FINAL REPORT

ACCIDENT OF M/S. AIRCRAFT SALES AND SERVICES BEECHCRAFT-1900D AIRCRAFT, REG. NO. AP-BII ON 18TH MARCH, 2016 AT JIAP, KARACHI

Synopsis

The accident was reported to Safety Investigation Board (SIB), Pakistan by the operator through Mandatory Occurrence Report. The accident was notified in accordance with ICAO Annex-13. Aviation Division, Government of Pakistan issued memorandum vide letter No. HQCAA/1901/376/SIB/211 dated 31st March, 2016 for inquiring into circumstances under which the accident took place and to recommend suitable measures to prevent a recurrence.

The aircraft made a belly landing just after takeoff on right side of the runway centerline, due to suspected one engine failure. After touchdown the aircraft went off the runway towards right side and then came back on the runway before coming to a final stop. The aircraft belly, both propellers and lower portion of the engines sustained damage. All occupants of the aircraft remained safe except Captain and 01 passenger who received serious injuries were shifted to the hospital.

1. FACTUAL INFORMATION

1.1 **History of the Flight**. The Aircraft Sales and Services (Private) Limited (ASSL) aircraft Beechcraft-1900D Registration No. AP-BII was scheduled for a chartered flight on 18th March, 2016 from Karachi to Sui. Just after takeoff from runway 25L at 0820 hrs local time, the crew observed power loss of right engine and made a gear up landing on the remaining runway on the right side of centreline. After touchdown, the aircraft went off the runway towards right side and then came back on the runway before coming to a final stop 1050ft short from the end of runway.

1.2 **Injuries to Persons.** The Captain and 01 passenger received serious injuries due to hard impact of the aircraft with ground. All other passengers and technician remained unhurt. The details of injured persons as a result of this accident are tabulated below:

Injuries	Crew	Passengers	Others	Total
Fatal	-	-	-	-
Serious	01	01	-	02
Minor	-	-	-	-
Total	01	01	-	02

1.3 **Damage to Aircraft**. The aircraft belly, both propellers and lower portion of the engines sustained damage.

1.4 **Other Damages**. None.

1.5 **Personnel information.** The cockpit crew included one captain and one first officer (FO). Their details are mentioned below:

Captain

- Date of Birth : 10th September, 1958
- ATPL No. : 1188 (A)
- Medical Validity Date : 31st March, 2016
- Total Flying Experience : 2885:20 hrs
- Total Hrs on Beechcraft 1900 : 717:10 hrs

First Officer (A qualified rated Captain on Beechcraft 1900D)

- Date of Birth : 10th May, 1967
- ATPL No. : 1576 (A)
- Medical Validity Date : 30th June, 2016
- Total Flying Experience : 3614:40 hrs
- Total Hrs on Beechcraft 1900 : 245:00 hrs

1.6 **Aircraft and Engines Information**.

Aircraft Information	
Aircraft Registration (Certificate # 773/1)	AP-BII
Aircraft Make and Model	Beechcraft 1900D
Aircraft Manufacture Serial No. (MSN)	UE-45
Aircraft Manufacturing Year	1993
Aircraft C of A (Charter, Aerial Work)	Valid till 22nd January, 2017
Aircraft Time Since New (TSN) / Cycles Since New (CSN)	19574.9 Hours / 30623 Cycles
Aircraft Phase Inspection	Performed on 19519.9 TSN on 30th Jan, 2016, Next due 19719.6 TSN on 30th May, 2016

Power Plant (PT6A-67D) Information			
Power Plant Part	**Serial No.**	**Time Since New (Hours/ Cycles)**	**Time Since Overhaul (Hours/ Cycles)**
Gas Generator No. 1 (Left)	PCE-114264	25292.3 / 38028	2910.1/4762
Power Section No. 1	PS-114022	31862.4/45332	5310.5/ 7778
Propeller No. 1	HJ-1846	29832.3/-	520.5/-
Gas Generator No. 2 (Right)	PCE-114014	20708/33436	4612.6/9465
Power Section No. 2	PS-114011	21719/36090	5516/9199
Propeller No. 2	HJ-1398	29542.1/-	520.5/-

1.6.1 The No. 2 Engine Propeller Governor Pt No. 8210-410 Serial Number 2490719 was overhauled by International Governor Services, Broomfield, USA in July, 2008. The unit has flown 2526.4 hours against its overhaul life of 6000 hours. The applicable aircraft documents did not reveal any record showing the unit was ever removed / serviced / repaired in the field after the last overhaul in 2008.

1.6.2 The aircraft was maintained in accordance with approved maintenance schedule and there was no previous reported defect which could contribute towards the occurrence. No inspection or life component of the aircraft and power plant was overdue. The last six months documented defects were scrutinized and there was no reported defect of propeller feathering malfunction.

1.7 **Meteorological Information.** On 18th March, 2016 the weather prevailing at Jinnah International Airport (JIAP), Karachi is appended below:

Outlook	Visibility	Clouds	Wind	Temp	QNH
Fair	7 Km	Few 020 Few 100	250^0 08Kt	26^0 C	1010

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

1.9 **Communications.** Beechcraft 1900D aircraft was equipped with two VHF sets for radio contact with all concerned / relevant agencies during the conduct of flight.

1.10 **Aerodrome Information**. 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 42000LBS (19TON)	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	870x150	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 (MEH) 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

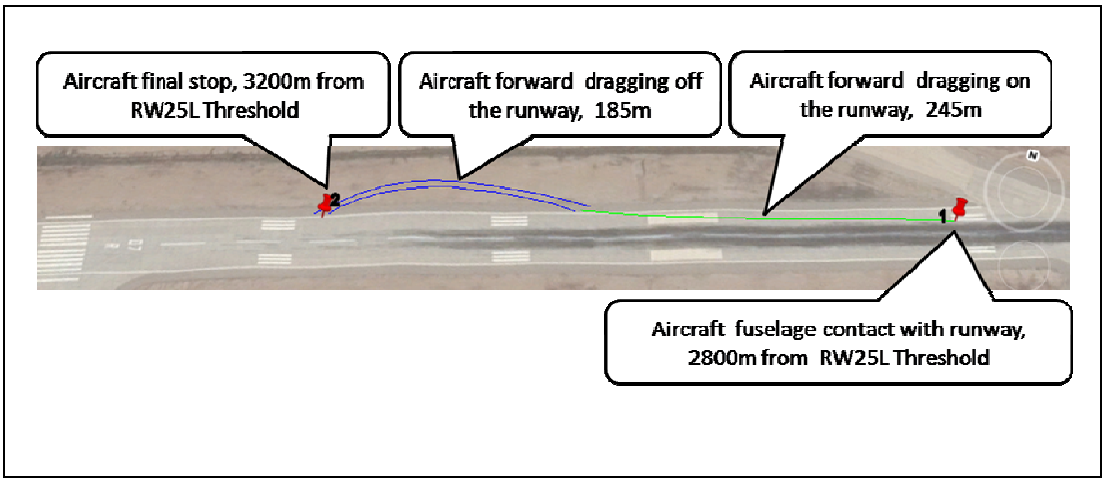
Service designation	Call sign	Frequency	Hours of operation	Remarks
TWR	KARACHI Tower	118.3 MHZ	H24	Primary
		118.8 MHZ	H24	Secondary
		121.5 MHZ	H24	Emergency
APRON	Karachi Ground	121.6 MHZ	H24	Primary
		118.4 MHZ	H24	Secondary
		121.8 MHZ	H24	Vehicle
		123.0 MHZ	H24	
ATIS	ATIS	126.7 MHZ	H24	
APP	Karachi 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

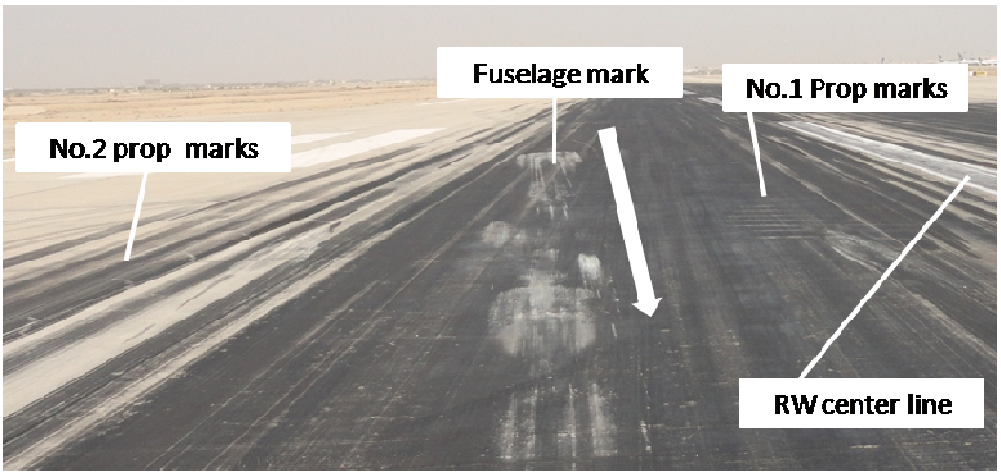
OPKC AD 2.19 RADIO NAVIGATION AND LANDING AIDS

Type of atd. 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 0671449.89E	-	3.9 NM FM THR
MM		75 MHZ	H24	245453.00N 0671107.98E	-	0.57 NM FM THR
GP/TDME 25L	Dots/Dashes	333.2 MHZ CH34X	H24	245432.35N 0671013.96E	-	2.98° RDH 72 FT
LLZ25L ILS CAT1 (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

1.11 **Flight Recorders**. The Flight Data Recorder (FDR) Part No. S703-1000-00 Serial No. 01124 and Cockpit Voice Recorder (CVR) Part No. 93-A100-83 Serial No. 59113 remained intact. Data from the units was retrieved and used for the purpose of investigation. The NTSB FDR report and CVR recording were effectively utilized for the investigation. The NTSB FDR report concluded that pitch attitude parameter ranges were invalid; however, unverified parameter was included in the report. Pressure Altitude contained out of bound spikes during ground operation; however, the parameters were seemingly valid during operational segments. Propeller Reverse parameter could not be validated by NTSB.

1.12 **Wreckage and Impact Information**. The aircraft remained intact after the incident. Both propellers, belly of the aircraft and lower part of the engine cowlings sustained damage due to gear up landing contact with the runway. The aircraft path on runway and other relevant pictures are shown below:





Initial runway marks

No. 2 Prop marks: Distance between marks 65 to 109 inches.

No. 1 Prop Marks : Distance between marks 19 to 22 inches

Aircraft right side- Prop in feather

Aircraft left side

Aircraft Belly : Looking forward

Aircraft Belly : Looking rearward

1.13 **Medical and Pathological Information**. Due to the hard impact of the aircraft with ground, the captain and one passenger received serious injuries. Both seriously injured persons' backbones were fractured necessitating prolonged hospitalization and lengthy treatment involving surgical procedures. Immediately after the accident, the Cockpit Crew (Captain and First Officer), were taken to hospital and necessary medical evaluations were conducted. The results of pertinent medical evaluation were within normal limits.

1.14 **Fire**. There was no evidence of pre-impact inflight or post impact fire. It was neither observed by the captain nor the FO. Moreover, the investigation team members also did not observe it at the site.

1.15 **Survival Aspects**. Not Applicable.

1.16 **Test and Research**. Post occurrence tear down examination of the right engine was conducted by Vector Aerospace Australia. Right Engine Prop Governor examination was conducted by Woodward Inc, USA. Analysis of FDR data was also conducted by Pratt & Whitney Canada.

1.17 **Organisational and Management Information**. Not applicable.

1.18 **Additional Information.**

1.18.1 **ATC Tape Extracts.** ATC Tower Tape Extracts were retrieved and utilised during the course of investigation for detailed analysis.

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

1.19 **Use of Effective 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. ANALYSIS

2.1 Operational Analysis

2.1.1 The mishap flight was a chartered flight to convey personnel of Pakistan Petroleum Limited from Karachi to Sui on Friday, 18th March, 2016. The flight was planned to take off at 0300 UTC and flight crew was informed a day in advance about it.

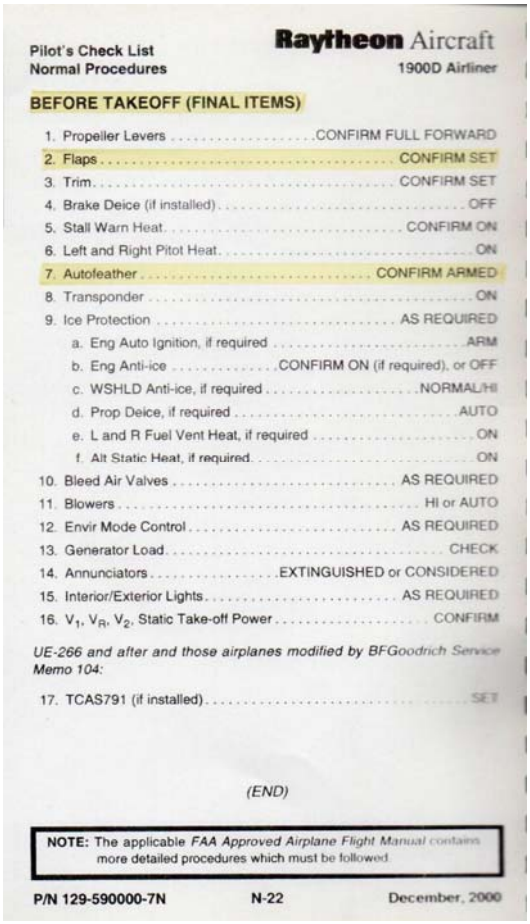
2.1.2 On the day of occurrence all 18 passengers came well in time to board the aircraft. Pre flight formalities were completed at M/s ASSL parking area at JIAP, Karachi. The calculated weight of 18 passengers and 01 technician in the cabin was 1429 Kgs. The baggage accompanied by the passengers weighed 227 Kgs. The total weight of the onboard load was within maximum takeoff weight limits. The calculated V_1 and V_2 speeds were 104 Kts and 106 Kts respectively, whereas the stalling speed was 84 Kts.

2.1.3 Captain was Pilot Flying (PF) and the FO was Pilot Monitoring (PM) for this sector. However, the FO was a qualified Captain on Beechcraft 1900D aircraft.

2.1.4 Before flight, aircrew obtained latest weather of departure aerodrome, enroute, destination airfield and alternate aerodrome. The weather at all of these places was within limits. They also conducted a very short informal pre flight brief as mentioned by captain in his statement**.**

2.1.5 The boarding of aircraft started at 0250 UTC and aircraft taxied out at 0305 UTC. The aircraft start up and taxiing was normal.

2.1.6 Flight was given runway 25L for takeoff. The aircraft lined up on the runway and after obtaining takeoff clearance completed pre take off checks during which, Flaps were rechecked "SET" and Autofeather "Armed". No abnormality was detected or observed till this place.



Pilot's Check List
Normal Procedures

Raytheon Aircraft
1900D Airliner

BEFORE TAKEOFF (FINAL ITEMS)

1. Propeller Levers	CONFIRM FULL FORWARD
2. Flaps	CONFIRM SET
3. Trim	CONFIRM SET
4. Brake Deice (if installed)	OFF
5. Stall Warn Heat	CONFIRM ON
6. Left and Right Pitot Heat	ON
7. Autofeather	CONFIRM ARMED
8. Transponder	ON
9. Ice Protection	AS REQUIRED
a. Eng Auto Ignition, if required	ARM
b. Eng Anti-ice	CONFIRM ON (if required), or OFF
c. WSHLD Anti-ice, if required	NORMAL/HI
d. Prop Deice, if required	AUTO
e. L and R Fuel Vent Heat, if required	ON
f. Alt Static Heat, if required	ON
10. Bleed Air Valves	AS REQUIRED
11. Blowers	HI or AUTO
12. Envir Mode Control	AS REQUIRED
13. Generator Load	CHECK
14. Annunciators	EXTINGUISHED or CONSIDERED
15. Interior/Exterior Lights	AS REQUIRED
16. V_1, V_R, V_2, Static Take-off Power	CONFIRM

UE-266 and after and those airplanes modified by BFGoodrich Service Memo 104:

17. TCAS791 (if installed)	SET

(END)

NOTE: The applicable *FAA Approved Airplane Flight Manual* contains more detailed procedures which must be followed.

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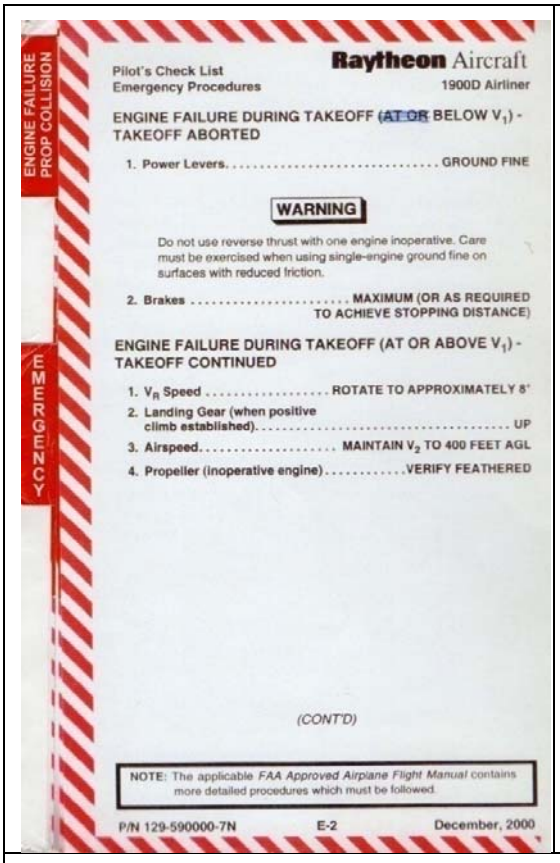
2.1.7 At 0323:06 UTC, take off thrust was applied very gradually by PF and the aircraft started to roll. The crew paused advancing power levers at approx 1400 ft/lbs Torque 10 seconds after beginning of advancing the power.

2.1.8 At 0323:31 UTC, the PM announced "Max Power Set" when propeller rpm reached 1691 and 1699 respectively for No. 1 and No. 2 Engine. The indicated torque value at this time was 3401 ft/lbs and 3211 ft/lbs for No. 1 and No. 2 Engine respectively. The aircraft had started takeoff roll and speed was building up. Five seconds after reaching the max power, at 0323:35 UTC the PM announced speed 80 kts. FDR data indicated that the speed cross check at this stage was correct, however an increasing trend in torque and drop in propeller rpm of No. 2 engine had set in, which was not monitored by the cockpit crew. The torque value touched 3895.95 ft/lbs followed by fluctuations while the propeller rpm continued to drop to minimum 709 rpm in next 11 seconds. Also, trend of drop in No. 1 Engine torque to 2288 ft/lbs had also started (without any significant change in rpm) which increased to 3549 at 0324:01 UTC. The aircraft was still rolling for takeoff and crossing 95 kts of speed. When the No. 2 Engine propeller rpm started to drop, the PF announced aircraft drifting towards right. The PM replied as "continue...continue".

2.1.9 At 0323:44 UTC when the aircraft was crossing 96.75 kts of speed during takeoff roll, the PM asked PF to turn left and apply left rudder. From this moment onwards the aircraft speed started to decrease gradually for next six seconds i.e. till 0323:50 UTC and reached 94.82 kts.

2.1.10 The cockpit crew could not realize at this stage that there was a problem with both engines and they were still below V_1 which, as per pre flight calculation / planning, was 104 kts. The applicable procedure given in Pilot Checklist (B1900 Emergency Procedures) for 'Engine Failure During Takeoff' at or below V_1 was not followed which mentions to abort takeoff. Their decision to continue take off with one engine not providing sufficient power at aircraft speed below V_1 was not correct.



ENGINE FAILURE PROP COLLISION

EMERGENCY

Pilot's Check List
Emergency Procedures

Raytheon Aircraft
1900D Airliner

ENGINE FAILURE DURING TAKEOFF (AT OR BELOW V_1) - TAKEOFF ABORTED

1. Power Levers ..... GROUND FINE

WARNING

Do not use reverse thrust with one engine inoperative. Care must be exercised when using single-engine ground fine on surfaces with reduced friction.

2. Brakes ..... MAXIMUM (OR AS REQUIRED TO ACHIEVE STOPPING DISTANCE)

ENGINE FAILURE DURING TAKEOFF (AT OR ABOVE V_1) - TAKEOFF CONTINUED

1. V_R Speed ..... ROTATE TO APPROXIMATELY 8°
2. Landing Gear (when positive climb established) ..... UP
3. Airspeed ..... MAINTAIN V_2 TO 400 FEET AGL
4. Propeller (inoperative engine) ..... VERIFY FEATHERED

(CONT'D)

NOTE: The applicable *FAA Approved Airplane Flight Manual* contains more detailed procedures which must be followed.

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Raytheon Aircraft
1900D Airliner

Pilot's Check List
Emergency Procedures

WARNING

Do not retard the failed engine power lever until the autofeather system has completely stopped propeller rotation.

5. Airspeed (at 400 feet AGL minimum) ..... ACCELERATE TO V_{ENR} CLIMB SPEED
6. Flaps ..... UP
7. Power ..... REDUCE TO MCP
8. Bleed Air Valve (operative engine) ..... ENVIR OFF
9. Climb To 1500 feet AGL and Accomplish the Following Cleanup Procedures (inoperative engine):
   a. Condition Lever ..... FUEL CUTOFF
   b. Propeller Lever ..... FEATHER
   c. Firewall Fuel Valve ..... PULL CLOSED
   d. Eng Auto Ignition ..... OFF
   e. Autofeather Switch ..... OFF
   f. Prop Sync ..... OFF
   g. Generator ..... OFF
10. Electrical Load ..... ENSURE WITHIN LIMITS

(END)

NOTE: The applicable *FAA Approved Airplane Flight Manual* contains more detailed procedures which must be followed.

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2.1.11 At 0323:49 UTC the First Officer asked captain to increase the power of left engine. By this time the drop in No. 1 engine torque had been arrested. It appears that the First Officer had a glance on torque indicator and asked Captain to increase power. Whereas, earlier suggestion to 'turn left' by 'applying left rudder' and later to increase left engine power for controlling direction, appear to be incongruous.

2.1.12 At 0323:53 UTC the Captain glanced at the engine instruments and wanted to express his concern about loss of power. The recorded speed in FDR at this time was 98.33 kts. The captain had yet not expressed his concern when FO announced 'V_1...rotate' at 0323:55 UTC and 101.4 kts of speed.

2.1.13 At 0324:02 UTC the aircraft got airborne at following parameters:

	Heading (Deg)	Airspeed (Kts)	Prop RPM (Left)	Prop RPM (Right)	Torque (Left)	Torque (Right)
Actual	271.43	102.62	1692	800	3540.52	3422.49

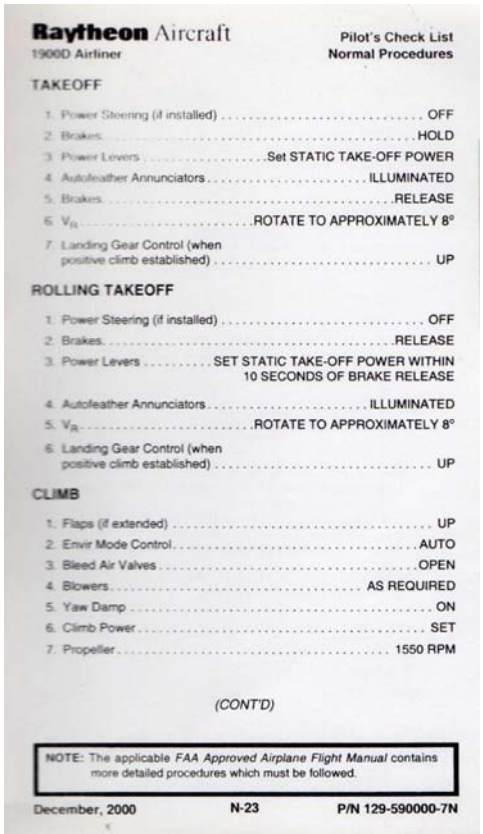
2.1.14 After getting airborne, the speed decreased to 101 kts and aircraft continued to drift towards right. In order to control the dropping speed and direction loss, the First Officer took over the controls.

2.1.15 At 0324:08 UTC when decreasing speed had reached 98.64 kts the First Officer asked Captain to raise the landing gears in order to reduce drag and gain speed. At this time, the FDR recorded that the landing gears were raised within next 2 seconds when No. 2 engine torque was near the maximum value (3382 ft/lbs) but No. 1 engine torque was still fluctuating and crossing through 3146 ft/lbs (corresponding engine rpms were 1692 and 798 for No. 1 and No. 2 engines respectively). The aircraft had climbed to approximately 39 feet above ground and the Captain asked First Officer to lower the nose in order to arrest the speed.

2.1.16 At 0324:15 UTC the speed got arrested with a very gradual increase to 100.8 kts in next four seconds.

2.1.17 At 0324:19 UTC when the aircraft was at 100.8 kts and approximately 41 feet above ground level, the First Officer asked Captain to raise the flaps. FDR recorded raising of flaps at this time.

2.1.18 The landing gears and flaps were raised without ensuring (no call out present in CVR) positive climb established which is contrary to Pilot Checklist "Takeoff Procedure" (page N-23).



Raytheon Aircraft
1900D Airliner

Pilot's Check List
Normal Procedures

TAKEOFF

1. Power Steering (if installed) ..... OFF
2. Brakes ..... HOLD
3. Power Levers ..... Set STATIC TAKE-OFF POWER
4. Autofeather Annunciators ..... ILLUMINATED
5. Brakes ..... RELEASE
6. V_R ..... ROTATE TO APPROXIMATELY 8°
7. Landing Gear Control (when positive climb established) ..... UP

ROLLING TAKEOFF

1. Power Steering (if installed) ..... OFF
2. Brakes ..... RELEASE
3. Power Levers ..... SET STATIC TAKE-OFF POWER WITHIN 10 SECONDS OF BRAKE RELEASE
4. Autofeather Annunciators ..... ILLUMINATED
5. V_R ..... ROTATE TO APPROXIMATELY 8°
6. Landing Gear Control (when positive climb established) ..... UP

CLIMB

1. Flaps (if extended) ..... UP
2. Envir Mode Control ..... AUTO
3. Bleed Air Valves ..... OPEN
4. Blowers ..... AS REQUIRED
5. Yaw Damp ..... ON
6. Climb Power ..... SET
7. Propeller ..... 1550 RPM

(CONT'D)

NOTE: The applicable *FAA Approved Airplane Flight Manual* contains more detailed procedures which must be followed.

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2.1.19 As soon as the flaps were raised the aircraft suddenly started losing altitude and an increase in speed was recorded. The corresponding engine parameters were:

RPM (No. 1 Engine)	RPM (No. 2 Engine)	Torque (No. 1 Engine)	Torque (No. 2 Engine)
1692	933	3409	4699

2.1.20 At 0324:23 UTC, while aircraft was losing altitude, the maximum speed 105.29 kts was recorded and aircraft was passing through 10 feet above ground level. Also, at this time the First Officer asked Captain to reduce the left engine power. The corresponding engine parameters were:

RPM (No. 1 Engine)	RPM (No. 2 Engine)	Torque (No. 1 Engine)	Torque (No. 2 Engine)
1692	829	2425	3571

2.1.21 According to First Officer's statement, at this time he observed the aircraft not climbing (losing height) and sluggish controls response (due low airspeed) and there was no option other than to make the aircraft land on the remaining runway. So, he attempted to land the aircraft and in that bargain hit the runway surface hard approximately 9000 ft from runway 25L beginning in right half. The aircraft continued to drag on the runway while continuously drifting right for 800 ft before departing towards right side on fair weather strip.

2.1.22 After travelling approximately 600 ft on fair weather strip, the aircraft veered towards left and came to final stop on the runway 1050 ft short from end of runway.

2.1.23 As the Captain was seriously injured, the First Officer brought Fuel Control Levers, Propeller Levers and Power Levers back; put Battery and Generators Off after the aircraft came to halt. An immediate evacuation of the passengers was carried out.

2.2 Technical Analysis

2.2.1 The post incident inspection revealed that No. 2 engine propeller blades broke approximately from mid point along the blade length whereas the No. 1 engine propeller blades broke from the root section. The consecutive runway marks of propeller blades of No. 2 engine were separated more as compared to No. 1 engine; indicating that that No. 2 engine was rotating at relatively lower RPM than No. 1 engine.

2.2.2 Post incident visual inspection of No. 2 engine propeller blades indicated that blades were at feather position.

2.2.3 The fuel samples from aircraft and oil samples from both engines were drawn and submitted to Perac Research and Development Foundation (PRD) Karachi for analysis. The PRD reports did not reveal any abnormality with fuel and oil of the mishap aircraft.

2.2.4 Pitot static lines got damaged after the crash landing and therefore leakage test could not be performed on the aircraft. The airspeed indicators (ASI) were checked for correct indication at PIA shop test bench. The test results showed that both ASIs were under reading on the average by 3 knots around take airspeeds. The ASI calibration check precluded the possibility of premature takeoff because of instrument error (at lower than indicated speeds).

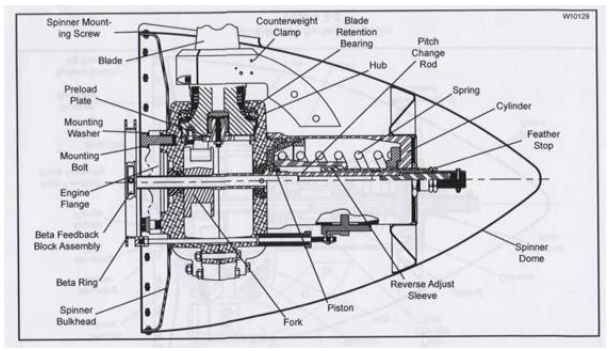
2.2.5 The NTSB FDR report and FDR tabular data file was shared with Pratt & Whitney (PWC) Canada. The PWC report concluded that :-

2.2.5.1 FDR data was characteristic of an **un-commanded propeller feathering event of No. 2 engine** as shown by the sharp propeller speed reduction being concurrent with the torque increase.

2.2.5.2 The engine turbo-machine and engine fuel governing system was not a likely contributor to the event, as shown by the high torque value reached.

2.3 **Description of the Propeller Pitch Change Mechanism**. The aircraft is equipped with PT6A-67D engines and Hartzell HC-E4A-3J four bladed constant speed, feathering and reversing propellers. The following paragraphs summarize the system as described in Hartzell Propeller Owner Manual.

2.3.1 While the propeller is operating the four forces are constantly present. The Spring Force and Counter Weight Forces, which attempt to rotate the blades towards higher blade angle (coarse pitch). The Centrifugal Twisting Moment of Blade, which attempts to rotate the blade towards lower blade angle (fine pitch). The Aerodynamic Twisting Moment of Blade, which is relatively small in magnitude and can attempt to increase or decrease blade angle. The summation of these constantly present forces is towards the higher blade angle (coarse pitch) and is opposed by variable force of oil pressure.



Propeller pitch change mechanism schematic

2.3.2 The oil pressure attempts to move the pitch towards lower blade angle (fine pitch). The pressurized oil is supplied by the internal pump of propeller Governor. The Governor uses its speed sensing mechanism to sense the desired selected RPM and directs oil to the propeller pitch change mechanism or drains it out to keep it at desired RPM (according to Propeller Control position) with varying power lever position and aircraft flight conditions.

2.3.3 If governor oil pressure is lost during operation, the propeller will increase pitch and feather. Feathering occurs because the summation of the propeller forces causes the oil to drain out of the propeller until the feather stop position is reached.

2.3.4 Normal in-flight feathering is accomplished when the pilot retards the Propeller Control lever past the Feather detent. This action operates Feather Dump Valve through mechanical linkages and drains oil from the propeller and returns it to the engine sump. The action of spring and counter weights moves the blades to feather position.

2.3.5 Control of the propeller blade angle in Reverse is accomplished by the Beta Valve. In Reverse mode of operation, the Governor operates in an under speed condition to act strictly as a source of pressurized oil, without attempting to control RPM. The cockpit control causes Beta Valve to supply oil from the Governor pump to the propeller. The controls and linkages provide blade angle feedback to the Beta Valve which is in turn maintains the desired reverse pitch position by regulating oil flow.

2.3.6 Study of the Propeller Pitch Change Mechanism showed that **uncommanded feathering** may take place because of Loss of oil pressure, Auto-feather system malfunction or Malfunction of propeller governor.

2.4 The No. 2 engine was examined by Vector Aerospace Australia. The examination report concluded that there was no anomaly with the engine which could contribute to the experienced un-commanded auto-feather. The over torque sustained was within limits and no maintenance action was required as per Maintenance Manual. No apparent damage to the engine was found as consequent to the crash landing.

2.5 The Primary Propeller Governor and Overspeed Governor of No. 2 engine were examined by Woodward Inc, USA. This examination report ascertained that there was no anomaly found which could cause the reported event of un-commanded auto feathering. Although few anomalies were observed at the IDLE settings, however, same can't cause the auto feathering as it had occurred at Max Power Settings of Take Off.

2.6 Components of Auto Feathering System comprising of two switches (Pressure Switch High and Pressure Switch Low) were subjected to Shop check at M/s PIAC Component Overhaul Shop and found with no discrepancy or anomaly which could contribute towards the reported incidence.

2.7 The operator was operating the aircraft since November, 2008. The authorized Release Certificate FAA form 8130-3 showed that Propeller Governor Part No. 8210-410 Serial No. 2490719 was overhauled and recalibrated in accordance with Woodward Manual 61-20-35 Rev (10/98) and Woodward SB 33531 was complied with. The Overhaul was performed by International Governor Services, Broomfield, USA on 14th July, 2008.

2.8 The Woodward finding that Propeller Governor Serial No. 2490719 was serviced by a facility other than Woodward and its several operating parameters were found away from the Woodward specifications indicated that the last servicing of the governor was improper but had no contribution towards the reported event of auto feathering.

2.9 The investigation therefore concluded that some internal malfunction of the Governor of No. 2 engine propeller may have caused uncommanded auto feather. However, exact cause of the occurrence could not be determined.

3. CONCLUSION

3.1 Technical Findings

3.1.1 The post incident inspection revealed that No. 2 engine was rotating at relatively lower RPM than No. 1 engine.

3.1.2 Post incident visual inspection of No. 2 engine propeller blades indicated that blades were at feather position.

3.1.3 The fuel samples from aircraft and oil samples from both engines did not reveal any abnormality with fuel and oil of the mishap aircraft.

3.1.4 Pitot static lines got damaged after the crash landing and therefore leakage test could not be performed on the aircraft.

3.1.5 The airspeed indicators (ASI) were checked for calibration which precluded the possibility of premature takeoff because of instrument error being at lower than indicated speeds.

3.1.6 The NTSB FDR report concluded that the relevant parameters were seemingly valid during operational segments.

3.1.7 The NTSB FDR report and FDR tabular data file were shared with Pratt & Whitney Canada (PWC).

3.1.8 The PWC report concluded that FDR data was characteristic of an un-commanded propeller feathering event of No. 2 engine.

3.1.9 The suspected No. 2 engine examined by Vector Aerospace Australia concluded that there was no anomaly with the engine which could contribute to the experienced un-commanded auto-feather.

3.1.10 The Primary Propeller Governor and Overspeed Governor of No. 2 engine were examined by Woodward Inc. USA, however could not find any anomaly which could cause the reported event of un-commanded auto feathering. Although few anomalies were observed at the IDLE settings, however, same can't cause the auto feathering as it has occurred at Max Power settings for Take Off.

3.1.11 Components of Auto Feathering System were subjected to Shop check at M/s PIAC Component Overhaul Shop and found with no discrepancy or anomaly which could contribute towards the reported incidence.

3.1.12 The operator was operating this aircraft since November, 2008.

3.1.13 The Propeller Governor (Part No. 8210-410 Serial No. 2490719) was overhauled and recalibrated in accordance with Woodward Manual 61-20-35 Rev (10/98) and Woodward SB 33531 by International Governor Services, Broomfield, USA on 14th July, 2008. The unit has flown 2526.4 hours (42%) against its overhaul life of 6000 hours

3.2 Operational Findings

3.2.1 The cockpit crew had valid licenses and medical fitness certificates; also they were authorized to undertake the flight.

3.2.2 The operator had provided sufficient rest to the cockpit crew before undertaking the flight.

3.2.3 The cockpit crew was trained on Beechcraft 1900D aircraft and operationally fit to fly the aircraft on mishap day.

3.2.4 Before flight, aircrew obtained latest weather of departure aerodrome, enroute, destination airfield and alternate aerodrome. The weather at all of these places was within limits. They also conducted a very short informal pre flight brief as mentioned by captain in his statement.

3.2.5 The mishap flight was a chartered flight to convey personnel of Pakistan Petroleum Limited from Karachi to Sui on Friday, 18th March, 2016. The flight was planned to take off at 0300 UTC. The cockpit crew had been informed on 17th March, 2017 and they had sufficient time for flight planning and rest before undertaking flight.

3.2.6 The aircraft was boarded with 18 passengers and 01 technician in the cabin. Pre flight formalities were completed at M/s ASSL parking area at JIAP, Karachi. The calculated weight of 18 passengers was 1429 Kgs. The baggage accompanied by the passengers weighed 227 Kgs.

3.2.7 Captain was Pilot Flying (PF) and the First Officer was Pilot Monitoring (PM) for this sector. First Officer was a qualified Captain on Beechcraft 1900D aircraft.

3.2.8 The aircraft taxied out at 0305 UTC. The aircraft start up and taxiing to departure runway was normal.

3.2.9 Flight was given runway 25L for takeoff. The aircraft lined up on the runway and after obtaining takeoff clearance completed pre take off checks during which Flaps were rechecked “SET” and Autofeather “Armed”. No abnormality was detected or observed till this place.

3.2.10 At 0323:06 UTC, take off thrust was applied very gradually by PF and the aircraft started to roll. The crew paused advancing at approx 1400 ft/lbs Torque 10 seconds after beginning of advancing the Power.

3.2.11 At 0323:31 UTC, the PM announced “Max Power Set” when propeller rpm reached 1691 and 1699 respectively for No. 1 and No. 2 Engine respectively. The indicated torque value at this time was 3401 ft/lbs and 3211 ft/lbs for No. 1 and No. 2 Engine respectively. The aircraft had started takeoff roll and speed started to build up.

3.2.12 Five seconds after reaching the max power, at 0323:35 UTC the pilot announced speed 80 kts. FDR data indicated that the speed cross check at this stage was correct, however an increasing trend in torque and drop in propeller rpm of No. 2 engine had started which was not monitored by the cockpit crew. The torque value touched 3895.95 ft/lbs followed by fluctuations while the propeller rpm continued to drop to min.709 rpm in next 11 seconds.

3.2.13 A similar trend of drop in No. 1 Engine torque to 2288 ft/lbs had also started without any significant change in rpm before rebuilding to 3549 ft/lbs at 0324:01. The aircraft was still rolling for takeoff and crossing 95 kts of speed. When the propeller rpm started to drop the PF announced aircraft drifting towards right. The PM replied as “continue...continue”.

3.2.14 At 0323:44 UTC when the aircraft was crossing 96.75 kts of speed, the PM asked PF to turn left and apply left rudder. From this moment onwards the aircraft speed started to decrease gradually for next six seconds i.e. till 0323:50 UTC and reached 94.82 kts.

3.2.15 The cockpit crew could not realize at this stage that there was a problem with both engines and they were still below V_1 which, as per pre flight calculation / planning, was 104 kts. The applicable procedure given in Pilot Checklist (B1900 Emergency Procedures) for ‘Engine Failure During Takeoff’ at or below V_1 was not followed which mentions to abort takeoff. Their decision to continue take off with one engine not providing sufficient power at aircraft speed below V_1 was not correct.

3.2.16 At 0323:49 UTC the First Officer asked captain to increase the power of left engine. By this time the drop in No. 1 engine torque had been arrested. It appears that the First Officer had a glance on torque indicator and asked Captain to increase power. Whereas, earlier suggestion to ‘turn left’ by ‘applying left rudder’ and later to increase left engine power for controlling direction, appear to be incongruous.

3.2.17 At 0323:53 UTC the Captain glanced at the engine instruments and wanted to express his concern about loss of power. The recorded speed in FDR at this time was 98.33 kts. The captain had yet not expressed his concern when first officer announced 'V_1...rotate' at 101.4 kts of speed.

3.2.18 At 0324:02 UTC the aircraft got airborne at following parameters:

	Heading (Deg)	Airspeed (Kts)	Prop RPM (Left)	Prop RPM (Right)	Torque (Left)	Torque (Right)
Actual	271.43	102.62	1692	800	3540.52	3422.49

3.2.19 After getting airborne, the speed decreased to 101 kts and aircraft continued to drift towards right. In order to control the dropping speed and direction loss, the First Officer took over the controls.

3.2.20 At 0324:08 UTC when decreasing speed had reached 98.64 kts the First Officer asked Captain to raise the landing gears in order to reduce drag and gain speed.

3.2.21 Landing gears were raised within next 2 seconds when No. 2 engine torque was near the maximum value (3382 ft/lbs) but No. 1 engine torque was still fluctuating and crossing through 3146 ft/lbs (corresponding engine rpms were 1692 and 798 for No. 1 and No. 2 engines respectively). The aircraft had climbed to approximately 39 feet above ground and the Captain asked First Officer to lower the nose in order to arrest the speed.

3.2.22 As the nose was lowered, the speed got arrested and showed very gradual increase to 100.8 kts in next four seconds.

3.2.23 At 0324:19 UTC when the aircraft was at 100.8 kts and approximately 41 feet above ground level, the First Officer asked Captain to raise the flaps. FDR recorded raising of flaps at this time.

3.2.24 The landing gears and flaps were raised without ensuring (no call out present in CVR) positive climb established which is contrary to Pilot Checklist "Takeoff Procedure" (page N-23).

3.2.25 As soon as the flaps were raised the aircraft suddenly started losing altitude and an increase in speed was recorded. The corresponding engine parameters were:

RPM (No. 1 Engine)	**RPM (No. 2 Engine)**	**Torque (No. 1 Engine)**	**Torque (No. 2 Engine)**
1692	933	3409	4699

3.2.26 While aircraft was losing altitude, the maximum speed 105.29 kts was recorded when aircraft was passing through 10 feet above ground level. Also, at this time the First Officer asked Captain to reduce the left engine power. The corresponding engine parameters were:

RPM (No. 1 Engine)	**RPM (No. 2 Engine)**	**Torque (No. 1 Engine)**	**Torque (No. 2 Engine)**
1692	829	2425	3571

3.2.27 According to First Officer's statement, at this time he observed the aircraft not climbing (losing height) and sluggish controls response (due low airspeed) and there was no option other than to make the aircraft land on the remaining runway. So, he attempted to land the aircraft and in that bargain hit the runway surface hard approximately 9000 ft from runway 25L in right half. The aircraft continued to drag on the runway while continuously drifting right for 800 ft before departing towards right side on fair weather strip.

3.2.28 After travelling approximately 600 ft on fair weather strip, the aircraft veered towards left and came to final stop on the runway 1050 ft short from end of runway.

3.2.29 As the Captain was seriously injured, the First Officer brought Fuel Control Levers, Propeller Levers and Power Levers back; put Battery and Generators Off after the aircraft came to halt. An immediate evacuation of the passengers was carried out. All passengers remained safe during evacuation.

3.3 Cause of Occurrence

3.3.1 The investigation therefore, concludes that:

3.3.1.1 Some internal malfunction of the Propeller Governor Part No. 8210-410 Serial No. 2490719 was the cause of experienced uncommanded auto feather. However, exact cause of the occurrence could not be determined.

3.3.1.2 Continuing take off below V_1 speed (104kts) after encountering engine malfunction and after takeoff raising flaps below recommended height (400ft AGL) lead to decrease in lift and unsustainability of flight.

4. SAFETY RECOMMENDATIONS

4.1 International Governor Services; Broomfield, USA may like to identify and remove the inadequacies at their overhauling facility as highlighted by Woodward Inc. in their strip examination report on the Governor of misshaped propeller.

4.2 Flight Standards Directorate, HQCAA may issue necessary instructions to all General Aviation Aircraft Operators to discuss takeoff / landing critical emergency procedures during pre flight briefing.

4.3 All operators to advise their aircrew to follow OEM recommended emergency procedures religiously during critical phases of flight.

4.4 The involved Captain and First Officer may undergo refresher simulator training especially focusing on takeoff / landing emergencies, followed by a route check under supervision of PCAA Flight Inspector for formal clearance of routine flight operations.

4.5 The involved Captain and First Officer are to undergo CRM refresher training.