



FINAL REPORT

**ACCIDENT TO M/S RAYMOND LTD. AS-355N
HELICOPTER VT-RLA AT PETHSHAHPUR
NEAR LONAVALA ON 22.9.2002**

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**FINAL REPORT ON ACCIDENT TO M/S RAYMOND LTD.
AS-355N HELICOPTER VT-RLA AT PETHSHAHPUR
NEAR LONAVALA ON 22.9.2002**

a) Helicopter

Type : Ecureuil

Model : AS-355N

Nationality : Indian

Registration : VT-RLA

b) Owner/Operator : M/s. Raymond Ltd.

c) Pilot-in-Command : Capt.K.Malhotra

Extent of Injuries : Fatal

d) Co-Pilot : Capt.N.K.Bhardwaj

Extent of injuries : Fatal

e) Passengers on board : Three

Extent of injuries : Fatal

f) Place of accident : Pethshahpur near Lonavala
Lat 18°40' N
Long 73°22' E

g) Date & time of accident : 22nd September, 2002;
1105 UTC Approx.

(All timings in the report are in UTC)

SUMMARY

M/S Raymonds Ltd. Ecureuil AS 355N, helicopter VT-RLA was chartered by M/s Air Sahara for Non-Scheduled flight for Juhu-Race Course-Amby Valley-Juhu sectors on 22.9.02. The helicopter operated Juhu - Racecourse - Amby Valley sectors uneventfully. Along with VT-RLA, M/s Air Sahara helicopters VT-SIP and VT-SIL also operated these sectors

uneventfully. All these three helicopters were scheduled to depart from Amby Valley for Juhu airport with an interval of 15 minutes same day evening. After VT-SIP took off at about 1045 UTC, VT-RLA took off at about 1100 UTC and was seen setting course straight for Juhu airport. There were a total of five persons on board. The visibility was 5 Km with hilltops clear and there were drifting clouds. After climb out, the helicopter deviated from its track and took a right turn. During the right turn the pilots entered into bad weather at low height and lost visual reference with the ground. The helicopter impacted the ground and got disintegrated and was destroyed due impact and post impact fire. All five occupants on board received fatal injuries. VT-SIP and VT-SIL (which took off after 15 minutes of VT-RLA) landed safely at Juhu airport. VT-RLA was neither in contact with any ATC unit nor with VT-SIP and VT-SIL.

1. FACTUAL INFORMATION

1.1 History of the flight :

M/S Raymonds Ltd. Ecureuil AS 355N, helicopter VT-RLA was chartered by M/s Air Sahara for Non-Scheduled flight for Juhu-Race Course-Amby Valley-Juhu sectors on 22.9.02. The helicopter took off from Juhu airport at 0627 UTC for Race Course under the command of Capt. K. Malhotra with Capt. N.K. Bhardwaj, as copilot. After picking up three passengers from Race Course, it took-off and set course for Amby Valley and landed safely at about 0845 UTC. Two other helicopters VT-SIL and VT-SIP of M/S Air Sahara had also taken off from Juhu airport on 22.9.2002 and after picking up passengers from Race Course also landed at Amby Valley alongwith VT-RLA. At about 1045 UTC, M/S Air Sahara helicopter VT-SIP took off from Amby Valley for Juhu airport under the command of Capt. Deepak Dhermy with Capt. Rakesh Sharma as copilot. There were four passengers on board. Prior to take-off, the pilots had checked up the weather from Juhu ATC, Visibility was 6 Kms. with clear sky. The weather at Amby Valley was 5 Kms. cloudy and hilltops were clear though there were drifting clouds. Capt. Deepak Dhermy had briefed the pilots of VT-RLA and VT-SIL to take-off after 15 minutes interval. After take-off, they(VT-SIP) took one orbit over Amby valley at an altitude of approx. 500 ft. AGL for about 5-7 minutes to show the area to the visitors on board and then set course for Juhu airport. M/S Raymond helicopter VT-RLA took off from Amby Valley at about 1100 UTC for Juhu airport under the command of Capt. K. Malhotra with Capt. N.K. Bhardwaj, as copilot. There were three passengers on

board. Before departure Capt. K. Malhotra had obtained the weather from Juhu ATC. Capt. A.K.Sen and Co-pilot Capt. R.S.Dev, who were scheduled to operate VT-SIL, observed the take-off of VT-RLA from the ground and setting course directly towards Juhu Airport and was not visible to them once it went abeam the Koraigarh fort. Thereafter they took-off with four passengers on board from Amby Valley and set course straight for Juhu airport at about 1115 UTC. They did not make an orbit over Amby Valley. Prior to take-off, they had checked up the weather from Juhu ATC. Visibility was 6 Kms. The weather at Amby Valley was about 5 Kms. cloudy with medium and high clouds. The clouds were broken and passing clouds in patches about 1000 ft. high. The hilltops around were generally clear of clouds.

Capt. Deepak Dhermy (commander of VT-SIP) has stated that after setting course for Juhu airport, after some time he contacted Mumbai Approach Radar and gave their position report. They were asked to route via south of Trombay to Bandra Point. He contacted Spartan Control and gave their position report. He tried to contact VT-RLA who was to take-off from Amby Valley helipad but there was no radio contact. He enquired from Bombay Radar and VT-SIL if there was any contact with VT-RLA and they replied in negative. They came over Bandra point and thereafter landed at Juhu airport at about 1134 UTC. Capt. A.K. Sen (Commander of VT-SIL) has stated that after getting airborne, after sometime they contacted Mumbai approach around 37 NM. After sometime they got a call from VT-SIP asking if there was any contact with VT-RLA. Then they tried to contact VT-RLA but there was no visual or radio contact. They also tried to contact Spartan control but there was no contact with them. They landed at Juhu airport at about 1136 UTC. As both the helicopters VT-SIP and VT-SIL had landed at Juhu airport except VT-RLA, subsequently, it was found that helicopter VT-RLA had crashed and its wreckage was found at about 4 Kms from Amby valley helipad in a nachani field at village Pethshahpur. After take off, VT-RLA was neither in contact with Mumbai Radar nor with any other station enroute nor with other helicopters VT-SIP and VT-SIL which had also departed from the Amby valley helipad. The helicopter got destroyed due impact with the ground and post impact fire. All five persons on board received fatal injuries. One lady who was working in the nachani field received superficial burn injuries by the fuel from the helicopter debris.

1.2 Injuries to Persons :

INJURIES	CREW	PASSENGERS	OTHERS
FATAL	2	3	Nil
SERIOUS	Nil	Nil	Nil
MINOR/NONE	Nil	Nil	1

1.3 Damage to aircraft : The helicopter was destroyed due impact with the ground and post impact fire.

1.4 Other damage : There was some damage to the nachani field where the helicopter crashed.

1.5 Personnel Information :

1.5.1 Pilot-in Command:

Name : Capt. Kanwal Malhotra

Age : 48 years approx.

Licence: CHPL no. 392 (initially issued on 13.11.95 and was last revalidated upto 2nd November, 2006)

FRT0 No: 5491 (Valid upto 2nd November, 2006)

He held PIC endorsements on his CHPL for Chetak helicopter (Day only) on 13.11.95, Bell 206 L3 helicopter on 27.6.97 & Ecureuil AS-355N helicopter on 18.11.99. As per available records, his flying experience was as follows:

Total flying experience	: 4322:55 hrs
Total flying experience as PIC	: 3950:40 hrs
Total flying experience on type	: 618:30 hrs
Flying experience during last 90 days	: 42:45 hrs
Flying experience during last 30 days	: 16:15 hrs
Flying experience during last 7 days	: 01:55 hrs
Flying experience during last 24 hours	: 00:35 hrs

He was last medically examined on 16.4.2002 and was found fit subject to wearing of corrective look over glasses while exercising the privileges of his license. He was also advised to use earplugs in noisy environment. His last proficiency check was carried out on 10.7.2002. His last Instrument Rating Check was carried out on 10.7.2002.

Scrutiny of Journey Log Book of VT-RLA revealed that Capt. K. Malhotra had earlier operated Amby Valley- Juhu- Amby Valley sectors on 22.4.2001 and 15/16.2.2002.

1.5.2 Copilot :

Name : Capt. Naresh Kumar Bharadwaj

Age : 51 years approx.

Licence: CHPL no. 398 (initially issued on 11.3.96 and was last revalidated up to 22nd February, 2007)

FRT0 No: 5579 (Valid upto 22.2.2007)

He held PIC endorsements on his licence for Chetak helicopter (Day only) on 11.3.96 and Ecureuil AS-355N helicopter on 14.7.97. As per available records, his flying experience was as follows :

Total flying experience	: 5994:00 hrs
Total flying experience as PIC	: 5289:40 hrs
Total flying experience on type	: 1349:20 hrs
Flying experience during last 90 days	: 43:45 hrs
Flying experience during last 30 days	: 14:35 hrs
Flying experience during last 7 days	: 03:55 hrs
Flying experience during last 24 hours	: 00:35 hrs

He was last medically examined on 6.8.2002 and was found fit subject to wearing of corrective Bifocal/look over glasses while exercising the privileges of his license. His last proficiency check was carried out on 10.7.2002. His last Instrument Rating Check was carried out on 18.4.2002

Scrutiny of Journey Log Book of VT-RLA revealed that Capt. N.K. Bharadwaj had earlier operated to Amby Valley nine times during 2000 and 2001 (lastly operated on 19-2-2001).

1.6. Helicopter Information:

1.6.1 Ecureuil AS 355N helicopter VT-RLA bearing constructor's serial No.5564, was manufactured in 1994 by M/S Eurocopter, France. It was brought to India by M/s Raymond Ltd. under export C of A No.20115 dated 14.12.95 issued by DGAC, France. It was issued with C of R No.2726 on 22.12.95 under Category 'A'. Its first Indian C of A No.2214 was issued on 22.12.95 under 'Normal' Category, subdivision 'Passenger Aircraft'. The Certificate of Airworthiness was being re-validated on yearly basis. Its last C of A was revalidated up to 13.12.2002. The minimum crew necessary was one and maximum all-up-weight authorized was 2600 Kgs. The maximum permissible seating capacity including crew was six. The helicopter was

equipped with two modular-design TURBOMECA ARRIUS 1 A turboshaft engines incorporating free-power turbine and full-authority digital governor. These engines were mounted at the top of the fuselage to the rear of the main gear box in two separate fire-proof compartments. The helicopter was owned, operated and maintained by M/s Raymond Limited, Mumbai.

The helicopter had done 2741:10 airframe hrs and 4603 landings since new and 225.50 airframe hrs and 287 landings since last revalidation of C of A. Port engine (Sl. No. 2001) had done 3448.10 hrs. since new and 1442.10 hrs. since last overhaul and starboard Engine (Sl. No. 2058) had done 3132 hrs. since new and 1285 hrs. since last overhaul as on date of accident. The mandatory modifications were also found complied with.

1.6.2 History of Engines :

The helicopter was fitted with engine Sl.no.2060 on LHS(#1) and engine sl.no.2058 on RHS(#2) at the time of issue of C of R and initial C of A. No.1 engine (Sl.no.2060) was replaced with sl. no. 2001 on 2.3.2000. No. 2 engine (sl. no.2058) was replaced with sl. no. 2080 on 9.3.98. Thereafter, it was replaced with sl. no. 2012 on 24.11.98 and again replaced with sl no. 2058 back at no. 2 position on 21.7.2001.

1.6.2.1 History of Engines(including components) installed and replaced on LHS (sl.no.2060 & sl.no.2001)

Engine Sl.no.2060 was replaced with Sl. no. 2001 on 2.3.2000, since on 12.2.2000 the pilot had reported that while repositioning the helicopter, the #1 engine started and all parameters observed normal and just before starting no.2 engine a loud thud noise was heard and #1 engine was switched off. During rectification combiner gear box input flange and its mounting bolts were found sheared and were replaced. Both MCD, oil filter and fuel filter were checked and no chips were found. Compressor, turbine blades checked for condition and freedom of rotation and found satisfactory. Air intake grid plenum casing checked and no abnormality found. Exhaust cone checked and found satisfactory. Boroscopic inspection of compressor, combustion chamber, gas generator turbine, free power turbine, MGB, combiner gear box carried out and found satisfactory. The helicopter was given ground run and during ground run No.1 engine started but Ng did not pick up beyond 22%. Engine was switched off. The engine-#1(S.N.2060) was then removed on 29.2.2000. At the time of removal, the engine had done 1825.15 hrs since new/since

last O/H. The removed engine Sl.no.2060 was sent to M/s. Turbomeca for investigation. Investigation report revealed that on dismantling of no.2 module, heavy signs of erosion on air path, diffuser assembly, centrifugal wheel, nozzle guide vane and HP blades were observed.

The engine sl.no.2001 was installed in place of sl. no. 2060 on 2.3.2000. At the time of installation, the engine had done 2535 hrs since new and 529 hrs since last overhaul. On 16.4 2001, HP pump Sl no. 401 B was removed at 1950.45 component hrs.(life 2000 hrs.) and replaced with new and serviceable HP pump sl. no. 346 M. On 13.7.2001, during switch off, leak was found from drain valve of HP pump of # 1 engine. Leak was beyond permissible limits. HP pump (Sl. no. 346 M which was installed on 16.4.2001 with 00 component hrs.) was suspected faulty and same was replaced. On 14.2 2002, at Juhu airport, # 2 engine failed to start and # 1 engine chip light flickered. For rectification of the snag on no.1 engine, reduction gear box and rear bearing MCD were checked and fine metal dust was found on both the chip detectors. The oil filter was checked and no metal particles were found. The oil system was drained and no metal particles were found. The engine oil system was flushed and on subsequent ground run no warning light illuminated. After ground run, negligible dust found on both the chip detectors. Same were cleaned and fitted back. Test flight was carried out and no warning light came ON. The chip detectors and oil filter did not indicate any metal particle. Engine run down time was 44 seconds. Boroscopic inspection on engine (sl.no.2001) was carried and found satisfactory. Thereafter the helicopter was released for flying. On 5.3.2002 at Aurangabad, the Pilot had reported that five minutes after take off, surging sound was heard from No.1 engine. All other parameters were observed normal. The helicopter landed back safely. During rectification the engine was checked externally and no abnormality was observed. Front and rear MCDs were checked and were found clean. Engine filter was opened and negligible amount of metal dust was found. Boroscopic inspection of compressor blades and gas generator turbine blades was carried out and no abnormality was observed. Boroscopic inspection of combustion chamber revealed black carbon deposit. Visual inspection of free turbine, after exhaust pipe removal, revealed rubbing marks on turbine casing. Free turbine could be rotated by hand without any rubbing noise. Rotation of gas turbine assembly was normal and no rubbing noise was observed. Engine run down time was 42 seconds. P2/P3 sensors of both the engines were swapped and the helicopter was given ground run. During the ground run,

surge noise was heard again from #1 engine. The helicopter was switched off. During further rectification, the HP pump was swapped with that of #2 engine. The helicopter was again given ground run and again surge noise was heard from #1 Engine. It was decided to replace the engine (sl.no.2001). Because of non-availability of complete engine, it was decided to replace module-2 as per the advice of Turbomeca. No.1 engine was removed for Module-2 replacement on 22.3.2002 and was installed back on 24.3.2002 after Module-2 replacement and completion of power assurance check and test flight. At the time of change, module-2 had done 00 component hrs. The engine had done 3320.40 hrs since new and 1314.40 hrs since last overhaul.

On 25.3.2002, the helicopter operated one non-scheduled flight from Auragabad to Juhu airport. Thereafter, it did not operate any flight up to 4.4.2002. On 5.4.2002 at Juhu airport, the Pilot reported that no.1 engine chip light came ON during ground run. The helicopter was switched off. The engine was again removed on 5.4.2002 for replacement of Module-1. It was re-installed on 9.4.2002 after replacement of the module and completion of power assurance check. At the time of change, module-1 had done 389 components hrs. The engine had done 3322.50 hrs since new and 1316.50 hrs. since last overhaul.

Both the removed modules were sent to M/s Turbomeca for defect investigation. The investigation report revealed that particles from No.1 Module were due to the flaking of output gear rear bearing outer ring. M/s Turbomeca had developed the modification TU98. This TU98 modification introduces an angular displacement of anti-rotation tab located on the output gear rear housing. This modification would reduce the stress on the outer ring. The investigation report of Module-2 revealed after having noticed significant erosion on the centrifugal diffuser during disassembly, further investigations were carried out on the different parts and revealed that the surge phenomenon was probably due to the rupture of centrifugal diffuser radial vanes on the leading edges. The radial vane complete detachment led to a modification of the resonance conditions of these vanes, which became free on one end, and thus rupturing 13 vanes by vibratory fatigue and cracking 4 others.

On 25.7.2002, fuel was found leaking from no.1 engine combustion chamber drain valve line during inspection for weekly ground run as booster pump was put ON. Pressuring Valve/Starting Electro valve was suspected faulty and same

was replaced with new one. During ground run, no leak was observed and the helicopter was released for flying.

On 13.8.2002 at Juhu airport, the Pilot reported that during start up of #1 engine, there was no torque meter indication. All other parameters were found normal. During rectification suspected torque meter transmitter was replaced with new one and checked for security of attachment and the helicopter was released for flying.

On 4.9.2002 at Juhu airport, fuel was found leaking from LP pump drive shaft sealing ring drain line of # 1 engine as the booster pump was put ON. During inspection, LP pump was suspected faulty and the same was replaced with an overhauled pump. During ground run, no leak was observed and the helicopter was released for flying.

1.6.2.2 History of Engines(including components) installed and replaced on RHS (sl. nos. 2058,2080 & 2012)

No. 2 engine (Sl. no. 2058) was replaced with Sl. No. 2080 on 9.3.98 since on 26.2.98 at Juhu airport, the Pilot reported that five minutes prior to landing, RH engine chip warning light flickered. All other engine parameters were normal. During rectification, chips were found in Accessory Gear Box Magnetic Chip Detector. The system was flushed. Engine ground run was carried out for 30 minutes and chip light flickered again. Chips were found again in Accessory Gear Box Magnetic Chip Detector. Engine (sl.no.2058) was suspected unserviceable and it was replaced with engine sl. no. 2080 on 9.3.98. At the time of replacement, the engine Sl.no.2058 had done 1127.15 hrs since new and engine sl. no. 2080 had done 2387 hrs. since new and 198 hrs. since last overhaul.

The engine sl.no.2058 was sent to M/s. Turbomeca for defect investigation. Investigation report revealed that the output shaft rear bearing deterioration was found in Module-1 and a severe air path erosion was noticed (Module-2) particularly on centrifugal compressor, radial diffuser and T1 blades and Flame tube omega film was found cracked.

On 24.11.98 , engine sl. no. 2080 was also replaced with sl. no. 2012 since on 17.11.98 at Raipur, the Pilot reported that no.2 engine oil pressure was fluctuating. During rectification, LOP s/w pressure transmitter was cleaned. Oil filter was checked and engine ground run was given. During ground run, no.2 engine oil pressure continued fluctuating. During rectification oil filter was removed and fine particles were found and MCD was found

OK. System was flushed with new oil. Low Pressure switch was checked and found OK. The engine was again given ground run. During ground run, no.2 engine oil pressure continued fluctuating and chip light flickered momentarily. During rectification, fine particles were found at rear MCD and oil filter. The helicopter was grounded and the engine (Sl.no.2080) was replaced with sl. no. 2012 on 24.11.98. At the time of replacement, the engine sl. no.2080 had done 2555.05 hrs since new and 366.05 hrs since last overhaul. It had flown 168.05 hrs after installation on #2 position on VT-RLA.

The engine sl no. 2080 was sent to M/s. Turbomeca for defect investigation. Investigation report revealed that on free turbine bearing, there was abnormal wear of balls and bearing cage was damaged(consequential damage). Apart from degradation of free turbine ball bearing, flaking of rear half internal ring raceway was also observed.

On 21.7.2001, the engine sl. no. 2012 was replaced with engine sl. no. 2058 (which was initially installed on VT-RLA and was sent to Turbomeca for defect investigation following an incident at Juhu airport on 26.2.98). At the time of removal of sl. no. 2012, it had done 3498.52 hrs. since new and 1914.50 hrs. since last overhaul (TBO being 2000 hrs.). At the time of re-installation of the engine sl. no. 2058 on 21.7.2001, it was found to have done 2761 hrs since new and 914 hrs since last overhaul. As per entries made in Manufacturers log book, on 12.4.2001 the engine had been removed from the airframe following an incident abroad and was returned to Turbomeca for test run and power assurance check. Igniter and fuel pump had been replaced. On the day of accident, the engine sl. no. 2058 was found installed on VT-RLA on no.2 position.

On 4.2.2002 at Delhi, No.2 engine failed to start. During rectification, electrical wiring and start electro valve was checked and found satisfactory. Relay 53K was suspected faulty and was replaced with new 53K relay and operation was found satisfactory during ground run.

On 14.2.2002 at Juhu airport, no.2 engine failed to start and No.1 engine chip light flickered. During rectification work on no. 2 engine, Combustion chamber drain valve was checked and found satisfactory. HE ignition unit and HE igniter were checked and found satisfactory. Start injector of # 2 engine swapped with that of # 1 engine and found no improvement. Starting/pressurizing valve of # 2 engine swapped from # 1 engine and found no improvement. HP pump metering valve of No.2 engine replaced with new HP pump and found no

improvement. The old HP pump was fitted back. LP pump of # 2 engine swapped with that of # 1 engine and found no improvement. Confirmation box of T4.5 without resistance swapped and found no improvement. T1 probe was replaced with new probe and found no improvement and the old one fitted back. Ng probe was swapped from # 1 engine, contact was cleaned and the engine started.

1.6.3 Scrutiny of the defect register of VT-RLA revealed that some incidents were merely recorded as snags in the past and serious snags were recorded to have been noticed on ground after the last flight. Few of them are enumerated below:

i) On 22.8.99 at Kandla, the Pilot reported that during No.1 engine starting, TGB chip light came ON. During rectification, TGB MCD were checked and found fine metal particles. TGB oil was drained and found its colour brownish and fine metal dust particle found in oil. TGB oil system was flushed and ground run was carried out. During ground run, TGB chip light came ON again. During further rectification, on checking the chip detector and TGB oil, fine metal dust particle ring was found. TGB assembly was suspected unserviceable and the same was replaced with new one. However, scrutiny of the journey log book did not reveal any incidents/observations of any similar snag on the previous sectors, which is quite unlikely as suddenly TGB chip light coming ON during engine starting would not require replacement of TGB assembly.

ii) On 26.9.99 at Juhu airport, nil vibrations were found recorded in the Pilot Defect Register(PDR). The journey log book also showed nil incidents/observations for this date. However, nil snag was found struck off and heavy vibrations were written over that column. During rectification vibration check was carried out and Starflex and frequency adopters were replaced with new and serviceable starflex and frequency adopters. Free turbine wheel of # 1 engine was also changed as it was left with 118 Nf cycles of its stipulated life. It is quite unlikely that without experiencing vibrations in earlier sectors, Starflex and frequency adopters required replacement on ground.

iii) On 23.5.2000 at Juhu airport, nil snag was found recorded in the Pilot Defect Register (PDR). In the journey log book also nil incidents/observations were found recorded for this date. However, in the rectification column it was mentioned that after last flight check, found all three spherical thrust-bearings

having a circumferential crack. All three bearings were replaced with new and serviceable spherical thrust-bearing. It is quite unlikely that without experiencing vibrations in earlier sectors, all three spherical thrust-bearings required premature removal after the last flight check.

1.6.4 After last renewal of C of A on 13.12.2001, other snags/incidents reported on the helicopter were as follows:

On 8.2.2002 after landing at Juhu airport, MGB chip warning light flickered and came ON. During rectification, fine dust particles were found on lower MGB chip detector and conical housing chip detector. Oil was drained from MGB, oil cooler and filter was removed and dust particles were found. Magnet was inserted through the oil filling hole and metal dust was found. MGB was flushed, oil cooler and pipelines were cleaned, filter element was replaced. Magnetic chip detector was cleaned, MGB was filled with oil. During ground run and test flight no abnormality was observed and the helicopter was released for flying.

On 5.6.2002 at Hazari Bagh, the Pilot reported LHS window panel beading dislodged from the groove due to inadvertent push. During rectification the LHS window panel was fitted, checked for security and attachment and found satisfactory and the helicopter was released for flying.

On 15.9.2002 at Juhu airport, the Pilot reported that HSI was erratic. During rectification Directional Gyro was replaced and operation was found satisfactory and the helicopter was released for flying.

1.7 Meteorological Information :

The area forecast from Juhu Airport and the forecast weather within 100 NMs which was valid from 0100 UTC to 1500 UTC on 22.9.2002 was as follows:

Surface wind calm, becoming 290/08 Kts at 10/12 UTC, upper winds NW between 05 to 10 kts, weather haze TEMPO 01-15 thunder showers, Visibility 3000M in Haze becoming 6KM and TEMPO 1500M in feeble rain. The cloud amount was scattered SC 600m to 750M, scattered CU 750M to 5000M and broken AC 3000M; TEMPO 1-15 scattered ST 300M, few CB 900M to 9000M, overcast AS 2400M with weather warning Nil.

There is no Met office at Amby Valley. Before departure from Amby Valley for Juhu Airport, the destination weather is obtained from Met office at Juhu airport. The assessment of inflight visibility and actual local weather lies with the flight crew to make their own decisions. On the day of accident, as per the pilots of VT-SIP who took-off about 15 minutes prior to VT-RLA, the visibility was 5 KMs cloudy and hilltops were clear though there was drifting clouds. The passing clouds were generally coming from west/north west direction near the Amby Valley area and were above their helicopter. As per the pilots of VT-SIL who took-off about 15 minutes after VT-RLA, the visibility was 5 kms. cloudy with medium and high clouds. The clouds were broken and passing clouds in patches of about 1000 ft high. The hill tops around were generally clear of clouds.

According to one lady eyewitness who was working in the nachni field where the accident took place, the weather was Dhuka (foggy), the visibility became poor and it was dark as well.

1.8 Aids to Navigation : Amby Valley is located on radial 135 and 42 NM from Bombay VOR and the routing is direct via south of Trombay.

1.9 Communications : As per the log entries from Mumbai ATC, the helicopter VT-RLA was not in their contact after departure from Amby Valley. Also VT-RLA was neither in contact with other two helicopters VT-SIL & VT-SIP nor with Kunjali (Naval) ATC.

1.10 Aerodrome Information : The helipad at Amby Valley is a VFR helipad. It was located within the premises of Amby Valley housing complex having proper security arrangements. It had a space to park three helicopters. The approach to land/ take-off to helipad was 12°/30°.

1.11 Flight Recorders : Neither fitted nor required.

1.12 Wreckage and Impact Information :

Examination of the crash site revealed that wreckage was lying on the right side (about 90°) of helicopter normal track to Juhu airport. The first contact of helicopter with the ground was found in the form of four consecutive blade marks (main rotor blade tip hitting the ground more and more deeply) separated by a maximum distance of about 14 ft. These marks were curved slicing the ground to a depth of approx 3 inches. Of one of the main rotor blade, a piece of roughly 60 cms. was not traceable but some part belonging to this piece was traced

about 70 meters on left side of the final trajectory of the helicopter indicating that the blade was badly damaged while hitting the ground. A tree trunk cut with an angle gave the indication of the fifth contact mark of the main rotor blade. This angle suggested the inclination of about 50° to the right on the roll axis when the main rotor of the helicopter hit the ground. There was also a ground mark (skid) alongside the first blade mark indicating the possibility of helicopter initially impacting the ground in right bank attitude. After the tree trunk cut, a lot of debris from the canopy was lying on the ground. Thereafter it bounced clearing over two trees about 6 ft high and started disintegrating in the forward motion and caught fire. It rolled through a sloppy nachani field and finally impacted with the number of boulders (stones). Both the engines, transmission and root portion of main rotor blades were found near the final rest point at about 165 meters from the initial impact. A second impact was noticeable at a distance of about 60 meters after the first impact. Splines of one engine/MGB coupling shaft was also found near the main wreckage. A portion of tail boom, TGB and broken tail rotor blades found lying at a close by distance. Vertical fin and tail rotor head, did not have any fire damage indicating that there was no inflight fire. There were severe burnt areas before the final impact area, which indicated that the fuel was sprayed during the final trajectory after impact and also indicating that the fire was post crash. Both digital engine control units were found in burnt condition. The wreckage diagram is shown at Annexure-I.

The wreckage was shifted in the hanger of Million Air, a division of M/S Raymonds Ltd., at Juhu airport. The main wreckage including the engines was examined in association with two specialists from Eurocopter and Turbomeca who were deputed to India to assist/participate on behalf of BEA, France in accordance with the provisions of ICAO Annex 13. The following observations were made:

Engine/MGB coupling shafts :

On both the shafts, the splines of the flange were broken. Aspect of the fractures was characteristic of a pure torsion rupture corresponding to an overtorque in the transmission line between the main rotor blades and the engines. This overtorque occurred when a main rotor blade hit the ground while engines giving power. The condition of both flex couplings on both shafts indicated no misalignment.

Combiner gearbox:

After removal from the main gearbox, it turned freely and condition of all the gears was satisfactory. The two freewheels were found jammed in the working position and could not be disengaged. When the freewheel is engaged, the rollers are held tightly between the top of the bosses on the freewheel shaft and the input pinion bore so the pinion is driven by the shaft. In the case of an overtorque due to a blade rotor strike while engine running, the bore of the pinion is buckled by the rollers under the increasing pressure loads which results in making hollowed marks. So the freewheel gets jammed in this position.

Main gearbox:

The condition of the gears was satisfactory and the bearing turned freely. The oil pump module was in normal condition considering that the TBO of the main gearbox was practically reached.

Tail rotor drive system:

The forward shaft was found bent and the coupling found broken. The two bearings on the fan drive shaft turned freely without resistance. Blades of the rotors were not broken and no rotation marks could be seen on the broken stators. The condition of the intermediate shaft was satisfactory without coupling failures. The long rear shaft was found broken in two parts (static failure) and all the six bearings turned freely without any resistance.

Tail rotor gearbox and tail rotor:

The gearbox was still fitted on the tail boom and turned freely without resistance. The pitch change device worked normally. The two pitch change links were found bent. There was no indication of imbalance at the attachment points.

Main rotor:

The main rotor mast did not indicate any abnormality and the four contacts ball bearing turned freely without resistance. The rotating scissors and the stationary scissors were in satisfactory condition. The ball bearing of the swash plate turned freely without resistance. One pitch link was found bent and all the three were still attached with the blade horn lever. The droop restraining ring was found buckled by the droop restrainers. On the Starflex rotor head, two arms were found broken in the drag direction (typical 45° angle rupture following a main

rotor strike) and the third one was mainly broken in the flapping direction (typical 90° angle rupture). All the three bushes fitted at the end of the arms were still bonded. The spherical thrust bearings as well as the frequency adapters were in satisfactory condition. The damages on the sleeve flanges were the consequence of the main rotor blades strikes.

Main rotor blades:

On one of the blade, the spar was broken two times with evidence of leading edge strike and tip strike. On the other blade, a 60 cm part at the end of the blade was found broken. On the third, the spar was broken roughly at 60 cm from the tip. Evident ground marks could be seen at the tip.

Tail rotor blades:

One blade was found broken at the middle with evidence of a tip trailing edge strike. The second broke near the blade cuff. There was no evidence of rupture while turning but static rupture when the tail hit the ground. These observations indicated that when the blades hit the ground the tail rotor shaft was not in power. This implied that these damages were consecutive to the Engine/MGB coupling shafts ruptures. This also explained why there was no evidence of imbalance.

Skid landing gear:

The front cross tube was found broken in three parts: the horizontal part of the front cross tube between the two landing supports was not bent which indicated very low crash vertical speed. The front cross tube was found bent and broke in the forward direction. The same observations could be made on the horizontal part of the rear cross tube between the two landing supports. The two skids were broken but not bent. The manner in which the skids landing gear broke indicated that the vertical speed was very low when the aircraft impacted the ground.

Flight controls and hydraulic system:

Most of the flight control lines located under the floor were found broken in very little parts and had been badly damaged by the fire. All fractures observed were typical of static rupture (45° angle rupture). The deformations of the pilot cyclic stick were in accordance with the direction of the crash and indicated it was firmly held by the pilot. No noticeable observations could be made on the copilot cyclic stick and the two collective

sticks. These two observations seemed to indicate that there was no conflict between the two pilots. All actuators of the Auto-Pilot were severely damaged by the fire. The main servo-controls were still fitted on the main rotor, one piston was bent near the mounting on the mast casing. The extension of the piston was the same for two of them (8 cms. from the end of the lower cylinder to the axis of the mounting bolt). On the left one whose piston was bent, the measurement was higher (9 cms.). It may indicate the possibility of a lateral position of the cyclic stick. The tail servo-control was partially damaged by the fire as well as the load compensator. The two hydraulic pumps were removed from the combiner gearbox without any fracture of the splined shafts. The two hydraulic units (regulating valve, filter and pressure switch) were still fitted on the main gearbox but were partially burnt. All the flexible hoses had been burnt.

Pilot seat:

On the bucket of the pilot seat, there was no evidence of high vertical load factor (the lateral walls were not crushed). The back of the seat was broken at the junction with the bucket indicating high horizontal load factor.

Tailboom, stabiliser and fins:

The tailboom was broken in two parts but the junction with the fuselage was found totally burnt. Observations of the burnt areas indicated that it was due to a post crash fire. The horizontal stabiliser was still fitted to the tailboom, the right side outer third was detached. A heavy distortion corresponded to an impact with a stone. The upper fin was still attached to the tail boom and heavy distortion of the top corresponded to an impact with the ground. The lower fin was torn out with heavy distortion of the tail guard following impact with the ground.

The general observations indicated that the body structure and the rear structure was found to be entirely burnt. The bottom structure and the cabin floor were found broken in little pieces which indicated a high energy impact. Instruments and electronic equipments located in the front part of the cabin did not have post crash fire evidence, but were severely damaged. The warning panel was in a relatively better condition. Concerning the "NG and failure electronic unit" only the selectors panel located on the instrument panel was remaining, the electronic unit itself had not been recovered as located in the totally burnt rear structure. The two fire extinguisher bottles showed evidences of overpressure (distortion of the

percussion heads) indicating that these had not been used in flight.

Engines:

The general condition of both the engines revealed that these were superficially burnt by post crash fire. Gas generator casings, accessories, pipes were severely distorted, exhaust pipes were severely distorted and free turbines and gas generators were found seized.

On LHS engine, no particles were found in the front plug. The rear plug was missing (area severely distorted on impact). On RHS engine, no particles were found in both plugs.

Inspection of the fuel and oil filters revealed that on LHS engine, filters and o'rings were partially burnt. On RHS engine, no particles were found in filters.

DECU's were found burnt by post crash fire.

Inspection of centrifugal compressors of both the engines revealed no visible damage on the blades except presence of soil and soot ingested in the air path.

Inspection of combustion chambers revealed presence of ingested soil.

Power turbines casings were found distorted. Both free turbines showed evidences of heavy rubbing between rear faces of turbine disks and distorted exhaust pipe cones with blue coloration on the cone metal. Rubbing traces were also visible on the trailing edges of turbine blades.

The ingestion of soil, the heavy rubbing traces on free turbines and exhaust cones in addition with the fact that both transmission shafts between engines and MGB had been found sheared (torsion fracture) and evidences of overtorque had been detected on MGB free wheels indicated that both engines were running and delivering power at the time of impact.

However in order to determine the exact amount of power demanded at the time of crash and to find out the internal conditions of the engines, taking into account

the history of engines, it was felt that the strip examination of the engines was necessary. However, the same could not be done at that time due non-availability of the required tools and was done at a subsequent date.

1.13 Medical and pathological information : Capt. K. Malhotra and Capt. N.K. Bhardwaj had undergone preflight medical examinations by their company doctor on the morning of 22.9.2002 and were found medically fit to operate the flight. After the accident, all five occupants on board received fatal injuries. Post mortem of all five bodies were carried out at Khandala hospital.

Post mortem of the body of Capt. K. Malhotra revealed that the opinion as to the probable cause of death was upper and lower limbs were amputated, crushed, multiple fractures and head amputated, ribs fractured, multiple abdominal parts were crushed, teared haemonorage shock in air accident.

Post mortem of the body of Capt. N.K. Bhardwaj revealed that the opinion as to the probable cause of death was superficial multiple burns, abdomen crushed, teared and head injury; haemorrhage shock; upper and lower limbs multiple fracture in air accident.

Post mortem of bodies of other three passengers on board revealed that the opinion as to the probable causes of death were mainly due to multiple injuries, head injuries and haemorrhage etc. due to shock in air accident.

1.14 Fire : There was post impact fire.

1.15 Survival aspects : The accident was not survivable.

1.16 Tests and research:

1.16.1 The damaged parts of the helicopter viz: Main Gear Box (MGB) drive shafts (2), Broken flange spline (male), Broken ends of the tail drive shaft, Main rotor blades end surface and Droop stops were sent to Research & Development Directorate at DGCA Hqrs., New Delhi for metallurgical examination. During Visual and Macro examination under a stereomicroscope upto a magnification of 40X, the following observations were made:

i) Main Gear Box (MGB) drive shafts and broken flange spline (male) member :

Both the MGB drive shafts were found broken at the same locations. The fractured surfaces were found flat and

completely rubbed off. Few spots of virgin fracture could be located at different regions. There was no evidence of any shear lip or plastic deformation etc. The spline region of the drive shaft showed no evidence of any crack or failure. The spline teeth flanks observed to have shallow bite marks/impression probably caused by the mating teeth of the female member. There was also no evidence of any twisting / bending of the drive shafts. The splines of both the failed drive shafts and the broken spline (male) member were found intact.

ii) Broken ends of the tail drive shaft:

One end portion of the failed drive shaft revealed a slant and fibrous fracture. There was no evidence of any progressive damage. The other end portion indicated brittle fracture having dull appearance. There was an evidence of ovality and transverse cracks on the outside surface of this portion.

iii) Main Rotor blades end surface:

The outside surface of the broken end was observed to have shallow wear impression marks throughout its circumference. There was no evidence of any deterioration/damage marks on these surfaces.

iv) Drop stops: Excessive flapping marks were observed on the top and inside surfaces of the drop stops. The severity of flapping marks had caused the bending of the middle flange of the drop stops.

Further, Scanning Electron Microscopic (SEM) examination was also carried out of the fractured surface of the broken spline (male) and the fractured surfaces of the broken ends of the tail drive shaft. The SEM examination of broken spline showed the presence of the shear dimples on the fractured surface at various locations. SEM examination of the broken ends of the tail drive shaft indicated the presence of equiaxed dimples on the slant and fibrous fracture on one broken end portion. Presence of shrinkage cavities, exposed dendrites having micro cracks, which are mostly confined to the outer dendrite layers and equiaxed dimples on the fractured surface of the other end portion were observed. Presence of cavities, dendrites and rubbing marks on the inside surface of the failed portion of the tail drive shaft were observed. Presence of cavities, dendrites and rubbing marks in the outer surface of the same end portion of the tail drive shaft were observed.

The above laboratory examination revealed that the failure of both the MGB drive shafts and the broken spline male member had occurred primarily under shear over load conditions. The evidence of shear dimples confirmed the failure of these parts under shear overload conditions. There was no evidence of any progressive damage. The evidence of dimpled, rough and brittle fracture surface textured along with the presence of transverse cracks on one side of the outer surface confirmed the failure of the tail drive shaft broken ends under overload condition in bending.

1.16.2 Both the engines were strip examined in the hanger of Million Air at the Juhu airport in association with a specialist from Turbomeca who was deputed to India along with the required tools to assist/participate on behalf of BEA, France in accordance with the provisions of ICAO Annex 13 and following observations were made:

LHS engine (sl. no. 2001)

Before strip examination of the engine, during visual inspection the general condition of the engine revealed that engine was superficially burnt due to post crash fire, however the engine was exposed to the heat for considerable time causing oil coking within the engine. Both modules were damaged due to impact during crash and all pipes were badly distorted. Power and gas generator turbine were found seized and there was big distortions at turbine casing bottom flange and it was found slightly bent.

All pipes and electrical control harness were removed in order to carry out modules separation/break down.

On disassembly, no fuel could be found in pipes and engine oil was only in the module casing in little quantity and its color was dark black.

Modules were separated in accordance with the maintenance Manual Procedure and using special Turbomeca Tools.

In Module-1, output shaft did not rotate by hand. Casing was in satisfactory condition. After dismantling the upper and bottom casing, all gears, pinions and bearing were found in satisfactory condition and rotated freely but was having dark black color all over because of the oil coking and the "O" rings started deforming due to excessive heat at the time of crash.

In Module-2, The HP compressor and turbine rotated freely by hand. On removal of free turbine together with its

bearing housing and nozzle guide vane, the free turbine rotated freely, bearing did not have any visible marks, the casing outer flange was distorted because of the impact.

On removal of the HP Turbine and its balance piston, there was no evidence of damage.

On removal of turbine casing with the flame tubes, it was observed that there was bad distortion at the casing end due to an impact at crash.

On removal of the centrifugal diffuser, there was no significant evidence of wear or erosion.

During inspection of Air intake casing assembly, centrifugal compressor and front cover, it was observed that the compressor rotated freely, its blades leading edge showed no impact or erosion. There was no visible damage or distortion.

RHS engine (sl. no. 2058)

Before strip examination of the engine, during visual inspection the general condition of the engine revealed that the engine was superficially burnt due to post crash fire, both modules were damaged due to impact at crash and all pipes were badly distorted. Power and gas generator turbine were found seized and there were big distortions at turbine casing front flange.

All pipes and electrical control harness were removed in order to carry out modules separation/break down.

The fuel was still present in few pipes. Engine oil was also left in pipes and in module casing, and its color was normal and no contamination was found.

Modules were separated in accordance with the Maintenance Manual Procedure and using special Turbomeca Tools.

In Module-1, output shaft rotated freely by hand with no abnormal noise. All the rotating kinematics gears and the accessory gears (HMU, LP fuel pump, Oil pump) also rotated freely by hand.

Casing was in satisfactory condition, except the engine front bracket, which had sheared a portion of the flange at crash. After dismantling the upper and bottom casing,

all gears, pinions and bearings were found in satisfactory condition and rotated freely.

In Module-2, on removal of free turbine together with its bearing housing and nozzle guide vane, it was observed that the free turbine rotated freely. Bearing was in satisfactory condition. The trailing edge of the blades showed heavy rubbing marks due to contact with the distorted exhaust pipe.

On removal of the HP turbine and its balance piston, no evidence of damage other than rubbing marks between the labyrinth and the felt metal located in the bore was observed.

On removal of turbine casing with the flame tubes, it was observed that there was bad distortion at the casing front flange due to impact at crash.

On removal of the centrifugal diffuser, it was observed that it was badly buckled and distorted at the junction with the turbine casing. It did not show evidence of wear or erosion.

During inspection of Air intake casing assembly, centrifugal compressor and front cover, it was observed that the compressor rotated freely. The leading edge of the blade did not show any sign of impact or erosion. There was no visible damage or distortion.

1.16.3 The engine oil collected from the oil cooler at the crash site was analysed for the soap test at PHHL facilities, Mumbai and the result was found to be within limits. Both the hydraulic pumps were opened and no damage to gear and outer casing was observed. Auto-pilot control and annunciator panel's bulb filament conditions were examined at Air India facilities, Mumbai. However, nothing conclusive could be established. No information from GPS could be obtained.

1.17 Organizational and management information :

M/s Raymonds Ltd. is a non-scheduled Air Transport Operator. It has a division named Million Air. The aviation division is headed by Director of Aviation. The Million Air is engaged in domestic non-scheduled charter services, for the carriage of passengers, Mail and freight etc.

1.18 Additional information :

1.18.1 At the accident site, ten cans of Mobil Jet-II, 5 litre can of hydraulic oil, tool box and one spare aircraft battery were found. M/s Raymonds Ltd. were requested the reason for carrying these items on board for Juhu-Amby Valley-Juhu sectors. They intimated that ten cans of Jet-II and 5 litre can of hydraulic oil and tool box were not carried on board their helicopter for this particular flight. They further intimated that since the helicopter was hired by 'Air Sahara', the possibility of 'Air Sahara' requesting their crew members to carry the above referred items in VT-RLA helicopter on the return flight to Mumbai, due to limitation of space in their baggage compartment could not be ruled out and they further intimated that the same may be confirmed from Air Sahara. Regarding the reason for carrying one spare battery onboard, they intimated that prior to operating the flight on 22.9.2002, they had earlier operated flight to Pune on 20.9.2002 and a spare battery was sent as abundant precaution by road, since the helicopter was expected to make multiple starts at Pune. After completion of the flight at Pune, the spare battery was placed onboard the helicopter, close to the aircraft battery in the baggage compartment, to bring back to Mumbai, in order to avoid Octroi problems. The helicopter VT-RLA returned to Mumbai late in the evening on 20.9.2002 and due to an oversight, the battery was not off loaded and remained onboard prior to operation of flight to Amby Valley on 22.9.2002. However, the AME who carried out pre flight inspection on 22.9.2002 stated that during daily inspection he had seen the battery lying adjacent to the active battery in cargo compartment. Immediately he instructed the technician to remove the battery and he(AME) was continuing his other DI items. However, due to over-sight the technician did not off load the spare battery from the helicopter and he (AME) also assumed that the spare battery was removed. He further stated that he regretted the lapse on his part.

On query from M/S Air Sahara regarding ten cans of Jet-II and 5 litre can of hydraulic oil, they intimated that it was an irresponsible statement on the part of M/s.Raymonds knowing fully well that loose oil cannot be carried on board or in luggage compartment. They further intimated that moreover, they had so many their company vehicles plying up and down from Amby Valley daily and conveyance of excess baggage, if any by surface transport was not a problem. They further intimated that why M/s Raymonds had made such a statement against them must be seen in correct perspective. It is quite likely that when the spare battery can be kept on board VT-RLA due to

oversight by the AME, then the possibility of the ten cans of Mobil Jet-II and 5 litre can of hydraulic oil and tool box, keeping on board by M/s Raymonds due to oversight can not be ruled out. In view of above and treating of incidents as mere snags, it is suggested that Safety audit of M/s Raymonds may be carried out.

1.18.2 BDDS, at the office of BCAS, Mumbai was requested to examine the wreckage at the site from the point of view of sabotage involving explosive if any. The wreckage was examined by BDDS at the site and it was also sniffed by explosive sniffer dog. Some bluish powder was seen scattered on ground, same was tested with field explosive chemical detection kit, but the result was negative. Some quantity of powder was sent for FSL testing and confirmation of explosive if any. However the result was negative. Their report revealed that from the examination of the wreckage and scrutiny of the statement of witnesses, it was opined that the accident to the subject helicopter can not be attributed to any on board or external explosion of explosive/explosive device.

1.19 Useful or effective investigation techniques : Nil

2. ANALYSIS

2.1 Serviceability/Maintainability of the helicopter:

2.1.1 The helicopter was manufactured in 1994. It was owned, operated and maintained by M/S Raymonds Ltd., Mumbai. It was issued with Certificate of Registration and initial Indian certificate of Airworthiness on 22.12.95. At that time it was fitted with engine sl. no. 2060 on LHS(#1) and engine sl. no. 2058 on RHS(#2). The Certificate of Airworthiness was revalidated on yearly basis and was last revalidated up to 13.12.2002. The helicopter has done 225 airframe hrs. after last renewal of C of A. The port engine sl. no 2001 (which was fitted on LHS at the time of accident) had done 1442.10 hrs. and starboard engine sl. no. 2058 had done 1285 hrs., since last overhaul.

Scrutiny of documents such as engine log books and Pilot's Defect Register revealed that No.1 engine (Sl.no.2060, which was originally fitted at the time of initial issue of C of A and C of R) was replaced with sl. no. 2001 on 2.3.2000. Even on this engine both the modules had been replaced one after the other. (Module 2 was

replaced on 22.3.2002 and after carrying out one non-scheduled flight, module 1 was replaced on 5.4.2002). No. 2 engine (sl.no.2058) was replaced with sl. no. 2080 on 9.3.98. Thereafter, it was replaced with sl. no. 2012 on 24.11.98 and again replaced with sl. no. 2058 back at no. 2 position on 21.7.2001.

The reason for replacement of LHS engine sl. no. 2060 with sl. no. 2001 was that on 12.2.2000 while repositioning of the helicopter, loud thud was heard. During the process of rectification, it was decided to replace the engine. At the time of replacement, the engine (sl. no. 2060) had done 1825.15 hrs. since New/last overhaul. During disassembly of the engine at Turbomeca, heavy signs of erosion on air path, diffuser assembly, centrifugal wheel, nozzle guide vane and HP blades were observed in no.2 module.

The reasons for replacement of both the modules of engine sl. no. 2001 were that on 5.3.2002 the pilot reported surging sound after five minutes of take-off and landed back. During the process of rectification, it was decided to replace the engine. Due to non-availability of the complete engine, module-2 was replaced on 22.3.2002. Thereafter one non-scheduled flight was carried out on 25.3.2002. There was no flight till 4.4.2002. On 5.4.2002, the pilot reported no. 1 engine chip light came ON during ground run. During the process of rectification, it was decided to replace module-1. During disassembly of both the modules at Turbomeca, module-1 revealed flaking of output gear rear bearing outer ring. Module-2 revealed erosion on the centrifugal diffuser and during further disassembly rupture of centrifugal diffuser radial vanes on the leading edges.

The reason for replacement of RHS engine 2058 with sl. no. 2080 was that on 26.2.98 the pilot reported flickering of RHS engine chip warning light about 5 mts. before landing. During the process of rectification, it was decided to replace the engine on 9.3.98. At the time of replacement, the engine (sl. no.2058) had done 1285 hrs. since last overhaul. Disassembly of the engine at Turbomeca revealed that the output shaft rear bearing deterioration was found in Module-1 and severe air path erosion was noticed (Module-2) particularly on centrifugal compressor, radial diffuser and T1 blades and Flame tube omega film was found cracked.

The reason for replacement of engine sl.no.2080 with sl. no. 2012 was that on 17.11.98, the pilot reported no. 2 engine oil pressure was fluctuating. During the process

of rectification, it was decided to replace the engine on 24.11.98. At the time of replacement, the engine (sl. no.2080) had done 366.05 hrs. since last overhaul. Disassembly of the engine at Turbomeca revealed that on free turbine bearing, there was abnormal wear of balls and bearing cage was damaged (consequential damage). Apart from degradation of free turbine ball bearing, flaking of rear half internal ring raceway was also observed.

The reason for replacement of engine sl. no. 2012 with sl. no. 2058 was recorded as it had done 1914.50 hrs. and TBO was 2000 hrs.

From the above, it is therefore evident that all the engines maintained by M/s Raymond Ltd. have been removed prematurely before completing TBO life of 2000 hrs.

2.1.2 On 22.9.2002, Sh. Jaspal Singh Sahans, (AME no. 3439) carried out the Daily Inspection Schedule on VT-RLA at Juhu airport at 0445 UTC before the helicopter took-off at 0627 UTC for Juhu-Race Course-Amby Valley-Juhu sectors. No snag was found recorded by the flight crew in the previous sector. Fifty hrs./ 30 days schedule/ check had been carried out on 28.8.2002 and the flight release certificate was issued on 28.8.2002 which was valid up to 26.9.2002 or completion of 2772.55 flying hrs.

After the accident, the helicopter wreckage was examined in association with specialists from Eurocopter and Turbomeca who were deputed to India on behalf of BEA, France in accordance with the provisions of ICAO Annex 13. The examination revealed that the helicopter wreckage was scattered over an area of approx. 165 meters. There were several burnt areas before the final impact area which indicated that the fuel was sprayed during the final trajectory after the impact. This also indicated the fire was a post crash. Vertical fin and tail rotor head also did not have any fire damage indicating that there was no inflight fire. The helicopter has hit the ground in a right bank attitude at very high horizontal speed. One main rotor blade was badly damaged when the tip hit the ground but was not entirely broken at that time indicating that it could have hit the canopy as the debris of the canopy was lying just after the tree trunk cut main rotor blades. The bottom structure and the cabin floor were broken in small pieces indicating high energy impact. The torsion fracture of the two engine/MGB coupling shafts indicated that the two engines were delivering power when the main rotor blades hit the ground. There was no evidence of previous malfunction or previous failure before the helicopter crashed. All the observed ruptures

appeared to be consequent of the crash. Breakage pattern of the skids indicated that the vertical speed was very low when the helicopter impacted the ground. Due to the fire, most of the flight controls components were severely damaged. All fractures observed were typical of static rupture. However there was no evidence of inflight failure of flight controls. The two fire extinguisher bottles showed evidences of overpressure indicating that these had not been used in flight.

During examination of the engines, the ingestion of soil, the heavy rubbing traces on free turbine and exhaust cones in addition with the facts that both transmission shafts between engine and MGB had been found sheared (torsion fracture) and evidences of over torque had been detected on MGB free wheels indicating that both engines were running and delivering power at the time of impact.

However, taking in to account the history of the engines, and to determine whether the engines were developing required power at the time of crash, the engines were strip examined in the hanger of Million Air at Juhu airport in association with a specialist from Turbomeca who was deputed to India along with the required tools to assist/participate on behalf of BEA, France in accordance with the provisions of ICAO Annex 13. Strip examination revealed that the engines were operating and delivering power at the time of crash. All damages observed on this engine resulted from impact from post crash fire.

Metallurgical examination of Main Gear Box (MGB) drive shafts (2), Broken flange spline (male), Broken ends of the tail drive shaft, Main rotor blades end surface and Droop stops revealed that both MGB drive shafts and of the broken spline (male) member have failed under shear overload conditions. One broken end portion of the tail drive shaft has failed under bending overload conditions.

2.1.3 From the evidences enumerated above, it is evident that all the engines have been removed prematurely without completing TBO life of 2000 hrs. However, no defect/incident was found recorded in PDR/Tech log in the previous (last) sector operated just prior to the premature removal of the engines. It is opined that premature removal of engines in the above scenario should have left some symptoms in the previous sector operated by the helicopter.

Further, the Scrutiny of the defect register of VT-RLA revealed that some incidents were merely recorded as

snags in the past and serious snags were recorded to have been noticed on ground after the last flight e.g. on 22.8.99 at Kandla, the Pilot reported that during No.1 engine starting, TGB chip light came ON. During the process of rectification, TGB assembly was replaced.

However, scrutiny of the journey log book did not reveal any incidents/observations of any similar snag on the previous sectors. On 26.9.99 at Juhu airport, nil vibrations were found recorded in the Pilot Defect Register(PDR). The journey log book also showed nil incidents/observations for this date. However, nil snag was found struck off and heavy vibrations were written over that column in the PDR. During the process of rectification, Starflex and frequency adopters were replaced. Free turbine wheel of # 1 engine was also changed as it was left with 118 Nf cycles of its stipulated life. On 23.5.2000 at Juhu airport, nil snag was found recorded in the Pilot Defect Register (PDR). In the journey log book also nil incidents/observations were found recorded for this date. However, in the rectification column it was mentioned that after last flight check, found all three spherical thrust bearings having a circumferential crack. All three bearings were replaced. It is opined that sudden replacement of major components is quite unlikely without leaving symptoms/observations in the earlier sectors. It therefore appears that though the helicopter was in serviceable condition on the day of accident, it is necessary that reporting of incidents should be taken seriously rather than treating these as mere snags for the purpose of proper investigation. All incidents should therefore be reported promptly by flight crew and QCM should have effective control of monitoring of snags/ incidents for prevention and recurrence.

2.2 Weather :

The pilots had obtained the weather from Juhu airport before departure for Amby Valley. The area forecast and the forecast weather within 100 NMs which was valid from 0100 UTC to 1500 UTC on 22.9.2002 was as follows:

Surface wind calm, becoming 290/08 Kts at 10/12 UTC, upper winds NW between 05 to 10 kts, weather haze TEMPO 01-15 thunder showers, Visibility 3000M in Haze becoming 6KM and TEMPO 1500M in feeble rain. The cloud amount was scattered SC 600m to 750M, scattered CU 750M to 5000M and broken AC 3000M; TEMPO 1-15 scattered ST 300M, few CB 900M to 9000M, overcast AS 2400M with weather warning Nil.

Since there is no Met office at Amby Valley, the assessment of inflight visibility and actual local weather lies with the flight crew to make their own decisions. On the day of accident, as per the pilots of VT-SIP who took-off about 15 mts. prior to VT-RLA, the visibility was 5 KMs cloudy and hill tops were clear though there was drifting clouds. The passing clouds were generally coming from west/north west direction near the Amby Valley area and were above their helicopter. As per the pilots of VT-SIL who took-off about 15 mts. after VT-RLA, the visibility was 5 kms. cloudy with medium and high clouds. The clouds were broken and passing clouds in patches of about 1000 ft high. The hill tops around were generally clear of clouds.

According to one lady eyewitness who was working in the nachni field where the accident took place, the weather was Dhuka (foggy) and it was dark as well. The weather had become poor.

From the foregoing, it can therefore be inferred that though the visibility at the time of take-off from Amby Valley was 5 Kms., there were passing and drifting clouds and the weather was foggy close to the ground and the visibility became poor on the right side of track in the area where the helicopter crashed. The weather is therefore a contributory factor to the accident .

2.3 Deviation of the helicopter from its normal track after take-off from Amby Valley:

Amby Valley is located on radial 135 and 42 NM from Bombay Radar and the routing is direct via south of Trombay. After VT-RLA had taken off, it was seen by the flight crew of VT-SIL, who were scheduled to take-off after 15 mts. of VT-RLA, and it was observed setting course directly on radial 315 towards Juhu airport and was not visible to them once it went abeam the Koraihar fort. Thereafter, VT-SIL also took-off after 15 mts. interval. VT-RLA was neither in contact with Mumbai ATC nor with VT-SIP, VT-SIL and Kunjali ATC.

It is quite likely that VT-RLA had deviated from its normal track towards right side due some of the reasons such as to show the Amby Valley area to the visitors (foreigners) on board at their request or drifting clouds coming from west/north west direction or attempting to force land in the field due to technical problem or attempting to land back at Amby Valley at the request of the visitors .

Considering the possibility of deviation due to showing the area to the visitors at their request, it is felt that the possibility can not be totally ruled out as the Amby valley area from the air was more prominently visible from the right side rather than the left side of the normal track of the helicopter .

Considering the possibility of deviation due attempt to force land in the field due technical problem, it is felt that though there were no obstructions around, the trajectory of the aircraft was not the best in case of an emergency procedure and most appropriated area to be used for an emergency landing. In such a situation, the horizontal speed of the helicopter would have been much lower. The horizontal speed of the helicopter was estimated to be very high (about 150 kts.) which was close to VNE. The possibility of the helicopter deviating from the normal track for attempting to force land in the field is therefore ruled out in view of above circumstances.

Considering the possibility of deviation due attempt to land back at Amby Valley helipad due drifting clouds, it is felt that since VT-SIP, VT-RLA and VT-SIL had taken off from the same helipad within an interval of 15 mts. and VT-SIP and VT-SIL had landed at Juhu airport, the weather at Ambay Valley was such that the visibility was 5 kms. and hill tops around were clear though there were passing/ drifting clouds. These clouds were coming from West/ North-West direction , and there is a possibility that the crew deviated to the right to avoid these clouds and in that area (where the accident took place) the weather was foggy and dark as well and the visibility had become poor , the crew might have attempted to turn back towards Amby valley for landing . Thus the possibility of the helicopter deviating from the normal track for attempting to land back at Amby Valley helipad due drifting clouds can also not be ruled out in view of above circumstances.

Considering the possibility of deviation due attempt to land back at Amby Valley helipad at the request of visitors, it is felt that the possibility can not be totally ruled out as the location of the wreckage was such that it was indicating that the helicopter was in a continuous right turn on radial 85 (towards Amby Valley helipad) from normal track when it crashed .

2.4 Sabotage aspects:

BDDS, at the office of BCAS, Mumbai was requested to examine the wreckage at the site from the point of view of

sabotage involving explosive if any. After the examination of the wreckage and scrutiny of the statements of witnesses, it was opined that the accident to the subject helicopter can not be attributed to any on board or external explosion of explosive/explosive device.

2.5 Circumstances leading to the accident:

Three helicopters had taken off from Amby valley helipad within an interval of 15 minutes. VT-RLA was the second to take-off. The weather at Amby Valley was such that the visibility was 5 kms. with hill tops clear and there were drifting clouds. VT-RLA, after take off, was seen setting course straight for Juhu airport. After climb out , the pilots turned right side either to avoid drifting clouds or to show the Amby valley area to foreigners or to land back at Amby valley at the request of visitors and while continuing right turn entered into bad weather in that area as the weather at the site of accident was foggy and the visibility became poor. While continuing right banked turn , the pilots lost visual reference to the ground , main rotor blades hit the ground more and more deeply and the helicopter bounced and a tree trunk was cut and it started disintegrating and was destroyed by the impact and post impact fire. All five persons on board received fatal injuries.

3. CONCLUSIONS

3.1 Findings :

1. The helicopter held valid Certificate of Airworthiness.
2. The helicopter held valid flight release certificate.
3. The pilots held valid licenses while undertaking the flight.
4. After take-off, the helicopter was seen setting course straight for Juhu airport on Radial 315 .
5. The visibility at Amby Valley was about 5 kms. There were medium and high broken and drifting clouds.
6. The helicopter deviated from its normal track and took right turn.

7. The weather was foggy , the visibility became poor and it was dark as well on the right side of track.
8. The trajectory was not the best in case of an emergency landing.
9. During the right turn at low height, the pilots entered into bad weather and lost visual reference with the ground.
10. While continuing the turn on radial 85, the helicopter banked about 50° to the right and main rotor blades sliced the ground four times and cut a tree trunk after clearing two trees.
11. In the process, the main rotor blades cut the canopy and the helicopter impacted the ground and started disintegrating and was destroyed due to the impact and post impact fire.
12. Examination of the wreckage/stripping of engines revealed that engines were operating and developing power. There was no evidence of in-flight failure of flight controls.
13. The accident is not attributed to any on board or external explosion of explosive/explosive device.
14. The helicopter has not hit any obstructions before impacting the ground.
15. At the accident site, ten cans of Mobil Jet-II, a 5 litre can of hydraulic oil, tool box and one additional aircraft battery was found.
16. There was post impact fire.

3.2 Probable cause of the accident :

The pilots after getting airborne turned towards right side of track and soon thereafter collided with the ground on losing visual reference due bad weather in that area.

4. RECOMMENDATIONS

- i) Safety Audit of M/s Raymonds Ltd. may be carried out.
- ii) Safety awareness amongst General Aviation Pilots should be enhanced by frequent monitoring of operational activities of Non - Scheduled / Private operators .

Mumbai
14.5.2002


(Subhash Chander)
Director Air Safety
Inspector of Accidents (VT-RLA)