FINAL ACCIDENT INVESTIGATION REPORT ON ACCIDENT TO M/s SWAJAS AIR CHARTERS LTD., BELL 407 HELICOPTER VT- SWA ON 19-06-2011 AT LADPUR, DEHRADUN

1	Helicopter	
	Type	Bell 407
	Nationality	Indian
	Registration	VT-SWA
2	Owner	M/s Consolidated Aviation Management Corporation Limited Rearour, Aherla Cork, Ireland
3	Operator	M/s Swajas Air Charters Ltd., Chennai
4	Pilot – in –Command	CHPL Holder
	Extent of injuries	Serious
5	No. of Passengers on board	01
	Extent of Injuries	Serious
6	Last point of Departure	Jolly Grant Airport, Dehradun
7	Intended landing place	Sehestra dhara Helipad, Dehradun
8	Place of Accident	Ladpur, Dehradun Lat 030° 19 ’ 26 ” N Long 078° 04 ’ 37 ” E
9	Date & Time of Incident	19.06.2011; 0854 UTC (approx.)

(All timings in the report are in UTC)

SYNOPSIS:

M/s Swajas Air Charters Ltd., Bell 407 Helicopter VT- SWA while flying from Jolly Grant Airport, Dehradun to Sehestra dhara Helipad crashed at Ladpur, Sunderwala Jungles, Dehradun on 19-06-2011 at 0854 UTC. The Helicopter was under command of Single Pilot with One (01) passenger (Aircraft Maintenance Engineer). Both pilot and passenger received injuries in the accident. There was no pre or post impact fire.

The accident was reported to DGCA by ATC, Airports Authority of India and by M/s Swajas Air Charters Ltd, Chennai.

DGCA has ordered an inquiry & appointed Inspector of Accidents under Rule 71 of the Aircraft Rules, 1937. NTSB, USA & TSB, Canada were informed about the accident. NTSB, USA appointed Rolls- Royce as a Technical Adviser for the investigation.

The involved engine was dis-assembled at Rolls-Royce facility, USA on 13th October 2011 and it was found that the gas generator turbine and engine casing around the Turbine Stage No. 2 was found damage.

Engineering analysis indicates that probably # 8 bearing spanner nut back off due to improper dimple during installation. The locking dimple on nut was not properly engaged to the locking flat on the turbine stub shaft, allowing the nut to back off during engine operation. The forward displacement of the gas generator turbine occurred allowing the shaft to separate from the turbine disk and an overspeed burst of the 2nd stage turbine wheel occurred.

1. FACTUAL INFORMATION:

1.1 History of Flight:

M/s Swajas Air Charters Ltd., Chennai Bell 407 Helicopter VT- SWA was hired by M/s SAR Aviation Services Pvt. Ltd., New Delhi for promoting Tourism at Uttrakhand & Char Dham Yatra. The pilot for flying the helicopter was hired from M/s Deccan Charters Limited, Bangalore by M/s Swajas Air Charters Ltd, Chennai & Maintenance of helicopter was carried by M/s Swajas Air Charters Ltd, Chennai. The helicopter was operating at Dehradun from 08-05-2011.

On 19-06-2011, helicopter was scheduled to operate flight from Sehestra dhara Helipad – Ananda Resort - Phata - Badri- Dehradun- Sehestra dhara Helipad. The Helicopter took off at 0210 UTC from Sehestra dhara Helipad with along with one (01) Pilot and One (01) passenger (Aircraft Maintenance Engineer). Helicopter landed at Ananda Resort & picked four (04) passengers. Helicopter landed at Jolly Grant Airport, Dehradun at 0805 UTC after completing the Char Dham Yatra & logged flight time of 2:20 hrs. All Four (04) Passengers de-boarded the helicopter at Jolly Grant Airport, Dehradun.

Helicopter again took off from Jolly Grant Airport, Dehradun at 0847 UTC to Sehestra dhara Helipad which is 12 Nm after refueling two hundred fifteen liters of fuel (215 liters) with one (01) pilot & One (01) passenger (Aircraft Maintenance Engineer) for parking. Air Traffic Control (ATC), Dehradun has cleared the helicopter to Sehestra dhara Helipad as per flight plan above 1000ft AGL. At 0848 UTC Helicopter contacted Dehradun ATC after 03 Miles out bound and gave estimate

time of Arrival (ETA) as 0854 UTC for Sehestra dhara Helipad. At 0850 UTC, again pilot contacted Dehradun ATC and gave call "4.5 miles out". At 0853 UTC, ATC tower gave three (03) calls to the helicopter but there was no reply. The VHF coverage of ATC was not available at Sehestra dhara Helipad due to hilly terrains. Later ATC received a phone call stating that a Helicopter has crashed at Ladpur, Sunderwala Jungles, Dehradun. ATC identifies the helicopter as Bell 407 Helicopter VT-SWA and informs all the concerned authorities about the accident. Search and rescue was started with the help of State Police. Pilot & Engineer received injuries and were shifted to hospital. There was no pre and post impact fire.

1.2 Injuries to Persons :

Injuries	**Crew**	**Passengers**	**Others**
Fatal	NIL	NIL	NIL
Serious	01	01	NIL
Others/ None	NIL	NIL	NIL

1.3 Damage to Helicopter: The helicopter received substantial damage.

1.4 Other Damages : Nil

1.5 Personnel Information:

1.5.1 Pilot- in- Command

The Pilot is 58 yrs old, Male, having DGCA CHPL valid up to 18-09-2011 and PIC endorsement on Alouette III, Bell 407 & Bell-206 L3/ B3 helicopters. Pilot has joined M/s Deccan Charters Ltd. in June 2006.

The Pilot has undergone Class-I Medical Assessment on 13-04-2011 at Air force Station, Palam and has met prescribed medical standards.

Pilot's last Proficiency Check was carried out on 14-04-2011, Recurrent training (Ground Training, CRM, Emergencies & Survival Training and DGR) was carried out on 05^{th} – 06^{th} February 2011.

His FRTOL No. 9695 was valid till 18-09-2011 & RTR (C) -1511/2009-COP was valid till 19-03-2012.Pilot flying experience as on 19-06-2011. The pilot had

Total Flying	6577:25 hrs.
Total Flying hours Day	6212:00 hrs.
Total Flying hours Night	365:25 hrs.
Hill flying Experience	4027:10 hrs.
Flying hours in last 01 year	343:15 hrs.
Flying hours in last 06 months	205:25 hrs.

Flying hours in last 03 months	95:15 hrs.
Flying hours in last 01 month	42:40 hrs.
Flying hours in last 07 days	18:40 hrs.
Flying hours in last 24 Hours	03:35 hrs.
Total hours on type (Bell 407)	1292:55 hrs.
Flying hours as Single Pilot on type	1164:35 hrs.

The involved pilot started flying this helicopter in this region from 03-06-2011 till the date of accident.

1.5.2 Aircraft Maintenance Engineer (AME):

The Aircraft Maintenance Engineer (AME) joined M/s Swajas Air Charters Ltd., Chennai in October 2009. He got Bell 407 endorsement on his Aircraft Maintenance Engineer license in year 2006 while working with Madhya Pradesh Government.

1.6 Helicopter Information :

1.6.1 General Description

Bell 407 is a multi-purpose utility helicopter manufactured by Bell Helicopter Textron , Mirabel, Canada. It has a four-blade rotor with composite hub, single-engine and carbon fiber composite tail boom. The helicopter has composite carbon fiber side body panels with close tolerance fit carbon fiber doors. The rotor blades and hub are made of

composite without life limits provide better performance and a more comfortable ride. The helicopter has standard seating for two crew and five cabin seats. As per flight Manual, minimum crew required to operate the helicopter is one. The helicopter landing gear is the skid type. The total fuel capacity of helicopter is 869 Lbs.

The Bell 407 helicopter is fitted with a single Rolls-Royce 250-C47B turbo shaft engine featuring a free power turbine, rated 650 Shaft Horse Power (SHP). The gas generator is composed of a single-stage, single entry centrifugal flow compressor directly coupled to a two stage gas generator turbine. The power turbine is two stage free turbine which is gas coupled to gas generator turbine. The integral reduction gearbox has multiple accessory pads and a splined output shaft which mates with the freewheel unit. The engine has a single combustion chamber with single fuel igniter. The engine incorporates a Full Authority Digital Engine Control (FADEC) system.

1.6.2 Helicopter Information

Helicopter Manufacturer	: Bell Helicopter Textron, Canada
Helicopter type	: Bell 407
Helicopter Manufacturer S. No.	: 53806
Year of Manufacturer	: June 2007
Certificate of Registration No.	: 3916/ 4
Date of Registration	: 25-02-2009
Certificate of Airworthiness No.	: 6025

Certificate of Airworthiness Valid up to	: 04-02-2014
Airworthiness Review Certificate (ARC)	: 05-02-2011
ARC Valid up to	: 04-02-2012
Noise Certificate No.	: 6025 (NC)
Engine Constructor	: Rolls –Royce, USA
Engine type	: RR 250- C 47B
Number of Engine	: 01
Engine Serial No	: CAE 848078
Aero-Mobile Station Licence No.	: A-029/01-RLO (SR)
Valid up to	: 31st December 2011

As on 19.06.2011

Helicopter hours since New	: 779:02 hrs.
Engine hours since New	: 779:02 hrs.
Hours done since last C of A	: 770:44 hrs

The Helicopter is registered in "Normal" category & Sub Division- "Passenger Helicopter".

Helicopter weighing was carried out at Planeweighs, United Kingdom on 24-10-2008. On the basis of UK Report No 11728 dated 24-10-2008, weight and balance schedule was made in March 2009 at New Delhi. As per the Helicopter Weight Schedule, Maximum Allowable All Up

Weight (AUW) is 2381 Kg and the Helicopter Empty Weight is 1368 kg. The CG (Centre of Gravity) position range between 3074.7mm and 3139.3 mm aft of datum.

The MEL in respect of Bell 407Helicopter VT-SWA was approved by O/o Director of Airworthiness, New Delhi vide No. A-7/VT-SWA/2139 dated 13-03-2009. The Maintenance program & load & Trim sheet of Helicopter was approved by O/o Deputy Director General, Chennai vide letter No. Swajas/498(A) dated 03-03-2010 & vide letter No. F/Swajas/899 dated 14-05-2010 respectively.

Following Inspections were carried on the Helicopter during the month of May 2011 and June 2011.

1. 50 hrs / 90 days inspections were carried out on 02-05-2011 at 675:51 Airframe hours at Kolkata.
2. 100 hrs inspections were carried out 07-05-2011 at 682:11 Airframe hours at New Delhi. (under permission from O/o Dy. DGCA , Chennai)
3. 25 hrs / 30 days inspections were carried out on 16-05-2011 at 705:56 Airframe hours at Dehradun.
4. 50 hrs / 90 days inspections were carried out on 28-05-2011 at 725:59 Airframe hours at Dehradun.
5. 150 hrs / 06 Month inspection were carried out 29-05-2011 at 732:10 Airframe hours at Dehradun. (under permission from O/o Dy. DGCA , Chennai)
6. 25 hrs / 30 days inspections were carried out on 09-06-2011 at 756:57 Airframe hours at Harshil , Dehradun.

7. Daily Inspection carried out on 19.06.2011 prior to the flight of the day.
8. Last 180 days Radio Inspection Schedule was carried out on 17.02. 2011 at 590: 51 Airframe hours.

Load and trim sheet of accident flight was not prepared. However even with full fuel & two person on board (one Pilot and one passenger), center of gravity was within limit.

Co-pilot side flight controls were found removed. However No log book entry of removal was found in Airframe logbook regarding removal of control.

Helicopter Fuel up liftment record register at Sehestra Dhara helipad, was not properly maintained by M/s Swajas Air Charters Ltd.

There were two (02) incidents of FADEC Assembly (ECU) failures:

1. FADEC Assembly (ECU) P/N 23080490, Serial No. JG6ALK1015 removed unserviceable due ECU reversionary governor failure on 23-04-2008 (Component hours at removal = 5.7 hrs times since new). Replacement FADEC assembly (EMC-35R ECU) Serial No. JG6ALK0978 was installed (Component hours at installation= 5.5 hrs times since new).

2. FADEC Assembly (ECU) S/No. JG6ALK0978 was found defective as maintenance terminal code “AIRNCH dfltRG” at 212:27 airframe hours on 24-10-2009 and was replaced with serviceable ECU S/No. JG06ANU1022.

ECU data downloaded on during 600 hrs engine inspection on 2-09-2011 at 584:58 hrs. The data doesn't reveal any discrepancy.

The last snag "Engine scavenge filter bypass indicator found popped out in post flight inspection" occurred on 13-06-2011 at 764:43 Airframe Hours at Sehestra Dhara helipad. During rectification "Engine oil and scavenge filter element was replaced and system flushed before oil replenishment". There was no other snag reported during last 3 months.

Last entry in Airframe & Engine log book was carried out on 05-06-2011. However as per CAR Section -2, Series X Part IV, Para 5.3, Log book entries are to be made within 48 hrs if aircraft is away from the base. Lot of cutting & over writing was found in Airframe Log book Engine logbook & Tech log.

The Artex ME 406 HM Emergency Locator Transmitter (ELT) P/No. 453-6604 & S. No.15183, ELT Code "B4664BE1634E781" was found blinking but no signal was picked up by the Indian Space Research Organization (ISRO) satellite. It was also found during investigation that the monthly check recommended by the manufacturer Artex Aircraft supplies, Oregon, USA on the ELT was not being carried out by the Maintenance agency. As per the Manufacturer's manual of ELT in the periodic maintenance in addition to the maintenance checks, a monthly self-test of ELT is also recommended (page 4-2, dated 11/4/2001). The same monthly check was not carried out by the Maintenance agency.

1.6.3 Pilot Statement

As per pilot statement regarding accident flight on 19-06-2011, "While flying above 1000 ft above ground, I saw the Engine Chip Light come

on. I immediately commenced a descent and reduced my speed so as to carry out an urgent precautionary landing in an open area just below my helicopter. However no sooner had I done this when the FADEC FAIL warning light and ALARM came on. To prevent N_g from exceeding, I started to raise collective, when there was a loud sound from the engine and the aircraft shook/shuddered. Immediately after this the LOW RPM Warning Light and ALARM came ON. The helicopter now started descending at a very rapid rate. I lowered full collective and flared the helicopter just above the trees to reduce my speed and get cabin level attitude." The helicopter hit the ground very hard after passing through the trees.

1.6.4 Aircraft Maintenance Engineer (AME) Statement

As per AME statement "Engine chip light came on in the caution panel. At this time we were flying at 1000ft altitude. Pilot decided to land and located a ground nearby, which is free of any obstacles to land safely. So he started descending and were at 800 ft altitude approximately, FADAC FAIL light came ON with aural warning. A thud sound heard and a shake (momentary) in the helicopter observed. After that the main rotor started drooping below 80 % and we were not able to gain power. This total thing happened with in 30 to 40 seconds. Then I lost my sense momentarily and I gained sense when we were on ground, helicopter toppled on my side."

1.7 Meteorological Information:

Meteorological report at Jolly Grant Airport, Dehradun is available at ½ hour intervals. Meteorological report on 19.06.2011 at 0830 hrs UTC

was: - Surface winds 260 degrees /04 knots, Visibility 07 kms, few Clouds at 2500 feet, scattered at 4000feet, Temp.32 deg. C, Dew point 23 deg. C, QNH 0998 hpa /29.49 in., QFE 0935 Hpa.

Meteorological report on 19.06.2011 at 0900 UTC was surface winds 270 degrees /04 knots, Visibility 05 kms, scattered Clouds at 2500 feet, Broken clouds at 4000feet, Temp.31 deg. C, Dew point 25 deg. C, QNH 0998 hpa /29.49 in., QFE 0935 hpa.

1.8 Aids to Navigation:

At Jolly Grant Airport, Dehradun following navigation aids was available.

a) Digital Very high frequency Omni Range (DVOR)
b) Distance Measuring Equipment (DME)
c) Non Directional Beacon (NDB)

1.9 Communication:

The Helicopter was in two way VHF communications with ATC, Jolly Grant Airport, Dehradun. At 0848 UTC Helicopter contacted Dehradun ATC after 03 Miles out bound and given estimate time of Arrival (ETA) as 0854 UTC for Sehestra dhara Helipad. At 0850 UTC, again pilot contacted Dehradun ATC and gave call "4.5 miles out". At 0853 UTC, ATC tower gave three (03) calls to the helicopter but there was no reply. The VHF coverage of ATC was not available at Sehestra dhara Helipad due to hilly terrains. However, ATC tape recordings revealed that pilot has not declared any emergency before crash landing.

1.10 Aerodrome Information:

Jolly Grant Airport, Dehradun is operated by Airports Authority of India & is situated at an elevation of 544.32 meters above mean sea level. The Airport reference point (ARP) is latitude 30°11'26.25" N and Longitude 78°10'55.98" E. The runway orientation is 08/26 with runway length of 7000 feet.

1.11 Flight Recorders :

Cockpit Voice Recorder (CVR) and Digital Flight Data Recorder (DFDR) were not fitted on helicopter neither required as per Civil Aviation Requirements.

1.12 Wreckage & Impact Information :

The crash site is situated at Ladpur jungles near Raipur on the periphery Vigyan Vihar and Instruments Research and Development Establishment (IRDE) of the Defence Research and Development Organisation, Dehradun. The site is about 100 meters from the road and covered by high tress.

The helicopter impacted high trees & tail boom of the helicopter broke down. The fuselage of Helicopter impacted ground on the skid & toppled to left. Further toppling of helicopter was restricted by trees. Tail boom along with the tail rotor was found hanging on the top of trees. All four Main rotor blades were broken into two pieces and were found near the wreckage. Main rotor hub, swash plate support, Transmission, controls was deformed and broken. Fuel tank, door, windshields, both skids, collective control stick

were found damaged. The engine casing around the Turbine Stage No. 2 was found damage & heat damage on the left side of engine cowling. The engine was found separated in two parts. The soil around the helicopter was found wet with fuel & fuel smell was observed.

The wreckage was shifted from Dehradun to Chennai (Main base of Swajas Air Charters Ltd). Detail examination of wreckage along with inspection of Engine was carried out with Rolls Royce representative on 4th -5th July 2011.The wreckage was in several pieces, with the tail, fuselage, cockpit, main transmission and engine all separated into individual components. The engine's combustor and gas generator turbine modules had been severed from the rest of the engine by liberated turbine debris. The compressor rotor was rotated by hand. Rotation was smooth, with no binding or unusual noises.

Both upper and lower magnetic chip detectors (MCD) were removed and inspected. The upper MCD contained a small amount of metallic debris; the lower MCD was found free of debris. Oil was present in the engine's accessory gearbox and the airframe-mounted oil reservoir. The oil was clean and bright with no abnormal odor. The engine's accessory gearbox oil filter was opened and examined. It contained clean oil with no apparent debris. The filter element was also free of debris.

Inspection of the inlet plenum chamber did not reveal any evidence of foreign material or missing hardware. Inspection of the compressor inlet revealed no visible damage or signs of foreign object ingestion.

The airframe-mounted fuel filter was removed to facilitate engine examination. The filter housing contained clean, bright fuel, and the filter element was free of debris

Data was downloaded from FADEC Assembly (ECU) Model No. EMC-45 R, Serial No. JG06ANU1022 at DGCA hqrs. on 30-06-2011 with the help of Rolls –Royce representative . FADEC data reveals that till 893:08:24 (FADEC time) all parameters were normal & helicopter was flying normal. After 1 second, later (893:08:25) the engine torque reduced to 30 % from 46 %. Subsequently after 2 second (893:08:25) the engine torque reduced to 0, temperature rises to 2500 F from 1180 F, Gas generator turbine rpm reduced to 46 % from 90% & main rotor rpm reduced to 87% from 100%. After 893:09:00 there was no recording on FADEC which mean helicopter crashed and impacted ground. As per FADEC data, the helicopter has taken approx. 33 seconds to impact the ground when engine measured gas temperature (MGT) rose to 2500 F. The FADEC does not record any indication of Magnetic Chip Detector.

S. No.	FADEC time HH:MM:SS	% Ng Compressor rpm	% Nr Rotor rpm	MGT F Measured Gas Temperature	% Q Torque	% Np Power Turbine rpm	% CP Collective Pitch
1.	893:08:23	92	100	1180	46	100	50
2.	893:08:24	92	100	1160	46	100	50
3.	893:08:25	90	100	1180	30	99	50
4.	893:08:27	46	87	2500	0	60	46
5.	893:08:28	34	80	2500	0	42	42
6.	893:08:29	26	76	2500	0	36	38
7.	893:08:30	21	74	2500	0	31	34
8.	893:08:31	18	76	2500	0	29	48
9.	893:08:33	16	72	2500	0	26	48
10.	893:08:34	13	70	2500	0	24	46
11.	893:08:35	12	69	2500	0	22	44
12.	893:08:36	10	69	2500	0	21	42
13.	893:08:37	9	71	2500	0	19	30
14.	893:08:39	8	74	2500	0	18	32
15.	893:08:40	7	76	2500	0	16	30
16.	893:08:41	7	76	2500	0	15	26
17.	893:08:42	6	76	2500	0	13	32
18.	893:08:43	5	75	2500	0	11	36
19.	893:08:45	5	74	2500	0	10	40
20.	893:08:46	4	73	2500	0	8	42
21.	893:08:47	3	71	2500	0	7	46
22.	893:08:48	3	69	2500	0	0	48
23.	893:08:49	3	67	2500	0	5	48
24.	893:08:51	2	66	2500	0	4	50
25.	893:08:52	2	64	2500	0	3	52
26.	893:08:53	0	63	2500	0	0	56
27.	893:08:54	0	60	2500	0	0	60
28.	893:08:55	0	58	2500	0	0	66
29.	893:08:57	0	53	2500	0	0	74
30.	893:08:58	0	43	2500	0	0	90
31.	893:08:59	0	29	2500	0	0	96
32.	893:09:00	0	13	2500	0	0	96
33.	000:00:00	0	0	0	0	0	0

1.13 Medical & Pathological Information:

Both Pilot and Engineer (passenger) were admitted to hospital & were in serious condition after the accident.

1.14 Fire: There was no pre or post impact fire.

1.15 Survival Aspects:

The accident was survival. Dehradun ATC receiving phone about crash informs all the concerned authorities about the accident. Search and rescue was started with the help of State Police. Pilot & Engineer received injuries and were rescued by local peoples who shifted them to hospital. There was no pre and post impact fire. Both persons survived in the accident.

Pilot received injuries mainly at Pelvis area and compression of backbone vertebra whereas AME received fracture in hand and injuries around pelvis area due to crash impact and helicopter toppling.

1.16 Test and Research:

1.16.1 Fuel, Engine Oil & Transmission Sample Report

A sample of fuel from the fuel Bowzer of Indian Oil (from which refueling of Helicopter was carried out before accident) was taken and subjected to full specification test at the Fuel lab in the Directorate General of Civil Aviation (DGCA). As per the examination report received, there was no abnormality in the sample and it passed the entire specification test.

A sample of Engine Oil and Transmission Oil was drained from helicopter and subjected to specification test at Fuel lab in the Directorate General of Civil Aviation (DGCA). As per the examination report received, there was no abnormality in the sample.

No fuel was left is helicopter fuel tank as it got damaged due impact. There was smell of ATF in the soil around helicopter.

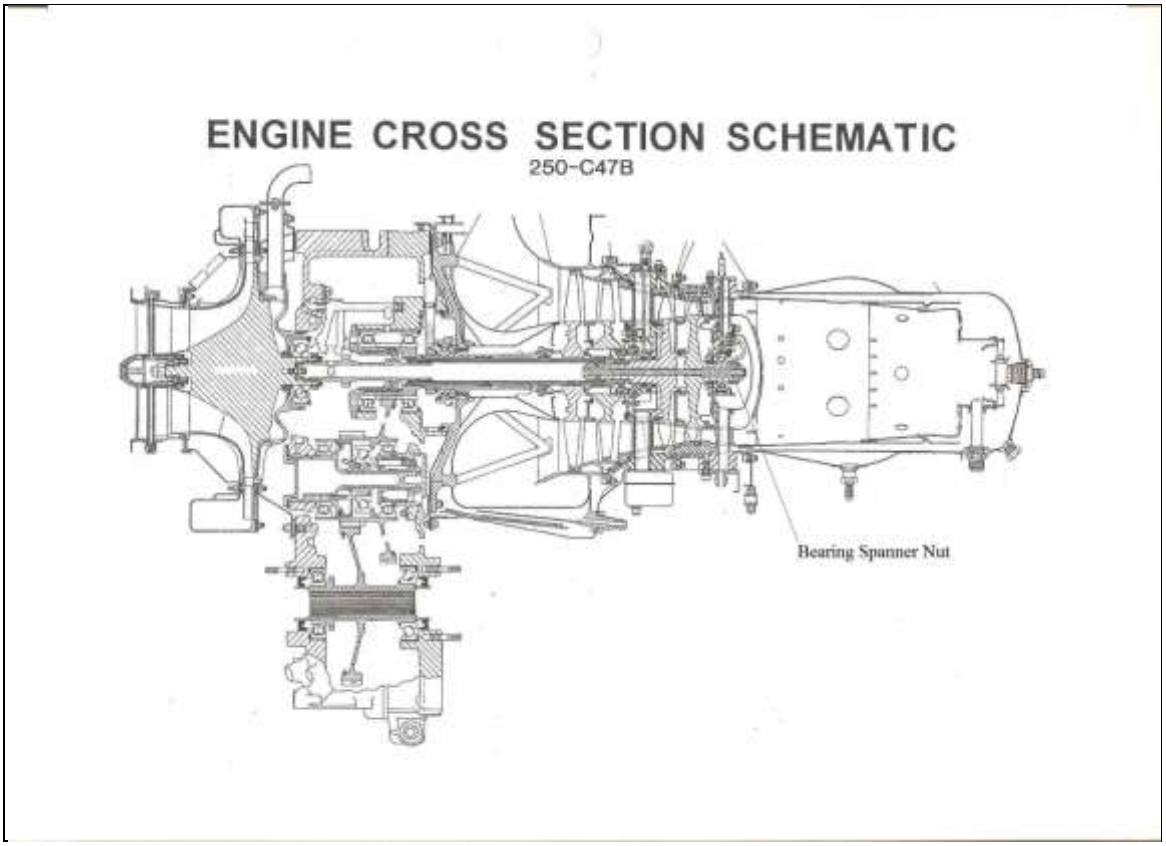
1.16.2 Metallurgical Examination Report

Fracture surface of Tail gear box drive shaft flange was examined in Metallurgical lab in the Directorate General of Civil Aviation (DGCA).The report reveals that "the flange of tail drive shaft has failed under overload".

1.16.3 Failure Analysis of Engine.

The involved engine was dis-assembled at Rolls-Royce facility, USA on 13th October 2011 & it was found that the gas generator turbine and engine casing around the Turbine Stage No. 2 was found damaged. NTSB, USA were requested to associate in the investigation.

The turbine section of the engine incorporates a two-stage gas producer turbine and a two-stage power turbine. Power to drive the compressor rotor and gas producer gear train is provided by the gas producer turbine rotor. The power turbine rotor develops the power which drives the power turbine gear train and helicopter rotor system. The turbine rotor assemblies are not mechanically coupled, but they are gas coupled i.e. exhaust gases flow through the four turbines. The turbine rotor stages are numbered 1 through 4, with the 1st stage at rear and the 4th stage at the front. There are nine main bearings numbered 1 through 8 in a front to rear direction.



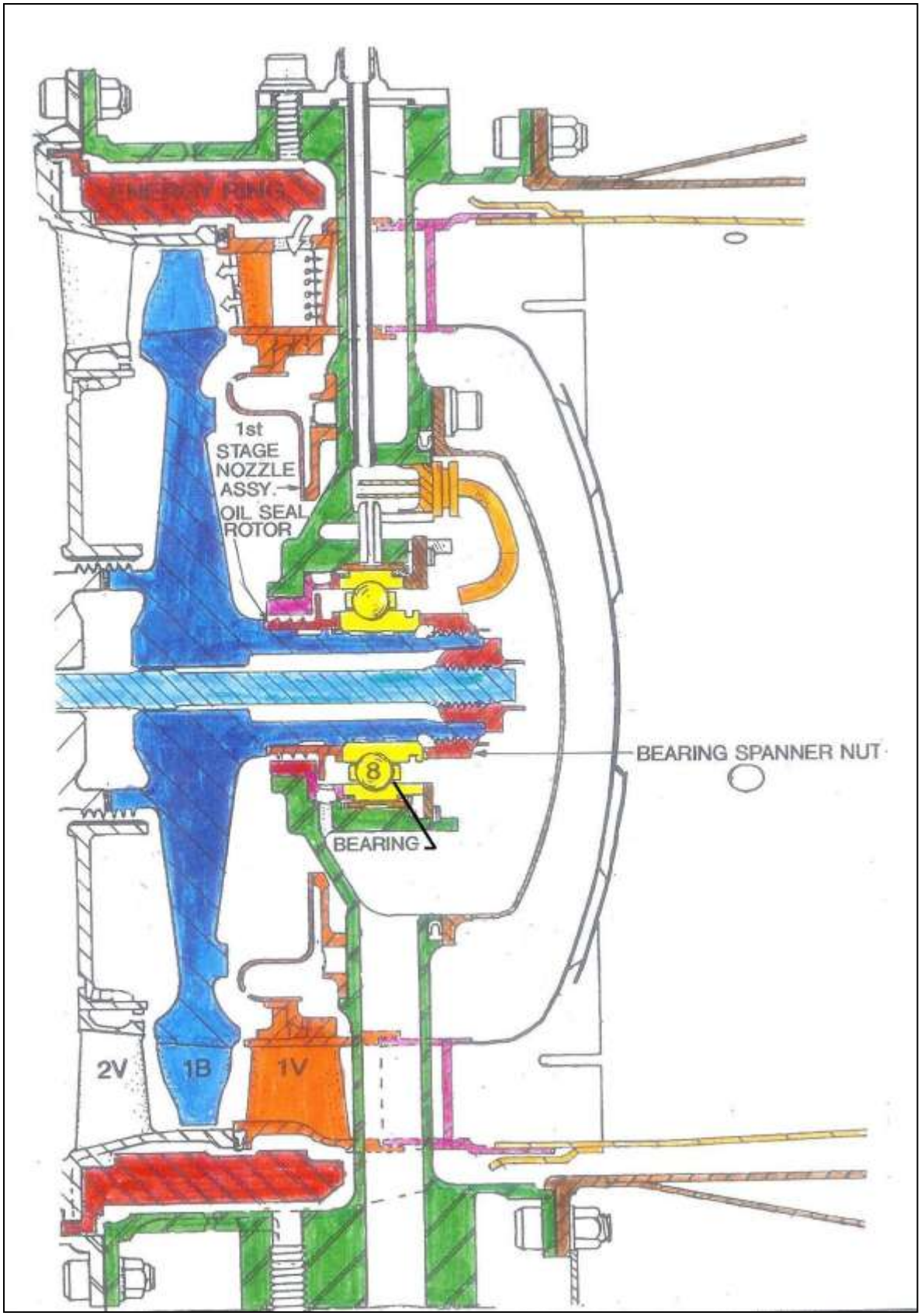
The gas producer turbine rotor consists of the 1st and 2nd stage wheels, tie bolt, and tie bolt nut. The No. 8 bearing and rotating part of its labyrinth seal are retained on the bearing shaft by a spanner nut. The #8 bearing provides both radial and axial support for the gas generator turbine rotor. In addition to providing radial support, the bearing resists the forward thrust being generated by the 1st and 2nd stage turbine wheels. The gas producer turbine rotor are radially supported and axially retained.

Rub damage on power turbine support assembly indicates that turbine rotor assembly move forward during engine operation.

During tear down inspection at Rolls Royce anomaly with the dimpling of the #8 bearing spanner nut was found. Locking of the spanner nut at assembly is accomplished by deforming a section of the ring on the aft nut inward into one of three slots machined in the aft end of the first stage wheel stub shaft. As designed, the dimple is meant to engage with a flat on the 1st stage turbine stub shaft; however the dimple was not engaged with the flat and the nut appeared to have backed off.

Engineering analysis indicates that probably # 8 bearing spanner nut back off due to improper dimple during installation. **The locking dimple on nut was not properly engaged to the locking flat on the turbine stub shaft, allowing the nut to back off during engine operation**. The forward displacement of the gas generator turbine resulted in rub damage to the 2nd stage turbine wheel web area and stub shaft, consequently reducing the cross-sectional area, allowing the shaft to separate from the turbine disk. When the turbine disk separated from the stub shaft, the load on the 2nd stage turbine wheel being lost, an overspeed burst of the 2nd stage turbine wheel occurred.

The Overhaul life of Engine is 2000 hrs. and Inspection of #8 bearing spanner nut can be performed during overhaul.


1st
STAGE
NOZZLE
ASSY.
OIL SEAL
ROTOR
BEARING SPANNER NUT
8
BEARING
2V
1B
1V

1.17 **Organizational & Management Information:**

M/s Swajas Air Charters Ltd. is based in Chennai having Non-scheduled Operating Permit (NSOP) No. 11/2009 & is valid up to 25-03-2013.

The company is having 01 aircraft (Cessna Citation 560 XL) & 03 helicopters (02 Bell 412 & 01 Bell 407).

M/s Swajas Air Charters Ltd., Chennai has an MOU regarding utilization of pilots with M/s Deccan Charters Limited, Bangalore. The involved pilot started flying this helicopter in this region from 03-06-2011 till the date of accident.

DGCA has issued Civil Aviation Requirements (CAR) , Section 3 Series C , Part III dated 1st June 2011 effective "forthwith" where in conditions are given regarding cross utilization of crew of one operator by another operator are given.

The Standard Operating Procedures for operation to Kedarnath, Badrinath and other helipads found in the helicopter after accident was not approved by DGCA. As per Operations Circular 13 of 2010, SOP's for operations at Kedarnath are to be approved by DGCA.

1.18 **Additional Information**: NIL

1.19 **Useful and Effective Techniques**: NIL

2. ANALYSIS:

2.1 Serviceability of Helicopter

The helicopter was in serviceable condition, having Certificate of Airworthiness (C of A) valid till 04-02-2014 and Annual Airworthiness Review Certificate (ARC) is valid 04-02-2012.

The last snag of "Engine scavenge filter bypass indicator found popped out in post flight inspection" occurred on 13-06-2011 at 764:43 Airframe Hours at Sehstra Dhara helipad". During rectification "Engine oil and scavenge filter element was replaced and system flushed before oil replenishment". There was no other snag reported during last 3 months.

Load and trim sheet of accident flight was not prepared. However even with full fuel & two person on board (one Pilot and one passenger), center of gravity was with in limit.

Co-pilot side flight controls were found removed. However No entry of removal was found in Airframe logbook regarding removal of controls.

Last entry in Airframe & Engine log book was carried out on 05-06-2011. However as per CAR Section -2, Series X Part IV, Para 5.3, Log book entries are to be made within 48 hrs if aircraft is away from the base. Lot of cutting & over writing was found in Airframe Log book Engine logbook & Tech log.

The Artex ME 406 HM Emergency Locator Transmitter (ELT) P/No. 453-6604 & S. No.15183, ELT Code "B4664BE1634E781"was found blinking but no signal was picked up by the Indian Space Research Organization

(ISRO) satellite. It was also found during investigation that the monthly check recommended by the manufacturer Artex Aircraft supplies, Oregon, USA on the ELT was not being carried out by the Maintenance agency. As per the Manufacturer's manual of ELT in the periodic maintenance in addition to the maintenance checks a monthly self-test of ELT is recommended (page 4-2, dated 11/4/2001). The same monthly check was not being done by the Maintenance agency.

Helicopter Fuel up liftment record register at Sehestra Dhara helipad, was not properly maintained by M/s Swajas Air Charters Ltd.

Daily Inspection schedule was carried out on 19-06-2011. Helicopter has logged flight time of 2:20 hrs on 19-06-2011 before the accident flight.

The aircraft is airworthy & safe to carryout flight.

2.2 Pilot Factor

The pilot was having valid license and medical. On 19-06-2011, pilot successfully flew Sehestra dhara Helipad – Ananda Resort - Phata - Badri-Dehradun and has logged flight time of 2:20 hrs of flight. Helicopter took off again from Dehradun to Sehestra dhara Helipad. While flying above 1000 ft above ground, Engine Chip Light comes on. Pilot decided to carry out an urgent precautionary landing in an open area but FADEC FAIL warning light and ALARM came on followed by LOW RPM Warning Light and ALARM. The helicopter descended at a very rapid rate and impacted the ground and toppled on its left side resulting in substantial damage to helicopter. Pilot received serious injuries in the accident.

Pilot tried to land in an open field but helicopter descended fast & crashed.

2.3 Aircraft Maintenance Engineer (AME)

The Aircraft Maintenance Engineer (AME) has Bell 407 endorsement. Daily Inspection schedule was carried out on 19-06-2011 at Sehestra dhara Helipad. AME successfully flew along with pilot Sehestra dhara Helipad – Ananda Resort - Phata - Badri- Dehradun as a passenger. He along with pilot took off again from Dehradun to Sehestra dhara Helipad.

As per AME, while flying at 1000ft altitude Engine chip light came on .Pilot started descending, decided to land and located a ground nearby, which is free of any obstacles to land safely. At 800 ft altitude approximately, FADAC FAIL light came ON with aural warning with thud sound heard and momentary shake in the helicopter observed. The main rotor rpm started dropping below 80 % and helicopter was not able to gain power. The helicopter descended at a very rapid rate and impacted the ground and toppled on its left side resulting in substantial damage to helicopter. AME received serious injuries in the accident.

The last snag of "Engine scavenge filter bypass indicator found popped out in post flight inspection" occurred on 13-06-2011 at 764:43 Airframe Hours at Sehstra Dhara helipad". During rectification "Engine oil and scavenge filter element was replaced and system flushed before oil replenishment". There was no other snag reported during last 3 months.

2.4 Weather

The visibility at the time 0830 UTC was 07 Km & at 2000 UTC as 05 Km. The accident occurred approximately at about 0854 Hrs IST. Weather is not a factor for accident.

2.5 Engine Strip- Examination

The involved engine was dis-assembled at Rolls-Royce facility, USA on 13th October 2011. During inspection, it was found that the gas generator turbine and engine casing around the Turbine Stage No. 2 was found damage.

During tear down inspection at Rolls Royce anomaly with the dimpling of the #8 bearing spanner nut was found. Locking of the spanner nut at assembly is accomplished by deforming a section of the ring on the aft nut inward into one of three slots machined in the aft end of the first stage wheel stub shaft. As designed, the dimple is meant to engage with a flat on the 1st stage turbine stub shaft; however the dimple was not engaged with the flat and the nut appeared to have backed off.

The forward displacement of the gas generator turbine resulted in rub damage to the 2nd stage turbine wheel web area and stub shaft, consequently reducing the cross-sectional area, allowing the shaft to separate from the turbine disk. When the turbine disk separated from the stub shaft, the load on the 2nd stage turbine wheel being lost, an overspeed burst of the 2nd stage turbine wheel occurred.

The locking dimple on nut was not properly engaged to the locking flat on the turbine stub shaft, allowing the nut to back off during engine operation.

2.6 Circumstances Leading to Accident.

While flying from Jolly Grant Airport, Dehradun to Sehestra Dhara helipad at above 1000 ft above ground, as reported, Engine Chip Light warning illuminated followed by FADEC FAIL warning light and ALARM. Pilot decided to carry out a precautionary landing in an open area but there was a loud sound from the engine and the helicopter shuddered. Immediately after this the LOW RPM Warning Light and ALARM came ON. The helicopter descended fast impacted the ground and toppled on its left side resulting in substantial damage to helicopter.

ATC received a phone call stating that a Helicopter has crashed at Ladpur, Sunderwala Jungles, Dehradun. ATC identifies the helicopter as Bell 407 Helicopter VT- SWA and informs all the concerned authorities about the accident. Search and rescue was started with the help of State Police. Pilot & Engineer received injuries and were rescued by local peoples who shifted them to hospital. There was no pre and post impact fire. Both persons survived in the accident.

During investigation, it was found that the gas generator turbine and engine casing around the Turbine Stage No. 2 was found damage. Failure analysis reveals that the #8 bearing spanner nut moved, allowing 2^{nd} stage turbine wheel to separate from shaft and resulted into over speed burst of 2^{nd} stage turbine wheel.

3. CONCLUSION :

3.1 Findings :

1. The Helicopter was having valid C of A & was maintained in serviceable condition.

2. The pilot was having valid license and his medical was current.

3. The Daily Inspection schedule of the Helicopter was carried out by the AME before the flight.

4. Helicopter took off from Jolly Grant Airport, Dehradun to Sehestra dhara Helipad for parking with one (01) pilot & one (01) passenger (Aircraft Maintenance Engineer). Helicopter was in contact with Dehradun ATC and at 0850 UTC gave call "4.5 miles out". At 0853 UTC, ATC tower gave three (03) calls to the helicopter but there was no reply.

5. The VHF coverage of ATC was not available at Sehestra dhara Helipad due to hilly terrains.ATC received a phone call stating that a Helicopter has crashed at Ladpur, Sunderwala Jungles, Dehradun. ATC identifies the helicopter as Bell 407 Helicopter VT- SWA and informs all the concerned authorities about the accident.

6. The helicopter impacted the ground and toppled on its left side resulting in substantial damage to helicopter.

7. Search and rescue was started with the help of State Police. Pilot & Engineer received injuries and were rescued by local peoples who shifted them to hospital. There was no pre and post impact fire. Both persons survived in the accident.

8. The visibility at the time 0830 UTC was 07 Km & at 2000 UTC as 05 Km. The accident occurred approximately at about 0854 Hrs IST. Weather is not a factor for accident

9. Load & Trim sheet of accident flight was not prepared. However even with full fuel & two person on board (one Pilot and one passenger), center of gravity was within limits. Helicopter Fuel up liftment record register at Sehestra Dhara helipad, was not properly maintained by M/s Swajas Air Charters Ltd.

10. The Standard Operating Procedures for operation to Kedarnath, Badrinath and other helipads found in the helicopter after accident was not approved by DGCA.

11. Last entry in Airframe & Engine log book was carried out on 05-06-2011. However as per CAR Section -2, Series X Part IV, Para 5.3, Log book entries are to be made within 48 hrs if aircraft is away from the base. Lot of cutting & over writing was found in Airframe Log book Engine logbook & Tech log.

12. The Emergency Locator Transmitter (ELT) was found blinking but no signal was picked up by the Indian Space Research Organization (ISRO) satellite. It was also found during investigation that the

monthly check recommended by the manufacturer Artex Aircraft supplies, Oregon, USA on the ELT was not being carried out by the Maintenance agency. As per the Manufacturer's manual of ELT in the periodic maintenance in addition to the maintenance checks a monthly self-test of ELT is recommended (page 4-2, dated 11/4/2001). The same monthly check was not being done by the Maintenance agency.

13. While flying from Jolly Grant Airport, Dehradun to Sehestra Dhara helipad at above 1000 ft above ground, as reported, Engine Chip Light warning illuminated followed by FADEC FAIL warning light and ALARM.

14. Pilot decided to carry out a precautionary landing in an open area, but there was a loud sound from the engine and the helicopter shuddered. Immediately after this the LOW RPM Warning Light and ALARM came ON. The helicopter descended fast impacted the ground and toppled on its left side resulting in substantial damage to helicopter.

15. The involved engine was dis-assembled at Rolls-Royce facility, USA on 13th October 2011. During inspection, it was found that the gas generator turbine and engine casing around the Turbine Stage No. 2 was found damage.

16. Engineering analysis indicates that probably # 8 bearing spanner nut back off due to improper dimple during installation. The locking dimple on nut was not properly engaged to the locking flat on the turbine stub shaft, allowing the nut to back off during engine operation. The forward displacement of the gas generator turbine

occurred, allowing the shaft to separate from the turbine disk and an overspeed burst of the 2nd stage turbine wheel occurred.

3.2 Probable Cause of Accident :

Power loss due to failure of 2nd Stage Turbine disc of engine resulted in accident.

4. Safety Recommendations :

1) Action as deemed appropriate be taken against M/s Swajas Air Charters Pvt. Ltd on the findings No. 3.1.9, 3.1.10, 3.1.11 and 3.1.12

2) Engine Manufacturer M/s Rolls- Royce should improve the installation and inspection of Number #8 bearing spanner nut.

(Amit Gupta)
Inspector of Accident
VT-SWA

Dated: 7th May, 2012


Sahastradhara helipad
ongc
gtc
crash site
Dehradun
Clement Town
Miyanwala
Image © 2011 DigitalGlobe
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Image © 2011 GeoEye
Google
Imagery Date: 9/25/2010


crash site
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Google
Imagery Date: 4/26/2010

Tailboom & Tailrotor hanging on tree

Failed 2nd Stage Turbine