Control System Category 1 and Collin EFIS-85B (14) Electronic flight instrument system.

The Autopilot system if engaged controls the aircraft in two dimensions i.e. lateral and vertical axis. It provides aural & visual indications regarding engagement and disengagement. During the period of engagement of the Autopilot, the various modes are Heading/NAV/APP/IAS/VS. In NAV mode the aircraft navigates on the selected radial /GPS track, while in the APP mode the Aircraft follows the ILS signals.

As per the section 2 of Instruction sheet of POH for B-200 Aircraft, the Autopilot should not be used below 500ft AGL during climb and 200ft above AGL during approach. Further the Autopilot or yaw damper is not be used during take-off & landing. If the Autopilot is to be used during flight, autopilot pre- flight checks must be conducted and found satisfactory prior to flight.

The Collins FCS-65 is an integrated flight control system which can be functionally divided into two general subsystems i.e. Flight Instrument System (FIS) and Flight Control System (FCS).

- **Flight Instrument System (FIS)**

The FIS consists of an attitude director indicator (ADI), a horizontal situation indicator (HSI), and associated components. The ADI presents attitude data, raw radio information, and steering commands. The HSI present the navigation situation.

EFIS ON/OFF SWITCHES – Control power to the EFIS symbol generators.

The switches should be selected OFF during engine start to protect the EFIS system from low/transient voltages.

- **Flight Control System (FCS)**

  The FCS consists of an autopilot computer, mode select panel, air data sensor, three primary servos, a vertical reference and a trim servo. The system also requires compass and navigation system inputs from the avionics system.

1.6.4.1 Autopilot Operation

To engage the autopilot, press the AP ENG switch on the autopilot control panel. If a red fault annunciator is illuminated (AP, TRIM), it requires pressing of the AP ENG switch to clear the fault and pressing again to engage the autopilot. If the fault does not clear, the autopilot will not engage.

An automatic pre-engagement test is performed each time the autopilot is engaged. This test requires approximately 2 seconds and is identified during the test by annunciation of red TRIM and AOP.

The autopilot may be engaged in any reasonable attitude. If the autopilot is engaged without lateral mode being selected and the aircraft goes beyond 30 degree bank, 17.5 degree pitch up, or 10 degree pitch down, the autopilot will return the airplane to these limits. No steering information will be presented on the flight director until a lateral mode is selected.

- **Control Wheel Synchronization (CWS)**

  Autopilot sync mode is controlled by the PITCH SYNC & CWS (control wheel synchronization) button on the control wheel. With the autopilot engaged, and in either manual or guidance mode, pressing the PITCH SYNC & CWS button cancels vertical modes and allows the pilot to maneuver the airplane without disengaging the autopilot. When the PITCH SYNC & CWS button is released, the autopilot maintains the new pitch attitude and follows commands received from the autopilot computer if in a lateral mode. CWS mode does not cancel GS when in APPR mode.

- **Yaw Damper Operation**

  The yaw is automatically engaged anytime the autopilot is engaged.

  The rudder channel of the autopilot may be selected separately for yaw damping by the YAW ENG switch on the autopilot panel.

  To disengage the yaw damper, operate the DISC TRIM/AP YD disc switch, or press the YAW ENG switch. The YAW ENG switch is disabled if the autopilot is engaged.

- **Electric Pitch Trim Operation**

  The autopilot computer provides manual electric trim operated by the split pitch trim switches located on the pilot's and co-pilot's control wheels. Electric trim operation is annunciated by the amber TRIM annunciator when the trim speed is above the present annunciation threshold for more than 5 seconds.

- **Mode Selection**

  All modes with the exception of GA are selected by pressing the PUSH ON/PUSH OFF switch on the mode control panel. Annunciators on the mode control panel and mode annunciator panel indicate the selected mode of operation.

  The flight director system supplies steering commands for the pilot and the autopilot. When the autopilot is engaged, the crew monitors autopilot performance on the attitude director indicator. When the autopilot is not engaged, the pilot flies the airplane manually in response to the attitude director indicator commands. A lateral mode must be selected to bring the command bars into view for manual flight director operation.

  The Electronic Flight Instrument System replaces the conventional electro-mechanical attitude director (ADI) and horizontal situation indicators (HSI). The CRT displays (EADI & EHSI) provide the necessary information for the pilot or copilot to respond to flight director and navigation commands in the same manner as with conventional instruments. The system also includes additional

features which allow the pilot or copilot to select alternate formats as a navigation aid or in the event of specific failures. The operator is cautioned that the primary displays (attitude and directional information) are required to be operational prior to initiating flight in conditions for which these displays are required.

- **Heading Mode (HDG)**

  The crew has to set desired heading and select HDG mode. The autopilot will turn the airplane to and maintain the selected heading. For proper operation, the HDG marker should not be displaced from the airplane heading by more than 150 degrees when the HDG mode is selected.

- **NAV Mode (NAV)**

  The crew has to set desired heading and course prior to selecting NAV mode. When NAV mode is selected, the HDG and NAV ARM annunciators will illuminate. The airplane will follow the selected heading until the centreline of the selected radio course is approached. HDG mode will then clear and the airplane will turn to track the beam centreline. The amber ARM annunciator will extinguish to indicate course capture and NAV will remain on. Crosswind correction, up to 30 degrees, is automatically computed after course capture.

1.6.5 POH Limitations

As per the POH of the aircraft (Engine Operating Limitations), under the operating condition of “take-off and max continuous speed” the maximum Propeller RPM (N_2) is 2000 and torque as 2230 ft.-lbs. The normal procedure after takeoff is

Landing Gear (when positive climb established)	UP
Flaps (at 121 knots minimum)	UP

CLIMB

Climb Power	SET
PROPS	1900 RPM
Yaw Damp	ON

In order to achieve the RPM of 1900, the PM reduces the torque to approx. 1800 ft-lbs. by bringing the throttles little backwards.

1.6.6 Preflight Checks (Before take-off – Autopilot/Yaw Damper/Elevator Trim)

As per the POH, the pre-flight checks for Autopilot/Yaw Damper/Elevator Trim are as follows:

1. Position pitch trim to the take-off position, turn ELEV TRIM switch on and engage the autopilot. Check that YAW and AP annunciators are on.
2. With control wheel in the forward position and the autopilot engaged, operate pilot then co-pilot pitch trim switches in both directions to ensure that the auto-pilot disengages. The yaw damper remains engaged.
3. Centre the control wheel and engage the autopilot. Apply forward pressure on control wheel. Note that pitch trim travels nose up and that the amber TRIM light comes on. Apply rearward pressure on control wheel. Note that pitch trim travels nose down and that the amber TRIM light comes on.
4. Hold the control wheel and disengage the autopilot by pressing the DISC TRIM/AP YD button on the pilot's control column to the first level. Note that the YAM DIS and AP DIS annunciators illuminate. Further press the DISC TRIM/AP YD button. Note that the ELEC TRIM OFF annunciator illuminates. Cycle the electric trim switch on the console, engage the autopilot, and repeat the check using the copilot's DISC TRIM/AP YD switch.
5. Engage yaw damper. Note YAW annunciator is on. Check for additional resistance to movement of rudder pedals. Disengage yaw damper.
6. Push the TEST button on the mode annunciator panel above the ADI to test the annunciators.
7. Reset pitch trim to the take-off position.

8. Move all primary flight controls through their full travel in both directions. Verify that controls move in proper direction and no restrictions to free movement are present.

1.7 Meteorological Information:

The information contained in the relevant METARS are as follows:

Time (UTC)	Winds	Visibility (meters)	Temp/Dew point (in ^{o}C)	QNH
0300	Calm	600	09/07	1021
0330	Calm	800	11/07	1021
0400	100^{o}/03	800	13/08	1022
0430	100^{o}/05	800	14/8	1022

1.8 Aids to Navigation:

The IGI Airport, New Delhi has got three runways which have orientation 09/27, 10/28 and 11/29. All the three runways are equipped with VOR/DME approaches, ILS landing facility and PAPI on either side.

The Super King Air B-200 aircraft is equipped with ADF, VOR &ILS as navigational aids. The aircraft was also equipped with GPS which was though not primary navigational equipment.

1.9 Communications

There was always two ways communication between the ATC and the aircraft. At the time of accident, the aircraft was under control of Delhi Tower.

1.10 Aerodrome Information:

The aircraft took-off from runway 28 of IGI Airport, New Delhi and hit the outer boundary wall of the airport during crash landing. The main base of the operator for fixed wing aircraft is at IGI airport. They have a hangar where all the maintenance activities are carried out as per CAR 145. The operator also has an operations office in the same hangar. The embarkation and disembarkation of passengers and baggage is carried out in the area in front of the hangar. The details of the IGI airport New Delhi are as follows:

Co-ordinates

ARP : N 28° 34' 07"
E 077° 06' 44"

Elevation : 778 Feet.

Runway Orientation and Dimension

Orientation- 10/28 Dimension 3810 x 45 Meters
11/29 Dimension 4430 x 60 Meters
09/27 Dimension 2813 x 45 Meters

Approach and Runway Lighting

RWY.	APCH LGT	THR LGT	PAPI	Rwy Centre Line LGT	RWY edge LGT
09	SALS	Yes	Yes	Yes	Yes
27	CAT-I	Yes	Yes	Yes	Yes
10	CAT-I	Yes	Yes	Yes	Yes
28	CAT IIIB	Yes	Yes	Yes	Yes
11	CAT IIIB	Yes	Yes	Yes	Yes
29	CAT IIIB	Yes	Yes	Yes	Yes

ATS Airspace:

a. Designation Delhi CTR. 30 NM centred at DPN VOR
b. Vertical Limits SFC to FL50
c. Airspace Classification D
d. Transition Altitude 4000 FT MSL

Fire Fighting Services: CAT – 10

Met Services

Met Office Hour of service is 24 Hrs. TAF, Trend Forecast and Briefing is available.

Navigation and Landing Aids

NDB, DVOR, ILS CAT-I, CAT-II, CAT-IIIA,CAT-IIIB, ASMGCS, SMR

ATS Communication Facilities

Delhi Radar	119.3/127.9 MHZ
Delhi Flow Control	119.5 MHZ
Delhi Approach	119.3/127.9 MHZ
Delhi Approach/Radar	124.2/124.25/124.6/125.675/125.85 MHZ
Delhi Tower	118.1/118.25/118.75/118.825 MHZ
DATIS	126.4 MHZ
Delhi Ground	121.625/121.75/121.9 MHZ

1.11 Flight Recorders

The solid state CVR installed on the aircraft was manufactured by Loral Data Systems Fairchildmodel A100S with part number S100-0080-00 and serial number 00675. The CVR had heat damages and it remained in water for some time. There was no obvious deformation to the CVR external housings a result of impact forces. For read out purposes, the CVR unit was taken to Engineering Laboratory, Operational Services Branch of Transportation Safety Board of Canada in person by a member of the Committee of Inquiry and he had associated in the readout process. CVR data and sonogram starting from take-off roll till end of recording was provided to the Committee by TSB Canada.

1.12 Wreckage and Impact Information

As per the evidences collected and inspection of the accident site the aircraft primarily impacted the trees as was evident from the chopping off the trees in the final phases of the path followed by the accident aircraft. The trees were probably chopped off by the aircraft wings as the aircraft was at a high roll attitude.

There were rubbing marks observed on the outside perimeter road of the airport and a part of wing tip was recovered beside the road indicating the rubbing marks were of the aircraft wing tip.

Thereafter, it impacted ‘head on’ with the outside boundary wall of the airport. After breaking the outside boundary wall, the aircraft, hit the holding tank of the water treatment plant. The tail portion and part of fuselage overturned and went into the holding tank. The portion of the aircraft outside the holding tank was destroyed in fire.

1. Left Engine was found about 25 meters ahead of the main wreckage with very little burn marks, however, burnt right engine was found along with the main wreckage.
2. The Fuselage, Cabin, Cockpit was completely burnt.

WRECKAGE INSPECTION

The wreckage distribution

Onsite wreckage observations were made as detailed below:

1. Propeller Blades of both the propellers are broken from the Hub. Since the Blades were separated from the Hub the Pitch of the blades could not be ascertained.
2. RH Engine was found completely burnt with Reduction Gear Box separated from the engine and broken. However LH engine was comparatively less burnt but Reduction Gear box of LH engine was also broken.
3. Both the engines were separated from main structure.
4. All the instruments were completely burnt and damaged. The readings/indications cannot be ascertained.
5. Condition of the Engine before the event could not be ascertained by the control levers in the cockpit as all the six levers were found burnt and friction lock completely damaged. All the six levers (Power, Prop RPM and Condition) were found loose.

6. Landing Gears were found in extended condition. RH Ldg Down lock was in place but LH Ldg down Lock was free but the actuator of both the Ldg gears were in extended condition.

7. Extension of the Landing Gear can be ascertained by the position of Landing Gear Lever in the cockpit which was found in down position.
8. Flaps were found completely damaged and broken. RH Flap roller was found stuck in mid position in Flap Track.
9. Rudder was intact with vertical Stabilizer and was free so the position of Rudder at the time of impact cannot be ascertained.

Though wreckage was self-contained
but was disturbed to carry out rescue operation

Personal luggage of the travelling technical personnel

Battery for MI-172 helicopter being transported

10. 

Damaged Engine

Horizontal & VerticalStabilizer

1.13 Medical and Pathological Information

The flight Crew had undergone Pre-flight Medical examination and no abnormality was observed.

As per the post mortem report the cause of death of the PIC is given as combined effect of cranio-cerebral damage, shock as a result of multiple ante mortem injuries as described consequent upon blunt force/ impact and burn injuries present over the body are post-mortem in nature. The pattern of injury is consistent with air-crash victim as alleged and found in a pilot/co-pilot.

The cause of death for Co-pilot is given as shock due to polytrauma caused by blunt external forces/impact. The pattern of injuries is consistent with an aircrash victim as alleged and found in pilot/co-pilot. Burn injuries present over the body are post-mortem in nature.

1.14 Fire

There was post impact fire.

1.15 Survival Aspects

The accident was not survivable.

1.16 Tests and Research

1.16.1 ENGINE TEARDOWN INVESTIGATION

Powerplant investigation (Tear down inspection) was carried out by Air Safety Investigator, Pratt &Whitney Canada Corp, through TSB Canada in association with the Committee of Inquiry at Safdarjung Airport, New Delhi. The investigator provided field notes covering his preliminary observations. Upstream and downstream references are in relation to gas path flow from the compressor inlet to exhaust.

1.16.1.1 LEFT HAND ENGINE

1.16.1.1.1External Condition

Severe impact damage was present on all Quick Engine Change (QEC) components. The front portion of the reduction gearbox was separated from the engine as well as the accessories gearbox as a result of the fracture of the inlet case. The exhaust stacks were partially crushed but showed no impact damage from exiting debris. Heavy impact damage was found on all major cases and housings at the 6 o'clock region. Examination of the propeller showed a complete fracture of the hub, liberating all 4 blades, one blade exhibited heavy impact damage with a portion of the tip fractured. One other blade showed "S" shape bending while the other 2 blades were relatively intact. All blades displayed gouging of the leading edge and chord wise scoring.

- **External Cases**

Reduction Gearbox (RGB): The front housing mounting flange was partially fractured. Impact damage was present at the bottom location.

Exhaust Duct: Heavy impact damage was observed at the 6 o'clock location causing secondary deformation on all other surfaces. The "C" flange was partially separated and circumferential cracking was found on the external housing adjacent to the mounting flange.

Gas Generator Case (GGC): The bottom section suffered heavy impact damage. Moderate de-formation of the compressor housing was also observed. The case had to be mechanically cut during engine disassembly to allow for removal of the combustion liners. A significant amount of organic dirt was found behind the diffuser pipes.

Inlet Case: The inlet struts were fractured causing complete separation between the inlet and oil tank. The oil tank itself exhibited impact damage with associated cracks at various locations.

Accessory Gearbox (AGB): The AGB housing and diaphragm showed partial fracture of the mounting flange at the 6 o'clock position. Impact damage with fracture of the various mounting pads was also noted.

- **Power Control and Reversing Linkage**

  All components of Power Control and Reversing Linkage were found bent.

- **Pneumatic Lines**

Compressor Discharge Air (P3): The line was crushed adjacent to the rear firewall and severed on both sides of the P3 filter. The fitting at the fuel control was loose but still secured with lockwire.

Power Turbine Control (Py): The line was severed aft of the Propeller Governor, forward of the Gas Generator firewall and forward of the fuel control. Impact and bending damage was noted on all surfaces. The fittings were found tight and secure.

- **Oil Filter:** Oil filter was found to be Clean.

1.16.1.1.2 Disassembly Observations

The 1st stage compressor drive shaft to the AGB was found fractured.

- **Compressor Section**

Compressor 1st, 2nd, and 3rd Stage Discs and Blades: The 1st stage blades exhibited severe impact damage to all leading edges resulting in bending of the airfoils in the opposite direction of rotation. Light blade tip rubbing was also noted. The visible portions of the 2nd stage blades showed light impact damage. There was no evidence of blade fracture on any of the stages.

Compressor 1st, 2nd, and 3rd Stage Stators and Shrouds: The 1st stage stator showed impact damage on most vane leading edges. No evidence of vane fracture found. Light scoring was noted on the 1ststage shroud. The other shrouds were not accessed.

Front Stub Shaft: The visible portion (turbine disk mating splines) appeared intact.

No. 1 Bearing: The bearing was free to turn.

No. 2 Bearing and Air seals: The air seal and bearing were intact.

- **Combustion Section**

Combustion Chamber Liner Outer: The liner was crushed at the location corresponding to the impact damage found on the GGC. The liner was otherwise in good condition with normal flame patterns observed.

Combustion Chamber Liner Inner: The liner was crushed at the location corresponding to the impact damage found on the GGC. The liner was otherwise in good condition with normal flame patterns observed.

Small Exit Duct: Intact.

- **Turbine Section**

Compressor Turbine (CT) Guide Vane Ring: Intact. The inner shroud trailing edge showed some scoring damage with associated heat discoloration.

Compressor Turbine Shroud: Moderate rubbing was found on an arc of approximately 120°. A small molten and re-solidified deposit was found on one of the shroud which easily peeled off. The shroud housing was deformed inwards at one location and had to be mechanically cut during disassembly to allow removal of the CT disk.

Compressor Turbine: The disk and blades were intact. Blade tip rubbing causing a slight rolled over material was noted. The blades exhibited scoring damage in the blade fixing area on both sides. The downstream inner hub of the disk as well as the 3 anti-rotation blocks on the balancing rim showed rubbing causing the detachment of slivers. This rubbing was caused by contact with the baffle of the 1ststage power turbine vane ring.

ITT Probes, Busbar, and Harness: The temperature probes were slightly bent. The harness and busbar were intact.

Power Turbine (PT) Housing: distortion of the bolting flange was visible with associated bolt fracture at 4 locations.

Power Turbine Guide Vane Ring and Interstage Baffle 1st stage: The outer shroud was distorted inwards on the upstream side. Six vane airfoils were cracked near the inner shroud. As a result of the outer shroud distortion, all vane trailing edges were wrinkled. The upstream baffle exhibited circular scoring from contact with the CT disk. The scoring was located on the centre portion of the baffle and the outer edge. The downstream baffle also showed circular scoring from contact with the 1ststage PT disk; damage located on the centre portion of the baffle. The inner shroud (both upstream and downstream) was rubbed, causing some rolled over material which small pieces had detached.

Power Turbine Shroud 1st stage: Light scoring from blade contact was noted.

Power Turbine 1st stage: The disk and blades were intact. Light tip rubbing was observed on all blades. All blades exhibited rubbing marks on the airfoil leading edge adjacent to the platform. This is the result of contact with the 1st stage PT vane inner shroud. The blade fixings upstream side showed rubbing damage from contact with the vane baffle.

Power Turbine Guide Vane Ring and Interstage Baffle 2nd stage: Intact; **Power Turbine Shroud 2nd stage:** Heavy rubbing from contact with the 2nd stage PT blades was visible. This resulted from the deformation of the exhaust case at impact.

Power Turbine 2nd stage: The blades showed heavy rubbing which resulted in bending of the blades near the tip. The disk and blades were otherwise intact.

- **Reduction Gearbox**

Rear Housing: Significant impact damage was visible on all surfaces. The mounting flange was fractured and organic dirt obstructed the No. 3 & 4 bearing oil scavenge port.

1st Stage Sungear: The mating splines appeared intact as seen through the carrier.

1st Stage Planet Gear Carrier: Structurally intact.

1st Stage Planet Gears: No evidence of pre-impact anomalies was found.

1st Stage Ring Gear: Dirty but intact.

2nd Stage Sun Gear and Flex Coupling: The coupling was dirty with organic debris but appeared intact.

2nd Stage Planet Gear Carrier: The carrier and planet gears were free to turn. No evidence of pre-impact anomalies was observed.

2nd Stage Planet Gears: No evidence of pre-impact anomalies observed.

2nd Stage Ring Gear: Dirty but intact.

No. 5 Bearing: Free to turn.

Propeller Shaft: Intact.

Nos. 6 and 7 Bearings: Free to turn.

Forward Housing: The mounting flange was fractured and impact damage was observed at the 6 o'clock position.

- **Accessory Gearbox**

The AGB housing was partially separated from the inlet case and portions of it were fractured. The AGB was opened and examination of the gears revealed no pre-impact damage. The rear bearing to the fuel pump drive gear lost one of

its rollers which were found inside the bearing cavity. Two pieces of metal were retrieved from the AGB housing which originated from the rear flange of the same bearing.

The remaining bearings were intact.

1.16.1.1.3 Controls and Accessories Evaluation

- **Ignition System**

Exciter Box: Showed impact damage.

Ignition Leads: Some fraying of the outer protection was evident at various locations and some impact damage which compressed the cable was noted.

Ignition Plugs: Intact.

- **Fuel System**

Fuel Pump: The pump mounting flange was fractured.

Fuel Control Unit (FCU): Severe impact damage was found resulting in the fracture of the drive body flange

Flow Divider: The outlet drain portion was fractured at the coupling flange.

Fuel Nozzles: All nozzles exhibited organic dirt on the stem which is located inside the air-blast sleeve. All nozzle tips were dirty and showed carbon deposits.

- **Air System:**

Compressor Bleed Valves: Both valves were intact but dirty with organic debris. Their pistons moved freely and some air resistance could be felt which is to be expected if the diaphragm is still intact.

- **Oil System:**

Propeller Governor: The governor lever was fractured off the top of the unit.

Overspeed Governor: Dirty but intact.

1.16.1.2 RIGHT HAND ENGINE

1.16.1.2.1 External Condition

Severe impact damage was found on all engine components. Damage from exposure to fire was also noted on most surfaces. The RGB as well as the power turbine module were completely separated from the engine. The inlet case was fractured resulting in complete separation of the AGB from the rest of the engine. The exhaust stacks showed heavy impact deformation but no evidence of impact from exiting debris was noted. Examination of the propeller showed a complete fracture of the hub, liberating all 4 blades, two of the blades showed “S” shape bending. One blade exhibited bending towards the face side with significant impact wear at the tip. The other blade was relatively intact. All blades displayed gouging of the leading edge and chord wise scoring.

- **External Cases**

Reduction Gearbox: Covered with soot and organic debris. The mounting flange was fractured at various locations. A portion of the housing itself was fractured off at the 8 o’clock position as a result of impact.

Exhaust Duct: Severe impact damage covered all surfaces. The case was completely ripped apart behind “A” flange allowing the PT module to exit the case.

Gas Generator Case (GGC): Heavy impact deformation and distortion was observed on all surfaces. The complete circumference of the case had to be mechanically cut just forward of the diffuser pipes to allow removal of the combustion liner. A significant amount of organic dirt was found behind the diffuser pipes.

Inlet Case: Fracture of all inlet struts occurred causing the oil tank and AGB to completely separate from the engine. The case showed significant fire/impact damage resulting in a large section of the case to fracture off, exposing the inside of the oil tank, which was found covered in soot.

Accessory Gearbox: Cracking associated with fire exposure as well as impact damage was visible on both the housing and diaphragm. The housing itself was fractured (with a piece missing) in the area of the fuel pump drive.

- **Power Control and Reversing Linkage**

The linkage was separated from its mounting and bent. The FCU control rod was fractured.

- **Pneumatic Lines**

Compressor Discharge Air (P3): the fitting to the FCU was tight and secured. The line was severed at the P3 filter housing.

Power Turbine Control (Py): The line was secured at the FCU. It was severed at the rear and GGC firewalls. A portion of the line remained attached to the propeller governor however the impact damage and deformation was present and the fitting was found loose.

- **Chip Detectors and Filters**

Oil Filter: Clean.

1.16.1.2.2 Disassembly Observations

The 1st stage compressor disk showed the fracture of all 6 of its retaining tie rods and the disk and blades, covered in fire residues, remained with the inlet case. The AGB drive shaft was bent and the No. 1 bearing cover was fractured in two pieces.

- **Compressor Section**

Compressor 1st, 2nd, and 3rd Stage Discs and Blades: All components were covered with soot. Severe impact damage was found on the recovered 1st stage blades (7 were missing from the disk).Blade tip rubbing resulting in bending of the tips in the opposite direction of rotation was noted. The disk bolt holes exhibited elongation at the point of bolt fracture which was in the opposite direction of rotation. Bending of all blades in the opposite direction of rotation was observed on the 2nd stage disk resulting from contact with its shroud.

Compressor 1st, 2nd, and 3rd Stage Stators and Shrouds: The 1st stage stator exhibited severe impact damage as well as bending of all the vanes due to

contact with the adjacent spacer. The vane trailing edges were severely deformed from rubbing with the 2nd stage blades. All vanes were accounted for.

Front Stub Shaft: The inner splines were intact.

No. 1 Bearing and Air seals: The bearing was intact.

No. 2 Bearing and Air seals: The bearing was axially displaced within its outer race due to impact. It showed however no evidence of pre-impact anomalies.

- **Combustion Section**

Combustion Chamber Liner: Distorted from impact (deformation of the GGC) but it was in otherwise intact condition showing normal flame patterns.

Large Exit Duct: Distorted from impact but otherwise intact.

Small Exit Duct: Intact.

- **Turbine Section**

Compressor Turbine Guide Vane Ring: The vanes were intact. The inner shroud showed scoring damage due to contact with the CT blades.

Compressor Turbine Shroud: The shroud housing was distorted and had to be mechanically cut to allow for the removal of the CT disk. The shrouds exhibited rubbing damage from contact with the CT blades. A thin layer of melted and re-solidified material was found on some shrouds. This layer could be easily peeled off and likely originated from the CT blade tips.

Compressor Turbine: All blades were in place. Blade tip rubbing was present on all blades with associated rolled over material at the tip of each blade. The edge of the blade platforms, at the leading edge showed scoring damage, due contact with the inner shroud of the CT vane ring. The trailing edges of all blades were damaged due contact with the inner shroud of the 1st stage PT vane ring. The downstream face of the disk as well as the blade fixings and retaining rivets exhibited scoring damage from contact with the PT vane ring baffle. Severe

scoring with associated deformation was observed on the disk centre hub and anti-rotation lugs due to contact with the PT disk retaining nut and vane baffle.

ITT Probes, Busbar, and Harness: The temperature probes were either bent or fractured. The bus bar and harness was intact.

Power Turbine Housing: Compressive deformation was observed in the T5 probe region. Scoring and multiple low energy impact marks were found on the downstream portion of the housing.

Power Turbine Guide Vane Ring and Interstage Baffle 1st Stage: The vane ring was fractured in multiple pieces. Only two portions of the inner shroud were available for examination. The baffle remained stuck to the centre hub of the 1st stage PT disk and it showed significant circular scoring damage from contact with the CT disk.

Power Turbine Shroud 1st Stage: Obliterated by the fracture of the 1st stage PT vane ring.

Power Turbine 1st Stage: All blades were fractured adjacent to the platform. Examination of the fracture surfaces revealed dendritic features characteristic of overload type fracture. No evidence of fatigue was found.

Power Turbine Guide Vane Ring and Interstage Baffle 2nd Stage: The leading edge of all vanes exhibited impact damage due to the fracture of the 1st stage PT blades. Significant impact damage was found on the trailing edge of the vanes as well as the outer shroud.

Power Turbine Shroud 2nd Stage: The shroud was covered with small impact marks and scoring caused by the fracture of the 1st stage PT blades. No evidence of high energy impact was found.

Power Turbine 2nd Stage: A number of blades were fractured near the platform. Some other blades were fractured at various locations with the airfoils. All of the fracture surfaces exhibited features characteristic of overload with no evidence of fatigue noted. The remaining blade tips exhibited severe rubbing resulting in partial loss of the shrouded tips.

- **Reduction Gearbox**

Rear Housing: Fracture of the bolting flange and housing was observed adjacent to the oil scavenge ports.

1st Stage Sungear: The splines appeared intact when viewed through the carrier. The inner diameter exhibited metal deposits and scoring from contact with the propeller oil sleeve. The sungear was not removed.

1st Stage Planet Gear Carrier: Dirty. The outer edge of the carrier showed scoring damage from contact with the 2nd stage planet gearshaft nuts. The carrier thrust washer was fractured and recovered within the RGB housing.

1st Stage Planet Gears: Intact. The gears were free of movement.

1st Stage Ring Gear: Intact.

2nd Stage Sun Gear and Flex Coupling: Dirty but intact. The oil slingers were dislodged.

2nd Stage Planet Gear Carrier: The carrier was intact. The planet gear shafts retaining nuts exhibited scoring damage from contact with the 1st stage carrier.

2nd Stage Planet Gears: The gears were dirty but intact and free to move.

2nd Stage Ring Gear: Appeared intact.

Propeller Shaft: The propeller bolting flange was bent due impact. The oil transfer sleeve showed significant circular scoring wear due contact with the 1st stage sun gear.

Forward Housing: The mounting flange was fractured at various locations. A portion of the housing itself was fractured off at the 8 o'clock position as a result of impact.

- **Accessory Gearbox**

Disassembly of the gearbox showed no evidence of pre-impact anomalies to any of the gears or bearings.

1.16.1.2.3 Controls and Accessories Evaluation

- **Ignition System**

Exciter Box: Impact damaged and covered in soot. Both lead connectors were fractured off the unit.

Ignition Leads: The leads were impact damaged.

Ignition Plugs: Intact.

- **Fuel System**

Fuel Pump: The pump had separated from its AGB mounting pad and the drive shaft was bent. Soot covered all surfaces.

Fuel Control Unit: Covered with fire residues. The P3/Py adapter was loose and the control levers were bent.

Flow Divider: Dirty but appeared physically intact.

Fuel Nozzles: Many transfer tubes were either bent or dislodged as a result of the structural deformation present on the GGC. All nozzles showed dirty tips. The nozzle stems were covered with organic dirt.

- **Air System:**

Compressor Bleed Valve: Both valves were covered in fire residues. The low pressure valve piston moved freely. The piston from the high pressure valve was not capable of movement and the diaphragm exhibited fire damage.

- **Oil System:**

Propeller Governor: The unit was dirty with fire residues and the control lever was fractured.

Overspeed Governor: The complete unit was fractured off its RGB mounting pad.

1.17 Organizational and Management Information

1.17.1 General

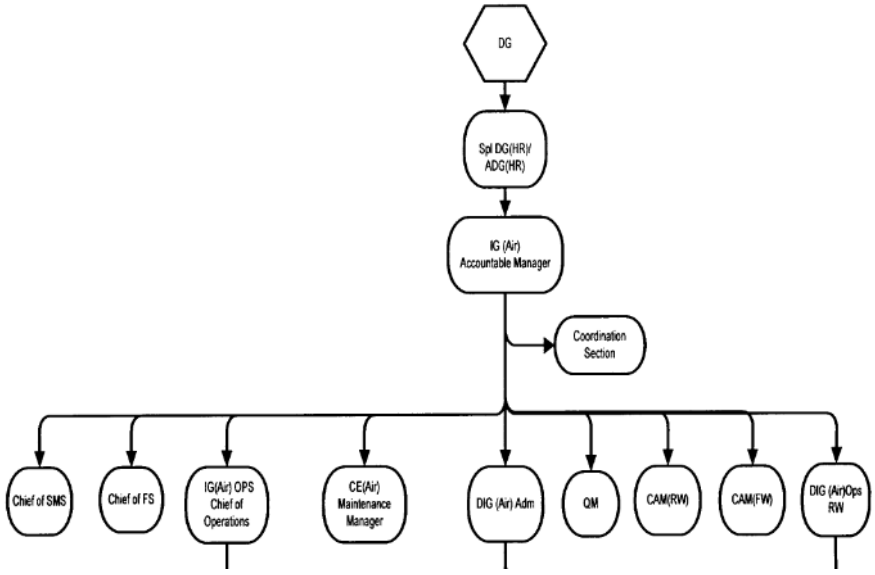
As per the Manual of the Organisation, it is an logistics support arm(of Ministry of Home Affairs, GOI) responsible to provide air lift support to Central Armed Police Force (CAPF) Organizations, VIPs and Senior Ministry/ State Officials. It is also assigned special tasks like causality evacuation, relief supplies

in the flood and earthquake affected areas and any special task assigned by the MHA.

All flights are undertaken on behalf of the State for bonafide Government duties as deemed appropriate by the Central Government and are not meant for commercial or remuneration purpose.

The Organisation has prepared Manual of Air Operations. As per the existing structure, the IG (Air) is the Accountable Manager. The present incumbent is a serving AVM from the Indian Air Force who is also a helicopter pilot. The alternate Accountable Manager is an officer of DIG rank from the General Duty branch of the Organisation. Below the Accountable Manager are two different wings, i.e., the Rotary Wing and the Fixed Wing.

The Organisation Chart as given in the Manual is as below:



In addition to the Maintenance and Operations Departments, the Organisational Chart shows two independent Departments i.e., the Flight Safety and the Safety Management System (SMS). As per this Manual, the Air Wing will have a full-fledged Department of Flight Safety headed by the Chief of Flight Safety, reporting to the Accountable Manager. The function of Accident

Prevention Advisor shall be carried out by the Chief of Flight Safety. Details of the safety programme are provided in the DGCA approved Flight Safety Manual. The main objective of the Accident Prevention and Flight Safety Programme is: “TO PREVENT AVIATION ACCIDENTS AND INCIDENTS FROM OCCURRING"

One of the duties and responsibilities of the IG (Air) is to establish effective Safety Management System, promote the Safety and Quality Policies and to ensure effectiveness of Safety Management System for Flight Operations & Engineering activities complying with Air Wing Policies and Operations Specifications.

The Chief of Flight Safety is responsible for:

- Conducting audits of Standards and Procedures and provide inputs to Line Operations and Training;
- Providing inputs to the Permanent Investigation Board;
- Periodically conducting audits of all Operational activities, which have direct bearing on Safety and Efficiency and ensure compliance;
- Co-ordinating with Departments on all matters concerning Flight Safety.

As per the Manual, in addition to the Chief of Flight Safety, there shall be a Chief of SMS who shall be responsible for carrying out all the functions of the Safety Manager as per Doc 9859.

On the date of accident, the following Type qualified flight crew were available with the Organisation for operating the B-200 aircraft:-

- An Examiner with around 8000 hrs of total flying experience (referred to as Examiner in the report.)
- Two Pilots (deceased in the present accident) who were the General Duty (GD) Officers of the Organisation and were selected through an in-house selection process. They were trained at Indira Gandhi Rashtriya Udaan Academy (IGRUA), Fursatgunj, U.P. to acquire their CPL and were then inducted in the Air Wing (referred to as PF and PM in the report).

- One Pilot (CPL holder) who was the GD Officer of the Organisation and had shifted to the Air Wing (referred to as 3rd GD Officer in the report).
- One retired Air Force Officer who was holding the position of the Senior Operations Officer (SOO) (referred to as SOO in the report).

1.17.2 Maintenance

The Air Wing is an approved Maintenance Organisation as per DGCA CAR 145. It is approved to carry out:

- Maintenance up to multiples of Phase –IV/800 Hrs/ 24 months inspection on SKA B-200 aircraft fitted with P&W PT 6A-42 engines.
- Bench check/ FTD check of radio and navigation equipments as per approved capability list.
- Maintenance of Ni Cd batteries as per approved capability list.
- Disassembly and assembly of main and nose wheels of Embraer, HS 748 Avro and SKA B200 aircraft.

1.17.3 Reporting of Incidents/ Defects

Documents available with the Organisation regarding Incident Reporting & Investigation thereof were scrutinised. The Engineering Department keeps a record of all the defects/ occurrences along with the action taken to rectify the defects. Some of the recent occurrences on this aircraft which required mention – as they reflect the snag reporting culture prevalent in the Organisation – are as follows:

a) On 21st September 2015, the aircraft made a suspected hard landing at Delhi on the return journey from Kanpur to Delhi as reported by the AME on board. The aircraft was inspected by the AME on duty. The pilot did not report any defect in the PDR from Kanpur to Delhi. On this flight, the SOO was acting as Co-pilot.

b) After a flight from Bhopal to Delhi on 24th November 2015, while taxing to hangar the left engine was inadvertently shut down by PM who was the PIC and the SOO was acting as Co- Pilot. The PIC reported in the PDR as 'PORT CONDITION LEVER DETENT SLIP TO FUEL CUT OFF, MAY BE CHECKED'. The aircraft was got checked by a senior AME and the AME on board. Rectification carried out was:

I. Checked the port side condition lever for proper operation as per procedure given in aircraft maintenance manual chapter 76-10-05 found satisfactory.
II. Port condition control catch Gate checked as per the procedure laid down in the Aircraft Maintenance Manual Chapter 76-10-05. Found Satisfactory.
III. Engine control checked for proper operation, free movement and routing as per the procedure laid down in the aircraft maintenance manual chapter 76-00-00. Found satisfactory.
IV. Operation ground run carried out to check the operation of the System and Engine parameters. Found all parameters within the limit and satisfactory.

As nothing was observed during the inspection, the aircraft was released for further flight. The aircraft was flown on 25th November 2015 from Delhi-Raurkela-Ranchi-Delhi. The flight was operated by the 3rdGD Officer as PIC with one of the deceased pilot as Co-Pilot. No defect was reported by the PIC on any of the three legs confirming that the aircraft was fully serviceable. Thereafter, till 22nd Dec 2015 no snag was reported pertaining to the port condition lever.

c) On 13th Nov 2015, while returning from Suratgarh to Delhi, three pieces of metallic weights, weighing 71 Kgs each with diameter of 8 inches and height of 1 foot were carried in the aircraft. The flight was operated by 3rd GD Officer as PIC and the SOO as Co- Pilot.

d) On 9th Dec 2015, a flight was operated from Ranchi to Delhi by the flight crew with the SOO as PIC, an AME and a Cabin Crew. The PIC reported NIL defects in the PDR. On 10th December, 2015 the aircraft was due for 25Hrs Inspection, while carrying out the inspection, multiple dents were observed on both sides of the Nose Avionics Compartment Panels, which was reported by the Quality Manager to the Chief of Flight Safety the same day. After obtaining clearance from the DGCA, the dents were rectified on 14th Dec 2015 by the AME.

1.17.4 Operational Procedures and Control

On the date of accident, the Organisation had an Examiner on B-200 aircraft who had joined the Organisation in the mid 1992. After completing 1000 hours of flying experience (on twin engine turboprop aircraft – HS 748 Avro having AUW of 14000 Kgs plus being operated by both the military and civil), he was appointed as Co-pilot with the rank of Commandant in 1995. From 1995 onwards he performed the duties of Commandant (Air Ops), DIG (Air Ops), Chief of SMS etc. He was approved as Examiner on B-200 aircraft by the DGCA in 2010.

Till the year 2009, he was operating B-200 aircraft as Pilot-in-Command and was permitted by the DGCA to operate B-200 aircraft as single crew. However in order to fly VIPs, the Organisation used to hire the services of outside B-200 Pilots to fulfil the requirements of CAR for VIP operations. In view of the need for additional pilots in the Organisation, a policy was drafted to select the General Duty (GD) Officers of the Organisation with Science background and to impart them flying training at IGRUA, Raibareli for obtaining CPL on fixed wing aircraft. Accordingly, two GD Officers were selected and trained at IGRUA. The 1st GD Officer (PF) was inducted in BSF Air Wing in August 2009 followed by 2nd GD Officer (PM) in September 2010 as Co-pilots on B-200 aircraft.

Sometime later, a 3rd GD Officer with endorsement on B-200 aircraft was attached to the Air Wing.

It was noted that the PF was checked by Capt. Vikas Sharma (Type Examiner) in November 2012 and was released to fly as PIC on B-200 aircraft. During the same period, the 3rd GD Officer was also released by Capt. Vikas Sharma to fly as PIC. At that time the Examiner of the Organisation was acting as Chief of SMS but was not consulted by the Organisation prior to the above two releases though both pilots had flown with him for more than 02 years.

It will be pertinent to note that Capt. Vikas Sharma was working with another State Government, where the minimum flying experience required is 1000 hrs as co-pilot on multi-engine aircraft before release as PIC subject to satisfactory assessment by the supervisory senior pilot/ Type Examiner. The Examiner had intimated the hazard of low Type experienced pilots being released as PIC to the DGCA on 22.03.2013 as Chief of SMS of the Organisation.

Between November 2012 and April 2013, it is revealed that the Examiner had flown as PIC with the PM. As per the Examiner, the roster was prepared by the young pilots (GD Officers) and approved by the IG Air and that he (Examiner) had no role to play. The scrutiny of the documents of the deceased flight crew revealed that the Examiner had flown as PIC with both of them (PF and PM) performing the duties of Co-Pilot. The Examiner had carried out the IR checks of the PF, PM & the 3rd GD pilot. But these pilots never operated as PIC with the Examiner pairing with them as Co-pilot/ Supervising Pilot.

It is a general practice in Aviation Organisations that though the DGCA accords PIC endorsement on Type to a Pilot for aircraft below AUW 5700 Kgs, such a Pilot initially functions as Co-Pilot till gaining sufficient experience to fly as Pilot in Command. This ‘sufficient experience’ is determined by the Supervisory Senior Pilots/ Operations Incharge of the Organisation and are then released to fly as PIC after being satisfactorily assessed for PIC role by a Type Examiner and are initially paired with a Senior Pilot.

There is no laid down procedure in the Organisation regarding 'Flying under Supervision'. Prior to the induction of the GD Pilots in the Organisation; after endorsement on B-200 aircraft the freshly endorsed Pilot was permitted to fly as PIC only after attaining multi engine flying experience of at least 1000 hrs. Thereafter, the Pilot would fly as PIC only with another Senior Captain/ Instructor/ Examiner on B-200 aircraft.

The Examiner provided a bunch of Letters/ Notes wherein he had been advising the appropriate authorities in the system from time to time much before the occurrence of this accident. These are related to:

- PIC/ release as PIC, explaining that there is no short cut to experience and type of aircraft which pilot is flying.
- CAPF pilots to fly as PIC/ release as PIC mentioning flying experience of these pilots, number of occurrences etc.
- On release of independent command on B-200 aircraft.
- Soliciting intervention for appropriate steps to avoid any fatal accident in near future.

As no documented procedure was provided to the Committee regarding transportation of the technicians, tools & equipments for servicing of the Mi-17 helicopter by the fixed wing aircraft of the Organisation including B-200 aircraft from Delhi and back; the Examiner was asked to explain the norm followed in this regard. As per him:

> "The Helicopter Wing takes permission of IG Air for the above transportation by fixed wing aircraft. The tools & equipments are then transported to the aircraft under the supervision of security team where the final decision lies with the pilot in consultation with engineer had to decide if the things can be taken on board. On occasions undersigned had refused for taking the loads on board due to weight limitations or type of load. The same used to be informed to the person who has brought the load under intimation to the competent authority. However the procedure for transporting is not documented as per my knowledge."

The weight and load data sheets for B-200 aircraft since April 2015 were perused. In all data sheets, the weight of baggage in the aft cabin compartment is calculated as 20 Kgs, irrespective of the number of passengers or sector. The flights had been operated at one time or the other by all the Pilots qualified on Type and operating as Pilot-in-Command. For all flights the baggage in the aft cabin compartment cannot be always calculated as 20 Kgs – it appears inconsistent.

1.18 Additional information

1.18.1 Scheduling of the Aircraft and Flight Crew

The Committee was not provided with any documented system of flight scheduling including that of the flight crew members. In order to understand the procedures being followed by the Organisation, various approvals of flying programme were reviewed and followed by interrogation of the then DIG (Air) & Alternate Accountable Manager, Chief Engineer (Fixed Wing) and Deputy Chief Engineer (Rotary Wing).

The documents revealed that as a procedure, the Senior Operations Officer (SOO) Palam would forward the flying programme including the names of the flight crew to the IG (Air) for approval. The proposed flying programme was approved by the IG (Air) and in his absence by the ADG (Logistics).

The then DIG (Air) in his statement stated that the procedure for scheduling the flights was that the programme is received by the Duty Officer at Air Operations Control Room (AOCR)in the IG (Air) Office at Palam. The Duty Officer forwards the programme to the IG (Air) for his approval. In the absence of the IG (Air), the DIG (Air) forwards the programme received from AOCR, Palam to the ADG (Logistics) for his approval. Only after the approval is accorded by the ADG (Logistics)/ IG (Air) the form containing the programme was resent to AOCR Palam. The accidental flight was also approved by the ADG (Logistics) as the IG (Air) was on temporary duty to Bhuj. The IG (Air) had instructed him (DIG Air) to put up the file to the ADG (Logistics).

During interrogation, the then DIG (Air) also provided a copy of the flying programme which was forwarded by one of the deceased flight crew and carried the name of the SOO as the other flight crew member. It was also mentioned in the proposed flying programme that it had telephonic approval of the IG (Air).

As per the Deputy Chief Engineer (Rotary Wing) the transportation of men and material for BSF Rotary Wing by BSF Fixed Wing aircraft is not a regular feature, but on as and when requirement basis. The Deputy Chief Engineer (Rotary Wing) after obtaining permission of the IG (Air) would forward the requirements to the BSF Fixed Wing to use their services. In this particular case, after taking permission from the IG (Air), the Fixed Wing was asked about the details of the flight to Ranchi and the Rotary Wing was informed that the Fixed Wing flight is scheduled in the morning of 22.12.2015. As the Deputy Chief Engineer (Rotary Wing) was on official duty to Jodhpur from 21.12.2015, he informed the In-charge, Movement Control Centre to route the gang, tools and testers for transportation to Ranchi by the Fixed Wing on 22.12.2015.

The Chief Engineer Fixed Wing (DIG) stationed at Palam was specifically asked about the reason for the flying programme for B 200 aircraft on 22.12.2015 being approved by the ADG (Logistics) on the recommendation of the DIG (Air). This flying programme did not have signature or recommendations of the Duty Officer, AOCR, Palam. Whereas, since April 2015 all flying programmes originated from Duty Officer, AOCR, Palam and were approved by the IG (Air).

The CE stated that, based on the four incidents occurring on B 200 aircraft on 21st September 2015,13th Nov 2015, 24th Nov 2015 and 09thDec 2015, the Engineering Section, Palam considering them as as a flight safety issue had raised a report on 11th December 2015 to the IG, Palam (Officer other than IG Air), for taking immediate necessary action. The IG, Palam had referred the matter to the ADG (Logistics).The Chief Engineer further stated that it seems in the interest of flight safety and based on the report of IG, Palam a decision would have been taken at the Head Quarters to detail the deceased flight crew in place of the crew composition proposed by AOCR, Palam for the flight dated

22.12.2015. In the revised crew composition, the SOO was replaced by the PF for the flight dated 22.12.2015.

1.18.2 Relevant DGCA Requirement

Civil Aviation Requirement Section 3 – Air Transport Series 'C' Part X Issue I, gives the minimum procedural requirements for the issue of permission to undertake aircraft operations by State Governments or Public Sector Undertakings of the Central/ State Governments. Some of the salient requirements are as follows:

- The Organization shall have division depending on its scope activity namely Engineering, Operations, Quality and Safety Divisions, etc. Such divisions will have competent person to ensure compliance with applicable regulations.
- The Organization shall have in their safety division adequately qualified person to analyse incidents, defects, carry out internal safety audits and monitor flight operation quality assurance by downloading flight data recorder information. The head of safety division shall be approved in accordance with CAR Section 5, Series F, Part I.
- An Operator shall formulate and implement a safety management system acceptable to the DGCA, which as a minimum:
    a) Identifies safety hazards;
    b) Provides for continuous monitoring and regular assessment of the safety level achieved;
    c) Ensure that remedial action necessary to maintain an acceptable level of safety takes place on a continual basis; and
    d) Aims to make continuous improvement to the overall level of safety.
- A safety management system shall clearly define lines of safety accountability throughout the Operator's Organization, including a direct accountability for safety on the part of senior management.

- When operating VIP flights with fixed wing aircraft, the pilot-in-command shall possess CPL or ATPL with at least 3000 hours including 2000 hours as PIC, 50 hours as PIC on type of aircraft to be flown and 50 hours of night flying experience. In addition, the pilot should have a minimum of 30 hours as PIC experience in the last 6 months including five hours on type in the last thirty days of the intended flight. In case 30 hours recency during the last 6 months is not met with, then in last 30 days, a satisfactory skill test (as required for licence renewal) shall be carried out followed by 5 hours of PIC experience.
- VIP flights shall always be operated with a multiple crew composition and the PIC shall meet the requirements of 6.15, as the case may be.

  Note 1: When a new type of aircraft is introduced in the fleet of State Government/ undertaking, the experience of PIC on type may be reduced with prior permission of DGCA, if the pilot has adequate flying experience of similar type of aircraft.
- The permit holder shall notify to the DGCA any accidents, incidents, major defects or other significant occurrence as given in Car Section 5 series C part I. Such information shall be provided to the DGCA (Attention: Director Air Safety) by the quickest means but not later than 24 hours.
- The Safety division shall follow proactive accident prevention procedures.
- The permission holder shall monthly return to DGCA on the number of hours flown by each aircraft of the fleet, defects encountered and reasons for prolonged grounding of the aircraft, if any. Such returns will be sent to local airworthiness office with a copy to the DGCA Hqrs (Attn: Director of Air Transport).

1.18.2.1Operating Permit as per CAR Requirement

In order to ensure better safety oversight control on the operation of the aircraft owned by State Governments and Public Sector Undertakings of the Central/ State Governments being used for carriage of Governors, Chief Ministers, State/ Central Ministers, and other important high dignitaries it was decided by the DGCA that all such Organisations shall obtain permission from the DGCA for operating such aircraft. As the above requirement was applicable

to the subject Organisation and was pointed out during surveillance, the subject Organisation had applied for issue of the Operating Permit in the year 2012.

The documents submitted by the Organisation were reviewed followed by meetings with the officials and post holders of the Organisation. Safety concerns were raised and the Organisation was informed to make these observations good for the issuance of the Permit.

Later a safety audit of Aviation Wing of the Organisation was also conducted by the DGCA from 24th to 26th July 2012 for ensuring the compliance of regulatory requirements. The audit team raised various non-compliance regarding Pilot Training, Operations and Maintenance aspects. Based on Non-compliance raised in the audit, the Operator submitted an Action Taken Report to the DGCA. As per the documents made available to the Committee, no further concrete step was taken from either side to ensure that the Organisation is accorded the permission though the requisite fees for grant of the Operating Permit was deposited with the DGCA. However, till date all the operations carried out by the Operator are without the issuance of the Operating Permit.

1.18.3 Flight Safety & Safety Management System (SMS)

Safety Management System is a standard throughout the aviation industry worldwide. SMS for stake holders and regulators integrates modern safety risk management and safety assurance concepts into repeatable, proactive systems. SMSs emphasize safety management as a fundamental process to be considered in the same manner as other aspects of business management. By recognising the Organization's role in accident prevention, SMSs provide to both stake holders and authorities:

- A structured means of safety risk management, i.e., decision making.
- A means of demonstrating safety management capability before system failures occurs.
- Increased confidence in risk controls through structured safety assurance processes.

- An effective interface for knowledge sharing between regulator and stake holder.
- A safety promotion framework to support a sound safety culture.

As mentioned above, though in the Organisation chart it is specifically indicated that there will be Chief of SMS & Chief of Flight Safety with a full-fledged Department of Flight Safety, none was existing. From the discussions with the Officers who were designated as the Chief of Flight Safety in the present and past, it was noted that as and when any regulatory requirement arose, an Officer was nominated for the purpose. At times Officers have conveyed their unwillingness to the Accountable Manager & Alternate Accountable Manager on the work load grounds and not being trained on Flight Safety. The Chief of Flight Safety was interviewed by the DGCA officials for the post of the Chief of Flight Safety and the aspect of lack of training on flight safety was brought out. Approval was accorded for the Chief of Flight Safety for 06 months on the precondition of Flight Safety training.

1.18.4 Training & Flying information Pilots on B-200 Aircraft Since 2008

The details of all pilots trained on B-200 aircraft and their related flying information on Type since 2008 is as follows:

Events	PF on the accident flight	PM on the accident flight	3rd GD Officer
Completion of CPL Training	October 2008 (200 Hrs – ab initio training)	September 2009 (200 Hrs – ab initio training)	December 2008
Commencement of flying on B-200 A/C in the Organisation	08.08.2009	24.09.2010	25.01.2011
First PIC flight on B-200 A/C & Type experience as Co-pilot on that date	27.06.2015; 620:35 hrs	20.11.2012; 183 hrs	26.11.2012; 413:05 hrs

From Nov. 2012 till April 2013, most of the flying was undertaken by the PM and the 3rd GD Officer as PIC & P2 alternatively; with few flights by Examiner as PIC and PF as P2.

From July 2013 to April 2015, all flying was undertaken by the Examiner as PIC and other pilots as P2.

In April 2015, an Outside Examiner (Outsider to the Organisation) carried out IR/PPC Checks for all three pilots, i.e., Examiner, PF and PM (due to long break in flying as the aircraft was grounded from 05.09.2014 to 13.04.2015).

The PM underwent satisfactory IR Check(s) in November 2012 by Outside Examiner (Outsider to the Organisation) and in May 2014 by Examiner of the Organisation.

Since May 2015, all flying was undertaken by the PF, PM & 3rd GD Officer by pairing mutually. Few flights were undertaken by the Examiner as PIC.

Since May 2015, the B-200 aircraft had flown 351:50 hours. The breakup of hours flown during this period by all Type qualified pilots of the Organisation are as follows:

Crew	As P1 (Hours)	As P2 (Hours)	Total (Hours)
Examiner	32:45	Nil	32:45
PF	62:05	105:10	167:15
PM	121:45	86:15	208
3rd GD Pilot	123:25	118:30	241:55
SOO	07:00	37:05	44:05

1.18.6 Weight & Balance of Aircraft

From the wreckage personal baggage/tools/equipment were retrieved and weighed. The weight of the personal baggage was around 152 Kgs. In addition

Battery: 22.8 Kg

Test box Tool Kit: 16.6 kg

Mi Docs: 1 kg

2nd Battery (Mi) New: 23 kg

As per the UO.853/ Gen-MiscVol.II/RW/SAP/AW/BSF/2015 dated 21.12.2015 the following items were supposed to be sent for Mi-17 servicing at Ranchi by B-200 Super King Aircraft.

1. Laptop Panasonic SRL no. -3FTCA86004 and accessories for FDR Milking.
2. 20 NKBN-25-TD-V3 Qty—2 (Ni Cd Battery SI No. BSF/001 & BSF/002)
3. U-6360-2455 FIXTURE (Engine Compressor Wear Check tool Qty-01)
4. 3026865 Special Ring (19) Qty-01
5. 8AT-9928-500- Engine Oil Drain Hose Qty-01
6. APU Oil Drain Hose Qty-01
7. Tensio Meter -01, Conical Nipple-01, Control Pin-04, Torch commander -01, Oil/Grease Hose with Conical Nipple-01, MGB Oil Drain Hose-01 & Tool Bag-01
8. Aircraft Servicing Record Book –II (Form -700B for MI-17 V5 helicopter of ZP-5243 for electrical, structure, propulsion, Radio & Weapon)
9. Aircraft Servicing Record Book –I (Work Order and Compliance Certificate of ZP-5243 helicopter)
10. Servicing Package Electrical ½ Qty-02 and Servicing Package Electrical 2/2 Qty-02, Servicing Package Electronic 1/1 Qty-01 and Servicing Package (OOPS) Structure 1/1 Qty-01, Task Order for Unscheduled Activities Qty-01, Servicing Package Propulsion (Floor) Qty-01
11. PAMAS S-40 Fuel Particle Count tester Srl No. 400-1808 with complete accessories and packing case.

1.19 Useful or Effective Investigation Techniques

Nil

2. ANALYSIS:

2.1 Serviceability of the Aircraft

2.1.1 General

Air wing of the Organisation is an approved maintenance organisation as per DGCA CAR 145. It is approved to carry out

- Maintenance up to multiples of Phase –IV/ 800 Hrs/ 24 months inspection on SKA B-200 aircraft fitted with P&W PT 6A-42 engines.
- Bench check /FTD check of radio and navigation equipments as per approved capability list.
- Maintenance of Ni Cd batteries as per approved capability list.
- Disassembly and assembly of main and nose wheels of Embraer, HS 748 Avro and SKA B200 aircraft.

The aircraft was maintained as per the DGCA approved maintenance schedule. Once flying program is duly approved and received in the Engineering Department, the Chief Engineer details the Engineer to be on board the aircraft.

No inspection was due on the aircraft prior to its release on the date of accident.

The snags reported from April 2013 till the date of accident were scrutinised. There was a repetitive snag with respect to the PROP lever and PROP Governor. The snag was not reported after replacement of the PROP (Port side) Governor. There was no reported defect requiring maintenance action on the date of accident which could have contributed to the accident.

All modifications and Service Bulletins were complied with before undertaking the accident-flight. No snag was pending for rectification before the

accident flight. It can be concluded that the aircraft was maintained properly and it was airworthy to take the flight.

2.1.2 Engines Investigation

The left hand engine exhibited complete separation of the front half reduction gearbox and accessories gearbox due to impact. Compressive impact damage was mostly concentrated at the 6 o'clock position. Impact damage and bending in the opposite direction of rotation was noted on the 1st stage compressor blades.

Rotational signatures were visible on the compressor and 1st stage power turbine disks, blades and adjacent stators. The 2nd stage disk showed extensive blade tip rubbing and subsequent bending of the blade airfoils in the direction opposite rotation.

The right hand engine showed complete separation of the power turbine module and reduction gearbox as well as complete separation of the accessories gearbox. Significant impact damage covered all surfaces of structural cases and all external components.

Extensive rotational signatures were found on the compressor turbine disk, blades and adjacent stators. The 1st stage power turbine blades were fractured adjacent to the platform. Examination of the fracture surfaces showed features characteristic of overload. The 1st stage power turbine stator exhibited the fracture of all vanes. A number of 2nd stage power turbine blades were fractured. Features characteristic of overload were found on the fracture surface as well as bending of remaining portions of airfoil in the opposite direction of rotation.

Bending of airfoils on blades and vanes consistent with rotation at impact was noted on the examined components of the compressor.

There was no evidence of pre-impact mechanical anomalies on the right hand engine or on the left hand engine.

2.1.3 Accessories investigation

Investigation of the engine accessories did not reveal any anomalies which could have prevented the engine from operating properly before impact.

Investigation of the accessories comprising of testing and analysis of the fuel control units (FCU), fuel pumps, compressor bleed valves (LPBOV & HPBOV), flow divider valves (FDV), propeller governors (CSU) and over-speed governors from each engine. Damage consistent with impact was apparent on many of the control units. The LP and HP BOV from the No. 1 engine and the LPBOV from the No 2 engine were leaking on test. However, each BOV was able to close, and the closing points were similar.

It is possible that the BOV leaks were caused by exposure to the post-crash fire. The No. 2 engine OSG was damaged and material analysis of the fracture surfaces confirmed that the fractures had occurred due to tensile overload. The nature of the damage suggests that this was a consequence of the crash, not a contributing factor.

There were no defects or damage evident that would have prevented normal operation prior to the event.

2.2 Weather

The weather at the time of accident at Delhi was foggy with visibility reported as 800 meters and winds of 3 knots. The previous METAR which was available with the flight crew mentioned visibility of 600 meters. The visibility was marginal and it is inferred that the marginal visibility was a contributory factor to the accident.

2.3 Crew Qualification

Both the involved cockpit crew, i.e., the Pilot-in-Command and the Co-pilot were qualified to operate B-200 aircraft. The Pilot-in-Command and the Co-pilot were holding valid CPL license with Type endorsement.The Instrument Rating on

Type for both Pilots was current. The PF had a total flying experience of 964 hrs including 77 hrs as PIC on Type and the PM had a total flying experience of 891 hrs including 196:35 as PIC on Type. Both Pilots had valid class I medical and had undergone Proficiency Checks on Type as per the requirements. Both pilots had undergone Pre-flight medical including breath-analyzer test before the flight and were not under the influence of alcohol.

In April 2015, a DGCA approved Examiner who was an outsider to the Organisation had carried out IR/ PPC checks for all three pilots, i.e., the Examiner, PF and PM. The PF & PM had carried out the required checks and procedures satisfactorily and operated the Check Flight as per the DGCA requirements. Their technical knowledge was also found to be satisfactory. Accordingly, IR/ PPC Check Forms were issued to both pilots with satisfactory remarks.

The Outside Examiner after conducting the aforementioned checks for both Pilots (PF & PM) had communicated to the Examiner that the PF & PM will require a good amount of experience and training before they are released to carry out flight duties independently as Commander (Pilot-in-Command). Till then they should fly under supervision of a suitably experienced Senior Commander. As per the statement of the outside examiner he had sent a sms to the DG, BSF on the above lines which was acknowledged by DG, BSF as 'noted'.

The Organisation had 05 Pilots qualified on B-200 aircraft, i.e., the Examiner, one retired IAF official and 03 CPL holders who were earlier GD Officers with the Organisation. As AUW of the B-200 aircraft is less than 5700 Kgs., after successful completion of training (including Simulator Training), the CPL holder is endorsed with PIC rating on Type. In the present case, the PF had started operating as PIC after 620:35 hours of flying experience on Type as Co-pilot, while the PM had started operating as PIC after 183 hours of flying experience on Type as Co-pilot. They were pairing with each other to operate flights on B-200 aircraft after being released to fly as PIC.

The pattern followed regarding the release of a Pilot to operate as PIC on B-200 aircraft after obtaining endorsement was discussed by the Committee with a number of Heads of Aviation operating B-200 aircraft within the country. The Committee noticed that initially the Pilot gains between 500 to 1000 hours of flying experience as Co-pilot and is then released to fly as PIC based on satisfactory assessment by their Supervisory Senior Pilot/ Release Check by Type Examiner. Furthermore, such newly released Pilot is initially paired with a Senior Commander functioning as Pilot Monitoring and never with a freshly endorsed/ low experience Co-pilot.

2.4 Flying Hours - B-200 Aircraft

The Organisation had 05 Pilots qualified for One B-200 aircraft; therefore the quantum of flying available to these pilots was not sufficient to maintain their proficiency. The Organisation took up the matter with the MHA suggesting them the ways to provide more flying experience to these pilots. The MHA while agreeing to the recommendations made by the BSF Air Wing by allocating minimum 15 hours per pilot per month for fixed wing also mentioned the following:

'It is desired that the above mentioned minimum required flying hours to the pilots shall be completed in normal execution of flying task. Any shortfall in the above mentioned minimum required flying hours to the pilot should be met by assigning extra flying/ sorties/ training hours. BSF Air Wing to plan coordinate and execute the regular flying task in such a way that at any point of time the requirement for allotting the additional training flying hours for recency / recurrent training / validation for a pilot is minimized'.

It was also conveyed that only in emergent cases for a pilot to maintain his bare minimum necessary qualifications as per the existing norms of the DGCA or the IAF, the additional flying hours may be allocated.

The Committee also perused the pay structure of the Organisational pilots including their allowances vis-a-vis the actual flying hours flown by them. Flying hours from the beginning are directly entitled for flying incentives for Organisational Pilots, whereas the flight crew on deputation from the IAF are entitled to flying pay, as well as, flying incentives.

2.5 Organisation

Both the PF and PM were current and qualified. There was no issue with the aircraft which might have contributed to the accident. The question then arises why a qualified crew in a well maintained smoothly running aircraft met with an accident?

Therefore deeper analysis of the Organizational Structure & Procedures (if existing), and those practiced is required to find out the answer to the circumstances leading to the accident. An Organisation may look compliant vis-a-vis the mandatory requirements but may still be seriously deficient in discharging its duties safely and efficiently.

- PERMISSION TO UNDERTAKE AIRCRAFT OPERATIONS

The DGCA had issued a CAR to ensure better safety oversight control on the operation of the aircraft owned by State Governments and Public Sector Undertakings whereby it is required that all such Organisations shall obtain permission (Operating Permit) from the DGCA for operating such aircraft. As the requirement to take 'permission to undertake aircraft operations' was applicable to the subject Organisation and was pointed out during surveillance, the subject Organisation had applied for issue of the Operating Permit in July 2011 along with the requisite fees and documents. The records revealed that meetings were held in the DGCA followed by submission of the documents as required by the DGCA. There were certain surveillance inspection by the DGCA Officers also, but till the date of accident the Organisation was not issued with operating authorisation under the said CAR.

- COMPLACENCY

The Organisation seems to suffer from Complacency which can be described as a loss of awareness of potential dangers. In the present case flying undertaken by the flight crew wherein both, the PF and the PM, were neither possessing adequate flying experience nor could mutually add or impart quality flying experience in the real sense of the terms.

The combination of this flight crew was continued over other Type qualified Pilots in the Organisation. Therefore, though the numbers of flying hours flown by this flight crew were increasing, but whether it added to qualitative improvement in their flying skills is questionable? All this while, the highly experienced Examiner was meagrely rostered for the flights.

- LACK OF KNOWLEDGE

The regulatory requirements for training and qualification of pilots are comprehensive and Organizations are required to strictly follow these requirements. However, lack of on-the-job experience and specific knowledge can lead a pilot into misjudging situations thereby falling into the trap of making unsafe decisions. Aircraft systems are complex and integrated, that it is near impossible for a low experienced pilot to multi task without suitable technical training, current relevant exposure to situations followed by continuous hands on flying experience with Senior Pilot/ Instructor / Examiner. It is therefore essential to undertake continued professional development and for the more experienced pilots to share their professional knowledge and expertise with their junior colleagues.

In the present case, inspite of the availability of a Type Examiner in the Organisation the finer safety aspects of flying have not reached his junior colleagues.

- LACK OF SAFETY & NON EXISTENCE OF SMS AS A TEAMWORK

Though the Organisational Chart specifically indicates the posts of The Chief of SMS & Chief of Flight Safety with a full-fledged Department of Flight Safety; but, none was existing. At times, Officers who were nominated as Chief of Flight Safety or SMS had conveyed their unwillingness to the Accountable Manager & Alternate Accountable Manager on the grounds of work load and them being not trained on flight safety. The present Chief of Flight Safety lacked on the requirements to be so, and, was accorded approval for 06 months on the precondition of Flight Safety training.

In aviation many tasks and operations are team affairs; no individual can be made responsible for safe outcomes of all tasks. To create an effective safe environment, it is necessary that the issues are discussed, clarified, agreed, understood and duties assigned. However, in the event of an individual being short in discharging the assigned duties, a situation may be created for unsafe outcomes.

The Flight Safety Manual and the Safety Management System Manuals have been prepared. The SMS Manual and the Safety Policy has been signed and issued by the Accountable Manager. It appears, however that these documents were prepared for fulfilling the regulatory requirements only.

Safety Training has been stated as a major way to achieve the goal of Safety Promotion and is required to be provided to all staff with refresher courses each year, but it was found that even initial training had not been imparted. So much so, the Chief of Flight Safety had not undergone any Safety Training. The safety duties are defined in the SMS Manual but in practice individuals were not aware of their functions.

To conclude, there was non-existence of safety culture, non-existence of SMS and nil supervision of the operations at ground level.

- LACK OF AWARENESS

Working in isolation and only considering own responsibility leads to tunnel vision. A partial view and lack of awareness about the result of one's actions on the wider task in the Organisation create risks. In the Organisation, the rotary wing flew under military regulations and the fixed wing (including B-200 aircraft) flew under civil regulations. In the Organisation, the various departments were working in isolated compartments. Essential foresight required to pre-empt the unsafe effects of action of one individual on other was missing, which resulted in loss of situational awareness particularly when there were no established safe working procedures.

Thus, in this Organisation the personnel working in two different operating environments were not fully aware of the effects of their practices on one another while being responsible for one Organisation.

- NORMS

On the accident flight, the PF was rostered in place of the SOO though no reasons for change could be traced as there was no documented procedure of rostering available with the Organisation. Organizational practices develop over time, through experiences and often under the influence of a specific working culture. These practices can be good or bad; safe or unsafe; and they are referred to as 'the way we do things round here' before becoming Norms. Such practices follow unwritten rules or behaviours, which often deviate from the mandatory rules, procedures and instructions. These Norms are enforced through peer pressure and by force of habit.

It is known, that most Norms are not designed to meet all circumstances and therefore are not adequately tested against potential threats.

2.6 Weight & Balance of Aircraft

From the wreckage, personal baggage and tools and equipment were retrieved and weighed. The weight of the personal baggage was around 152 Kgs. In addition

Battery: 22.8 Kgs

Test box Tool Kit: 16.6 Kgs

Mi Docs: 1 kg

2nd Battery (Mi) New: 23 Kgs

As per the UO.853/ Gen-MiscVol.II/RW/SAP/AW/BSF/2015 dated 21.12.2015 the following items were sent for Mi-17 servicing at Ranchi by B-200 Super King Aircraft.

1. Laptop Panasonic SRL no. -3FTCA86004 and accessories for FDR Milking.
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3. U-6360-2455 FIXTURE (Engine Compressor Wear Check tool Qty-01)
4. 3026865 Special Ring (19) Qty-01
5. 8AT-9928-500- Engine Oil Drain Hose Qty-01
6. APU Oil Drain Hose Qty-01
7. Tensio Meter -01, Conical Nipple-01, Control Pin-04, Torch commander -01, Oil/Grease Hose with Conical Nipple-01, MGB Oil Drain Hose-01 & Tool Bag-01
8. Aircraft Servicing Record Book –II (Form -700B for MI-17 V5 helicopter of ZP-5243 for electrical, structure, propulsion, Radio & Weapon)
9. Aircraft Servicing Record Book –I (Work Order and Compliance Certificate of ZP-5243 helicopter)
10. Servicing Package Electrical ½ Qty-02 and Servicing Package Electrical 2/2 Qty-02, Servicing Package Electronic 1/1 Qty-01 and Servicing Package (OOPS) Structure 1/1 Qty-01, Task Order for Unscheduled Activities Qty-01, Servicing Package Propulsion (Floor) Qty-01

11. PAMAS S-40 Fuel Particle Count tester Srl No. 400-1808 with complete accessories and packing case.

The aircraft AUW was therefore far higher than what was reflected in Load & Trim sheet.

2.7 Analysis of CVR Recorders

The occurrence was captured on the two crew channels. The recording ended with impact sounds approximately fifty seconds after aircraft rotation. The quality of the recording on Channels two and three was good. Most of the crew conversation could be accurately and easily understood. Hot mikes were being used by both crew members for the duration of the flight. The extra channel did not capture any conversation but did capture some ambient noise in the form of engine/propeller sound.

2.7.1 Audio Recording Analysis – Cockpit Scenario

The relevant conversation providing the glimpse of cockpit scenario is discussed below.

TIME* A	STATION B	COVERSATION C
20:24	ACFT	Iska jo jack hai na thoda andar dal lo
20:05		Isko aagey kar jara phir phir khiska ke na phir....
		theek
19:56		thoda pair se rotate karke dekh

*The timings are in mm:ss prior to the crash.

The aircraft was loaded with lot of tools and equipments for carrying out maintenance of Mi-172 helicopter. The above conversation indicates that the big equipments like jack and other equipments were being adjusted below the seats and in the aisle.

A	B	C
16:23	ACFT	Thoda dekh lete hain is position pe
16:14		VT-BSA we will take 10 minutes delay for taxi sir due administrative reasons
16:06	Gnd	VT-BSA report ready for taxi and taxi instructions cancelled
16:00	ACFT	Roger Sir, Wilco
10:52		VT-BSA request taxi now

The aircraft after taking permission from the ATC started taxiing which however was stopped after about a minute and half of taxi clearance. (The SMGCS recording revealed that the aircraft stopped on taxiway E1). The flight crew discussed amongst themselves and decided to review the situation at that location. Review was probably in view of the visibility prevailing at that time particularly when the aircraft came in the open area away from the cluster of hangars near their parking bay. Though, the flight crew cancelled the taxi clearance citing administrative reasons at that point they carried out thorough serviceability checks of the autopilot.

A	B	C
05:37	ACFT	We will rotate at 110 and above, ok thik hai
03:53		120/06 knots so we will be getting tail winds component
03:49		So we have to rotate after 120...
		Thik hai
03:25		Oh ye bag kitna bada hai peechhe, kitna bada

The above conversation indicates the cockpit scenario when the flight crew is discussing a very important phase and procedure, i.e., take-off and the rotation speeds. At the same time their concentration was being diverted probably due to the movement of heavy bags of technical staff in the cabin.

Time	AIRCRAFT CONVERSATION
01:04	Callouts Speed - 60, 65, 70, 75, 80, 85, 95, 100
00:51	----- Rotate
00:47	What are you doing????
00:46	Chodo chodo
00:43	Please maintain direction
00:34	Right left ko ja raha hai
00:28	Ok, Leave it, engage, leave it
	Ya leaving
00:21	Heading is not engaged
00:19	Not engaged I will take manual
00:17	AUTO PILOT DISENGAGE ALARM ALTITUDE ALERT ALARM BANK ANGLE ALARM STALL WARNING ALARM
00:12	Shit
00:08	“BANKING” (Auto Alarm in the cockpit)

*The timings are in mm:ss prior to the crash.

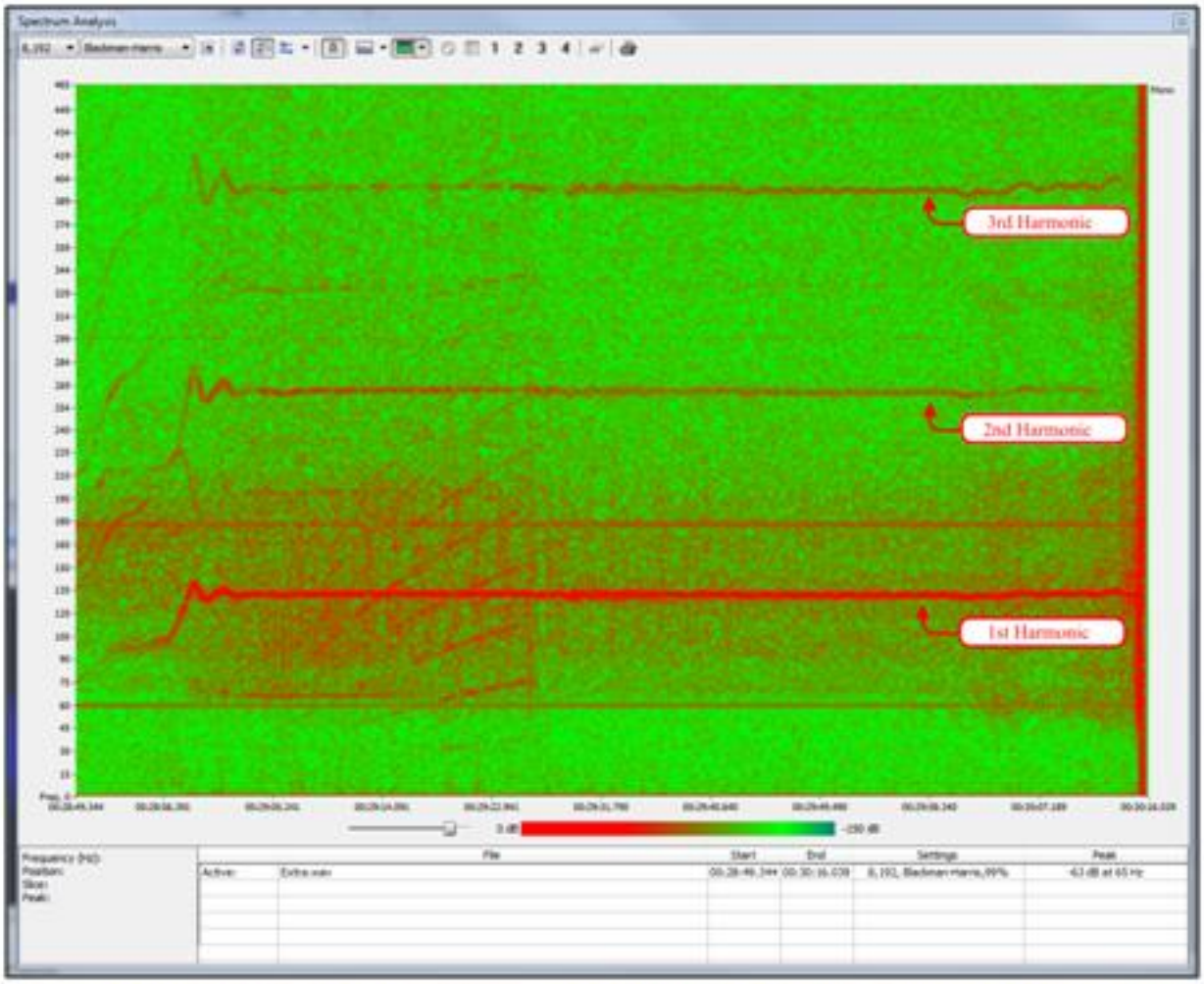
The above call outs, conversation and the warnings indicate that the Auto-pilot was engaged just after the aircraft had lifted off (even the landing gear had not been retracted). The heading mode was not engaged and probably both the crew members presumed that the aircraft shall fly on the auto-pilot. The aircraft however started turning left probably due to the existing left bank at the time of engagement of the autopilot followed by multiple warnings.

2.7.2 Harmonics Analysis

The first three harmonics of the propeller sounds were visible. A strong, consistent signal at approximately 133 Hz was visible in the first harmonic signature.

This value corresponds to a propeller RPM of approximately 1995, which is consistent with a take-off propeller shaft speed of 2000RPM and is in conformity with the value given in aircraft type certificate data sheet. Some fluctuation was noted during the last 15 seconds of the recording. These fluctuations are limited to +/- 25 RPM (1.25% of nominal takeoff RPM). No split in propeller RPM speed was observed between engines.

Spectrum analysis of the audio data was carried out in order to determine if the propeller speeds were within normal range during the accident sequence. As there was no CAM audio available in this case, the extra track was used for the analysis.



Spectrum analysis of takeoff portion of occurrence flight using data from the recovered extra channel

The first three harmonics of the propeller sounds were visible. A strong, consistent signal at approximately 133 Hz was visible in the first harmonic signature.

2.8 Pilot Handling & Circumstances Leading to the Accident

The B-200 aircraft was detailed for the purposes of transport of men and material of Rotary Wing Division of the Organisation. After according approval for operation of flight, the office of the IG (Air) is not in the picture for actual operations. There were 06 technical persons of the Rotary Wing along with their personal baggage (152 Kgs), tools and Equipment (63.4 Kgs).

On the day of the accident, the passengers reached the aircraft at 0215 UTC (0745 Hours IST). The expected Off Block Time was 0330 UTC (0900 hours IST).The latest METAR which the flight crew had received was of 0330 hours UTC (0830 hours IST) which indicated visibility of 600 meters with calm winds. The progress strip was generated for this flight by ATC, Delhi. The flight was cleared from Runway 28.

- Initial flight level as co-ordinated with Area Control Centre (ACC) was FL 210 and flight level as per flight plan was FL 230.
- The first call to the ATC was given at 0343 Hours UTC (0913 hours IST) and the aircraft start-up was at 0344 hours UTC (0914 hours IST).
- There were a total of 10 persons (including flight crew, an AME and cabin crew) on board through security.
- Initial taxi clearance was given at 0350 hours UTC (0920 hours IST) which was then changed to 0357 hours UTC (0927 hours IST).
- The departure clearance was given ‘after take-off from runway 28, turn right heading 295 climb to FL 60, further with radar’.

On the day and time of the flight, men and material board the aircraft with no checks or supervision on the material being loaded including its weight. The aircraft is cleared for operation by an approved AME on B-200 aircraft.

As per the CVR readout and ATC tape transcript, the flight crew asked for start-up clearance when the aircraft was parked in front of the hangar of the Organisation. The general visibility at that time was 800 meters (improved from the previous METAR value of 600 meters). Mid RVR was 1100 meters. The location where the aircraft was parked is surrounded by hangars and parking bays.

The start-up clearance was given and the flight crew carried out the start-up checklist. Taxi clearance was obtained and the aircraft started taxiing from their dispersal towards holding point of runway 28 via taxiway E1, E. The flight crew after obtaining taxiing clearance had taxied the aircraft from their dispersal towards taxiway E1. The aircraft stopped taxiing at E1 as revealed on the SMGCS recording, and the flight crew informed the ATC for 10 minutes delay for further taxi due to administrative reasons (the actual delay was of 07 minutes as per the flight progress strip). The ATC had accordingly cancelled their taxi clearance.

The location (taxiway E1) where the aircraft had stopped is an open area with full view of the runway 28 in the direction of the intended take off by the subject aircraft. At this location one gets the actual feel of the existing visibility conditions. The intra- cockpit recording of that moment reveals about the discussion amongst the flight crew whether or not to continue the flight from that point onwards? After deliberation, the flight crew decided to continue the flight. In the mean time they discussed about checking the serviceability of the autopilot. After obtaining permission of ten minutes delay for further taxiing due to administrative reasons, the flight crew carried out serviceability checks of the autopilot. These checks are to ensure that the autopilot gets engaged when actions are taken to engage, and does not disengage unless specific inputs are given to do so.

After completion of the autopilot checks, the flight crew again obtained taxi clearance and taxied from taxiway ‘E1’ to the holding point for runway 28 on taxiway ‘E’. The flight crew then carried out checklist and decided that during

take-off roll they will rotate after 120 knots. The Tower then cleared the aircraft to taxi via 'E', line-up and wait on runway 28. The crew carried out 'before take-off' checklist. The aircraft was then cleared for take-off. The speed call outs were given followed by rotate call out after the aircraft attained a speed of 110 knots at 51 seconds before the crash. At 43 seconds before the crash, the PM asked the PF to maintain direction as the aircraft was going left – right. At 21 seconds prior to the crash, the PM realises that the heading mode of the autopilot is not engaged followed by his attempt to fly the aircraft manually. Simultaneously, at 17 seconds prior to the crash there were successive warnings, i.e., of the autopilot disengage alarm, altitude alert alarm, bank angle alarm and stall warning alarm. At 08 seconds prior to the crash stall warning alarm came ON. The alarm continued till the end along with Bank Angle warning from the EGPWS. Soon afterwards the aircraft crashed.

The total PIC experience of the PF on the B-200 aircraft was 77:00 hours and that of the PM was 196:35 hours as PIC. The PF was released as PIC after 620:35 hours of co-pilot experience on Type, while the PM was released as PIC after 183 hours of co-pilot experience on Type. Most of the on Type experience of these two flight crew was gained while flying amongst themselves. Despite written instructions of the Accountable Manager that an experienced pilot should be on board as the second pilot whenever the PF or PM were flying as PIC, these low experienced pilots did not fly under supervision of an experienced pilot while building their respective PIC experience.

Therefore, in such a scenario there was no opportunity available to this flight crew to identify their deficiencies in flying techniques, operational procedures, correct interpretation of the effects of weather, airmanship, etc. and applicable appropriate correction/ response even though a well experienced and seasoned Senior Pilot on Type was available in-house. Also, the series of occurrences in the past 06 months prior to the crash and their non-reporting indicates lack of flying expertise and complete non-supervision of their unsafe acts.

For operating the accident flight, it appears that the flight crew were not confidant due to the poor foggy condition prevailing at the time of planned departure. With an understanding that immediately after take-off, autopilot will be engaged and the aircraft will fly away on the autopilot, the crew cancelled the taxi clearance and carried out the serviceability checks of the operation of (engagement/ disengagement) of the autopilot.

The flight crew during discussion among themselves regarding the conduct of flight had decided to rotate after 120 knots (additional 10 knots) considering tail wind component of 06 knots. The take-off roll and rotation of the aircraft was carried out as discussed. Their decision to increase the rotation speed by 10 knots to allow for the tail wind of 06 knots itself shows that they were ignorant of the fact that the tailwinds do not affect the rotation speeds of the aircraft at all.

Just after lift-off, even without retracting the landing gear, the crew engaged the autopilot but did not engage the 'Heading Mode' of the autopilot. This hurried and non-standard action by the flight crew by engaging the auto-pilot immediately after lift-off reveals their eagerness to let the aircraft be flown by the autopilot and underlines their inability to fly the aircraft manually until autopilot engagement height was achieved. As per the Pilot Operating Handbook procedure, after lift–off and establishing of positive rate of climb, the landing gear is retracted. Thereafter the climb power is set and the autopilot should be engaged only after attaining the height of 500 feet AGL. Engagement of the autopilot without engaging the Heading Mode resulted in the aircraft turning left probably due to the existing left bank or inadvertent manual input by the flight crew at the time of engagement of the autopilot. The bank angle increased progressively and beyond 45^{o}, a situation the flight crew could not decipher because of their disorientation. After disengagement of the autopilot, probability exists that the flight crew had further increased the bank instead of taking corrective action to decrease the bank. This allowed the bank angle to increase

beyond 45^{o} resulting in multiple altitude warning and stalling of the aircraft. The aircraft crashed after turning almost 180^{o} from the direction of the take-off.

3. Conclusions:

In the previous sections, in addition to the unsafe acts for the conduct of the flight, the Committee has put forward the factual state of affairs as existing in the Organisation on the date of accident and analysed the same particularly for the actions or inactions which could have acted as precursor to the accident. In the following section, active and latent failures identified within the functioning of the various Departments of the Organisation are compiled that culminated into the accident. The approach is based on broad human error framework to investigate and analyse human factors aspects. The aim is not to attribute blame; but to understand the underlying causal factors that lead to this accident.

3.1 Findings:

3.1.1 General

- The Operator is a Government Organisation carrying out aircraft operation for official purposes and not for hire or reward. The maintenance of aircraft was carried out under CAR 145.
- The Certificate of Airworthiness, Certificate of Registration and Certificate of Release to Service was valid on the date of accident.
- All the concerned Airworthiness Directive, Service Bulletins, DGCA Mandatory Modifications on this aircraft and its engine were found complied with.
- The defect records were scrutinized and there was no defect pending on the aircraft prior to the accident-flight which could have contributed to the accident.

- The PIC & the Co-pilot were holding valid license on the Type of the aircraft. Both the flight crew held valid medical certificates.
- The flight crew had undergone pre-flight medical examination at Delhi and was normal. The BA test was negative.
- It was observed that the Organisation has not established the Flight Safety Department in true letter and spirit.
- Though the flights were approved by the IG (Air) along with his clear instructions for safe operations, there was no documented monitoring/ supervision of the operations at ground level to check if decisions taken by the flight crew were otherwise.
- The Chief of Flight Safety/ SMS is supposed to carry out all the proactive safety oversight activities but is not trained on any of these aspects.

3.1.2 Organizational Influences

The Department of Safety and Safety Management System was practically non-existent. The SMS Manual though submitted to the DGCA does not contain the various 'How to do' functions mentioned therein. The Manual just remains a document without performance of these functions at working level.

- The existing structure of the Organisation is not as per the Manual of Air Operations of the Organisation. The senior level Officials required for these positions were either non-existent or were short of meeting the mandatory requirements.

- Though the Organisation operates for Very Important Persons (as defined in the DGCA CAR on the subject), that mandates higher experienced flight crew; but the Organisation recruited flight crew from the scratch (CPL holders) and permitted them to operate mutually unsupervised inspite of their low Total/ Type flying experience.

- The Organisation was not issued authorisation (Operating Permit) to undertake aircraft operations as required in the CAR on the subject.

- There was lack of awareness of the effects of the actions of the Individuals and Departments on the wider tasks in the Organisation. (Absence of risk analysis and its mitigation).

- The Organisation was working on NORMS instead of well laid down Systems & Procedures.

3.1.3 Unsafe Supervision

- The Safety & Quality Policies were existing on paper, but no documentary evidence existed to prove that effective procedures for implementation of these policies were followed.
- Some isolated instructions were issued on the subject of planning of flights, but the rostering of the flight crew rested with the junior most pilots without supervision, which is an unsafe practice.
- The B-200 aircraft was endorsed on the license of the involved flight crew, which legally permits them to function as PIC on Type, but the Committee is of the considered view that these pilots should have gained qualitative experience with Type qualified Senior Pilot (acting as Co-pilot/ Supervising pilot) including the one available in the Organisation – as is the general practise.
- The Flight Standards Directorate (FSD) of the DGCA had carried out Surveillance Checks and Audits of the Organisation which included their flight operations also. The findings during the present investigation by the Committee either do not find mention in the reports of the FSD or there was lack of effective action taken by the Organisation on the findings of the FSD.
- There is no laid down procedure in the Organisation regarding 'Flying under Supervision' and accordingly no such flights were documented/ logged.

3.1.4 Preconditions for Unsafe Acts (Latent)

- The Operations Department of the Organisation did not have a system of maintenance of documentation including updating of Operations Manual, Safety Manual, SMS Manual etc.
- Though rectification action was taken on the snags reported, but not all the incidents/ snags were reported by the flight crew.
- The regulatory requirements (CAR etc.) were being complied on paper but not at working level.

3.1.5 Unsafe Acts (Active)

- Different Departments of the Organisation were following different regulations which were heterogeneous in character and content, resulting in non-cohesiveness of procedures and processes at the working level.
- One of the highest ranking official showed ignorance about the transportation of dangerous/ prohibited goods by air. There was no supervision (checks & balances) on the type of goods being transported by air or the weight limit on them.
- Despite written instructions by the Accountable Manager, the junior pilots were pairing with each other on flights for addition in their respective flying experience. This pairing did not provide any qualitative experience to them or transfer of knowledge to handle emergent/ demanding situations.
- The Weight & Balance Schedule maintained for the flights including the accident flight was always a fixed baggage weight of 20 Kgs. The rationale behind the calculation of this ‘standard figure’ is unanswered.
- Both the involved flight crew were incapable to undertake the flight in the existing conditions, but could still do so in the absence of effective supervision.
- The aircraft was overloaded.
- The actual visibility at the time of taking the flight clearance from the ATC was below minima.

3.2 Probable Cause of the Accident:

The accident was caused due to engagement of the autopilot without selecting the heading mode by the flight crew just after lift-off (before attaining sufficient height) in poor foggy conditions and not taking corrective action to control the progressive increase in left bank; thereby, allowing the aircraft to traverse 180° turn causing the aircraft to lose height in a steep left bank attitude followed by impact with the terrain.

4. Safety Recommendations:

1. The DGCA should amend the para 6.15 of CAR Sec 3 Air Transport Ser C Part X dated 02nd June 2010 as follows:
    - When operating VIP flights with fixed wing aircraft, the pilot-in-command shall possess CPL or ATPL with at least 3000 hours out of which 1000 hours on Multi/ Twin Engine aircraft including 2000 hours as PIC out of which 500 hrs as PIC on Multi/ Twin engine aircraft, 100 hours as PIC on type of aircraft to be flown and 50 hours of night flying experience. In addition, the pilot should have a minimum of 30 hours as PIC experience in the last 6 months including five hours on type in the last thirty days of the intended flight. In case 30 hrs. recency during the last 6 months is not met with, then in last 30 days, a satisfactory skill test (as required for licence renewal) shall be carried out followed by 5 hrs. of PIC experience.

2. The Organisation must carry out procedural and systemic introspection of the Air Wing Operations in view of the subject accident and follow one system of regulation to avoid resultant unsafe practices at ground level.

3. The Organisation should ensure that risk analysis is carried out for every action and mitigation action is evolved. Ways and means be developed to avoid false sense of safe operations.

4. The DGCA should carry out thorough regulatory audit of the organisation and ensure that the Organisation meets at least all the requirements of

CAR, SECTION 3 – AIR TRANSPORT SERIES 'C' PART X, and issue the Organisation with the requisite authorisation, if found suitable.

5. The DGCA should ensure continued compliance with the regulations through continuous oversight checking, acting as one of the stake holders.

15/8/17

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Chairman,
Committee of Inquiry

15/8/17

(Raje Bhatnagar)
Member
Committee of Inquiry

15/08/17

(Capt. Anant Sethi)
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K. Ramachandran

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Place : New Delhi
Date : 15/08/2017