FINAL REPORT

AIRCRAFT ACCIDENT INVESTIGATION REPORT M/s JAHANGIR SIDDIQUI AIR FLIGHT – 201, BEECHCRAFT 1900C-1 REG # AP-BJD CRASHED SHORTLY AFTER TAKE OFF FROM JIAP, KARACHI ON 05TH NOVEMBER, 2010

Synopsis

On 05th November, 2010 M/s Jahangir Siddiqui (JS) Air Hawker Beechcraft 1900C-1 aircraft Reg # AP-BJD was scheduled to fly chartered flight from Jinnah International Airport (JIAP), Karachi to Bhit Shah Oil Fields to convey 17 employees of M/s Eni company including one foreign national from Italy. The flight crew included two cockpit crew ie Captain and First Officer (FO), one JS (Air) ground crew (technician) and one Airport Security Force staff. The Mishap Aircraft (MA) took off from JIAP, Karachi at 02:04:31 UTC. The reported weather was fit for the conduct of ill-fated flight to Bhit Shah Oil Fields. After takeoff aircraft experienced Engine No 2 abnormal operation and cockpit crew decided to land back at JIAP Karachi after calling right hand downwind for runway 25R. While joining for right hand downwind for 25R the mishap aircraft could not sustain flight and crashed at a distance of around 1 nm from runway 07R beginning JIAP, Karachi. All souls (21) onboard got fatally injured as a result of aircraft ground impact and extensive post impact ground fire.

Investigation Authority

Ministry of Defence issued notification vide Letter No AT-8(5)/2010/1803 dated 10th November, 2010 authorising to investigate the accident. In accordance with ICAO Annex-13, as the state of manufacture of the aircraft National Transportation Safety Board (NTSB), USA appointed a US accredited representative and Canada as a state of Manufacturer of Pratt & Whitney (P&W) Engines, appointed an accredited representative from Transportation Safety Board (TSB) Canada. Additionally, Italy as a State suffering fatality appointed an accredited representative. The US accredited representative was assisted by technical advisors from Raytheon Air Safety, Federal Aviation Administration and NTSB power plant engineer.

1. FACTUAL INFORMATION

1.1 **History of the Flight.** This was first flight of the day and mishap aircraft was declared serviceable in the morning on the day of accident.

1.2 **Injuries to Persons.** All souls (21) onboard got fatally injured as a result of aircraft ground impact and extensive post impact ground fire.

1.3 **Damage to Aircraft.** M/s JS Air Beechcraft 1900C-1 (Reg # AP-BJD) aircraft was completely destroyed as a result of ground impact and extensive post impact ground fire.

1.4 **Other Damages.** No other apparent damage was observed to any other person, property or equipment on ground as a result of said accident.

1.5 **Cockpit Crew Information.** There was a set of two pilots onboard the aircraft including one Captain and one Co-pilot (a qualified Captain on B-1900C aircraft). The details are as under:

(a) Captain

- Date of Birth : 14th August, 1957
- ATPL No : 1193 (A)
- Medical Validity Date : 31st March, 2011
- Total Flying Experience : 8114:25 hrs
- Flying Experience : 1820:20 hrs
- Simulator / Link Hrs : 28:00 hrs
- Instructional Flying Hrs : 3010:20 hrs

(b) Co-pilot / First Officer (A qualified rated Captain on type)

- Date of Birth : 16th February, 1977
- ATPL No : 1370 (A)
- Medical Validity Date : 31st December, 2010
- Total Flying Experience : 1746:25 hrs (as on March, 2010)
- Total On type Flying Experience : 1338:05 hrs (as on March, 2010)

1.6 **Aircraft Information.** The mishap aircraft was inducted on the inventory of M/s JS Air in May, 2006. The detailed aircraft and engine related data is appended below:

1.6.1 **Aircraft.**

- Aircraft Make and Model : Beechcraft 1900C-1
- Manufacture Serial No (MSN) : UC-157
- Aircraft Inducted in JS Air : May, 2006
- Registration Marking : AP-BJD
- Aircraft Total Flight Hours : 18545.22FH (As on 05th Nov, 2010)
- Total Landings : 24990CSN
- Engine Make and Model : PT6A-65B
- Propeller Make and Model : Hartzel HC-B4MP

1.6.2 **Engines Information.** The details of engines and propellers installed at induction and at the time of crash are as below:-

1.6.2.1 **At Induction**

Item	Serial No.	TSN	TSO	CSN
Engine – 1	PCE-32612	12062.5	1435	NA
Engine – 2	PCE-32613	14074.01	2821.6	13054
Propeller – 1	FWA-3330	13503	00.00	NA
Propeller – 2	FWA-4191	3122.48	00.00	NA

1.6.2.2 **On the day of Occurrence**

Item	Serial No.	TSN	TSO	CSN
Engine – 1	PCE-32476	13,855.56	754.32	15214
Engine – 2	PCE-32613	14,732.47	3,479.47	13728
Propeller – 1	FWA-3330	15181.46	1678.58	NA
Propeller – 2	FWA-4191	4798.16	1776.28	NA

1.6.3 The daily inspection / servicing of mishap aircraft was carried out on 05th November, 2010 prior to the departure of mishap flight JS-201 and no defect was recorded. No anomaly in the aircraft system performance was recorded or discussed by the cockpit crew before departure from JIAP, Karachi.

1.7 **Meteorological information.**

1.7.1 On 05th November, 2010 the weather reports of JIAP, Karachi before and after the accident are as follows:

Time UTC	Weather Report
0100	NW 02KTS VIS 2.5KM HAZE 1SC040 2AC100 QNH 1009 TEMP 20/10
0200	NW 02KTS VIS 2.5KM HAZE 2AC100 QNH 1008 TEMP 21/12
0300	NW 04KTS VIS 3KM HAZE 2AC100 QNH 1009 TEMP 23/15

1.8 **Navigation Aids Availability.** Beechcraft 1900C-1 aircraft was equipped with serviceable ADF, VOR / DME, ILS and GPS equipment for the conduct of flight operations. All the ground equipment related to ADF, VOR / DME and ILS was found serviceable at the time of occurrence.

1.9 **Communication Aids Availability.** Beechcraft 1900C-1 aircraft was equipped with serviceable two VHF for its two way radio contact with all concerned / relevant agencies during the conduct of flight.

1.10 **Type of Fuel used.** The aircraft was refueled with JET A1 fuel. The sample of the fuel taken from the source was tested for contamination. The Fuel Test report did not reveal any abnormality.

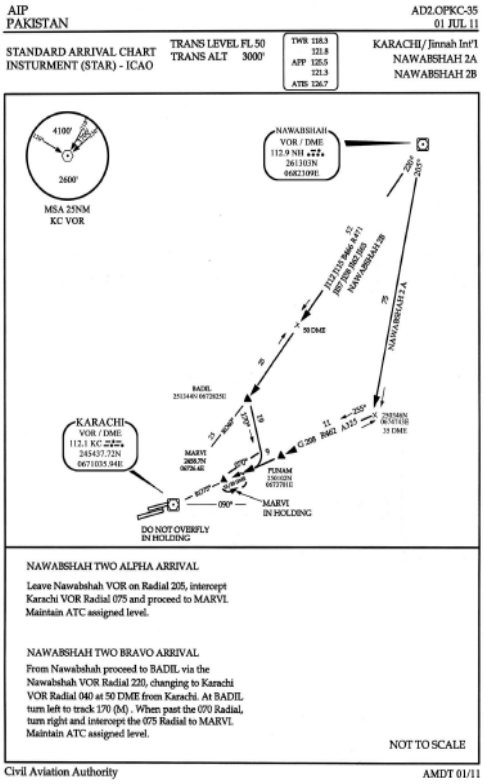
1.11 **Impact Information**. The mishap aircraft impacted the ground in a stalled state while maintaining a right hand bank of around 45^0. After the first ground impact, the fuselage of mishap aircraft got split into two halves, the front and the rear. The rear fuselage after separation remained close to the Impact Point whereas, the front fuselage got dragged in the direction of final flight path, which was towards the JIAP, Karachi. The aircraft was completely destroyed as a result of ground impact and post impact ground fire. The main wreckage remained confined to an area of 200 x 150 sq ft (length x width).

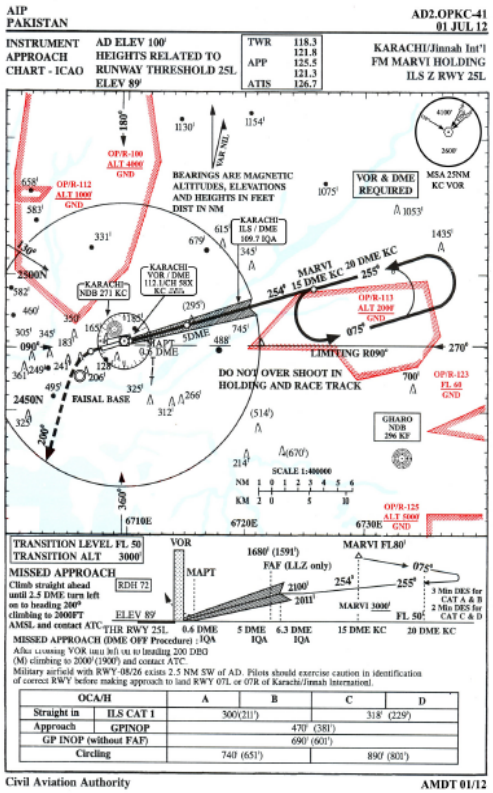
1.12 **Aids to Navigation.** All the navigation aids were available and serviceable at JIAP, Karachi prior to the crash of ill fated Flight JS Air-202.

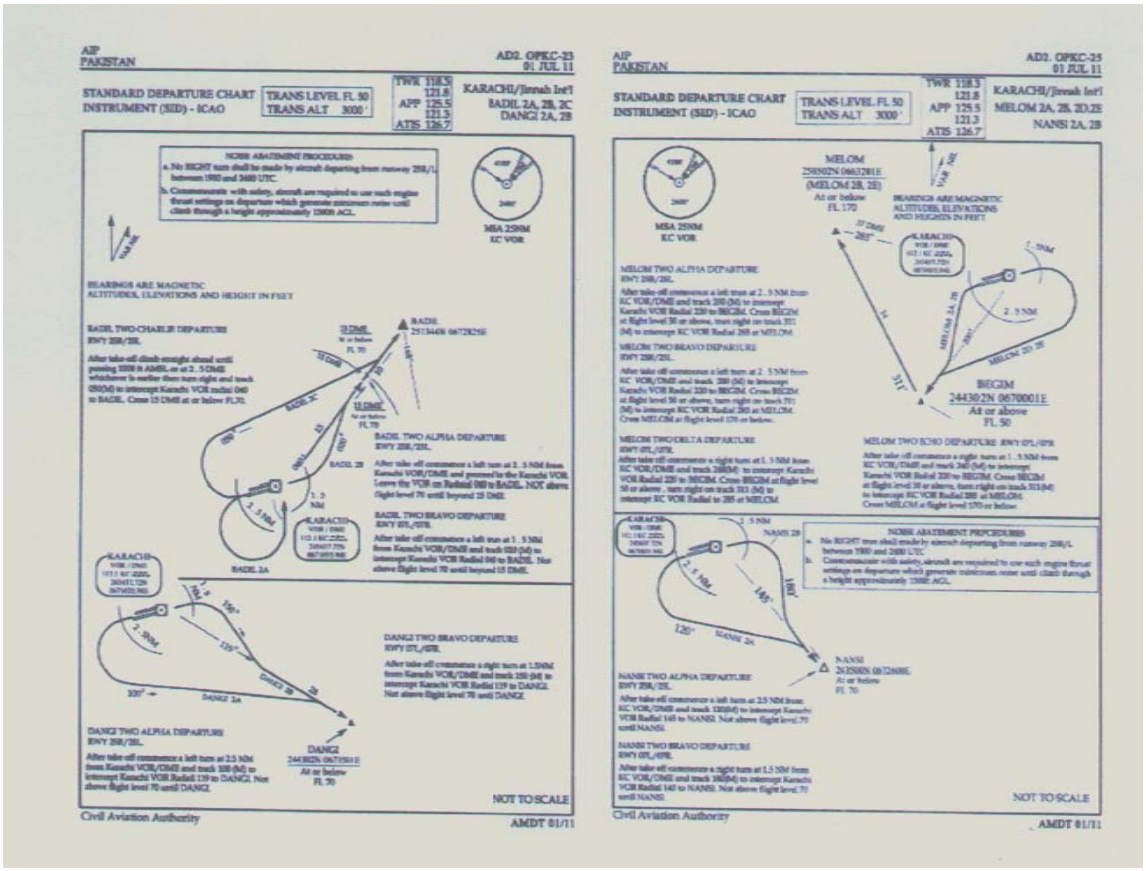
1.13 **Communications.** All the communication facilities were available and serviceable.

1.14 **Aerodrome information**

1.14.1 The JIAP Karachi standard arrival chart along with ILS approach runway 25L are appended below:







1.14.2 The JIAP Karachi detailed aerodrome data is appended below:

OPKC AD 2.12 RUNWAY PHYSICAL CHARACTERISTICS

Designations RWY NR	True bearing	Dimensions of RWY (M)	Strength (PCN) and surface of RWY and SWY	THR coordinates	THR elevation and highest elevation of TDZ of precision APP RWY
1	2	3	4	5	6
07L	074.29	3200 x 46	54/R/C/X/U CONCRETE Avble for ACFT having Max TKOF Weight Aprox 420000LBS (191TON)	245416.90N 0670851.02E	THR 23.50M / 77FT
25R	254.29			245444.69N 0671040.84E	THR 30.40M / 100FT
07R	074.29	3400 x 45	87/R/B/W/T CONCRETE SWY bitumen	245402.15N 0670833.56E	THR 21.62M / 71FT
25L	254.29			245431.79N 0671030.20E	THR 27.25M / 89FT

Designations RWY NR	Slope of RWY/SWY	SWY dimension (M)	CWY dimension (M)	Strip dimension (M)	Obstacle Free Zone
7	8	9	10	11	12
07L	0.2% UP	305 x 46	914	3931 x 305	-
25R		305 x 46	580		
07R	0.168% UP	305 x 45	670x150	4753 x 150	-
25L		301 x 45	483X150		

Remarks: RWY 07R RESA – 180M X 120M

OPKC AD 2.13 DECLARED DISTANCES (M)

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

OPKC AD 2.14 APPROACH AND RUNWAY LIGHTS

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

OPKC AD 2.18 ATS COMMUNICATION FACILITIES

Service designation	Call sign	Frequency	Hours of operation	Remarks
TWR	KARACHI Tower	118.3 MHZ	H24	Primary
		118.8 MHZ	H24	Secondary
		121.5 MHZ	H24	Emergency
APRON	Karachi Ground	121.6 MHZ	H24	Primary
		118.4 MHZ	H24	Secondary
		121.8 MHZ	H24	Vehicle
		123.0 MHZ	H24	
ATIS	ATIS	126.7 MHZ	H24	
APP	Karachi APP	125.5 MHZ	H24	Primary
	Karachi APP	121.3 MHZ	H24	Secondary
	Karachi APP	121.5 MHZ	H24	Emergency
BS	Radio	830 KHZ	HX	0130-1900 HR
BS	Pakistan	1450 KHZ	HX	Variable SKED

OPKC AD 2.19 RADIO NAVIGATION AND LANDING AIDS

Type of aid. CAT of ILS (VAR VOR/ILS)	ID	Frequency	Hours of operation	Site of transmitting antenna coordinates	Elevation of DME transmitting antenna	Remarks
1	2	3	4	5	6	7
GP 25R	Dots/Dashes	334.4 MHZ	H24	245448.11N 0671029.32E	-	-
LLZ 25R	IKC	110.1MHZ	H24	245413.64N 0670837.68E		
ILS CAT I (1°E/1995)					-	-
LOM	KO	235 KHZ	H24	245547.74N 0671449.88E	-	3.9 NM FM THR
MM		75 MHZ	H24	245453.00N 0671107.98E	-	2.57 NM FM THR
GP/DME 25L	Dots/Dashes	333.2 MHZ CH34X	H24	245432.35N 0671013.96E	-	2.95° RDH 72 FT
LLZ25L ILS CAT I (1°E/1995)	IQA	109.7 MHZ	H24	245359.00N 0670820.94E	-	-
NDB	KC	271 KHZ	H24	245523.80N 0670936.28E		Coverage 500NM
VOR / DME	KC	112.1 MHZ CH 58X	H24	245437.72N 0671035.94E	37.83M	Coverage 200NM Radial 300 un-reliable

1.15 **Medical and Pathological Information.** A total of 21 souls were onboard the mishap aircraft including Captain, First Officer, a Technician of operator, a foreigner {Expat (Italian) staff member of M/s Eni company}, an Airport Security Force employee and 16 other passengers died due to impact.

1.16 All the dead bodies were evacuated from the crash site and brought to Jinnah Post Graduate Medical Centre (JPMC), Karachi. The 10 dead bodies were identified on same day and one was identified on 6th November 2010. All the identified dead bodies were handed over to the legal heirs / relatives of the deceased.

1.17 The remaining unidentified dead bodies were handed over to the relatives / families of air crash victims after identification through DNA testing / analysis which was conducted by M/s National Forensic Science Agency, Islamabad.

1.18 **Fire.** Pre-impact in-flight fire indications were neither reported by the Captain / FO of ill fated aircraft nor were observed by the Investigation Team Members at the crash site. However, post impact ground fire was observed at the wreckage site.

1.19 **ATC Tower / Approach Radar Tape Extracts.** ATC Tower / Approach Radar Tape Extracts were retrieved for detailed analysis.

1.20 **Mishap Flight CVR and FDR Data Retrieval**

1.20.1 After the occurrence the investigation team along with rescue parties reached the crash site. The FDR and CVR were identified and recovered from the crash site. The Investigation in-charge along with Operational Investigator proceeded to National Transportation Safety Board (NTSB), USA facility in March, 2011 for downloading of the recorded data on both the modules.

1.20.2 The Flight Data Recorder and Cockpit Voice Recorder were received on 22nd March, 2011 by the NTSB with following details:

Flight Data Recorder (FDR)

- Manufacturer / Model : Solid State Flash Memory (Model F-1000)
- Recorder Serial Number : 01317

Cockpit Voice Recorder (CVR)

- Manufacturer / Model : Fairchild Model A-100A tape CVR
- Recorder Serial Number : 59645

1.20.3 **Flight Data and Cockpit Voice Recorders Condition.** The Flight Data Recorder (FDR) was recovered by the investigation team from the crash site. It was found in good condition without any exposure or damage caused by aircraft ground impact or post impact ground fire. The Cockpit Voice Recorder (CVR) was recovered from the wreckage of mishap aircraft from a location which was exposed to post impact ground fire. It was also observed that FDR

Underwater Locating Beacon (ULB) battery was overdue for replacement with an inspection date of June, 2010.

Recovered CVR Module

Recovered FDR Module

1.20.4 The data of FDR and CVR was successfully recovered and downloaded at NTSB, USA facility. After downloading the entire data from both the modules, detailed analysis of the CVR and FDR was carried out in USA with the assistance of NTSB investigators. The major focus was to retrieve any information which could assist and help in ascertaining all possible operational and technical aspects along with factors (if any) specifically related to cockpit crew in the aircraft handling after encountering abnormal situation. The FDR contained over 97 hours of flight data whereas CVR module data of 30 minutes audio information was listened and pertinent calls and the conversation amongst the ground crew / technicians, cockpit crew and ATC Controller or the cockpit crew and cabin crew were documented and analysed in detail. The data when correlated with the time and compared with the FDR recorded data helped in re-enacting the entire sequence of events prior to the aircraft ground impact. The vital FDR and CVR data helped the investigation team to ascertain various facts / factors which could have directly or indirectly contributed towards the causation of accident.

1.21 **Crew Resource Management (CRM).** At the time of occurrence, Captain of aircraft was the Pilot Flying (PF) whereas FO was Pilot Monitoring (PM). Both the cockpit crew had valid CRM certification at the time of accident.

1.22 **Useful Investigation Techniques.** Besides employing various investigation techniques and procedures, data extracted from CVR and FDR was extensively utilized for development of flight profile and events leading to the accident and their analyses.

2. Analyses

2.1. Operational Analysis

2.1.1. The operational analysis in the proceeding paragraphs is based on the data collected from various sources inclusive of FDR, CVR, wreckage and expert agencies' inputs.

2.1.2. The mishap Flight JS Air-201 was the first chartered flight of M/s JS Air from JIAP, Karachi to Bhit Shah Oil Fields on the day of accident.

2.1.3. The operational investigation and analyses were conducted on all available evidences started from wreckage examination / analysis, witnesses statements, equipment, weather records, Radar / ATC Tower tape extracts, CVR and FDR extracts, personnel records and other domains pertaining to the mishap aircraft and cockpit crew were critically analysed in order to

determine, their direct or indirect contribution into the accident or otherwise. The detailed investigation and analyses of various domains have been carried out which are appended below.

2.1.4. It is a considered fact that even if mishap aircraft had experienced a serious anomaly with one of the engines' operation and had only single engine power available, the aircraft is designed to make a safe recovery with single engine operation. It warranted a very thorough operational investigation, in order to analyse all operational factors, which could have contributed directly or indirectly in the causation of accident.

2.1.5. Following operational factors were considered during the process of investigation:

2.1.5.1. Facts from CVR / FDR Data and their Analyses

2.1.5.2. Cockpit crew history, flying experience and medical fitness

2.1.5.3. Cockpit crew rest period and flight duty time limitation (FDTL) evaluation to ascertain undesired exposure to stress and fatigue

2.1.5.4. Cockpit crew training and skill competence level at JS Air

2.1.5.5. Cockpit crew interpretation and understanding of engine abnormal behaviour / performance

2.1.5.6. Cockpit crew performance and behaviour evaluation after encountering abnormal engine performance during last phases of flight (human factor)

2.1.5.7. Evaluation of ground proximity warning system (GPWS)

2.1.5.8. Incapacitation of the cockpit crew

2.1.5.9. Lack of situational awareness

2.1.5.10. Crew resource management (CRM) training

2.1.5.11. Why did the cockpit crew fail to avert accident

2.1.5.12. In-flight Structural failure

2.1.5.13. In-flight Fire

2.1.5.14. Bird Strike

2.1.5.15. Sabotage

2.1.6. The mishap flight JS-201 was a chartered flight by M/s Eni company to convey their employees from Karachi to Bhit Shah Oil Fields.

2.1.7. At 01:55:30.0 UTC the cockpit crew contacted Karachi Ground and said "Karachi Ground Assalam o Alaikum JS-201" (*Karachi Ground best wishes from JS-201*).

2.1.8. At 01:55:34.8 UTC the Karachi Ground Controller replied “Wa alaikum assalam JS-201 go ahead” *(Exchanged best wishes and asked JS-201 to go ahead).*

2.1.9. At 01:55:37.8 UTC cockpit crew told Karachi Ground “JS-201 parked at night parking (confirmation) Charlie requesting start up permission for Bhit level requested one three zero P-O-B two zero endurance four hours”. It is important to note that the information available with cockpit crew was 20 persons onboard whereas actually they were 21 persons onboard. It is important to note that this variation of one passenger changes the weight of onboard persons by around 5% that requires recalculation of the take off data.

2.1.10. At 01:55:54.9 UTC Karachi Ground Controller said “copied JS-201 start up approved runway two five left” which was acknowledged by cockpit crew at 01:55:59.2 UTC.

2.1.11. At 01:56:10.5 UTC FO told Captain “avionics off kar dain sir” *(to kindly* switch *off the avionics sir).*

2.1.12. At 01:57:02.1 UTC FO asked Captain about starting sequence of engines and he informed him that he would be starting Engine No 1 first.

2.1.13. At 01:57:05.2 UTC Captain told FO “pehlay is ko bhi start karo gay baad mein feather kar dain gay” *(First we shall start this and then we will select to feather position).*

2.1.14. At 01:57:23.8 UTC Captain cleared the area towards left side and started the Engine No 1.

2.1.15. At 01:57:37.7 UTC FO kept announcing and monitoring the engine performance parameters during start and gave 28 seconds as starting time.

2.1.16. At 01:58:18.4 UTC Engine No 2 (Right) was started after clearing area and FO kept monitoring and announcing the engine performance parameters during start.

2.1.17. At 01:58:47.2 UTC FO told Captain “ITT bhee bichari mar mar kay charhi hay” (*the poor ITT has risen in extreme difficulty)* and there was laughter.

2.1.18. At 01:59:10.5 UTC FO asked Captain “left fuel quantity ki light kyun aai ja rahi hai” *(why the light of left fuel quantity is coming ON).*

2.1.19. At 01:59:14.8 UTC FO told Captain “wo ... indicator to aap nay nikal he diya hai chalen ji” *(OK you have removed that indicator)* and the captain replied “switch he garbur kar raya aiy” *(the switch is malfunctioning).* Captain probably pulled out the CB for left fuel quantity indication light on annunciator panel. The Captain pulled out the CB contrary to the normal procedure.

2.1.20. At 01:59:23.3 UTC the cockpit crew requested Karachi Ground for the taxi instruction.

2.1.21. At 01:59:30.2 UTC Karachi Ground said “two zero one, taxi holding point two five left via taxiway Juliet echo hotel” and the taxi instruction were acknowledged by the cockpit crew.

2.1.22. At 01:59:51.4 UTC Karachi Ground said “two zero one ATC available” and cockpit crew replied as “go ahead sir”.

2.1.23. At 01:59:54.4 UTC Karachi Ground said “okay JS-201 to destination Bhit follow Juliet one one two, BADAL TWO Charlie departure climb and maintain flight level one three zero squawk on departure seven two two zero” and the instructions were read back by cockpit crew and acknowledged by Karachi Ground.

2.1.24. At 02:01:13.7 UTC right engine propeller feathering was checked in manual position. As per procedure run up checks are supposed to be carried out and feathering function of both engines is to be checked simultaneously, however, cockpit crew in this case only checked No 2 engine feathering mechanism serviceability manually contrary to the documented procedures.

2.1.25. At 02:02:09.0 UTC FO asked Captain that should he go for hotel link but Captain told him no, go for foxtrot then they discuss the other traffic on ground which could have affected departure.

2.1.26. At 02:02:11.6 UTC Captain told FO that the other traffic is also going.

2.1.27. At 02:02:14.7 UTC FO told Captain “qayun aagay nikal gai na to phir yeh hamen nahi rok pai ga is kay chakar main” (*if we go in front of earlier referred traffic, then he will not be able to stop us).*

2.1.28. At 02:02:20.5 UTC FO further told Captain “yeh BADAL two Charlie nahi banay ga” (*this will not be able to make BADAL 2 Charlie).*

2.1.29. At 02:01:22.1 UTC Captain told FO “sir bun jai ga kafi dheet hai” *(sir he will make it as he is reasonably crook”.*

2.1.30. At 02:02:38.5 UTC cockpit crew asked Karachi Ground for entering foxtrot link which was cleared by Karachi Ground.

2.1.31. At 02:02:45.1 UTC cockpit crew asked Karachi Tower “JS air holding foxtrot two five left, JS air two zero one is ready for immediate”.

2.1.32. At 02:02:50.1 UTC Karachi Tower cleared JS-201 to line up runway 25L and wait” which was acknowledged by cockpit crew.

2.1.33. At 02:02:59.4 UTC the cockpit crew cleared the area left / right along with approach path and runway for any traffic.

2.1.34. At 02:03:26.0 UTC Karachi Tower Controller said “JS-201 wind light and variable, BADAL TWO charlie departure cleared for takeoff runway 25L”. The instructions were acknowledged by the cockpit crew.

2.1.35. At 02:03:41.2 UTC Captain told FO “autofeather” and it was acknowledged by saying okay. The FO confirmed the checking at 02:03:48.1 UTC.

2.1.36. At 02:03:55.1 UTC FO told Captain “autofeather” and Captain acknowledged by saying “autofeather off”. It is important to note that autofeather switch should be in “Arm” position instead of “OFF” as per the OEM instructions and laid down procedures in FCOM and QRH.

2.1.37. At 02:04:00.4 UTC Captain checked the controls of aircraft after taking clearance from FO.

2.1.38. At 02:04:02.8 UTC Captain told FO “all set, we are cleared for takeoff”. It is important to note that cockpit crew were supposed to carry out “run up checks” prior to entering the runway as per QRH however, those were not carried out.

2.1.39. At 02:04:05 UTC, the engine torque and propeller RPM parameters began to increase and there was an increase in longitudinal acceleration indicating start of takeoff roll.

2.1.40. At 02:04:14.2 UTC FO told Captain “power set autofeather light is ON”.

2.1.41. At 02:04:18.7 UTC Captain said “off”. As the cockpit crew before takeoff intentionally selected the autofeather switch to “OFF” position, therefore the light was “ON” and the autofeather “OFF” position is confirmed by the Captain.

2.1.42. At 02:04:25.0 UTC FO said “80 kts”.

2.1.43. At 02:04:26.0 UTC Captain said “power set”.

2.1.44. The airspeed began to increase followed by the aft movement of the pitch control position parameter. At 02:04:29.8 UTC FO said “V_1...rotate”.

2.1.45. As per the FDR recorded Data, at about 02:04:31 UTC, the pitch parameter began increasing in value and the airspeed was approximately **113** knots with altitude recorded as **-29 ft** Below Mean Sea Level and heading **253.1^0**.

2.1.46. At 02:04:33.2 UTC the sound of reduced engine noise is recorded on CVR Central Area Mic (CAM). As per the FDR recorded Data, at this particular moment the airspeed of aircraft was **119** knots with altitude recorded as **-37 ft** Below Mean Sea Level, heading **253.4^0**, angle of bank as **-0.22^0** (left angle of bank) and pitch attitude **+4.63^0**.

2.1.47. At 02:04:33.8 UTC FO said “oh teri” *(Oh no)* and Captain asked him immediately “kia hua” *(what has happened).* As per the FDR recorded Data, at this particular moment the airspeed of aircraft was **119** knots with altitude recorded as **-37** ft Below Mean Sea Level, heading **253.4^0**, angle of bank as **-0.51^0** (left angle of bank) and pitch attitude **+6.07^0**.

2.1.48. At 02:04:36.5 UTC FO told Captain “right engine ka prop chala gia hai” *(*right *engine prop has gone”.* As per FDR recorded Data, at this particular moment the airspeed of aircraft was **123** knots with altitude recorded as **-31 ft** Below Mean Sea Level, heading **256.2^0**, angle of bank as **2.57^0** (right angle of bank) and pitch attitude **+6.66^0**.

2.1.49. At 02:04:41.1 UTC FO told Captain “feather ho raha hai....kar doon kiya feather?” *(it is feathering...should I select it to feather position?)* and Captain told him immediately at 02:04:43.1 UTC by saying “hain ... kar do” *(yes, put it to feather position)*. As per FDR recorded Data, at this particular moment the airspeed of aircraft was **121** knots with altitude recorded as **9.25 ft** Above Mean Sea Level, heading **256.6^0**, angle of bank as **0.74^0** (right angle of bank) and pitch attitude **+7.49^0**. At this stage, it is considered that probably FO may have observed partial feathering due to which he wanted to feather the propeller of engine No 2 which was approved by Captain contrary to the documented procedures of no remedial action below 400 ft above ground level.

2.1.50. At 02:04:44.8 UTC FO asked Captain “feather karoon ...ya” *(should I put it to feather ...or)* and Captain asked him “hain” *(what).* As per the recorded Data, at this particular moment the airspeed of aircraft was **119** knots with altitude recorded as **36.9 ft** Above Mean Sea Level, heading **256.4^0**, angle of bank as **-2.69^0** (left angle of bank) and pitch attitude **+7.34^0**. It is important to note that cockpit crew instead of retracting the landing gears were engaged in feathering of engine No 2 propeller below the minimum safe altitude of 400 ft AGL.

2.1.51. At 02:04:47.4 UTC FO told Captain “power pehlay peechay lay ata hoon” *(I shall bring the power back first).* As per FDR recorded Data, at this particular moment the airspeed of aircraft was **117** knots with altitude recorded as **57.1 ft** Above Mean Sea Level, heading **256.4^0**, angle of bank as **-2.21^0** (left angle of bank) and pitch attitude **+7.57^0**.

2.1.52. At 02:04:50.7 UTC FO asked Captain “mang loon wapsi ka?” *(should I ask for* recovering *back?* As per the recorded Data, at this particular moment the airspeed of aircraft was **116** knots with altitude recorded as **77.4** ft Above Mean Sea Level, heading **256.4^0**, angle of bank as **1.37^0** (right angle of bank) and pitch attitude **+6.96^0**. It is considered that it was too early and premature decision to ask for this clearance at this altitude, the main focus of cockpit crew should had been on flight deck management.

2.1.53. At 02:04:51.9 UTC Captain told FO “ha usay bolo keh .... we have No 1 engine problem...” *(yes tell him that we have No 1 engine problem).* It is important to note that the actual problem being discussed amongst the cockpit crew was related to No 2 engine, whereas at this stage Captain advised the FO to inform ATC Tower that they had problem with engine No 1 which indicates the confused state of mind, pre occupation and lack of situational awareness on part of Captain. As per the FDR recorded Data, at this particular moment the airspeed of aircraft was **116** knots with altitude recorded as **79.2 ft** Above Mean Sea Level, heading **256.7^0**, angle of bank as **+0.45^0** (right angle of bank) and pitch attitude **+7.87^0**.

2.1.54. At 02:04:55.9 UTC Captain continued “....indication problem and we would like to switch off”. It appears from the Captain’s advice that either he was trying to conceal the actual information of engine problem from ATC Tower or physically he was not facing any anomaly in the engine behaviour / performance. As per FDR recorded Data, at this particular moment the airspeed of aircraft was **115** knots with altitude recorded as **105 ft** Above

Mean Sea Level, heading **255.6^0**, angle of bank as **-1.61^0** (left angle of bank) and pitch attitude **+7.8^0**.

2.1.55. At 02:04:57.8 UTC Captain told FO "is ko switch off na karna" *(Don't switch it off).* Captain wanted to inform ATC Tower about switching off the suspected affected engine but actually never wanted FO to switch it off. It may be deduced that suspected affected engine running was acceptable to the Captain at this stage. As per the recorded Data, at this particular moment the airspeed of aircraft was **114 knots** with altitude recorded as **114 ft** Above Mean Sea Level, heading **255.4^0**, angle of bank as **-1.61^0** (left angle of bank) and pitch attitude **+7.49^0**.

2.1.56. At 02:04:58.6 UTC FO told Karachi Tower "Karachi Ground JS Air – 201, ah request to proceed back to Kilo Charlie we have number one engine problem". At this stage FO knowing from his own observation on engine No 2 performance instead of challenging the Captain's advice of announcing engine No 1 problem to ATC Tower, followed his advice. As per the recorded Data, at this particular moment the airspeed of aircraft was **114** knots with altitude recorded as **116** ft Above Mean Sea Level, heading **255.5^0**, angle of bank as **-1.37^0** (left angle of bank) and pitch attitude **+7.34^0**.

2.1.57. At 02:05:07.7 UTC Karachi Tower Controller said "JS-201 report right downwind runway two five left". As per the recorded Data, at this particular moment the airspeed of aircraft was **112 knots** with altitude recorded as **157 ft** Above Mean Sea Level, heading **264.2^0**, angle of bank as **+13.08^0** (right angle of bank) and pitch attitude **+9.75^0**.

2.1.58. At 02:05:10.5 UTC FO asked Captain "sambhal raha hai" *(is it under control)?* As per the recorded Data, at this particular moment the airspeed of aircraft was **109 knots** with altitude recorded as **276 ft** Above Mean Sea Level, heading **276.2^0**, angle of bank as **12.28^0** (right angle of bank) and pitch attitude **+8.96^0**. At this stage, it is considered that FO was asking Captain about control of aircraft airspeed, attitude and bank etc.

2.1.59. At 02:05:14.1 UTC cockpit crew acknowledged the ATC Tower clearance and said "right downwind 25L JS-201" and this was the last recorded call of cockpit crew to the ATC Tower. As per the recorded Data, at this particular moment the airspeed of aircraft was **106 knots** with altitude recorded as **229 ft** Above Mean Sea Level, heading **288.8^0**, angle of bank as **+12.12^0** (right angle of bank) and pitch attitude **+9.99^0**.

2.1.60. At 02:05:16.0 UTC Captain asked FO "Kia kar rahay ho?" *(what are you doing?)* As per the recorded Data, at this particular moment the airspeed of aircraft was **102 knots** with altitude recorded as **255 ft** Above Mean Sea Level, heading **296.3^0**, angle of bank as **+17.02^0** (right angle of bank) and pitch attitude **+9.2^0**. At this stage, it is considered that FO was moving the engine No 2 feather control lever.

2.1.61. At 02:05:16.9 UTC FO told Captain "sir feather nahin ho raha" *(sir it's not* feathering*).* As per the recorded Data, at this particular moment the airspeed of aircraft was **102 knots** with altitude recorded as **255 ft** Above Mean Sea Level, heading **296.3^0**, angle of bank as **+18.43^0** (right angle of bank) and pitch attitude **+9.04^0**.

2.1.62. At 02:05:17.7 UTC Captain told FO “aik minute aik minute” *(wait for a minute, wait for a minute).* As per the recorded Data, at this particular moment the airspeed of aircraft was **98 knots** with altitude recorded as **268 ft** Above Mean Sea Level, heading **300.7^0**, angle of bank as **+22.03^0** (right angle of bank) and pitch attitude **+10.24^0**. Till this stage, Captain had not been able to achieve the minimum safe recommended flying parameters and the airspeed of aircraft was continuously decreasing with increasing pitch attitude as well as right angle of bank and first time it is observed that Captain told FO to wait and hold his ongoing actions, whereas it is considered that at this stage FO feathered the propeller as the reduction in engine noise was observed at this stage in CVR recording.

2.1.63. At 02:05:19.2 UTC further reduction in engine sound was observed. As per the recorded Data, at this particular moment the airspeed of aircraft was **83 knots** with altitude recorded as **301 ft** Above Mean Sea Level, heading **307.8^0**, angle of bank as **+28.26^0** (right angle of bank) and pitch attitude **+7.95^0**. At this stage, it was evident that right bank was continuously also increasing due to full power on serviceable engine No 1 and as the power on engine No 1 was reduced indicated by reduction in engine noise, the right angle of bank started to decrease subsequently. It is important to note that the aircraft at this stage was flying at very low airspeed which was close to the stalling speed with landing gears down and at maximum all up weight.

2.1.64. At 02:05:19.3 UTC Karachi Tower asked JS-201 “201 are you able to land...” However, no reply was given by the cockpit crew to the Tower as they were extremely busy in cockpit to manage and handle the abnormal situation. As per the recorded Data, at this particular moment the airspeed of aircraft was **83 knots** with altitude recorded as **301 ft** Above Mean Sea Level, heading **307.8^0**, angle of bank as **+25.83^0** (right angle of bank) and pitch attitude **+7.49^0**.

2.1.65. At 02:05:20.2 UTC increase in engine sound (two surges) were observed on CVR recording. As per the recorded Data, at this particular moment the airspeed of aircraft was **94 knots** with altitude recorded as **273 ft** Above Mean Sea Level, heading **313^0**, angle of bank as **+22.22^0** (right angle of bank) and pitch attitude **+7.42^0**. Probably at this stage, cockpit crew advanced the power on serviceable engine No 1 to recover out of unsafe set of conditions which resulted in two surges being recorded on CVR.

2.1.66. At 02:05:21.0 UTC sound of high pitch tone, similar to stall warning was recorded on CVR which continued till end of recording. As per the recorded Data, at this particular moment the airspeed of aircraft was **95.8 knots** with altitude recorded as **273 ft** Above Mean Sea Level, heading **317.5^0**, angle of bank as **+22.7^0** (right angle of bank) and pitch attitude **+9.91^0**. The aircraft parameters indicated rise in pitch attitude which resulted in stall warning despite having gone to slightly higher airspeed.

2.1.67. At 02:05:21.2 UTC FO told Captain “wapis aayen wapis aayen” *(come back come back).* As per the recorded Data, at this particular moment the airspeed of aircraft was **95 knots** with altitude recorded as **273 ft** Above Mean Sea Level, heading **317.5^0**, angle of bank as **+25.23^0** (right angle of bank) and pitch attitude **+10.32^0**. At this stage, FO’s spontaneous request to “comeback

come back" relates to coming back to flight worthy (out of stall regime) parameters of aircraft.

2.1.68. At 02:05:23.5 UTC Captain said "bismillah bismillah" *(with the name of Allah).* As per the recorded Data, at this particular moment the airspeed of aircraft was **85.6 knots** with altitude recorded as **292 ft** Above Mean Sea Level, heading **323.7^0**, angle of bank as **+38.1^0** (right angle of bank) and pitch attitude **+6.96^0**. At this stage, Captain was sure that the aircraft would be either forced landing on unprepared surface or impact the ground due to stalled state of aircraft.

2.1.69. At 02:05:25.8 UTC FO was heard saying "ya Allah" *(O God)* As per the recorded Data, at this particular moment the airspeed of aircraft was **95.8 knots** with altitude recorded as **285 ft** Above Mean Sea Level, heading **338.3^0**, angle of bank as **+45.78^0** (right angle of bank) and pitch attitude **+5.85^0**. At this stage, FO was probably sure of ground impact.

2.1.70. At 02:05:26.8 UTC sound of ground proximity warning "whoop, whoop" was recorded. As per the recorded Data, at this particular moment the airspeed of aircraft was **88.4 knots** with altitude recorded as **290 ft** Above Mean Sea Level, heading **352^0**, angle of bank as **+49.91^0** (right angle of bank) and pitch attitude **+2.3^0**.

2.1.71. The sound of ground proximity warning "whoop, whoop" continued till end of recording.

2.1.72. As per the recorded Data, at 02:05:27.0 UTC the airspeed of aircraft was **73.9 knots** with altitude recorded as **275 ft** Above Mean Sea Level, heading **7.42^0**, angle of bank as **+52.24^0** (right angle of bank) and pitch attitude **+0.69^0**. The aircraft was continuously losing altitude under stalled state.

2.1.73. As per the recorded Data, at 02:05:28.0 UTC the airspeed of aircraft was **66 knots** with altitude recorded as **247 ft** Above Mean Sea Level, heading **21.46^0**, angle of bank as **+48.46^0** (right angle of bank) and pitch attitude **-7.52^0**. At this stage, the aircraft was well below the stalling speed due to which the pitch attitude dropped below the horizon under stalled state.

2.1.74. As per the recorded Data, at 02:05:29.0 UTC the airspeed of aircraft was **80.4 knots** with altitude recorded as **160 ft** Above Mean Sea Level, heading **34.6^0**, angle of bank as **+42.65^0** (right angle of bank) and pitch attitude **-15.12^0**. This was the last recorded parameter of FDR recorder of mishap aircraft.

2.1.75. It is observed that from 02:04:33.8 UTC when the FO first registered the right engine propeller feathering till aircraft impact with the ground, the cockpit crew were extremely busy in handling the abnormal situation.

2.1.76. The Beechcraft 1900C-1 at its full all up weight is capable of sustaining safe flight after experiencing non availability of one engine provided the OEM recommended procedures as per QRH and FCOM are followed. The first recommended action after experiencing engine failure after V1 or takeoff is having positive control of aircraft and raising the landing gears in order to reduce the drag immediately so that aircraft can quickly achieve minimum

safe flying parameters ie altitude 400 ft above ground level while maintaining minimum single engine safety speed.

2.1.77. The cockpit crew after experiencing the engine No 2 anomaly, never discussed and raised the landing gears after takeoff. This is one of the very important factor due to which the mishap aircraft could not achieve the minimum safe flying parameters and crashed after experiencing one engine un-serviceability.

2.1.78. The FDR recorded data in respect of previous flights was scanned to develop a baseline and identify previous activity. The detailed comments and analyses on the maintenance activity undertaken prior to the mishap flight is deliberated at length in Technical analysis part of the investigation report.

2.1.79. The investigation team discussed at length the factors which could have contributed towards in-effective management of flight deck (thrust, airspeed, altitude and attitude of aircraft) by the cockpit crew despite knowing the associated dangers while operating aircraft at such a low airspeed and altitude. For these reasons the cockpit crew's history and their professional competence at various stages of their flying career were specifically focused to find out all possible factors which could have directly or indirectly contributed towards this type of in-effective management by both Captain and FO. The detailed analysis has been carried out in the succeeding paragraphs:

2.1.80. **Cockpit crew History, Flying Experience and Medical Fitness**

2.1.80.1. **Captain.** The Captain was born on 14th August 1957 at Karachi. He was reasonably religious minded individual and had a beard. He joined Pakistan Air Force (PAF) Academy Risalpur in 1977 as trainee pilot. During his service career he flew various training / fighter and light communication aircraft including MFI-17, T-37, FT-5, FT-6, Piper (Seneca-II), Beech Baron, Y-12, Super King (B-200), Cessna-172 and Cessna-402 aircraft. He got retired at the rank of Squadron Leader from PAF in 2003 while accumulating 6279:55 hrs. He was a Qualified Flying Instructor and had 2863 hrs of instructional experience on various PAF aircraft.

2.1.80.2. The Captain was medically examined first time on 02nd August, 2004. He was subsequently examined on 09th August,` 2005 and assessed fit for issuance of Airline Transport Pilot Licence (ATPL-Aircraft). He was issued ATPL-Aircraft Serial No 1193 on 07th October, 2005 by Civil Aviation Authority, Pakistan after completion of all requirements / formalities. He joined JS Air (Pvt) Ltd and satisfactorily completed his "Beechcraft-1900D" with "C" differences Training Course at Farnborough Training Centre from 10th to 29th October, 2005. He underwent his simulator training satisfactorily under the supervision of CAA inspector on 27th October, 2005 at Farnborough.

2.1.80.3. He started to fly as First Officer in JS Air after clearing his route check by CAA Inspector on 13th June, 2006. He was then trained as Captain on Beechcraft-1900C aircraft. During his Captain training, it was documented that he needs to concentrate more on procedures.

2.1.80.4. It was observed that the recurrent simulator training of Captain was conducted by the operator without any authority by CAA Pakistan on 12th October, 2008.

2.1.80.5. The recurrent simulator training of Captain was conducted on 01st October, 2009 by the operator under the supervision of Designated Check Pilot (Operator) and CAA Inspector. Although the simulator training was assessed as "satisfactory", however it was observed that "Recovery from initial buffeting", "One engine out go-around" (Mandatory) and "Maintenance of minimas" during the simulator training check session were marked as **"Satisfactory with briefing (SB)"**.

2.1.80.6. It is important to note that the recurrent simulator training of Captain was conducted on 07th October, 2010 by the operator under the supervision of DCP and CAA Inspector and like the previous year ie 2009 evaluation of simulator training was assessed as "satisfactory" however critical areas like; "Simulated Engine Fire after V1" and "One engine out go-around" (both these are Mandatory exercises), were marked as **"Satisfactory with briefing (SB)"**. The SBs in CAAF-628 do not quantify the skill level of under check pilot in these two mandatory exercises where the overall simulator training report is satisfactory. Subsequently, no further training and monitoring of skill level was observed at operator level in these two SB exercises.

2.1.80.7. As per the medical investigation / analysis, the Captain was fit to undertake the mishap scheduled flight and possessed valid medical certificate till 31st March, 2011.

2.1.80.8. **First Officer (FO).** The FO was occupying the seat of co-pilot on the day of fatal aircraft accident of Beechcraft 1900C. He was born on 16th February, 1977.

2.1.80.9. He was initially medically examined on 27th November, 1994 and declared fit for issuance of Student Pilot Licence S No 1754. He started his flying training at Schon Air (Pvt) Ltd with effect from 21st January, 1995. He flew Cessna-152 and Cessna-172 at Schon Air (Pvt) Ltd. After completing all requirements / formalities, he was issued Commercial Pilot Licence S No 2280 on 16th September, 1996 by CAA Pakistan.

2.1.80.10. He was given multiengine aircraft rating on Cessna-402 aircraft on 23rd December, 2004 after completing all requirements / formalities by CAA Pakistan.

2.1.80.11. He joined JS Air and underwent his Beechcraft-1900 ground and simulator training at Farnborough Learning Centre, United Kingdom from 30th October, 2006 till 10th November, 2006 and successfully accomplished his training. After completing his flying training at JS Air, he was cleared by CAA Pakistan to fly as Co-pilot (under supervision) on 13th February, 2007. He was issued Airline Transport Pilot Licence S No 1370 on 30th March, 2010 and then after completion of all requirements / formalities was declared Captain on Beechcraft-1900C aircraft.

2.1.81. **Cockpit crew Flight Duty Time Limitation (FDTL) evaluation.**

2.1.81.1. Cockpit crew rest period and fatigue aspects could be the critical factors in causation of the accident. It therefore became imperative to probe into the cockpit crew routine activities prior to mishap flight. In this case, the mishap chartered flight to Bhit Shah Oil Fields was the first flight of cockpit crew on the day of accident. The scrutiny of the cockpit crew engagements at operator level revealed that both the cockpit crew had availed the required rest period before undertaking the mishap flight.

2.1.81.2. The CAA Pakistan approved rules and regulations in respect of FDTL were adhered to. Therefore, the possibility of exposure of cockpit crew to undesired and unnecessary stress / fatigue as a result of FDTL rules and regulations violation by JS Air, was ruled out.

2.1.82. **Cockpit Crew Training and Skill Competence Level at JS Air**

2.1.82.1. Both the Captain and FO underwent formal ground schooling and simulator training for converting onto Beechcraft-1900D with "C" differences at Farnborough Learning Centre, United Kingdom. They were exposed to all the required and necessary training exercises for the conduct of safe flight operations of Beechcraft-1900C aircraft.

2.1.82.2. While going through the recurrent simulator training record of Captain, it was observed that on 01st October, 2009 he achieved performance level **"satisfactory with briefing"** during simulator check critical areas like "Recovery from initial buffeting", "One engine out go-around" (Mandatory), "Maintenance of minimas" and likewise on 07th October, 2010 again evaluated by the JS Air Designated Check Pilot and CAA Inspector **"Satisfactory with briefing (SB)"** for critical areas like; "Simulated Engine Fire after V1" and "One engine out go-around". It is important to note that both these simulator training exercises are Mandatory for the conduct of simulator check.

2.1.82.3. It was noted with concern that the performance of Captain during these simulator training check flights remained almost the same. He could not safely handle these training exercises during critical phases of takeoff / just after takeoff without briefing to achieve the satisfactory performance level in these mandatory exercises. The current and previous simulator check performance was neither co related at operator nor CAA Pakistan level.

2.1.82.4. Additionally, It is important to note that the cockpit crew of mishap aircraft did not undergo their six monthly recurrent / refresher simulator training in between the two annual simulator training checks; rather they were undertaking emergency procedures training between two annual simulator checks on aircraft as per CAA Pakistan instructions issued vide letter No. HQCAA/1774/01/GA dated 05th March, 2009 on the subject.

2.1.82.5. **Cockpit Crew Interpretation and Understanding of Engine Abnormal Behaviour / Performance**

2.1.82.6. First of all after V_1, the FO being Pilot Monitoring (PM) observed the propeller of engine No 2 (right engine) going towards feathered position and he promptly informed the Captain who was Pilot Flying (PF) at that time. The Captain told FO to inform the Karachi ATC Tower that they had a problem with engine No 1 and will join right hand down wind for recovering back to JIAP, Karachi. The Karachi ATC Tower and CVR recording revealed that the

FO transmitted the same incorrect information of engine No 1 problem to ATC Tower.

2.1.82.7. Whereas in actual case, the cockpit crew were experiencing engine No 2 propeller going to feathered position and not problem with engine No 1. The engine No 1 performance parameters were observed well within the design parameters of the engine and very close to the cockpit crew desired parameters as well.

2.1.82.8. Therefore, it is considered that the cockpit crew transmitted the incorrect information due to the anxiety / stress of flying in abnormal set of conditions while operating at low airspeed and below minimum safe altitude.

2.1.82.9. **Cockpit crew Performance and Behaviour Evaluation after Encountering Abnormal Engine Performance during Last Phases of Flight (Human Factor)**

2.1.82.10. Captain (PF) performance in last two simulator training check flights evaluation indicated that single engine safe flight operation was one of the areas which needed invariably briefing for achieving the satisfactory level of his performance. On the day of mishap, when the aircraft encountered engine No 2 abnormal operation then it was incorrectly understood by Captain as problem with engine No 1. Due to the stress and anxiety level, Captain failed to ensure carrying out of the recommended remedial actions as per QRH and FCOM. He never achieved prescribed minimum safe altitude of 400 ft above ground level for subsequent recovery to the airfield.

2.1.82.11. It was discussed at length amongst the investigation team members to ascertain the status of landing gears after encountering the abnormal engine No 2 operation. After going through the CVR and detailed actions taken by PM and PF, it is concluded that cockpit crew neither discussed nor raised the landing gears after takeoff. The wreckage also confirmed the landing gears in extended position at the time of ground impact. The Beechcraft-1900C aircraft will have very low rate of climb with landing gears in down position due to increased drag while operating with single engine. Any angle of bank is going to aggravate the situation and the marginal rate of climb would at one stage change into a rate of descend which actually happened in this particular case.

2.1.82.12. The FO was a qualified Captain on Beechcraft-1900C aircraft, however his actions and assistance available to the Captain of aircraft was not at optimum level. He failed to retract the landing gears after takeoff and undertook remedial actions well below the defined minimum safe altitude contrary to the recommended procedures as per QRH and FCOM which shows his pre-occupation, anxiety and stress in handling abnormal situation. Due to these non conformances, the mishap aircraft failed to achieve the safe flying parameters despite having a serviceable engine.

2.1.82.13. Therefore non conformances of the recommended remedial actions by both the cockpit crew resulted into the in-effective management of

flight deck causing the aircraft to lose initially airspeed and then altitude after takeoff.

2.1.83. **Evaluation of Ground Proximity Warning System (GPWS)**

2.1.83.1. The installed onboard GPWS alerted the cockpit crew as per the design parameters of approaching close to the ground. However, FDR and CVR data confirmed that no remedial actions were initiated by the cockpit crew to get out of unsafe set of conditions / imminent danger.

2.1.84. **Incapacitated Cockpit crew**

2.1.84.1. The possibility of cockpit crew incapacitation was studied in detail. The CVR and ATC tape extracts revealed communication amongst the cockpit crew and ground agencies with no signs of incapacitation.

2.1.84.2. Therefore, the possibility of incapacitation of cockpit crew contributing directly or indirectly towards causation of accident is ruled out.

2.1.85. **Lack of Situational Awareness (SA)**

2.1.85.1. The mental formulation and retention of the detailed picture of references and conditions, is called situational awareness (SA). The cockpit crew needs to be well orientated all the time with the entire environment around them. Due to various reasons and factors, at times the cockpit crew start to have degradation in mental picture formulation and retention, which is called lack of situational awareness.

2.1.85.2. The cockpit crew did not have the required SA as evidenced from their following actions:

2.1.85.2.1. After experiencing the abnormal engine No 2 operation, at one stage the cockpit crew indicated confusion about the engine No 1 or 2 and subsequently transmitted incorrect information to the ATC Tower that they were experiencing abnormal operation of engine No 1.

2.1.85.2.2. The OEM recommended remedial actions were not complied with by both the cockpit crew which indicates their lack of comprehension regarding the serious consequences of non conformance of QRH and FCOM procedures.

2.1.85.2.3. Both the cockpit crew could not identify the root cause of loss of airspeed and altitude with one serviceable engine actually due to landing gears in extended position and contribution of angle of bank.

2.1.86. **Crew Resource Management (CRM) Training**

2.1.86.1. During the CRM training, the cockpit crew is educated on hazard identification, hazard management and optimum utilization of available resources. As a result of CRM training, the flight crew evolve techniques to mitigate the hazards in order to reduce the human errors in flying operations.

2.1.86.2. The documentation in respect of both the cockpit crew was scrutinized in detail to find out any anomaly in their CRM training. The record indicated that

both the cockpit crew were qualified and had undergone CRM training. However, during the abnormal engine No 2 performance handling of ill fated flight, it was observed that the cockpit crew did not follow the CRM tools / techniques effectively and efficiently to safely get out of abnormal set of conditions and imminent danger to the onboard personnel and the aircraft. The failure of CRM aggravated the abnormal set of conditions to unsafe and directly contributed towards causation of accident.

2.1.87. **Why did the Cockpit crew fail to avert Accident?**

2.1.87.1. The Captain during two simulator training check flights was observed achieving the satisfactory standard of performance after briefing (SB) in safely handling the single engine operation of aircraft. It points to the fact that despite being instructor on various types of aircraft, the Captain was not confident and lacked the required proficiency level / skill to independently handle the aircraft operations with single engine during critical phases of flight.

2.1.87.2. FO as PM was exposed to serious level of stress and anxiety when he observed the propeller feathering of No 2 (right) engine. The situation was aggravated due to the fact that the auto feathering was selected to “Off” which entailed the cockpit crew to manually manage feathering of Propeller in case of any anomaly. He did communicate to the Captain correct information, however, Captain did not register engine No 2 and told him to inform ATC Tower that they were experiencing problem with engine No 1 and FO communicated the same without questioning Captain or correcting himself. He got mentally pre-occupied to a level where he could not perform the recommended remedial actions as per the QRH and FCOM. Thus, he did not effectively contribute towards handling of abnormal set of conditions.

2.1.87.3. The cockpit crew could not effectively and efficiently employ CRM tools and techniques to achieve safe flying parameters of aircraft for executing safe recovery back to JIAP, Karachi.

2.1.88. **In-flight Structural Failure**

2.1.88.1. The onsite evaluation of the wreckage revealed that there was no evidence of any structural parts separation before impact. The fuselage broke into pieces after ground impact and subsequent disintegration also occurred after ground impact. Same was verified by FDR and CVR read outs as no distress or abnormality was observed till first ground impact of mishap aircraft.

2.1.89. **In-flight Fire**

2.1.89.1. The examination of the onsite wreckage, reconstruction / layout of wreckage spread, signs of fire and heat on aircraft structural parts / components revealed no sign of in-flight fire. No evidence of uncontained engine failure or engine fire prior to impact was identified from either engine as verified by FDR and CVR data analysis.

2.1.90. **Bird Strike**

2.1.90.1. The possibility of a bird strike to the aircraft or to any engine, causing damage to the engine or aircraft structure to an extent which could have

resulted into the mishap aircraft crash, was also studied in detail and ruled out due to the following reasons:

2.1.90.2. The cockpit crew never discussed bird activity or their presence on their flight path after takeoff and the ATCO also never transmitted the presence of the birds on or around the runway or the adjoining areas especially towards the flight path after takeoff.

2.1.90.3. No evidence of bird impact or its remains were observed or found on any of the aircraft body parts or in the engines area.

2.1.90.4. On the basis of above mentioned evidence, the possibility of a bird strike to the aircraft resulting in abnormal engine No 2 performance was ruled out.

2.1.91. **Sabotage**

2.1.91.1. An in-depth analysis of the aircraft wreckage was carried out to ascertain internal / external sabotage. It was ruled out on the basis of the following:

2.1.91.1.1. The aircraft did not disintegrate or explode in the air, and no part of the aircraft structure was found from outside the general wreckage area or from the final flight path, or from the route or prior to the first ground impact point. The complete inventory of the aircraft structure was available within the wreckage site.

2.1.91.1.2. The CVR data gave complete recording for the entire mishap flight which included the cockpit crew and various ground agencies communication, sound / noise of the engines and various warnings alerting the cockpit crew during final phases of the flight. The CVR data neither showed any abnormal sound of explosion or aircraft disintegration, nor did the flight crew express any concern about onboard detonation or explosion.

2.1.91.1.3. The complete wreckage did not reveal any chemical explosive deposits on any of the aircraft component / structural part.

2.1.91.2. Therefore, sabotage causing the crash of aircraft was ruled out.

2.2. **Technical Analysis**

2.2.1. **Flight Data and Cockpit Voice Recorders (FDR & CVR)**

2.2.1.1. The Cockpit Voice Recorder (CVR) PN 93-A1000-83 S.No. 59645 and FDR S.No.703-1000-00 S.No. 01317 onboard the mishap aircraft were recovered from the wreckage on the same day without any apparent damage and heat effects. Later on, these were taken to National Transportation Safety Board (NTSB), USA. The recorded data from both the units was successfully downloaded and decoded at NTSB, USA in the presence of Safety Investigation Board (SIB), Pakistan team.

2.2.1.2. From the CVR readout, it was ascertained that the cockpit crew carried out all checks before takeoff and found all parameters of both the engines normal. However, during takeoff roll as soon as V1 was reached and aircraft was rotated, the FO observed that the propeller of No.2 Engine was indicating abnormal behaviour of feathering on its own and then not reacting to the

cockpit crew's input of manual feathering. Following which the cockpit crew decided to return to JIAP Karachi. In that process, while the aircraft was in the right bank suddenly a few panic conversational sentences spoken by the FO for the Captain were recorded before the MA hit the ground.

2.2.1.3. It was also observed from the CVR readout that two ground runs were performed prior to the mishap flight. The FDR data analysis also suggested that some maintenance work and ground runs were performed somewhere between the previous flight on 04th November, 2010 and the mishap flight on 05th November, 2010.

2.2.1.4. Although the time of those ground runs was not recorded in the CVR; still the conversations among the Aircraft Maintenance Engineers (AME) indicated that the last ground run was conducted just before the mishap flight. The aircraft maintenance engineers, however, insisted that both the ground runs were performed on the previous day i,e. 04th November, 2010.

2.2.1.5. Since the cockpit crew encountered inconsistent behaviour of No.2 Engine initially, therefore, it was imperative to determine as to what maintenance was being performed before the mishap flight and whether it could have any direct or indirect bearing on the cause of No.2 Engine feathering on its own.

2.2.1.6. During the subsequent interviews with the AMEs, it was learnt that upon return from a previous chartered flight on 4th November, 2010, ground maintenance staff observed few drops of oil under the Engine No. 2.

2.2.1.7. The AMEs inspected all the suspected areas and components of Engine No.2, but did not find any anomaly. To verify further, Engine No.2 ground run was performed during which engine idle rpm were found less, but no oil leakage was observed. The engine was shut down and minor adjustment on the dead band screw of Fuel Control Unit (FCU) was done to bring the engine idle rpm within the specified limits. Subsequently, another ground run was performed to confirm the engine idle rpm correct adjustment. All performance parameters of the engine were found normal and thus the aircraft was declared fit for further routine / chartered flight operations.

2.2.1.8. It was also observed from the aircraft and engine log books that the defects and their corresponding rectifications including the ground runs performed on 4th and / or 5th November, 2010 were not documented in any of the aircraft or engine documents / technical log books. It indicated that there had been a general trend in the engineering set up of M/s JS Air of not documenting the maintenance performed on the aircraft or engines.

2.2.2. **Wreckage Examination and Analysis.**

2.2.2.1. The aircraft impacted the ground in a right bank. Right at the first ground impact, its fuselage was split into two halves, the front and the rear. The rear fuselage after separation remained close to the Impact Point (IP) whereas, the front fuselage got dragged in the direction of final flight path, which was towards the JIAP, Karachi. The aircraft was completely destroyed as a result of ground impact and subsequent fire.

2.2.2.2. The main wreckage was confined to an area of only 200 x 150 sq ft (length x width). Following are the salient points of detailed wreckage inspection, examination and analysis:

2.2.2.3. There was no evidence of structural parts separation before the ground impact.

2.2.2.4. There was no evidence of in-flight fire or bird hit.

2.2.2.5. The mishap aircraft experienced extensive post impact ground fire due to onboard fuel.

2.2.2.6. The aircraft fuselage was found split into two pieces from frame No. FS 456 behind the cargo door. The rear fuselage was without any fire effects; whereas, the front fuselage along with the wings had been badly burnt.

2.2.2.7. The front fuselage was found twisted due to severe dragging on ground after the ground impact.

2.2.2.8. The engine controls in the cockpit indicated the position of Engine No 1 propeller lever forward (fine) and Engine No 2 at feathered position.

2.2.2.9. Both engines' Fuel Cut Off condition levers and Power Levers on the throttle quadrant were observed at full forward position.

2.2.2.10. The evidence of engines wreckage revealed that Engine No 1 was probably operating at high power whereas Engine No 2 was operating at low power setting at the time of ground impact.

2.2.2.11. No evidence of engine failure or engine fire prior to ground impact was found on either of the engines.

2.2.2.12. Landing gears lever in the cockpit was found at down selection and the corresponding system debris' evidence confirmed that landing gears were in extended state at the time of ground impact.

2.2.3. **Reconstruction of Aircraft**. After completion of onsite wreckage examination, the wreckage was moved to JIAP, Karachi. All aircraft parts were regrouped for reconstruction of mishap aircraft to ascertain integrity of aircraft structure, engines and all related systems. However, no anomaly was observed and following possible causes of crash were ruled out.

2.2.3.1. **Bird Hit.** No bird remains were found on any of the aircraft body parts or inside the engines.

2.2.3.2. **In-Flight Structural Failure.** All structural parts were inspected and their completeness before ground impact was verified. No signs of external or internal damage before ground impact were observed. The area under the flight path of aircraft from JIAP Karachi up to the crash site was also searched, but no structural or any other aircraft / engines' part was found which confirmed that there was no in-flight structural failure.

2.2.3.3. **In-Flight Fire.** The examination of the wreckage onsite, wreckage spread, signs of fire and heat on the aircraft, engines and other components / parts

revealed no sign of in-flight or pre-impact fire. No evidence of the same was found from the DFDR and CVR analyses.

2.2.3.4. **Sabotage.** The wreckage was critically examined for evidence of sabotage. However, it was ruled out as the aircraft did not disintegrate or explode in the air, and no part of the aircraft structure was found from outside the general wreckage area or from the route along the flight path behind the first ground impact point. The complete inventory of the aircraft parts was available within the wreckage. The CVR transcript also did not reveal any such conversation amongst the flight crew or any other abnormal sound of explosion / aircraft disintegration which could point toward the sabotage activity.

2.2.4. **History of the Aircraft, Engines & Propellers**

Aircraft.

2.2.4.1. The MA Beechcraft, Reg. No. AP-BJD and MSN UC-157 was inducted in the inventory of M/s JS Air in May, 2006 .

2.2.4.2. At the time of induction PT6A-65B engines were installed on the MA with PCE – 32612 as No.1 Engine and PCE – 32613 as No.2 Engine.

2.2.4.3. Both these engines were overhauled in 2001 from USA.

2.2.4.4. On 4th September, 2010 No.1 Engine # PCE-32612 was removed from the aircraft due to oil leakage from compressor inlet case at aircraft 18456.22 Flight Hours (FH) and Engine # PCE-32476 was installed on the aircraft.

2.2.4.5. Aircraft 200 & 50 FH inspections were simultaneously carried out on 10th October, 2010 at 18501.02 FH and Cycle 24938. During these inspections, both engines metal chip detector (MCD) inspection, both engines' compressor wash and visual inspection of lower wing spar were performed.

No.1 Engine S. No. PCE – 32476

2.2.4.6. On 4th September, 2010 Engine No. 1 (Left), S. No. PCE – 32476 was installed on mishap aircraft with TSN – 13767.56 FH, TSO – 665.32 FH and CSN – 15107.

2.2.4.7. On 15th September, 2010, during verification flight, its rpm dropped to 700. The pilot switched off the engine in air and landed back successfully with single (right) Engine S. No. PCE-32613.

2.2.4.8. After landing back, during the fault isolation process and subsequent ground run, the maintenance staff did not observe any drop in the engine rpm. The engine was, therefore, released to service after minor re-adjustment of Beta backlash cable.

2.2.4.9. The engine had flown about 90 FH after installation on MA before crash.

No.2 Engine S. No. PCE – 32613

2.2.4.10. On 4th December, 2006, Engine No. 2 (Right) S. No. PCE-32613 was installed on mishap aircraft with TSN - 12687.5 FH, TSO - 1435 FH, CSN - 11751 and CSO - 1215.

2.2.4.11. On 8th December, 2008, the engine failed due to compressor stall which resulted in damage to its blades and stator vanes.

2.2.4.12. On 13th December, 2008 the engine was sent to ADAT (GAMCO) Gulf Aircraft Maintenance Company at Abu-Dhabi for requisite repair.

2.2.4.13. The engine was received back on 17th March, 2009 after refurbishment of compressor and inspection of hot section.

2.2.4.14. The engine was installed on mishap aircraft on 17th April, 2010 at aircraft 18255 FH and the engine with TSN – 14444 FH , TSO – 3191 and CSN – 13466.

2.2.4.15. The replacement of Fuel Nozzles on this engine was carried out on 30th September, 2010.

2.2.4.16. On 15th October, 2010, slow acceleration / deceleration was reported by the cockpit crew on this engine after a passenger flight.

2.2.4.17. During rectification process, Fuel Control Unit (FCU) was suspected defective. Same was replaced by cannibalizing serviceable FCU from Engine S. No. PCE - 97432.

2.2.4.18. No defect was reported since 15th October, 2010 till 3rd November, 2010.

2.2.4.19. The Engine No. 2 # PCE-32613 had flown approx 291.00 FH after installation on MA and 659.00 FH after refurbishment since March 2009.

Propeller (Left) S. No. FWA – 3330

2.2.4.20. In May, 2007 the Propeller (Left) Serial No. FWA – 3330 was inducted with TSN - 13503.48 FH and TSO - 00.00 and same was installed on B-1900 Reg # AP-BJS.

2.2.4.21. The details of inspections carried out while installed on that aircraft are as below:-

Item	Type of Inspection	TSN	TSO	Date Accomplished
Propeller – 1 FWA – 3330	200 + 50	13558.56	55.08	22-02-2008
	200	13660.07	156.19	20-06-2008
	200	13715.28	211.40	17-10-2008

2.2.4.22. On 12th December, 2008, it was removed from B-1900 aircraft Reg # AP-BJS at TSN - 13736.41 FH and TSO - 232.53 FH and was installed on MA.

2.2.4.23. The details of inspections carried out while installed on MA are as appended below:-

Item	Type of Inspection	TSN	TSO	Date Accomplished
Propeller – 1 FWA – 3330	200 + 50	13938.41	434.53	02-02-2009
	200	14132.01	629.13	23-03-2009
	200	14327.46	824.58	23-05-2009
	200	14517.01	1014.13	19-07-2009
	200	14678.01	1175.13	08-09-2009
	200	14857.41	1354.53	10-12-2009
	200	14877.26	1374.38	17-02-2010
	200	14939.36	1436.48	17-06-2010
	200	15137.26	1634.38	10-10-2010

Propeller (Right) S. No. FWA – 4191

2.2.4.24. In May, 2007 the Propeller (Right) Serial No. FWA – 4191 was procured which had TSN 3122.48 FH and TSO 26.49 FH and same was installed on B-1900 aircraft Reg # AP-BJS. The details of inspection carried out while installed on that aircraft are as below:-

Item	Type of Inspection	TSN	TSO	Date Accomplished
Propeller – 2 FWA – 4191	200 + 50	3177.56	55.08	22-02-2008
	200	3279.07	156.19	20-06-2008
	200	3334.28	211.40	17-10-2008

2.2.4.25. On 12th December, 2008, Propeller (R) Serial No. FWA – 4191, was removed from B-1900 aircraft Reg # AP-BJS at TSN 3355.41 FH and TSO 232.53 FH and was installed on MA on 13th December, 2008.

2.2.4.26. The details of inspections carried out while installed on MA are as below:

Item	Type of Inspection	TSN	TSO	Date Accomplished
Propeller – 2 FWA – 4191	200 + 50	3557.41	434.53	02-02-2009
	200	3750.10	629.13	23-03-2009
	200	3945.55	824.58	23-05-2009
	200	4137.01	1014.13	19-07-2009
	200	4298.01	1175.13	08-09-2009
	200	4477.41	1354.53	10-12-2009
	200	4497.26	1374.38	17-02-2010
	200	4559.36	1436.48	17-06-2010
	200 + 50	4753.56	1732.08	10-10-2010

2.2.5. **Defect History**

2.2.5.1. The last three months' analysis of documented defects reported by air and ground crew did not show any defect which could be related to propellers' feathering or abnormal torque values on either of the engines.

2.2.5.2. The last maintenance on No.2 Engine FCU done prior to the mishap flight and recorded in the CVR was not documented in the aircraft or engine log book. Thus, whether there had been any unscheduled maintenance performed and not documented could not be verified from any of the aircraft and engine documents.

2.2.6. **Engines' and Related Components' Strip Examination & Analysis at OEM Facility.** Both the engines and their related components as recovered from the wreckage were taken to the OEM Facility (Pratt & Whitney, USA). Detailed strip examination and analyses of both the engines were conducted to determine their status at the time of ground impact and to identify any anomaly which could have caused Engine No.2 feathering on its own or any other anomaly which could have resulted into either of the engines malfunction. The salient findings along with deductions of detailed investigation conducted at OEM (P&W) Facility are appended below*:*

2.2.6.1. **Engine No.1**.

2.2.6.1.1.*The engine No.1 housings displayed light impact damage and severe post impact ground fire damage.*

2.2.6.1.2.*Disassembly and inspection of the engine revealed no indications of operational distress to any of the components examined.*

2.2.6.1.3.*Strong circumferential rubbing and machining were displayed by the 1st stage power turbine vane ring, 1st stage power turbine shroud, 1st stage power turbine, 2nd stage power turbine vane ring, 2nd stage power turbine shroud, and 2nd stage power turbine due to their making contact with their adjacent components under impact loads and external housing deformation.*

2.2.6.1.4.*The 2nd stage planet gear retaining bolts displayed heavy circumferential machining due to their making contact with the No. 5 bearing housing.*

2.2.6.1.5.*The reduction gearbox propeller shaft coupling webs were fractured under torsional loading.*

2.2.6.2. **Engine No. 2.**

2.2.6.2.1.*The engine No.2 housings displayed moderate impact damage and severe post impact ground fire damage.*

2.2.6.2.2.*Disassembly and inspection of the engine revealed no indications of operational distress to any of the components examined.*

2.2.6.2.3.*Circumferential rubbing, with frictional heat discoloration, were displayed by the compressor impeller and shroud, the compressor turbine, and the 1st stage power turbine vane ring upstream side due to their making contact*

with their adjacent components under impact loads and external housing deformation.

2.2.6.2.4. *The 1st stage power turbine vane ring downstream side and the 2nd stage power turbine vane ring displayed light circumferential rubbing, with concurrent static imprint marks, due to their making contact with their respective power turbine rotors under impact loads and external housing deformation.*

2.2.6.3. *Ground impact and fire damages to both the engines' controls and accessories precluded any functional testing of the units. Disassembly and inspection identified no conditions that would have precluded normal engine operations.*

2.2.6.4. **Deductions from the Engines' Strip Examination & Analysis**

Engine No.1.

2.2.6.4.1. *The engine No 1 displayed contact signatures to its internal components, and torsional fracture of the reduction gearbox propeller shaft coupling webs, characteristics of the engine producing power at the time of ground impact, likely in a mid to high power range.*

2.2.6.4.2. *There were no indications of any pre-impact mechanical anomalies or dysfunction to any of the engine components observed.*

Engine No.2.

2.2.6.4.3. *The right hand engine displayed contact signatures to its internal components characteristic of the engine gas generator operating in a low power range at the time of impact.*

2.2.6.4.4. *The contact signatures of the power section are characteristic of the propeller rotating with extremely low energy at the time of impact, typical of the propeller being in feathered condition.*

2.2.7. **Examination and Analysis of Propeller (Right) No.2 Engine**. Since feathering of the right engine propeller was initially encountered as recorded in the CVR, therefore, only right engine propeller was taken to the OEM facility, Hartzell Propeller Inc. Ohio, for examination & analysis.

2.2.7.1. The salient findings along with deductions of detailed investigation conducted at OEM (Hartzell Propeller Inc. Ohio) Facility are appended below*:*

2.2.7.1.1. ***Findings***. *There were several indications that the propeller was feathered at the time of impact*: *Same are appended below:-*

2.2.7.1.1.1. The beta rod end ring (on the front of the propeller) was crushed aft and created gouges in the piston at two locations. The piston was in the feather position when the gouges were created.

2.2.7.1.1.2. One beta rod was bent on the forward side of the piston. The piston was in the feather position when the beta rod was bent.

2.2.7.1.1.3. The feather stop screws had impact damage and the piston was internally gouged by contact with the feather stop screws. The piston was in the feather position when the damage occurred.

2.2.7.1.1.4. Also, oil pressure in the piston could not have been present when the feather stop damage occurred.

2.2.7.1.1.5. Impact damage to the links screws (attached to the blade clamps) occurred while the blades/clamps were at an extreme feather position.

2.2.7.1.1.6. The direction of the damage on the fracture surface of the two blades was noted.

2.2.7.1.1.7. With the blades in the feather position, the damage was not aligned with the trailing edge but more toward the camber side of the blade. This suggests that possibly the propeller may have been rotating (although feathered) at the time of impact.

2.2.7.1.2. ***Deductions*.** Appended below are the deductions regarding status of the Propeller (Right) No.2 Engine :-

2.2.7.1.2.1. The right propeller was feathered at the time of impact.

2.2.7.1.2.2. There were no discrepancies noted that would preclude normal operation. All damage was consistent with impact damage.

2.2.7.2. **Accessories Examination & Analysis**.

2.2.7.2.1. The accessories of both the Engines No.1&2, as listed below, were subjected to thorough examination and functional testing (where possible) at their respective OEM facilities.

Accessory	P&WC P/N	Manufacturer	Supplier P/N	S/N
Fuel pump	3033808	Eaton	399701-5 SB73-2	1978
Propeller governor (CSU)	None	Woodward	8210-310	1992875
Fuel control unit (FCU)	None	Woodward	8061-328B	2240802
Compressor bleed valve (BOV)	3112714-01	P&WC	3112714-01	U/K
Overspeed governor	None	Woodward	210954A	2257918

2.2.7.2.2. Due to extensive fire and impact damage none of the components were suitable for functional testing. Each component was disassembled for detailed inspection. No pre-impact anomalies or conditions could be identified that would preclude normal operation. The fuel control unit bellows were forwarded to the fuel control unit manufacturer, Woodward, for examination and testing if possible. However, testing of Bellows at WOODWARD could not

provide any useful results due to leakage caused by post ground impact fire and heat effects.

2.2.8. **Anomalies observed from CVR Recorded Data**.

2.2.8.1. There were two serious anomalies observed from the readout of CVR. One was related to the ground crew who performed ground run between the previous flight and the mishap flight without documentation. Second was related to the cockpit crew, whose actions after experiencing abnormality in Engine No.2 performance depict a confusion in the cockpit crew's understanding of the problem encountered and the corresponding handling vis a vis the correct checklist actions.

2.2.8.2. Referring to the ground run performed before this flight, it was conclusively established that the ground run was performed to verify suspected oil leak from Engine No.2 which was found satisfactory. However, in that ground run engine idle rpm were observed less. Hence, after minor adjustment on the FCU, another ground run was performed to verify the correct engine idle rpm. During the process of investigation, it was also established from all the available evidences on wreckage site and detailed strip examination of the engine and its accessories at the OEM facility in the presence of NTSB, USA and SIB, CAA Pakistan representative that the Engine No.2 had no pre-accident anomaly which could have prevented its normal operation. Moreover, had there been any deterioration in the engine performance, then the engine rpm would have decreased and resultantly the Torque would not have increased. Whereas; in this mishap the first observation of the cockpit crew was engine feathering on its own and Torque increasing. Therefore, it was conclusively ascertained that there was no adverse effect on the performance of Engine No.2 due to the maintenance performed on the FCU or the ground runs performed before the mishap flight.

2.2.8.3. With respect to the cockpit crew, it was observed that after finding all parameters normal and reaching the takeoff point, firstly, auto feather switch was selected to "Manual" contrary to the take off instructions which require the auto feather selector's switch at "Auto" before takeoff. Subsequently, following are some of the calls exchanged between the Captain and the First Officer:

Time UTC	**Action**
02:04:02.8	All set, we are cleared for t/off
02:04:25.0	80 knots
02:04:29.8	V1….rotate
02:04:33.2	Sound of reduced eng noise
02:04:33.8	Oh teri (Oh No)
02:04:35.8	Kia hua (What Happened)
02:04:35.8	Right engine prop chala gia hai
	(Right propeller has gone)

Time UTC	Action
02:04:41.1	Feather ho raha hai, kar doon kiya feather
	(Its feathering, should I selkect it to feather)
02:04:43.1	Hain.....kar do (Yes do it)
02:04:44.8	feather karoon...ya (select it to feather ...or)
02:05:16.0	Kiya kar rahay ho (What are you doing)
02:05:16.9	Sir, feather nahein ho raha (Sir,its not feathering)
02:05.21.0	sound of high pitch tone, similar to stall warning continues to end of recording
02:05.23.5	Bismillah..Bismillah (Starting with the name of God, Starting with the name of God)
02:05.25.8	Ya Allah***** (Oh God****)

2.2.8.4. With the Auto Feather Selector Switch at “Auto”, the feathering of one engine propellers is automatically done by the other engine if its core engine has developed any deficiency in its ability to produce sufficient power to maintain the desired Torque or rpm at any stage. However, with selection at “Manual”, feathering of the Propellers would have to be managed by the cockpit crew, and there would be two conditions which may result into Propellers feathering without any such input from the cockpit crew. Those are; depletion of oil pressure and beta block malfunction. These two conditions would be discussed in proceeding paras.

2.2.8.5. In this case, after V1 rotate was reached, the FO expressed that No.2 engine Propeller was feathering on its own, but the Captain had not observed any abnormality in the aircraft response (yaw towards right side) corresponding to the propeller feathering and resultant loss of thrust as he did not report any such variation or anomaly. Then FO asked the Captain whether he should feather it or not? Again he asked, “should I feather it or,.....(did not complete the question) ?”. At this stage, why he wanted to feather the Propeller when it was already feathering on its own. Or, if he wanted to secure the No.2 Engine, then he should have accordingly asked the Captain and taken the measures prescribed in the FCOM.

2.2.8.6. After a few seconds, observing some abnormality (not clear if it was from the aircraft or engine behaviour, or was it something physically seen by the Captain as wrong / incorrect being done by the FO), the Captain asked the FO as to what was he doing. To this, the FO replied that it (No.2 Engine) was not feathering.

2.2.8.7. Subsequently, upon inquiry from the FO regarding information to ATC about their discontinuation of the flight and recovery back to JIAP, Karachi, the Captain replied in affirmative and said that the FO should inform the ATC that they had problem with No.1 Engine and they would be returning back. The FO also communicated the same to ATC. At this stage why they communicated like that whereas in reality, they had encountered problem with No.2 Engine.

2.2.8.8. Just before the crash, the FO shouted in panic, “sir, kia kar rahey hain, wapis aain, wapis aain, (what are you doing sir, come back, come back)”. Immediately after that, the Captain was heard reciting the holy verses and calling God (“Bismillah, ya Allah”). Two seconds after that, the mishap aircraft crashed and was completely destroyed along with all souls onboard fatally injured.

2.2.8.9. All twin engine aircraft are designed to sustain a safe flight even if one of the engines has failed or is switched off due to any abnormality provided the laid down emergency handling procedures are correctly followed. Similarly, Beech 1900C also had the capability to sustain safe flight with single engine operation. In this mishap, after encountering abnormality with No.2 Engine Propeller, the checklist actions warranted that no actions should have been taken before reaching 400 ft AGL. Contrarily, immediately after observing some abnormality with No.2 Engine Propeller feathering, the FO started taking some actions and the Captain also allowed him to do so much before 400 ft AGL was reached.

2.2.8.10. It is also a fact that on 15th September, 2010 during a verification flight of the Mishap Aircraft, the rpm of No.1 Engine (left) S No. PCE-32476 dropped to 700 rpm. The pilot switched off the engine in air and landed back successfully with single engine (right) Engine S. No. PCE-32613. Similarly, there are number of evidences in the Beech craft history which substantiate that the aircraft have been successfully making safe landings with a single engine when one of the engines was switched off in air due to any observed anomaly or performance deterioration.

2.2.8.11. Therefore, whether the actions taken by the cockpit crew were in conformance with the laid down emergency handling procedures required thorough analysis. The same have been critically analysed and discussed in the Operations Analysis.

2.2.9. **Testing of Fuel Sample.**

2.2.9.1. Fuel Jet A-1 was serviced in the aircraft. The sample taken on the day of occurrence was tested which did not show any abnormality and were found meeting the standard Jet A-1 fuel specifications for aviation usage**.**

2.2.10. **Brief Description of PT6 Engine.**

2.2.10.1. The PT6 is a lightweight turbine engine driving a propeller via a two-stage reduction gearbox. Two major rotating assemblies compose the heart of the engine.

2.2.10.2. The first is the compressor and the compressor turbine (compressor section) and second, the two power turbines and the power turbine shaft (power section). The two rotors are not connected and rotate at different speeds and in opposite directions. The compressor draws air into the engine via an annular plenum (inlet case), air pressure increases across 3 or 4 axial stages and one centrifugal stage and is then directed to the combustion chamber. Air enters the combustion chamber via small holes. At the correct compressor speed, fuel is introduced into the combustion Chamber via 14 fuel nozzles. Two spark igniters located in the combustion chamber ignite the

mixture. The hot gases generated by the combustion are then directed to the turbine area. The hot expanding gases accelerate through the compressor turbine vane ring and cause the compressor turbine to rotate, thus rotating the compressor (39,000 rpm, 100%). The expanding gases travel across the 1st and 2nd stage power turbines, providing rotational energy through reduction gear box to drive the propeller shaft

2.2.10.3. The reduction gear box reduces the power turbine speed (30,000 rpm approx) to one suitable for propeller operation (1400/1700 rpm with over speed governor 1768 rpm).

2.2.10.4. Gases leaving the power turbines are expelled to the atmosphere by the exhaust duct. An integral oil tank located in the rear section of the inlet case and the accessory gearbox provides oil to bearings and other various systems, such as propeller and torque systems. A Woodward Governor Co. fuel control unit (FCU) mounted on the accessory gearbox regulates fuel flow to the fuel nozzles in response to power requirements and flight conditions.

2.2.10.5. Propeller system change the power produced by the engine into thrust in order to propel the aircraft through the air. The propeller governor mounted on the reduction gearbox controls the speed of the propeller by varying the blade angle/ pitch, depending on power requirements, pilot speed selection and flight conditions.

2.2.10.6. The propeller pitch is a direct function of the beta valve position (power lever). Bringing the propeller lever to the **feather position** cause the speed selection lever on the CSU to push the feathering valve plunger and allows propeller servo oil to dump into the reduction gear box sump. The pressure loss in the propeller hub causes the feathering spring and the propeller counterweights to feather the propeller quickly.

2.2.10.7. Pitch change mechanism allow varying the propeller blade angle in order to maintain a constant Prop RPM (Np) through various ambient conditions and power setting. When oil from the propeller governor feeds into the propeller shaft and to the servo piston via the oil transfer sleeve mounted on the propeller shaft ,hence as oil pressure increases, it pushes the servo piston forward and feather spring to get compressed. Servo piston movement is transmitted to the propeller blade collars via a system of levers, this increase in oil pressure drives the blades towards a finer/low pitch, faster prop RPM. When oil pressure is decreased, the return spring and counter weights force the oil out of the servo piston and change the blade pitch to a coarser/high pitch, slower prop RPM. When the prop lever is put in the cut position feathering plunger will be pushed in and allow the oil to drain in the dome resulting in feather position.

2.2.11. **Probable Cause of Un-Commanded Engine No 2 Propeller Feathering**

2.2.11.1. A review of the engine's relevant Technical Manuals and the experience indicate that the beta valve is the only part in the propeller governing system that has the authority to bring the propeller into a coarse or feather pitch in such a quick manner as observed in this accident. There are two possibilities of beta valve malfunction; mis-rigging after some maintenance work or fair

wear & tear during routine service. Unfortunately, the beta system's integrity and rigging status could not be verified because the propeller governor had been completely consumed in the post ground impact fire. However, it was confirmed from the documented history and the engineering staff that there was neither any reported defect related to the beta system nor was there any scheduled or unscheduled maintenance performed in the recent past. Therefore, the only probable cause of occurrence could be fair wear and tear of the beta valve.

2.3. Medical Analysis

2.3.1. All 21 souls onboard mishap aircraft sustained fatal injuries due to aircraft impact with ground causing 98% fire burns personnel leading to cardio-respiratory failure because of neurogenic shock.

2.3.2. All the dead bodies were evacuated from the crash site and were brought to Jinnah Post Graduate Medical Centre (JPMC).

2.3.3. Ten bodies were identified on same day and one on 06th November, 2010 and handed over their relatives.

2.3.4. There was no evidence to support any other cause of death of all 21 souls onboard mishap aircraft.

2.3.5. The human remains / parts of 10 unidentified bodies were identified by DNA profiling / matching at National Forensic Science Agency Islamabad Pakistan and were handed over to the relatives of deceased.

2.3.6. Captain was issued his initial class-I medical certificate on 02nd August, 2004. Thereafter, his medical record did not reveal any significant problem.

2.3.7. First Officer, was issued his initial class-I medical certificate on 06th November, 1995. He was a young pilot with no significant problem throughout his medical record.

2.3.8. Both the cockpit crew were medically fit to undertake the scheduled flight of M/s JS Air with valid class-I medical certificate on the day of occurrence.

2.3.9. There was no evidence to support any other cause of death of all souls on board the mishap aircraft.

2.3.10. The CVR transcript also did not reveal any abnormality related to the fitness or consciousness / alert level of both cockpit crew as the CVR recorded data till the end of mishap flight revealed that they were talking to each other and relevant ground agency normally.

3. Findings

3.1. Operational Findings

3.1.1. The mishap flight JS-201 was a chartered flight to convey the employees of M/s Eni company from Karachi to Bhit Shah Oil Fields.

3.1.2. As per the medical investigation / analysis, the Captain was fit to undertake the mishap scheduled flight.

3.1.3. The mishap flight took off at 02:04:05 UTC for destination and was cleared for climb to FL130 for Bhit.

3.1.4. The FDR data was available for last 90 hours of FDR recording.

3.1.5. The CVR recording contained ground crews' (technicians') discussion during the conduct of maintenance activity on one of the engines of mishap aircraft prior to the mishap flight. The details of various maintenance activities being undertaken on mishap aircraft prior to the mishap flight are appended in Technical Analysis of the investigation report.

3.1.6. The FDR started to record the aircraft parameters with effect from 01:59:10UTC.

3.1.7. At 01:55:37.8 UTC cockpit crew requested Karachi Ground for start up permission for Bhit and asked for level 130 with 20 souls onboard, whereas actually 21 persons were onboard mishap aircraft.

3.1.8. At 01:55:54.9 UTC Karachi Ground Controller approved the start up for runway two five left which was acknowledged by cockpit crew at 01:55:59.2 UTC.

3.1.9. At 01:57:23.8 UTC Captain started the Engine No 1 & 2 respectively and FO kept announcing and monitored the engine performance parameters during start.

3.1.10. At 01:59:10.5 UTC FO asked Captain why left fuel quantity light of left fuel quantity is coming ON and Captain probably pulled out the CB for left fuel quantity indication light on annunciator panel contrary to the normal procedure and said that the switch was malfunctioning.

3.1.11. At 01:59:23.3 UTC the cockpit crew requested Karachi Ground for the taxi instruction.

3.1.12. At 01:59:30.2 UTC Karachi Ground Controller transmitted taxi instruction to JS-201 which were acknowledged by the cockpit crew.

3.1.13. At 01:59:54.4 UTC Karachi Ground Controller transmitted the ATC clearance for departure to JS-201 which were also acknowledged by cockpit crew.

3.1.14. At 02:01:13.7 UTC right engine propeller feathering was checked in manual position. As per procedure runup checks are supposed to be carried out and feathering function of both engines is to be checked simultaneously, however, cockpit crew in this case only checked No 2 engine feathering mechanism serviceability manually contrary to the documented procedures.

3.1.15. At 02:02:38.5 UTC cockpit crew asked Karachi Ground for entering foxtrot link which was cleared by Karachi Ground.

3.1.16. At 02:02:45.1 UTC cockpit crew asked Karachi Tower that they were holding foxtrot two five left and were ready for immediate departure.

3.1.17. At 02:02:50.1 UTC Karachi Tower cleared JS-201 to line up runway 25L and wait" which was acknowledged by cockpit crew.

3.1.18. At 02:03:26.0 UTC Karachi Tower Controller cleared JS-201 for takeoff runway 25L and BADAL TWO charlie departure. The instructions were acknowledged by the cockpit crew.

3.1.19. At 02:03:55.1 UTC FO told Captain to check auto feather and Captain acknowledged it by saying "auto feather off" contrary to the OEM instructions and laid down procedures in FCOM and QRH to keep it to "Arm" position instead of "OFF".

3.1.20. At 02:04:02.8 UTC Captain told FO that everything was set and they had been cleared for takeoff. It is important to note that cockpit crew were supposed to carry out "run up checks" prior to entering the runway as per QRH however, those were not carried out.

3.1.21. At 02:04:05 UTC, the engine torque and propeller RPM parameters began to increase and there was an increase in longitudinal acceleration indicating start of takeoff roll.

3.1.22. At 02:04:14.2 UTC FO told Captain that power set auto feather light is ON and Captain acknowledged it by saying "off".

3.1.23. The airspeed began to increase and at 02:04:29.8 UTC FO told Captain "V1...rotate".

3.1.24. At 02:04:33.2 UTC the sound of reduced engine noise is recorded on CVR Central Area Mic (CAM). As per FDR recorded Data, at this particular moment the airspeed of aircraft was **119** knots with altitude recorded as **-37 ft** Below Mean Sea Level, heading **253.4^0**, angle of bank as **-0.22^0** (left angle of bank) and pitch attitude **+4.63^0**.

3.1.25. At 02:04:33.8 UTC FO said "oh teri" *(Oh no)* and Captain asked him immediately "kia hua" *(what has happened).*

3.1.26. At 02:04:36.5 UTC FO told Captain "right engine ka prop chala gia hai" *(*right *engine prop has gone".* As per FDR recorded Data, at this particular moment the airspeed of aircraft was **123** knots with altitude recorded as **-31 ft** Below Mean Sea Level, heading **256.2^0**, angle of bank as **2.57^0** (right angle of bank) and pitch attitude **+6.66^0**.

3.1.27. At 02:04:41.1 UTC FO told Captain "feather ho raha hai....kar doon kiya feather?" *(it is feathering...should I select it to feather position?)* and Captain told him immediately at 02:04:43.1 UTC by saying "hain ... kar do" *(yes, put it to feather position)*. Captain approved the feathering of Engine No 2 propeller contrary to the OEM documented procedures of no remedial action below 400 ft above ground level.

3.1.28. At 02:04:44.8 UTC FO asked Captain "feather karoon ...ya" *(should I put it to feather ...or)* and Captain asked him "hain" *(what).* As per the recorded

Data, at this particular moment the airspeed of aircraft was **119** knots with altitude recorded as **36.9 ft** Above Mean Sea Level, heading **256.4^0**, angle of bank as **-2.69^0** (left angle of bank) and pitch attitude **+7.34^0**. It is important to note that cockpit crew got engaged in feathering of engine No 2 propeller below the minimum safe altitude of 400 ft AGL and forgot to retract the landing gears in down position.

3.1.29. At 02:04:47.4 UTC FO told Captain that he should bring the power back first. As per the recorded Data, at this particular moment the airspeed of aircraft was **117** knots with altitude recorded as **57.1 ft** Above Mean Sea Level, heading **256.4^0**, angle of bank as **-2.21^0** (left angle of bank) and pitch attitude **+7.57^0**.

3.1.30. At 02:04:50.7 UTC FO asked Captain that should he ask for recovering back? As per the recorded Data, at this particular moment the airspeed of aircraft was **116** knots with altitude recorded as **77.4** ft Above Mean Sea Level, heading **256.4^0**, angle of bank as **1.37^0** (right angle of bank) and pitch attitude **+6.96^0**. It is considered that it was too early and premature decision to ask for this clearance at this altitude. The main focus of cockpit crew should have been on flight deck management.

3.1.31. At 02:04:51.9 UTC Captain told FO that yes tell him that we had No 1 engine problem. It is important to note that the actual problem being discussed amongst the cockpit crew was related to No 2 engine, whereas at this stage Captain advised the FO to inform ATC Tower that they had problem with engine No 1 which indicated the confused state of mind, pre occupation and lack of situational awareness on part of Captain. As per the recorded Data, at this particular moment the airspeed of aircraft was **116** knots with altitude recorded as **79.2 ft** Above Mean Sea Level, heading **256.7^0**, angle of bank as **+0.45^0** (right angle of bank) and pitch attitude **+7.87^0**.

3.1.32. At 02:04:55.9 UTC Captain continued and said that they had indication problem and would like to switch off. It appears from the Captain's advice that either he was trying to conceal the actual information of engine problem from ATC Tower or physically he was not facing any anomaly in the engine behaviour / performance. As per the recorded Data, at this particular moment the airspeed of aircraft was **115** knots with altitude recorded as **105 ft** Above Mean Sea Level, heading **255.6^0**, angle of bank as **-1.61^0** (left angle of bank) and pitch attitude **+7.8^0**.

3.1.33. At 02:04:57.8 UTC Captain told FO that Don't switch it off. Captain wanted to inform ATC Tower about switching off the suspected affected engine but actually never wanted FO to switch it off. It is considered that suspected affected engine running was acceptable to the Captain at this stage. As per the FDR recorded Data, at this particular moment the airspeed of aircraft was **114 knots** with altitude recorded as **114 ft** Above Mean Sea Level, heading **255.4^0**, angle of bank as **-1.61^0** (left angle of bank) and pitch attitude **+7.49^0**.

3.1.34. At 02:04:58.6 UTC FO informed Karachi Tower that they would proceed back to Kilo Charlie as there was a problem with number one engine. At this stage FO knowing from his own observation on engine No 2 performance instead of challenging the Captain's advice of announcing engine No 1 problem to ATC Tower, followed his advice. As per the FDR recorded Data, at

this particular moment the airspeed of aircraft was 114 knots with altitude recorded as 116 ft Above Mean Sea Level, heading 255.5^0, angle of bank as -1.37^0 (left angle of bank) and pitch attitude $+7.34^0$.

3.1.35. At 02:05:07.7 UTC Karachi Tower Controller cleared the mishap flight for right downwind runway two five left. As per the FDR recorded Data, at this particular moment the airspeed of aircraft was 112 knots with altitude recorded as 157 ft Above Mean Sea Level, heading 264.2^0, angle of bank as $+13.08^0$ (right angle of bank) and pitch attitude $+9.75^0$.

3.1.36. At 02:05:10.5 UTC FO asked Captain that was it under control? As per the FDR recorded Data, at this particular moment the airspeed of aircraft was 109 knots with altitude recorded as 276 ft Above Mean Sea Level, heading 276.2^0, angle of bank as 12.28^0 (right angle of bank) and pitch attitude $+8.96^0$. At this stage, it is considered that FO was asking Captain about control of aircraft airspeed, attitude and bank etc.

3.1.37. At 02:05:14.1 UTC cockpit crew acknowledged the ATC Tower clearance and said "right downwind 25L JS-201" and this was the last recorded call of cockpit crew to the ATC Tower. As per the FDR recorded Data, at this particular moment the airspeed of aircraft was 106 knots with altitude recorded as 229 ft Above Mean Sea Level, heading 288.8^0, angle of bank as $+12.12^0$ (right angle of bank) and pitch attitude $+9.99^0$.

3.1.38. At 02:05:16.0 UTC Captain asked FO that what was he doing? As per the FDR recorded Data, at this particular moment the airspeed of aircraft was 102 knots with altitude recorded as 255 ft Above Mean Sea Level, heading 296.3^0, angle of bank as $+17.02^0$ (right angle of bank) and pitch attitude $+9.2^0$. At this stage, it is considered that FO was moving the engine No 2 feather control lever.

3.1.39. At 02:05:16.9 UTC FO told Captain that sir it's not feathering. As per the FDR recorded Data, at this particular moment the airspeed of aircraft was 102 knots with altitude recorded as 255 ft Above Mean Sea Level, heading 296.3^0, angle of bank as $+18.43^0$ (right angle of bank) and pitch attitude $+9.04^0$.

3.1.40. At 02:05:17.7 UTC Captain told FO to wait for a minute, wait for a minute. As per the FDR recorded Data, at this particular moment the airspeed of aircraft was 98 knots with altitude recorded as 268 ft Above Mean Sea Level, heading 300.7^0, angle of bank as $+22.03^0$ (right angle of bank) and pitch attitude $+10.24^0$. Till this stage, Captain had not been able to achieve the minimum safe recommended flying parameters and the airspeed of aircraft was continuously decreasing with increasing pitch attitude as well as right angle of bank and first time it is observed that Captain told FO to wait and hold his ongoing actions, whereas it is considered that at this stage FO feathered the propeller as the reduction in engine noise was observed at this stage in CVR recording.

3.1.41. At 02:05:19.2 UTC further reduction in engine sound was observed. As per the FDR recorded Data, at this particular moment the airspeed of aircraft was 83 knots with altitude recorded as 301 ft Above Mean Sea Level, heading 307.8^0, angle of bank as $+28.26^0$ (right angle of bank) and pitch attitude $+7.95^0$. At this stage, it is evident that right bank was also continuously

increasing due to full power on serviceable engine No 1 and as the power on engine No 1 was reduced indicated by reduction in engine noise, the right angle of bank started to decrease subsequently. It is important to note that the aircraft at this stage was flying at very low airspeed which was close to the stalling speed with landing gears down and at maximum all up weight.

3.1.42. At 02:05:19.3 UTC Karachi Tower asked the cockpit crew of mishap flight that would they be able to land at Karachi. However, no reply was given by the cockpit crew to the Tower as they were extremely busy in cockpit to manage and handle the abnormal situation. As per the FDR recorded Data, at this particular moment the airspeed of aircraft was **83 knots** with altitude recorded as **301 ft** Above Mean Sea Level, heading **307.8^0**, angle of bank as **+25.83^0** (right angle of bank) and pitch attitude **+7.49^0**. It is important to note that there was continuous reduction in aircraft airspeed towards dangerously low values to sustain a safe flight.

3.1.43. At 02:05:20.2 UTC increase in engine sound (two surges) were observed on CVR recording. As per the FDR recorded Data, at this particular moment the airspeed of aircraft was **94 knots** with altitude recorded as **273 ft** Above Mean Sea Level, heading **313^0**, angle of bank as **+22.22^0** (right angle of bank) and pitch attitude **+7.42^0**. Probably at this stage, cockpit crew advanced the power on serviceable engine No 1 to recover out of unsafe set of conditions which resulted in two surges being recorded on CVR.

3.1.44. At 02:05:21.0 UTC sound of high pitch tone, similar to stall warning was recorded on CVR which continued till end of recording. As per the FDR recorded Data, at this particular moment the airspeed of aircraft was **95.8 knots** with altitude recorded as **273 ft** Above Mean Sea Level, heading **317.5^0**, angle of bank as **+22.7^0** (right angle of bank) and pitch attitude **+9.91^0**.

3.1.45. At 02:05:21.2 UTC FO spontaneously told Captain to come out of stall regime parameters of aircraft. As per the FDR recorded Data, at this particular moment the airspeed of aircraft was **95 knots** with altitude recorded as **273 ft** Above Mean Sea Level, heading **317.5^0**, angle of bank as **+25.23^0** (right angle of bank) and pitch attitude **+10.32^0**.

3.1.46. At 02:05:23.5 UTC Captain said “bismillah bismillah” *(with the name of Allah).* As per the FDR recorded Data, at this particular moment the airspeed of aircraft was **85.6 knots** with altitude recorded as **292 ft** Above Mean Sea Level, heading **323.7^0**, angle of bank as **+38.1^0** (right angle of bank) and pitch attitude **+6.96^0**.

3.1.47. At this stage, Captain being unable to maintain a level flight was sure that the aircraft would be either forced landing on unprepared surface or impact the ground due to stalled state of aircraft.

3.1.48. At 02:05:25.8 UTC FO was heard saying “ya Allah” *(O God)* As per the FDR recorded Data, at this particular moment the airspeed of aircraft was **95.8 knots** with altitude recorded as **285 ft** Above Mean Sea Level, heading **338.3^0**, angle of bank as **+45.78^0** (right angle of bank) and pitch attitude **+5.85^0**.

3.1.49. At this stage, FO was probably sure of ground impact.

3.1.50. At 02:05:26.8 UTC sound of ground proximity warning “whoop, whoop” was recorded which continued till end of FDR recording. As per recorded Data, at this particular moment the airspeed of aircraft was **88.4 knots** with altitude recorded as **290 ft** Above Mean Sea Level, heading **352^0**, angle of bank as **+49.91^0** (right angle of bank) and pitch attitude **+2.3^0**.

3.1.51. As per recorded Data, at 02:05:27.0 UTC the airspeed of aircraft was **73.9 knots** with altitude recorded as **275 ft** Above Mean Sea Level, heading **7.42^0**, angle of bank as **+52.24^0** (right angle of bank) and pitch attitude **+0.69^0**. The aircraft was continuously losing altitude under stalled state.

3.1.52. As per the FDR recorded Data, at 02:05:28.0 UTC the airspeed of aircraft was **66 knots** with altitude recorded as **247 ft** Above Mean Sea Level, heading **21.46^0**, angle of bank as **+48.46^0** (right angle of bank) and pitch attitude **-7.52^0**. At this stage, the aircraft was well below the stalling speed due to which the pitch attitude dropped below the horizon under stalled state.

3.1.53. As per the FDR recorded Data, at 02:05:29.0 UTC the airspeed of aircraft was **80.4 knots** with altitude recorded as **160 ft** Above Mean Sea Level, heading **34.6^0**, angle of bank as **+42.65^0** (right angle of bank) and pitch attitude **-15.12^0**. This was the last recorded parameter of FDR.

3.1.54. It is observed that from 02:04:33.8 UTC when the FO first registered the right engine propeller feathering till aircraft impacted the ground, the cockpit crew were busy and occupied in handling the abnormal situation while disregarding and violating OEM documented procedures to handle such non normal situation.

3.1.55. As per QRH and FCOM, the first recommended action after experiencing engine failure after V1 or takeoff is having positive control of aircraft and raising the landing gears in order to reduce the drag immediately so that aircraft can quickly achieve minimum safe flying parameters ie altitude 400 ft above ground level while maintaining minimum single engine safety speed. Due to the cockpit crew non conformance of procedures, the mishap aircraft could not achieve the minimum safe flying parameters and crashed after experiencing one engine un-serviceability.

3.1.56. A detailed study / investigation was conducted to ascertain all factors which could have directly or indirectly contributed towards ineffective management of flight deck, in such a critical situation. The details are appended in following paragraphs.

3.1.57. The Captain was an ex-Pakistan Air Force officer. During his PAF service career, he flew various training / fighter and light communication aircraft including MFI-17, T-37, FT-5, FT-6, Piper (Seneca-II), Beech Baron, Y-12, Super King (B-200), Cessna-172 and Cessna-402 aircraft. He got retired from PAF in 2003 while accumulating 6279:55 hrs. He was a Qualified Flying Instructor and had 2863 hrs of instructional experience on various PAF aircraft.

3.1.58. Captain was medically examined on 09th August, 2005 and assessed fit for issuance of Airline Transport Pilot Licence (ATPL-Aircraft). He was issued

ATPL-Aircraft Serial No 1193 on 07th October, 2005 by Civil Aviation Authority, Pakistan after completion of all requirements / formalities.

3.1.59. He joined JS Air (Pvt) Ltd and satisfactorily completed his "Beechcraft-1900D" with "C" differences Training Course at Farnborough Training Centre from 10th to 29th October, 2005. He underwent his simulator training satisfactorily under the supervision of CAA inspector on 27th October, 2005 at Farnborough.

3.1.60. He started to fly as First Officer in JS Air after clearing his route check by CAA Inspector on 13th June, 2006. He was then trained as Captain on Beechcraft-1900C aircraft. During his Captain training, it was documented that he needs to concentrate more on procedures.

3.1.61. The recurrent simulator training of Captain was conducted by the operator without any authority by CAA Pakistan on 12th October, 2008.

3.1.62. The recurrent simulator training of Captain was conducted on 01st October, 2009 by the operator under the supervision of DCP (Operator) and CAA Inspector. Although the simulator training was assessed as "satisfactory", however it was observed that "Recovery from initial buffeting", "One engine out go-around" (Mandatory) and "Maintenance of minimas" during the simulator training check session were marked as **"Satisfactory with briefing (SB)"**.

3.1.63. It is important to note that the recurrent simulator training of Captain was conducted on 07th October, 2010 by the operator under the supervision of DCP and CAA Inspector and like the previous year ie 2009 evaluation of simulator training was assessed as "satisfactory" however critical areas like; "Simulated Engine Fire after V1" and "One engine out go-around" (both these are Mandatory exercises), were marked as **"Satisfactory with briefing (SB)"**. The SBs in CAAF-628 do not quantify the skill level of under check pilot in these two mandatory exercises whereas the overall simulator training report is satisfactory. Subsequently, no further training and monitoring of skill level was observed at operator level in these two SB exercises.

3.1.64. It is a considered opinion of investigation team members that the performance of Captain during these simulator training check flights remained almost the same. He could not safely handle these training exercises during critical phase of takeoff / just after takeoff without briefing to achieve the satisfactory performance level in these mandatory exercises and on the day of accident he failed to manage the single engine anomaly right after V1 observed and reported by FO.

3.1.65. The current and previous simulator session performance (CAAF-628) of the Captain were also not correlated at CAA Pakistan.

3.1.66. On 05th November, 2010 the Captain could not safely handle the aircraft abnormality ie one engine un-serviceability / non normal situation after V_1 which resulted in crash of aircraft.

3.1.67. As per the medical investigation / analysis, the Captain was fit to undertake the mishap scheduled flight and possessed valid medical certificate till 31st March, 2011.

3.1.68. FO was also a qualified Captain on the type of aircraft and occupying the seat of co-pilot on the day of fatal aircraft accident of Beechcraft 1900C.

3.1.69. He was initially medically examined on 27th November, 1994 and declared fit for issuance of Student Pilot Licence S No 1754.

3.1.70. After completing all requirements / formalities, he was issued Commercial Pilot Licence S No 2280 on 16th September, 1996 by CAA Pakistan.

3.1.71. He was given multi-engine aircraft rating on Cessna-402 aircraft on 23rd December, 2004 after completing all requirements / formalities by CAA Pakistan.

3.1.72. He joined JS Air and underwent his Beechcraft-1900 ground and simulator training at Farnborough Learning Centre, United Kingdom from 30th October, 2006 till 10th November, 2006 and successfully accomplished his training. After completing his flying training at JS Air, he was cleared by CAA Pakistan to fly as Co-pilot (under supervision) on 13th February, 2007.

3.1.73. He was issued Airline Transport Pilot Licence S No 1370 on 30th March, 2010 and then after completion of all requirements / formalities was declared Captain on Beechcraft-1900C aircraft.

3.1.74. At organizational level, FO enjoyed a reputation of being a good confident professional who always kept himself up to date on all aviation related procedures.

3.1.75. As Captain and FO did not follow the recommended procedure of keeping propeller auto feather switch at “Arm” position which acted as a catalyst to increase the stress and anxiety level of the cockpit crew. This prompted the FO to initiate immediately manual feathering to remedy the situation after observing propeller going to feather position.

3.1.76. The FO was observed taking the remedial actions well below the OEM recommended altitude of 400 ft above ground level. He did not extend the required help to the Captain in safely handling the non normal situation.

3.1.77. The mishap aircraft never achieved an altitude of 400 ft above ground level for safe conduct of flight as per the OEM recommended procedures / instructions.

3.1.78. Therefore, due to the in-effective management of flight deck by both the cockpit crew, the aircraft continued to lose initially airspeed and then altitude after takeoff and impacted the ground in a stalled state resulting in the catastrophe.

3.1.79. It was found that the CAA Pakistan approved rules and regulations in respect of FDTL were adhered to and the cockpit crew of ill fated mishap aircraft was not observed exposed to any undesired stress / fatigue / unrest prior to the flight as a result of any FDTL violation.

3.1.80. The onboard GPWS alerted the cockpit crew as per the design parameters while approaching close to the ground; however, the cockpit crew failed to

carry out the remedial actions with one serviceable engine to get out of unsafe set of conditions / imminent danger.

3.1.81. The technical investigation / analysis confirmed that all aircraft systems, accessories and one engine were functioning normal, till the aircraft impacted the ground.

3.1.82. The cockpit crew announced the abnormal engine operation and joining right hand downwind for recovering back to JIAP, Karachi.

3.1.83. The possibility of any aircraft system / accessory malfunction / failure or cockpit crew incapacitation, except Engine No 2 power non availability, contributing directly or indirectly towards causation of accident, was ruled out.

3.1.84. In case of JS Air Beechcraft-1900C aircraft accident, it was observed that both the cockpit crew till the ground impact of aircraft were not having the required SA. Initially the diagnosis of the problem with No 1 or No 2 engine created lot of confusion in the minds of the cockpit crew. The OEM suggested and recommended remedial actions / decisions were not taken by both the cockpit crew. They were not aware of the disastrous consequences of the initiation of remedial measures below the OEM recommended minimum safe altitude. They did not conform to the OEM recommended altitude before initiation of the right hand side roll / bank.

3.1.85. Both the cockpit crew could not identify the root cause of loss of airspeed and altitude with one serviceable engine actually due to landing gears in extended position. Therefore, it is a considered fact that both the cockpit crew did not have the correct SA for handling a serious in-flight abnormal situation after encountering the engine No 2 propeller suddenly going to feathered position just after V_1 / takeoff, which resulted in in-effective flight deck management by both the cockpit crew.

3.1.86. The non conformance of Beechcraft-1900C Pilot Checklist, Pilot Handbook and Flight Operational (Ops) Manual resulted in ineffective management of flight deck by the cockpit crew which contributed directly in the catastrophic consequences in the form of aircraft crash and loss of 21 precious human lives.

3.1.87. The documentation in respect of both cockpit crew was scrutinized in detail to find out any anomaly in the CRM training of cockpit crew. The record indicated that both the cockpit crew were qualified and had undergone CRM training. However, during the abnormal engine No 2 performance handling of ill fated flight, it was observed that the cockpit crew did not follow the CRM tools / techniques effectively and efficiently to safely get out of unsafe set of conditions / imminent danger to the onboard personnel and the aircraft. The failure of CRM aggravated the unsafe set of conditions which directly contributed towards causation of accident.

3.1.88. The Captain during two simulator training check flights was observed achieving the satisfactory standard of performance after briefing (SB) in safely handling the one engine operations of aircraft due to any reason. It is a considered fact that despite being instructor on various types of aircraft Captain was not confident and lacked the required proficiency and skill level

to independently safely handle the one engine operation during critical phases of flight like just after V1 or takeoff.

3.1.89. FO as PM was exposed to serious level of stress and anxiety when he observed the propeller feathering of No 2 (right) engine. He did communicate to Captain the correct information, however Captain did not register No 2 (right) engine and told him to inform ATC Tower that they are experiencing problem with No 1 engine and co-pilot communicated problem of engine No 1 to ATC Tower despite knowing the fact that the actual problem is with No 2 engine. He got mentally pre-occupied to a level where he could not perform the correct recommended remedial actions and decisions while taking into account all the precautions which could had aggravated the situation. By virtue of the mental pre-occupation stress and anxiety FO could not effectively contribute towards effective management of flight deck.

3.1.90. The cockpit crew did not effectively and efficiently employ CRM tools and techniques to achieve safe flying parameters of aircraft for executing safe recovery back to JIAP, Karachi.

3.1.91. The onsite evaluation of the wreckage revealed that there was no evidence of any structural parts separation due to overload before ground impact. The fuselage broke into pieces after ground impact and subsequent disintegration also occurred after ground impact.

3.1.92. The examination of the onsite wreckage, reconstruction / layout of wreckage spread, signs of fire and heat on aircraft structural parts / components revealed no sign of in-flight fire. Therefore, in-flight fire causing the accident is ruled out.

3.1.93. The complete wreckage analysis did not reveal any chemical explosive deposits on any of the aircraft component / structural part.

3.1.94. Therefore sabotage (internal / external) is ruled out due to the absence of any evidence which could have confirmed its contribution towards causation of accident.

3.1.95. The cockpit crew never discussed bird activity or their presence on the flight path and the ATCO also never transmitted the presence of the birds on or around the runway or the adjoining areas especially towards the final approach flight path direction.

3.1.96. No evidence of bird impact or its remains were observed or found on any of the aircraft body parts or in the engines area.

3.1.97. On the basis of above mentioned evidences, the possibility of a bird strike to the aircraft or bird ingestion into the engines causing the accident is ruled out.

3.2. **Technical Findings**

3.2.1. The MA Beechcraft, Reg. No. AP-BJD and MSN UC-157 was inducted in the inventory of M/s JS Air in May, 2006.

3.2.2. All the scheduled inspections on MA had been carried out regularly on due dates.

3.2.3. On 5th November, 2010, the day of crash, MA was serviceable and had no outstanding inspection or maintenance work.

3.2.4. On the day of crash, Engine No. 1 (Left) S. No. PCE – 32476 and Engine No. 2 (Right) S. No. PCE-32613 were installed on the MA.

3.2.5. Engine No.1 had flown 90 FH and Engine No.2 had flown 291 FH since their installation before mishap.

3.2.6. The documented history for the last three months before crash did not bear evidence of any recorded defect related to malfunction of propeller feathering on either of the engines.

3.2.7. The CVR recording indicated that the propellers were not selected to "Auto Feathering" mode before starting the take off roll contrary to the laid down take off procedures.

3.2.8. The CVR recording indicated that the first problem observed by FO was related to Engine No.2 Propeller around 5 seconds after FO announced V1 rotate.

3.2.9. The CVR recording indicated that the FO started taking few actions including manual feathering to cater for the observed anomaly with the Propeller of No.2 Engine soon after observing it and much before reaching the minimum safe altitude (400 ft AGL) contrary to the OEM recommended procedures.

3.2.10. The CVR recording indicated that FO on the instructions of Captain passed an incorrect information to the ATC Controller, JIAP, that they had encountered problem with No.1 Engine; whereas, FO himself had observed some problem with the Propeller of No.2 Engine.

3.2.11. Detailed strip examination and analysis on recovered parts of both the engines and their accessories indicated the following:

3.2.11.1. The left hand (No.1) engine housings displayed light impact damage and severe post impact fire damage.

3.2.11.2. There were no indications of any pre-impact mechanical anomalies or operational distress to any of the components which could have prevented normal operation of the core of Engine No.1 (Left).

3.2.11.3. The contact signatures to its internal components and torsional fracture of the reduction gearbox propeller shaft coupling webs were consistent with the characteristics of the engine producing power at impact, likely in a mid to high power range.

3.2.11.4. The right hand (No.2) engine housings displayed moderate impact damage and severe post impact fire damage.

3.2.11.5. There were no indications of any pre-impact mechanical anomalies or operational distress to any of the components which could have prevented normal operation of the core engine.

3.2.11.6. The contact signatures to its internal components were consistent with the characteristics of the engine operating in a low power range at the time of impact.

3.2.11.7. The contact signatures of the power section were consistent with the characteristics of the propeller rotating with extremely low energy at the time of impact, typical of the propeller being in feathered condition.

3.2.12. **Propeller Engine No. 2 (Right)**.

3.2.12.1. All the evidences on beta rod end, piston, feather stop screws and blade clamp screws indicated that the Propeller was in feathered condition at the time of ground impact.

3.2.12.2. With the blades in the feather position, the damage was not found aligned with the trailing edge. Instead it was found more toward the camber side of the blade indicating the propeller being in rotational status (although feathered) at the time of ground impact.

3.2.12.3. No pre-impact or operational distress was observed that would have precluded its normal operation. All damage was consistent with the ground impact damage.

3.2.13. **Auto Feather Switches.** Detailed teardown and examination of the auto feather switches did not indicate any pre-existing conditions which would have prevented their normal operation.

3.2.14. **Accessories**.

3.2.14.1. The accessories of both the Engines No.1 & 2, including Fuel Pump, Propeller Governor, Fuel Control Unit (FCU), Compressor Bleed Valve (BOV) and Over Speed Governor, were subjected to thorough examination at their respective OEM facilities.

3.2.14.2. Due to extensive fire and impact damage none of the components could be functionally tested. Each component was disassembled for detailed inspection.

3.2.14.3. No pre-impact anomalies or conditions could be identified that would have prevented them from operating normally.

3.2.15. The only probable cause of engine propeller un-commanded feathering could be fair wear and tear of the beta valve which could not be ascertained during the process of investigation as it had been completely consumed by post impact extensive ground fire.

3.3. **Medical Findings**

3.3.1. Both the cockpit crew were medically fit to undertake the scheduled flight of M/s JS Air.

3.3.2. The results of chemical examination of Captain and First Officer reflected only carbon monoxide detection in samples collected from dead bodies of both cockpit crew.

3.3.3. No alcohol, poison, psychoactive substance or dangerous element was found during the chemical examinations of various specimens collected from deceased cockpit crew.

3.3.4. The Post Mortem reports of Captain and First Officer revealed 98 per cent and 100 per cent fire burnt bodies respectively with destruction of whole skin and muscles along with smell of carbon monoxide.

3.3.5. The skulls and ribs of both cockpit crew were found fractured.

3.3.6. The CVR transcript did not reveal any abnormality related to the fitness or consciousness / alert level of both cockpit crew.

3.3.7. The medical report of Captain and FO did not reveal any other cause of death.

3.3.8. According to the post mortem reports, death of both cockpit crew was caused by direct impact with ground and subsequent post impact ground fire resulting in extensive fire burn.

4. Observations

4.1. The cockpit crew of mishap aircraft were observed undergoing simulator training / check once a year and found not following the ICAO Annex-6 guidelines and Flight Standards Directorate ANO 024-FSXX-6.1 & ANO 91.0017 in respect of recurrent / refresher simulator / emergency procedures training twice in a year.

4.2. CAA Pakistan issued instructions to all the operators in Pakistan vide letter No. HQCAA/1774/01/GA dated 05th March, 2009 for conducting recurrent / refresher emergency training on aircraft between two annual simulator checks.

4.3. The log book of Engine S No. PCE - 32613 indicated pencil filled data from 27th October, 2010 to 3rd November, 2010 with no signatures.

4.4. Entries in aircraft log book had been filled in with lead pencil from 21st October, 2010 to 3rd November, 2010.

4.5. On 15th September, 2010 after replacement of Engine PCE - 32476 during short flight to verify engine performance, switching off in air related entry was not recorded in the engine log book, once the aircraft landed back with other Engine S. No. 32613.

4.6. As per aircraft log book, Engine S No. PCE-32613 was replaced at aircraft 18255 FH on mishap aircraft on 16th April, 2010 and FCU was replaced on 15th September, 2010, but no defect was recorded in the engine log book.

5. Conclusion

5.1. Detailed investigation and analyses of the examinable evidence confirmed that the aircraft had developed some problem with its Engine No.2 (Right) immediately after takeoff which was observed by the cockpit crew as propeller feathering on its own. No concrete evidence could be found which would have led to the engine's propeller malfunction as observed. The only probable cause of propeller feathering on its own could be the wear & tear of the beta valve leading to beta system malfunction. However, this anomaly at the most could have led to the non availability of one engine and making a safe landing with a single engine since the aircraft was capable of landing with a single engine operation. Some of the actions by the cockpit crew before takeoff and subsequent to the observed anomaly in the Engine No.2 were not according to the QRH / FCOM which aggravated the situation and resulted into the catastrophic accident.

6. Factors leading to the Accident

6.1. The aircraft accident took place as a result of combination of various factors which directly and indirectly contributed towards the causation of accident.

6.1.1. The primary cause of accident includes, inappropriate skill level of Captain to handle abnormal operation of engine No 2 just after takeoff, failure of cockpit crew to raise the landing gears after experiencing the engine anomaly, execution of remedial actions by FO before the attainment of minimum safe altitude of 400 ft AGL resulted in non conformance and non compliance of cockpit crew to OEM recommended procedures to handle such situations.

6.1.2. The lack of situational awareness and CRM failure directly contributed towards ineffective management of the flight deck by the cockpit crew.

6.1.3. The contributory factors include inadequate cockpit crew simulator training monitoring mechanism both at operator and CAA Pakistan levels in respect of correlation of previous / current performance and skill level of cockpit crew during the simulator training sessions along with absence of conduct of recurrent / refresher simulator training between two annual simulator checks in accordance with ICAO Annex-6 guidelines and CAA Pakistan (applicable ANOs) requirements for specific type of aircraft in a year.

7. Finalization

7.1. A number of non conformances and non adherences to Beechcraft 1900C aircraft OEM recommended QRH, FCOM procedures and remedial actions by the cockpit crew, their lack of situational awareness, CRM failure and unprofessional handling of the anomaly in one of the engines' operation (Engine No 2 propeller feathering without any cockpit crew input) aggravated the situation and caused the accident.

7.2. The cause of Engine No 2 propeller feathering on its own is attributed to probable wear & tear of the beta valve during its service life leading to beta system malfunction.

8. **Safety Recommendations**

8.1. All operators in Pakistan are to devise mechanism for ensuring strict supervision and monitoring of skill level during previous as well as current simulator training check performances of all the cockpit crew.

8.2. All operators in Pakistan are to re-emphasize on the importance of strict compliance by the cockpit crew of OEM recommended and all other applicable documented procedures while handling non normal situations.

8.3. All operators in Pakistan are to re-emphasize on the cockpit crew regarding importance of good aircraft system knowledge, non normal situations and corresponding remedial actions in order to handle non normal situations effectively and efficiently.

8.4. All operators in Pakistan are to re-emphasize on the importance of following CRM tools / techniques strictly in order to handle non normal situations effectively and efficiently.

8.5. All operators and ground handlers in Pakistan are to ensure that the air and ground crew record all entries / snags related to aircraft operations and maintenance performed in the applicable documents, log books and technical data sheets of aircraft, engines and other systems and subsystems' components.

8.6. All operators and ground handlers in Pakistan are to ensure that their aircraft maintenance engineers and other staff do not fill in the data and other entries with lead pencil or erasable ink in the applicable log books and technical data sheets of aircraft, engines and other systems and subsystems' components.

8.7. All operators and ground handlers in Pakistan are to ensure that all entries are recorded only in the applicable documents of aircraft, engines and other systems and subsystems' components. No papers / documents other than the applicable ones or as secondary to the original ones (for rough notes) are to be maintained in any office or maintenance work centre.

8.8. CAA Pakistan is to study and review the instructions issued for conduct of recurrent / refresher emergency training on aircraft instead of simulator between two annual simulator checks to bring it in line with ICAO Annex-6 guidelines and CAA Pakistan (applicable ANOs) requirements.

8.9. CAA Pakistan is to devise mechanism for monitoring and correlation of previous and current simulator training performance for maintaining safety oversight of flight crew.

8.10. CAA Pakistan is to ensure strict conformance and implementation of all above safety recommendations by all the operators and ground handlers in Pakistan.