FINAL INVESTIGATION REPORT ON ACCIDENT TO AMAN AVIATION & AEROSPACE SOLUTIONS (P) LTD.

ROBINSON R-44 HELICOPTER VT-PHB

ON 11-12-2016 NEAR JUHU, MUMBAI

AIRCRAFT ACCIDENT INVESTIGATION BUREAU
MINISTRY OF CIVIL AVIATION

GOVERNMENT OF INDIA

FOREWORD

This document has been prepared based upon the evidences collected during the investigation and opinion obtained from the experts. The investigation has been carried out in accordance with Annex 13 to the convention on International Civil Aviation and under Rule 11 of Aircraft (Investigation of Accidents and Incidents), Rules 2012 of India. The investigation is conducted not to apportion blame or to assess individual or collective responsibility. The sole objective is to draw lessons from this accident which may help to prevent such future accidents.

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Final Report on accident to Aman Aviation & Aerospace Solutions (P) Ltd. Robinson R44 helicopter VT-PHB on 11-12-2016 Near Juhu, Mumbai

1	Helicopter	Type	Robinson R44
		Nationality	Indian
		Registration	VT- PHB
2	Owner		Aman Aviation & Aerospace Solution (P) Ltd.
3	Operator		Aman Aviation & Aerospace Solution (P) Ltd.
4	Pilot- in- Command		CPL (H) Holder
	Extent of Injuries		Fatal
5	Date & Time of Accident		11.12.2016, 0630 UTC.
6	Place of Accident		Aarey Colony, Near Juhu, Mumbai
7	Co-ordinates of Accident site		Lat 29^0 46’ 21” N, Long 77^0 30’ 33” E
8	Last point of Departure		Juhu Aerodrome
9	Intended Landing Place		Juhu Aerodrome
10	No. of Passengers on Board		03
	Extent of Injuries		02 Fatal
11	Type of Operation		Joy Ride
12	Phase of Operation		Cruise
13	Type of Accident		Fatal Accident during Forced Landing

All timings in the report are in UTC

1. FACTUAL INFORMATION

1.1 History of Flight:

On 11.12.2016 Robinson R-44 helicopter was planned to operate 06 sorties of Joy ride over Mumbai (Juhu - Juhu) during the day. The pilot completed a walk-around inspection of the helicopter. He checked all systems described in the Pilot Operating Handbook (POH). No abnormalities were observed.

At 060217 UTC the pilot asked the ATC for start-up for the first sortie of the day and informed ATC about flight as per flight plan i.e. local flying Powai and back with 4 persons on board. It was also informed that there will be about six sorties during the day. The start-up was approved. Thereafter the helicopter was cleared for local flying. The routing given was overflying Powai and back maintaining 500 feet with instructions to turn right after departure. The above instructions were read back by the pilot. Thereafter the helicopter was cleared for take-off and winds informed were 290/08 knots. The instructions were copied by the pilot. The helicopter was asked to report when over Powai and these were also read back.

The helicopter took-off at 0609 UTC. At 0613 UTC pilot informed ATC its position as over Powai and requested for set course back. The ATC cleared the helicopter to land on runway 26 and informed winds as 300/10 knots. The landing clearance given to the helicopter was read back by the pilot. The helicopter then landed on runway 26. The flight was uneventful.

After landing both the passengers were deplaned and the next two passengers boarded the helicopter for next sortie. One technician who was on board during the sortie sitting next to the pilot in order to maintain weight & balance of the helicopter for the flight. He was again asked by the pilot to remain seated for the next sortie also and the technician remained seated for the next sortie also. The deplaning and boarding were carried out with engine ON.

The normal flight path being followed by the helicopter of the operator for flights is as below:

At 061820, ATC gave taxi clearance to the helicopter for next (second) sortie. At 062030, the pilot requested for lineup on runway 34 and informed Persons on Board as 04. The request for lineup was approved by ATC. At 062135, ATC cleared the helicopter for take-off from runway 34 and informed winds as 300/11 knots.

At 062225, the pilot informed ATC that the helicopter was then airborne, turning right and would contact ATC when over Powai. As per the technician who was on board the helicopter, the passengers were shown Powai lake, vihar lake and film city before returning for Juhu Airport. He was looking outside the cockpit and felt some reduction in the RPM. He immediately looked inside the cockpit and had not observed any of the caution or warning light glowing.

Simultaneously, at around 0627 UTC, while at an altitude of approximately 500 feet AGL, the pilot had informed the ATC that he was making a forced landing

in Powai due clutch failure. As per the tape transcript, the pilot intimated the ATC “Forced landing in Powai, ------- Clutch in is failure”.

The technician further stated that the pilot tried to land the helicopter on a level ground but saw some children playing there and decided to land beside the ground.

However, during this process the helicopter kept on loosing height and it hit the bunch of trees ahead of the field and finally impacted ground in between that bunch of trees. The helicopter caught fire just after impact with ground.

After about 2½ minutes of the last call given by the helicopter, ATC gave a call to the helicopter but there was no response. Another helicopter flying in the area also tried to contact the helicopter but there was no response. The other helicopters which were on listening watch and flying in the area at that time were asked to divert to Powai side and search the helicopter.

The technician who was on the left hand side was taken out of the helicopter by the local people. The pilot and the two passengers though rescued by the local people had received serious injuries.

After receiving the message from the local people the police authorities arrived at the site. All the 04 persons were then rushed to the nearby hospital for further medical attention. The pilot received fatal injuries and was declared dead at hospital. The passengers were also critical and succumbed to their injuries. The technician though survived his injuries.

1.2 Injuries to Persons :

Injuries	**Crew**	**Passengers**	**Others**
Fatal	01	02	NIL
Serious	NIL	01	NIL
Minor/None	NIL	NIL	NIL

1.3 Damage to Helicopter:

The helicopter was destroyed due impact during the accident. The post impact fire also caused damage to the rubber parts. Following are the main damages:

- The cockpit was completely destroyed and burnt. All the cockpit instruments were burnt.
- The cyclic/ collective were found dislodged from its mount and were found broken.
- The rotor blades were intact but one of the rotor blades was found cracked at 40% span from root section and the other was found having dents at the lower surface and delaminated at various sections throughout its span.

- One pitch link rods was found broken and disengaged from one end.
- The push-pull rods connecting main rotor with the shaft assembly was found damaged and burnt.
- The engine was found intact with its mounting but the mounting had burn marks.
- The engine case was found damaged and burnt.
- The tail rotor drive shaft was found intact but the connecting rods were found broken and burnt.
- The tail boom was intact, however there were some dents observed at various positions.
- Both the tail rotor blades were found intact. However, one of the tail rotor blades was found damaged at tip section.

- Lower vertical stabilizer was found bent near root section.
- Horizontal stabilizer was found damaged due impact with ground.
- Both the skids were found disengaged from the main body and broken.
- The LH forward door was found separated (might have been done during rescue) from the main body and was damaged.

1.4 Other Damages :

- Some of the trees were found cut from the top by the helicopter during final fall.
- A tree with damaged bark at around 4 feet from ground was observed probably due impact with the helicopter. Also, some pieces of glass were found stuck inside the trunk.
- A small tree was found cut and completely burnt.

1.5 Personnel Information:

1.5.1 Pilot- in- Command

AGE	53 Years
License	CPL (H)
Date of License Issue and Valid up to	14.01.2008 / 13.01.2018
Category	Helicopter
Class	Single Engine Land
Endorsements as PIC	Robinson R-44 & Cheetah
Date of Joining Company	01.12.2013
Date of Endorsement as PIC on type	14.01.2008
Date of RTR Issue and Valid up to	16.03.2007 & 15.03.2032
Date of FRTOL issue & validity	14.01.2008 & 13.01.2018
Date of Med. Exam & validity	16.11.2016 & 21.11.2017
Date of last Route Check	15.07.2016
Date of Last Proficiency Check	15.07.2016
Date of English language Proficiency & Valid up to	05.03.2011 & 04.03.2017

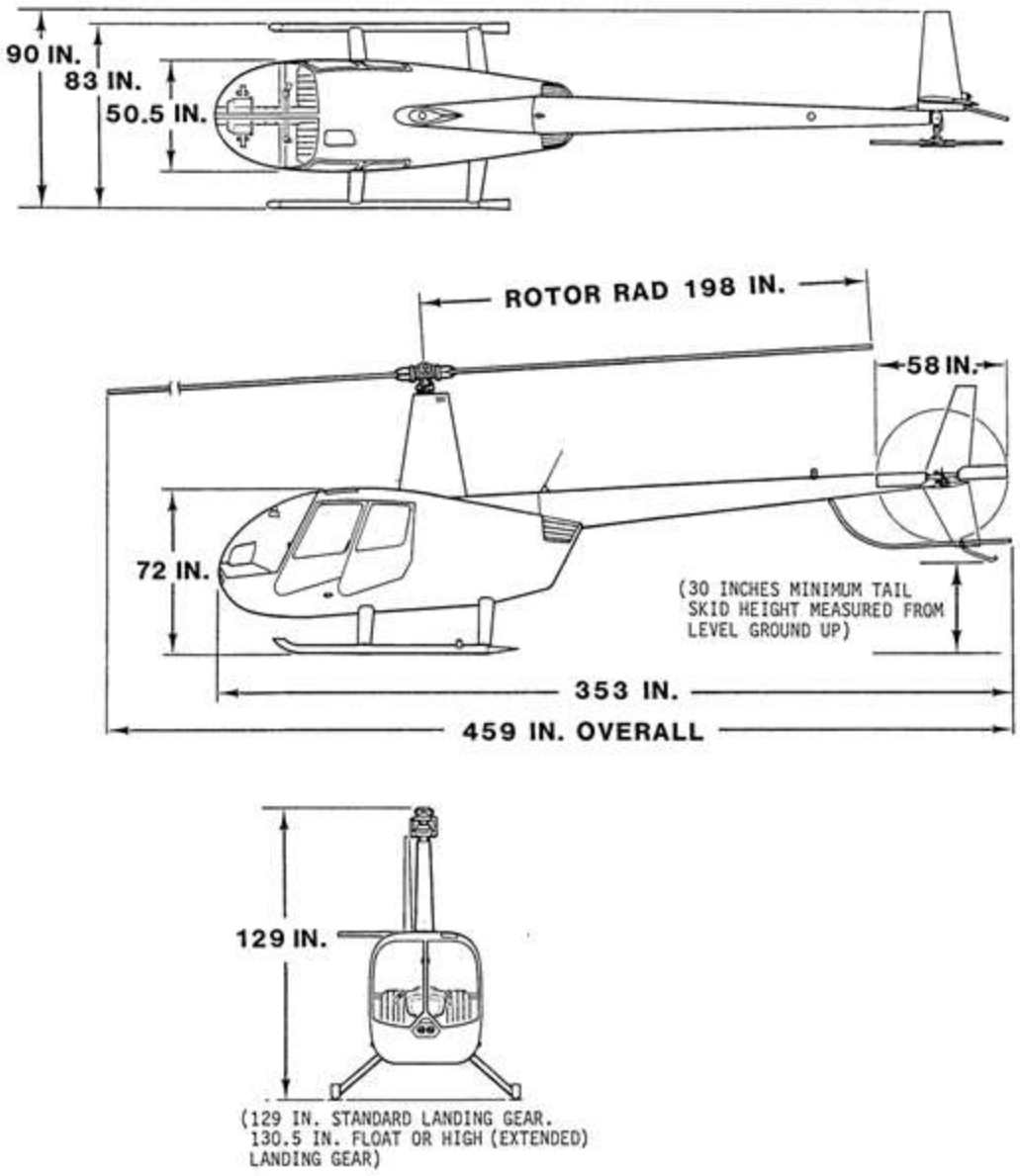
Simulator Training for Critical Emergencies	19.05.2016 on helicopter
Total flying experience	3957:10 Hours
Total Experience on type	1755:00 Hours
Total Experience as PIC	2335:10 Hours
Last flown on type	10.12.2016
Total flying experience during last 01 Year	 338:50 Hours
last 180 days	163:05 Hours
last 90 days	117:40 Hours
last 30 days	46:05 Hours
last 07 Days	16:50 Hours
last 24 Hours	04:05 Hours
Rest period before the flight	17 hours approximately

1.6 Helicopter Information :

1.6.1 General Description

Robinson R44 helicopter is a single engine helicopter manufactured by M/s Robinson Helicopter, California, USA. The helicopter is certified in transport category, for day operation under VFR. The maximum operating altitude of this helicopter is 14,000 feet density altitude and maximum take-off weight is 2400 lbs (1089Kgs). Helicopter length is 9.12 meters (359 inch) and width is 2.18 meters (86 inch), height of this helicopter is 3.27 meters (129 inch). The standard helicopter seating configuration is 01 Pilot and 03 passengers.

It is constructed primarily of metal and equipped with skid-type landing gear. Primary structure is welded steel tubing and riveted Aluminum. The tail cone is a semi-monocoque structure in which Aluminum skins carry most of the primary loads. Fiberglass & thermoset plastics are used in the secondary structure of the cabin, engine cooling system, and in various other ducts & fairings.



3 View Diagram of Robinson R44 Helicopter

POWERPLANT:

The helicopter was powered by one Textron-Lycoming O-540-F1B5 six-cylinder, horizontally opposed, overhead-valve, air-cooled, carbureted engine with a wet sump oil system.

Lowering collective mechanically adds carburetor heat and raising collective reduces carburetor heat. The pilot may override the friction clutch and

increase or decrease carburetor heat as desired. A latch is provided at the control knob to lock carburetor heat off when not required.

Cooling is supplied by a direct-drive, centrifugal fan wheel enclosed by a fiberglass scroll. The scroll directs cooling air via flexible ducts to the muffler, the main rotor gearbox, the hydraulic reservoir, the drive belts, and engine-mounted sheet-metal cooling panels. The cooling panels also direct cooling air to the drive belts, and further guide cooling air to the cylinders, external oil cooler (two on R44 II), alternator, magnetos, fuel flow divider, and battery.

A sheave bolted to the propeller flange transfers engine power to the clutch assembly via four double v-belts engaged by a vertically mounted electric belt tension actuator.

DRIVE-TRAIN

A V-belt sheave is bolted directly to the crankshaft of the engine, four double V-belts transmit power to the upper sheave, which has an overrunning clutch in its hub. The clutch shaft transmits power forward to the main rotor and aft to the tail rotor. Flexible couplings are located at the input to the main gearbox and at each end of the long tail rotor drive shaft. The main rotor gearbox contains a single-stage spiral-bevel gear set, which is splash-lubricated. The long tail rotor shaft has no hanger bearings but has a lightly-loaded damper bearing. The tail rotor gearbox also contains a splash-lubricated spiral bevel gear set. The tail rotor gearbox input and output shafts are both made of stainless steel to prevent corrosion. The other shafts throughout the drive system are made of alloy steel.
The Minimum extension of the actuator is 0.015 inches in fully retracted position and maximum extension is 1.60 Inches in fully extended position. When the helicopter is operating normally, the clutch actuator is extended fully in order to make sure that all the power from the engine is transmitted to the main and tail rotors for normal flight. The clutch actuator circuit incorporates a low-amperage fuse to prevent a motor overload from tripping the circuit breaker, turning off the

CLUTCH light prematurely and to prevent motor burnout due to prolonged motor overload. This also results in drive belt over-tensioning protection.

BEARINGS

In a typical arrangement on R44 helicopter (above photo from other R44 helicopter available with the operator), just to the left of the four belts, there is an upper bearing. The purpose of the upper bearing is to hold the drive shaft up (or down) while allowing it to turn. There is an orange teletemp mounted on the bearings which gives an idea of the temperature the bearing has been running at because bearings can run hot before failure. If the bearing suddenly starts to run hot, that would indicate a developing problem. Just to the right of the upper bearing, built into the hub of the upper sheave is the freewheeling unit. The purpose of the freewheeling unit is to allow the rotor to keep turning if the engine stops (to autorotate).

FLIGHT CONTROLS

Left side controls were removed though dual controls are available as standard equipment. All primary controls are actuated through push-pull tubes and bellcrank. R44 flight controls operate conventionally. The cyclic grip is free to move vertically allowing the pilot to rest his forearm on his knee if he chooses. The collective stick is conventional with a twist grip throttle. When the collective control is raised, the engine throttle is opened automatically by an interconnecting

linkage. Additionally, an electronic throttle governor adjusts throttle position to maintain RPM.

LIGHTS

Warning lights on the instrument panel include clutch, low oil pressure, low fuel, main rotor and tail rotor gearbox chip lights, main rotor gearbox over-temp, engine fire (sensor activates at 275 ± 10 °F), low rotor RPM light, low voltage (ALT), rotor brake, and starter engaged. R44 additionally include fuel filter, aux fuel pump, and carbon monoxide warning lights.

CIRCUIT BREAKER PANEL

The circuit breaker panel is on the ledge just forward of the left front seat. Breakers are marked to indicate function. Inflight resetting of circuit breakers is not recommended.

1.6.2 Helicopter Information

The helicopter with manufacturers Serial Number 0055 was manufactured on 10-11-1994. Certificate of Registration No. 2597/2, under Category 'A' was initially issued in name of M/s Pawan Hans Helicopter (PHL) Ltd. In 2008, PHHL decided to dispose the helicopter as it was due for overhaul requiring major overhaul work and replacement of components. The helicopter was on ground for about 2 years before it was bought by the present operator as the helicopter and major components were due for overhaul. The ownership of the subject helicopter was subsequently transferred to present operator by DGCA.

The certificate of Airworthiness Number 2085 was issued under "normal" category sub-division "passenger" issued by DGCA on 18.04.1994 and specifying minimum crew as one. The present operator has carried out the maintenance activity and after overhaul C of A was re-issued on 12.03.2015 to the present operator by DGCA with lifetime validity. ARC No. PHB/2085/ARC valid upto17.03.2017 was also issued. The helicopter has logged 2887:50 airframe hours till the date of accident.

The helicopter and its engine are being maintained under continuous maintenance programme consisting of calendar period based maintenance and Flying Hours / Cycles based maintenance. Last major inspection 2200Hrs/ 144 Months Inspection schedule was carried out at 2180:30Hrs on 30/07/2012 at Mumbai. The helicopter was last weighed on 04/03/1994 at Robinson Helicopter, USA and the weight schedule was recomputed on 28/07/2013 and duly approved by DGCA. There has not been any major modification affecting weight & balance since last weighing.

First flight Daily inspection Schedule was carried out on the day of accident and helicopter had carried out uneventful 00:13 hrs of flight with 01 landing before the accident sortie. Load and trim sheet of flight was prepared with center of

gravity within limits. All the higher inspection including checks/ inspection were carried out. Horizontal Stabilizer, Lower & Vertical Stabilizers were replaced on helicopter on 21.11.2016.

ENGINE

O-540 F1B5 engine manufactured by Lycoming having Engine S/No L-25282-40A was installed on the helicopter. This Engine had logged 1241:25 hrs since new and 359:05 hrs since last overhaul. The last major inspection carried out on Engine was 2200 hrs/ 144 Months. It was carried out on 30/04/2015 at 885:20 engine hours.

1.7.1 Meteorological Information:

The MET report of Juhu during the period from 0600 UTC to 0700 UTC is as below:

Time (UTC)	Winds (^{o}/Knots)	Visibility (Meters)	Clouds	QNH (HPA)	Temp (^{o}C)	Dew Point (^{o}C)
0600	290/08	6000	NSC	1013	30	17
0630	300/10	6000	NSC	1013	30	18
0700	300/13	6000	NSC	1012	30	19

1.8 Aids to Navigation:

The helicopter was VFR cleared and is equipped with ADF, VOR, ATC Transponder and GPS. Helicopter was flying using Jeppesen Charts, Map, Ground references and GPS.

1.9 Communication:

There was always two way communications between the helicopter and ATC.

1.10 Aerodrome Information:

The airport is a VFR airport with only day operations. The airport has two intersecting runways, runway 08/26 and runway 16/34. The primary runway is runway 26. It is used by small General Aviation aircraft and helicopters. Runway Specifications are as below:

Rwy Orientation	Dimension	PCN
08/26	1142mx30m	PCN 17 F/D/Y/T
16/34	726mx20m	--

Juhu runway is non-instrumental. No designated apron is available. Aircraft are parking in dispersal area as per the provisions of SOP. Watch Hours are from 0200 to 1230 UTC. The VHF tower frequency is 124.35 MHz and the alternate frequency is 118.75 MHz.

1.11 Flight Recorders:

Cockpit Voice Recorder (CVR) and Digital Flight Data Recorder (DFDR) were neither fitted nor required as per existing Civil Aviation Requirements.

1.12 Wreckage & Impact Information:

As per the evidences collected and inspection of the accident site the helicopter impacted the trees. The helicopter left side cabin hit one of the trees as evident from the glass pieces found stuck on the tree and a broken part of the cabin door was found lying alongside the tree.

The helicopter turned to its right side after hitting trees as landing gear skids impacted the tree. Finally, the helicopter impacted the ground on its right and immediately caught fire.

On examining the wreckage and the accident site following observations were made:

- Wreckage found lying on ground on RH side.
- Helicopter found lying on ground facing south and tail on north side.

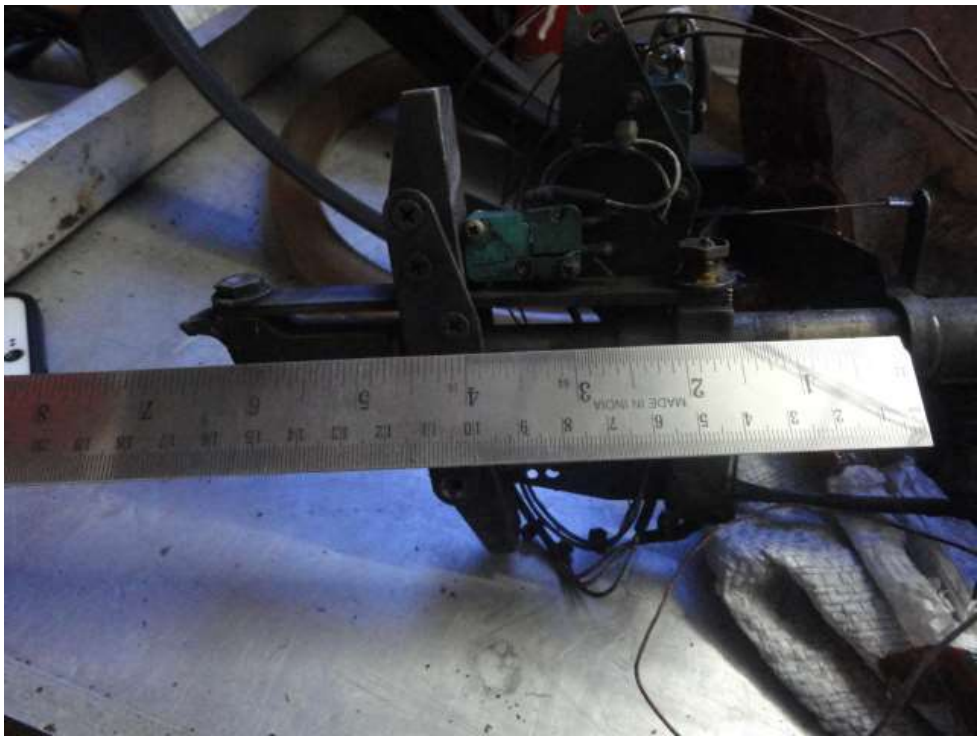
MRH got entangled with a tree and came down by uprooting the tree.

Both main rotor blades damaged due to impact but stay connected on mast hub.

Front part (Cockpit/Cabin) of the helicopter completely burnt.

- Passenger and crew deck area of the helicopter found burnt and missing.
- Small pieces of wreckage found scattered all around.
- Parts of the trees found burnt due to wreckage fire.
- MGB cowling melted and gears visible.

- MR mast fairing damaged, push pull tubes for cyclic and collective burnt and broken due to impact.
- Clutch assembly burnt and broken due to impact, actuator motor found in full extended position, upper limit switch & restraint found intact in place.



- Clutch V belts (drive belts) were found intact but burnt from upper sheave.

- Complete cockpit instrument panel radio equipment's found damaged and burnt. It was not possible to take instrument readings.

- All airframe parts, doors, panels, exhaust pipe, induction tubes, carburetor broken & separated from the airframe and engine.

- Landing gear skids broken and separated in pieces due to impact with ground/trees.
- Tail rotor gear box & tail rotor hub found intact on tail boom with no apparent signs of damage.

- One Tail Rotor Blade (TRB) found intact and undamaged, second TRB found intact with bent on the tip due to impact with tree.

1.13 Medical & Pathological Information:

The Pilot was subjected to Preflight Medical including Breath Analyser Test before the first flight of the day and was found satisfactory. Breath Analyser test was negative (not under the influence of alcohol).

After the accident the injured pilot was taken by the police to hospital in asystole condition with multiple injuries and trauma. Immediate CPR was initiated but the pilot succumbed to his injuries. The differential diagnosis as per the hospital was Cardiogenic Shock, Cardiac Arrest and Trauma as the cause of death.

1.14 Fire:

There was post impact fire.

1.15 Survival Aspects:

The accident was not survivable.

1.16 Test and Research:

The engine was strip examined and the damage observed were due to the impact and post-crash fire. No abnormality was found during the strip examination. All the accessories were found intact before strip investigation. Engine Controls were in place at the time of removal of engine from the airframe. The electrical harness was attached to various points on the fire wall. All the oil lines were intact in its place and on removal of the pipelines the engine oil was found dripping from the connectors. All the fuel primer lines were in place and attached to the cylinders. Exhaust and induction lines were secured to the respective locations.

After undressing the engine, the cylinder base mountings were found intact in place. There was no trace of oil leak from the base of the cylinders. All the electrical connections i.e. alternator, starter and spark plug harness were

found intact. Shroud tubes were found intact with no evidence of leakages or physical damages.

Oil cooler was found intact with no damage and both oil lines found securely attached. Lower sheave and engine ring gear found intact with no evidence of any damage. Engine crank case (both upper and lower section) hardware was found intact with no evidence of any abnormality.

Cylinders were removed from the crankcase and the condition of pistons, gudgeon pin, all piston rings was found satisfactory with no evidence of any abnormality. External and internal conditions of cylinders were found satisfactory. All connecting rods found properly connected and moving. Crankshaft was found turning normally in both the directions when moved from the lower sheave without additional effort.

1.17 Organizational & Management Information:

The operator has non- schedule operator permit from DGCA which was valid on the date of accident. The operator carries out non schedule Air transport (Passenger) service and from the records available it was observed that local joy rides were being provided on regular basis by 02 Robinson R-44 helicopters. The helicopters are single pilot certified with VFR (day) operations. In addition it has also got an approval under CAR 145 as a MRO for carrying out maintenance activities. The main base for both those activities is Mumbai.

Standard operating procedure (SOP) dated 10/08/2012 for non schedule operation by the operator was prepared and found acceptable by the DGCA. As per the copy of the SOP provided by the operator the various non schedule operations also include Joy rides. The SOP then covers the various aspects of these operations such as procedures, ATC/ MET Clearance, Embarking of Passengers, Flight Procedure, Security at temporary helipads, Payload/ CG Calculations, Passenger Manifest, Carriage of check list, Medical facilities, Passenger's baggage, Maximum number of person on Board (POB) and Flight Safety. The more emphasis in this SOP was on banner towing.

On 26/12/2016 i.e. after the accident the operator has submitted standard operating procdure-2 where in details of Joy ride which were being followed like nature of activity, period of activity, operating sites etc has been covered. The relevant portion of this SOP is as follow:

NATURE OF ACTIVITY

This SOP lays down standard operating procedures for safe and smooth conduct of operations by Aman Aviation using R-44 helicopter for joy ride in and around Maharashtra especially from Juhu Airport, Mumbai and also in other parts of India.

PERIOD OF ACTIVITY

Helicopter Joy Rides from Juhu Airport and other parts of India would be carried out throughout the year except for adverse weather days and during monsoon season when it is not meeting the visibility and qualification criteria.

OPERATING SITES

Joy Rides from Juhu Airport - Routes:

- North Mumbai - Up to 10 NM with respect to Mumbai VOR towards Pagoda / Essel world.
- East Mumbai - Up to 10 NM with respect to Mumbai VOR towards Powai lake, Vashi, Panvel, vihar lake - Film City Goregaon.
- South Mumbai - Up to 12 NM. Towards Worli Sealink, MLRC, Marine Drive, Colaba Point.

CONDUCT OF FLIGHT OPERATIONS

Joy Rides

The salient details under this section are:

- The operator provides information to passengers regarding the details of flying, route, time, duration of flight ID proof requirements.
- On receipt of confirmation of flight the latitude/ longitude is conveyed to pilots. Pilots plan the flight and flight plan is booked to FIC either online or

fed direct to the AMSS. Pilots carry out necessary sortie preparation and NAV plan etc.

- Pilots undergo preflight medical check with breath analyzer under the supervision of company medical officer and make entry on the preflight medical register and sign on arrival which is 30-35 min prior to the proposed departure.
- At base fueling is carried out by the AME in co-ordination with the pilots and helicopter is prepared for the flight by preflight checks. At out station pilot in command assumes the responsibility of refueling with the help of ground crew and also performs his pre-flight checks.
- Operations Manager prepares passenger manifest (3 copies) based on the input received from the passengers, gets it counter signed by the ATC. Original copy is given to ATC, second copy to the security supervisor at the airport entry gate, third copy to the pilot in command/ Co-pilot.
- Hard copy of Flight Plan is submitted to ATC after obtaining the MET briefing. ADC / FIC is obtained either from AMSS or over telephone from FIC/ MLU.
- The pilots prepare the load & trim sheet based on the inputs received.
- On arrival of passengers near the helicopter, the pilot / Ops manager conducts a safety briefing of the passengers before boarding.
- Ground crew will ensure no passengers at any stage go towards the tail of the helicopter. On completion of flight the pilot will complete the flight report book.

The relevant flight procedures are:

- All procedure will be followed in Mumbai/ Controlled Airspace as per the instructions of ATC.
- Whenever in the controlled zone of Mumbai ATC, RT contact will be maintained unless instructed otherwise by the controller.
- Procedure at the runway will be followed as per ATC, Mumbai Airport.

- At all the helipads the procedure of recce of the area, assessing winds, deciding circuit and landing maintaining correct speed/ distance configuration will be maintained.
- All time keep a clear area in sight for precautionary landing for any unforeseen emergency which may occur during the flight.
- Always keep a look out for obstructions like high rise buildings high tension wires etc. and keep safe distance.

1.18 Additional Information:

As per the emergency procedures given in the POH for power failure is as given below:

POWER FAILURE – GENERAL

A power failure may be caused by either an engine or drive system failure and will usually be indicated by the low RPM horn. An engine failure may be indicated by a change in noise level, nose left yaw, an oil pressure light, or decreasing engine RPM. A drive system failure may be indicated by an unusual noise or vibration, nose right or left yaw, or decreasing rotor RPM while engine RPM is increasing.

In case of power failure, immediately lower collective to enter autorotation and reduce airspeed to power-off V_{NE} or below.

CAUTION

Aft cyclic is required when collective is lowered at high airspeed.

CAUTION

Do not apply aft cyclic during touchdown or ground slide to prevent possible blade strike to tailcone.

In case of power failure above 500 feet AGL, the POH gives the following procedure

POWER FAILURE ABOVE 500 FEET AGL

1. Lower collective immediately to maintain rotor RPM.
2. Establish a steady glide at approximately 70 KIAS.
3. Adjust collective to keep RPM between 97 and 108% or apply full down collective if light weight prevents attaining above 97%.
4. Select landing spot and, if altitude permits, maneuver so landing will be into wind.
5. A restart may be attempted at pilot's discretion if sufficient time is available
6. If unable to restart, turn unnecessary switches and fuel valve off.
7. At about 40 feet AGL, begin cyclic flare to reduce rate of descent and forward speed.
8. At about 8 feet AGL, apply forward cyclic to level ship and raise collective just before touchdown to cushion landing. Touch down in level attitude with nose straight ahead.

The indication of CLUTCH warning/ caution light as per POH is as follows:

CLUTCH Indicates clutch actuator circuit is on, either engaging or disengaging clutch. When switch is in the ENGAGE position, light stays on until belts are properly tensioned. Never take off before light goes out.

NOTE

Clutch light may come on momentarily during run-up or during flight to re-tension belts as they warm-up and stretch slightly. This is normal. If, however, the light flickers or comes on in flight and does not go out within 10 seconds, pull CLUTCH circuit breaker and land as soon as practical. Reduce power and land immediately if there are other indications of drive system failure (be prepared to enter autorotation). Have drive system inspected for a possible malfunction.

CLUTCH ACTUATOR

After the engine is started, it is coupled to the rotor drive system through vee-belts which are tensioned by raising the upper drive sheave. An electric actuator, located between the drive sheaves, raises the upper sheave when the pilot engages the clutch switch. The actuator senses compressive load (belt tension) and switches off when the vee-belts are properly tensioned. The clutch caution light illuminates whenever the actuator circuit is energized, either engaging, disengaging, or retensioning the belts. The light stays on until the belts are properly tensioned or completely disengaged.

Belt slack during engine start should be adjusted such that blades begin turning within five seconds of clutch engagement. Excessive slack may cause belts to jump out of sheave grooves during start. Periodic readjustment by a mechanic may be required as belts wear in service.

A fuse located on the test switch panel prevents an actuator motor overload from tripping the clutch circuit breaker. If the fuse blows, the actuator motor will stop but the clutch caution light will remain illuminated. An open circuit breaker removes power from both the motor and the light. With an open circuit breaker, no belt tensioning will occur, and the light will not function to indicate an abnormal condition.

The helicopter manufacturer has issued a safety notice SN-28 regarding impending bearing failure and clutch light warning as follows:

ROBINSON
HELICOPTER COMPANY

Safety Notice SN-28

Issued: Jul 1988 Rev: Jul 2012

LISTEN FOR IMPENDING BEARING FAILURE

An impending ball or roller bearing failure is usually preceded by a noticeable increase in noise. The noise will typically start several hours before the bearing actually fails or before there is any increase in bearing temperature. To detect pending failure of a drive system bearing, the pilot should uncover one ear and listen to the sound of the drive system during start-up and shutdown. After the pilot becomes familiar with the normal sound of the drive system, he should be able to detect the noise made by a failing bearing. The failing bearing will produce a loud whine, rumble, growl, or siren sound. Upon hearing an unusual noise, the pilot must immediately ground the aircraft and have the bearings thoroughly inspected by a qualified mechanic. Failure of a bearing in flight could result in a serious accident.

Do not rely on Telatemps to indicate impending bearing failure. A failing bearing may not run hot enough to black out the Telatemps until it actually starts to disintegrate. This may occur only seconds before complete failure.

CLUTCH LIGHT WARNING

It is normal for the clutch light to come on occasionally in flight for a short time (approximately 3 to 6 seconds) to re-tension the drive belts. If the clutch light flickers or does not go out within 10 seconds, it can indicate a belt or bearing failure. If abnormal clutch light indication occurs, pull clutch circuit breaker and reduce power. Select a safe landing site and make a precautionary landing to check drive system. If additional symptoms of drive system failure (smell of hot rubber, noise, or vibration) are present, land immediately. If tachometer needle split occurs, enter autorotation.

After landing, shut down and check the drive belts to insure that the belts are in their grooves and not damaged. Check the upper and lower actuator bearings for seal damage. Also check the Telatemp indicator readings. If drive system problems are found, have the aircraft inspected by a mechanic before further flight.

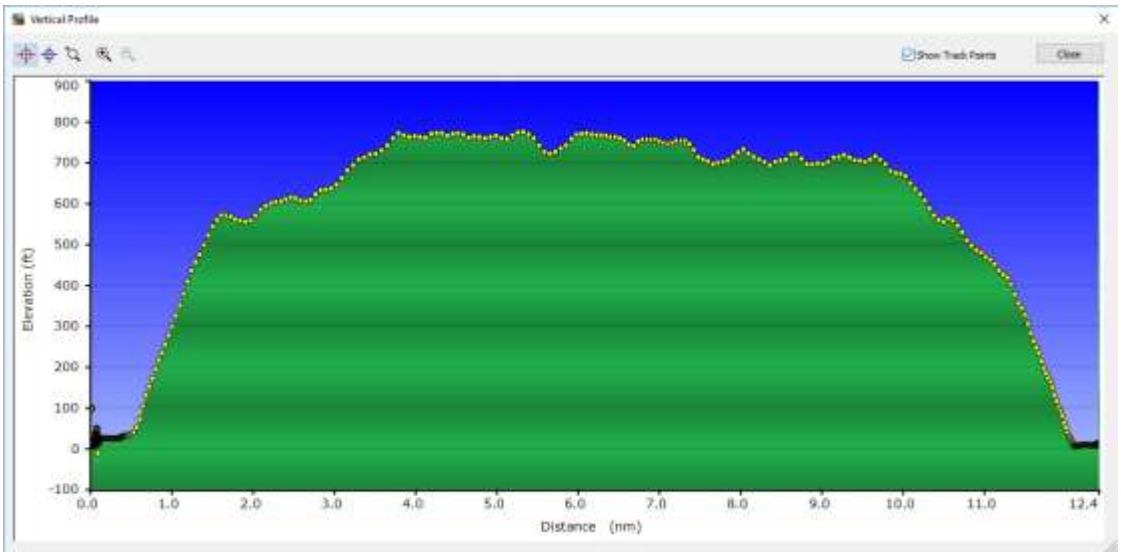
1.18.2 Civil Aviation Requirements

DGCA has issued Civil Aviation Requirements under Section 8 Series H Part I Issue I dated 28th July 2014

As per Para 5.3 of this CAR

"5.3. Simulator Training – Critical Emergencies. At least 5 hours of mandatory practice of critical emergencies in simulator such as engine failure, system failure, tail rotor failure etc. which cannot be practiced in actual flying shall be carried out by a pilot on specific to type flight simulator once in two years. Training of autorotative landing is to be carried out close to the maximum permissible all up weight but in no case it should be less than 70% of the all up weight. In case a specific to type simulator is not available, 2:30 hours of flying training in simulated emergency handling is to be carried out in 2-3 dedicated sorties every two years on the type of helicopter. All Helicopter operators should include the same in their training manual/ procedures accordingly."

1.18.3 Normal Vertical Profile of Sight Seeing Flight



1.18.4 The Straight ahead autorotation

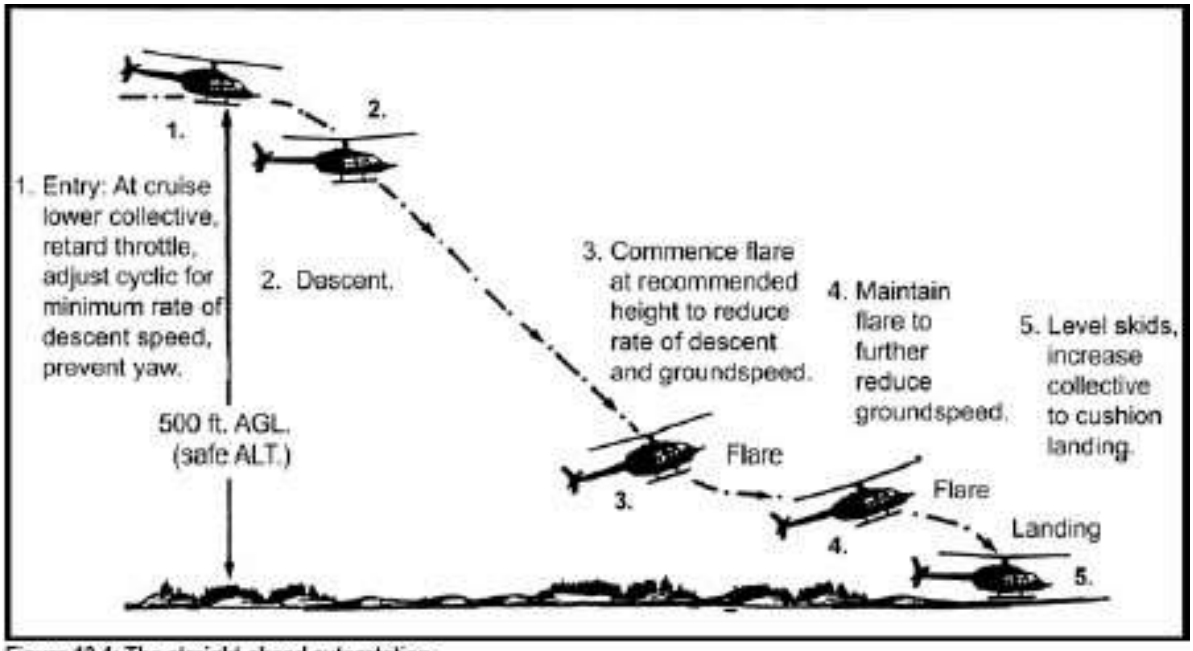


Figure 13-1: The straight-ahead autorotation

1.18.5 Practice Autorotation

1.19 Useful and Effective Techniques: NIL

2. ANALYSIS:

2.1 Serviceability of the Helicopter

The helicopter was approx. 22 years old and was initially registered with another Indian non scheduled operator. Eight years back that operator decided to sell the helicopter as it was due for major overhaul which required replacement of components. The helicopter was not being utilised for few years before it was bought by the present operator as the helicopter and major components were due for overhaul. Overhaul was carried out as per the laid down approved procedures and the ownership of the helicopter was subsequently transferred to present operator by DGCA. The certificate of registration was re-issued on 25.07.2012 and was valid on the day of accident. The Certificate of Airworthiness was revalidated on 13.08.2012. The last ARC issued on 18.3.2016 was also valid on the day of accident.

The helicopter and its engine were being maintained as per the maintenance program consisting of Flying Hours / Cycles based maintenance approved by DGCA. Last major inspection 2200Hrs/ 144 Months (Overhaul) was carried out at 2180:30 Hrs on 30/07/2012 at Mumbai. The helicopter has logged more than 700 hrs since the last major overhaul and around 16 hours from the last 50 hrs inspection.

First flight (daily) inspection schedule on the day of accident was carried out by an approved AME. Helicopter had carried out uneventful 00:13 hrs of flight & 01 landing before the accident flight. Load and trim sheet of flight was prepared and center of gravity was found within limit. Scrutiny of the maintenance records revealed that there was no defect reported on the transmission components before the accident.

In view of the above maintenance or serviceability of the helicopter does not appear to have contributed to the accident.

2.2 Weather

The weather at the time of accident was fine, sky clear, visibility 6Kms and winds 300/ 08 Kts. The weather is not a contributory factor to the accident.

2.3 Pilot

The PIC was qualified to operate the subject flight. He was holding a valid license and was qualified on the type of helicopter. The PIC was current in all the trainings and ratings as per the requirements. The PIC had total flying experience of about 4000 hours with 1755 hours on type and about 2335 hours as PIC. He had undergone Class I medical examination on 16.11.2016 and was valid on the day of accident.

He had flown the same helicopter on the previous day of the accident i.e. on 10.11.2016 and carried out a total flying of 04:05 hours which was uneventful. He was quite familiar with the route as he was flying on this route for almost 04 years, since joining the company.

2.4 Various possible scenarios

The technician on board the helicopter has informed that he was looking outside and observed some change in the noise indicating reduction of main rotor rpm. He has also informed that at that instance he was looking outside the cockpit. Immediately he looked inside and has not observed any light or aural warning. At the same time he has noticed that the PIC had intimated the ATC, 'Force landing Powai….clutch is in failure". As per the records maintained by the operator, the maintenance of the helicopter was as per the laid down requirements. In view of the above, the Committee deliberated on various failure scenarios which could have caused the reduction in rotor rpm/ the accident and are discussed below:

2.4.1 Engine

The accident sortie was the second sortie of the day and during the first sortie or in the subject sortie (till the time of reduction of RPM) the flight crew has not reported any abnormalities. At site the engine was externally examined and

other than impact or fire damage, no external anomalies were noted that would have precluded normal engine operation.

To rule out any possibility (to the extent possible), of engine misbehaving, the engine was strip examined. All the attachments (of accessories) were found intact before strip investigation. The electrical harness was attached to various points on the fire wall. Exhaust and induction lines were secured to the respective locations. The cylinder base mountings were found intact in place. Lower sheave and engine ring gear found intact with no evidence of any damage. Engine crank case (both upper and lower section) hardware was found intact with no evidence of any abnormality.

Condition of pistons, gudgeon pin, all piston rings did not indicate any abnormality. External and internal conditions of cylinders were found satisfactory. All connecting rods found properly connected and moving. Crankshaft was found turning normally in both the directions when moved from the lower sheave without additional effort.

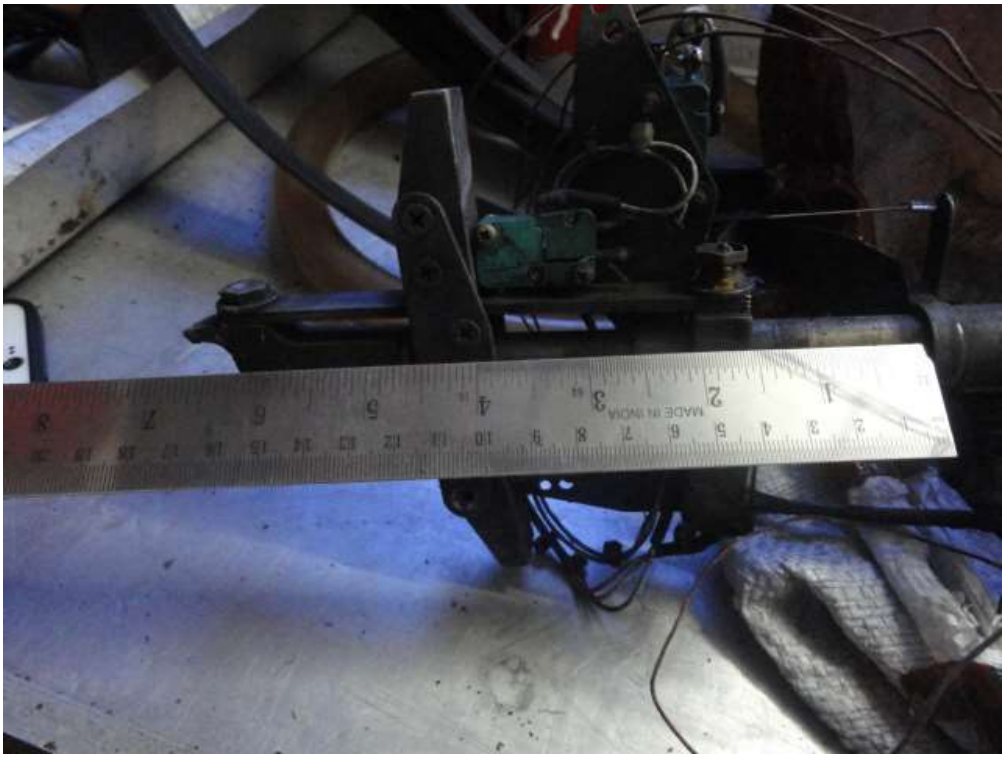
2.4.2 Bearing

The overheating of the upper bearing which holds the drive shaft up (or down) while allowing it to turn had caused occurrences resulting in forced landings. In the present case there was no previous indication which could have resulted in the seizure of the bearing. The condition of bearing post accident could not provide any indication because of fire & impact damage.

2.4.3 V Belts

After the accident, the clutch V belts (drive belts) were found intact at lower engine sheave but had burnt from upper sheave. The grooves were clear and had no indication of relative rubbing of the V belts. As the belts have burnt no further investigation could be carried out on the belts but physical condition appeared to be normal.

2.4.4 Clutch mechanism



The clutch unit (actuator mechanism) was found separated from the helicopter after the accident. The actuator was stuck at the last position before the impact which was measured and was found 1.60 inches which corresponds to the fully extended position which also indicates there might not have been any relative movement between the V-belts and the pulley.

2.4.5 Pilot Incapacitation

The PIC had undergone Class I medical examination on 16.11.2016 i.e. less than a month before the accident and was found fit. He had carried out more than 04 hours of uneventful flying on the day previous to the day of the accident and an uneventful first flight on the day of accident. He had a rest period of about 17 hours before carrying out the first flight on the day of accident.

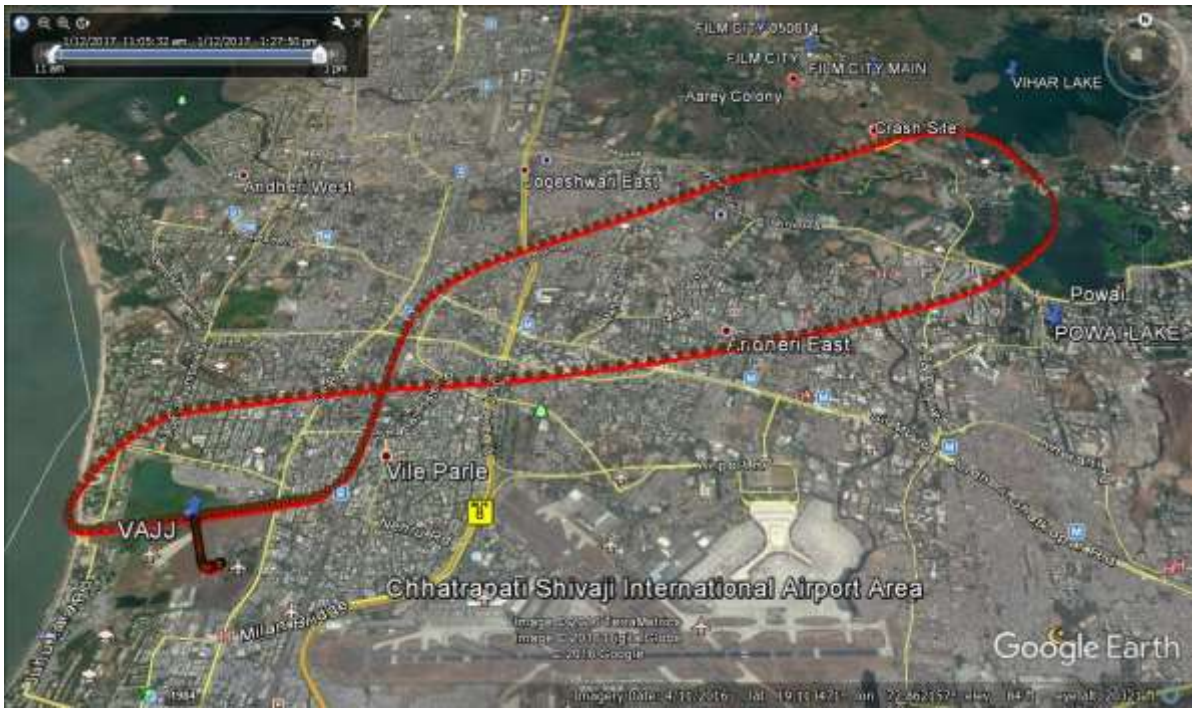
During the accident flight he reported to ATC (twice) that he is going to force land the helicopter in Powai and as per the procedure he initiated autorotation and tried to land the helicopter in an open ground in his flight path.

Further as per the evidences available, when he saw some children playing in the field, he avoided and tried to land at an open space ahead of the ground.

In view of the above it is evident that during all this time the pilot was in full control of the helicopter and was maneuvering the helicopter to land on the suitable place. Hence, the pilot being incapacitated during flight is highly improbable.

2.5 Circumstances leading to accident.

The helicopter took off from Juhu airport for Mumbai sightseeing. In front, along with captain there was a technician and in rear there were two passengers. This was the second flight of the day and no abnormality was reported during the first flight. The normal flight path followed by the helicopter for such flights was followed on that day as below:

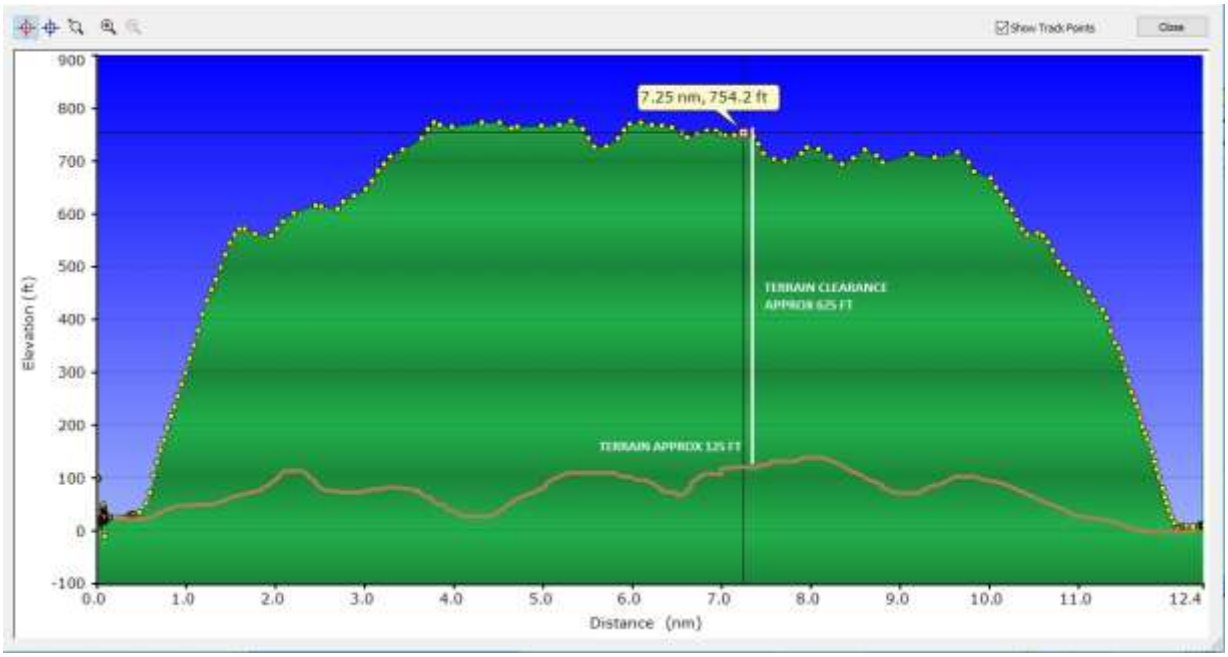


During sightseeing helicopter maintains 500ft AGL throughout the sortie to enable passengers to have a closer look of the area below. After crossing Powai lake this helicopter took a left turn to fly over parts of Vihar lake and turned back towards Juhu. Close to Aarey colony the pilot gave a call to Juhu ATC “Juhu,

(The helicopter) force landing Powai, due clutch failure. In case of clutch unit failure when confirmed, pilot is supposed to pull out the clutch circuit breaker which is located below the co-pilot's seat to avoid further disengagement of clutch and enables little blade slippage giving some power to the rotors.

The clutch CB is located under the co-pilot's seat and it is very difficult for the pilot to be able to perform this action at low altitude where reaction time is less. The CB is required to be red collared (though was not done on the subject helicopter) for ease of identification and the co-pilot be able to pull it out by feel without physically looking at it. The action to pull out the CB was not done by the pilot.

This flight was being operated by single pilot, maintaining 500ft AGL and fully loaded with 4 persons on board. The time to get back to ground from this height was going to be less than a minute as he had to maintain minimum 700-800 fpm ROD to keep the rotor rpm in autorotation, which would actually be 30-40 seconds of autorotative flight, keeping in view the time available with the pilot for decision making and human reaction.



As per the procedure, during the period available for forced landing, he was required to lower collective, enter autorotation to build up rotor rpm, select a suitable field and turn towards it. Thereafter stabilize his flight and concentrate on a safe autorotative landing.

The pilot had put the helicopter in proper autorotation and selected a force landing field which was clear of obstructions. During autorotation when the helicopter came close to the ground, PIC realised that there were children playing there. He stretched his glide path by using some collective input and proceeded further, in this process he must have lost some of his rotor RPM. While he was flaring he saw a few workers in the field where he would have landed, hence he carried out a right yaw to avoid landing his helicopter on those workers. This resulted in the helicopter side slipping and slight roll to the right into a grove of trees and bushes. To cushion the landing he had used his full collective which led to zero rotor RPM while impacting the trees/bushes/ground. This is evident from the fact that neither the main rotor or the tail rotor blade had any frontal impact marks, suggesting that during the autorotative process, all kinetic energy of the main rotor system generated due to auto-rotation was utilized during the flare and recovery of the helicopter.

Just prior to the impact, as the helicopter was yawing to the right, it got into further effect of right yaw and rolled towards the right. It made contact with the ground and tilted to the right, which led to impact loads on PIC and right rear passenger side. The technician who was sitting on the co-pilot seat (left side) was unhurt. As the engine was still running without giving power to the transmission system and helicopter, it caught fire on impact.

3. CONCLUSION :

3.1 Findings :

1. The Certificate of Airworthiness, Certificate of Registration & Certificate of flight release of the helicopter was valid on the date of accident.
2. The helicopter and Engines were being maintained under continuous maintenance program approved by Office of DGCA.
3. The PIC was having valid license, endorsements and was fit to operate the flight.
4. The total flying experience of pilot was 3957:10 Hrs out of which 1755 Hrs flying experience was on R44 helicopter.
5. The weather at the time of accident was fine.
6. The accident sortie was second sortie of the day and no abnormality was reported during the first sortie.

7. During sightseeing helicopter maintains 500 ft AGL throughout the sortie to enable passengers to have a closer look of the area below.
8. When after crossing Powai Lake the helicopter took a left turn to fly over parts of Vihar lake and turned back towards Juhu, it had given a call to Juhu ATC Juhu, (The helicopter) force landing Powai, due clutch problem.
9. In case of clutch unit failure when confirmed, the clutch circuit breaker which is located below the co-pilot's seat is pulled to avoid further disengagement of clutch and enables little blade slippage giving some power to the rotors.
10. The clutch CB is located under the co-pilot's seat and is required to be red collared (though was not done on the subject helicopter) for ease of identification so that the co-pilot be able to pull it out by feel without physically looking at it. This CB was not pulled out by the pilot probably because it is very difficult for the pilot (PIC) to do so at low altitude where reaction time is less.
11. This flight was probably at 500 ft AGL and to keep the rotor rpm in autorotation, the PIC was required to maintain rate of descent of a minimum of 700-800 fpm which meant that time available was very less i.e. approx. 30-40 seconds of autorotative flight.
12. The pilot had put the helicopter in proper autorotation and selected a force landing field which was clear of obstructions.
13. During autorotation when the helicopter came close to the ground, PIC realised that there were children playing at the point of intended forced landing.
14. PIC stretched his glide path by using some collective input and proceeded further and in this process losing some of his rotor RPM.
15. To avoid people working in the field where he would have landed, he carried out a right yaw which probably resulted in the helicopter side slipping and rolling slightly to the right into a grove of trees and bushes.
16. During the autorotative process, all kinetic energy of the main rotor system generated due to auto-rotation was utilized during the flare and recovery of the helicopter which is evident from the absence of any frontal impact marks on the rotor blades.

17. Just prior to the impact the helicopter got into right yaw and rolled towards the right after impacting with the ground, which led to impact loads on PIC and right rear passenger.
18. As the engine was still running without giving power to the transmission system and helicopter, it caught fire on impact.
19. The helicopter was destroyed and the cockpit was completely burnt in post impact fire (blast). All the damaged/burnt parts of the helicopter were confined to its main wreckage. There was no disintegration of any part while the helicopter was in air.
20. Immediate initial rescue was carried out by the local people working in the field and was followed by the local police authorities.

3.2 Probable Cause of accident :

The accident occurred as the helicopter toppled to its right during final impact with the ground, when the PIC was carrying out forced landing (autorotative landing as required by POH) due to reported clutch failure. Exact cause of the clutch failure could not be established.

4. Safety Recommendations :

DGCA may review from the safety perspective the revised SOP submitted on 26.12.2016 by the operator.

(R S Passi)
Chairman

(Col Pradeep Srivastava)
Member

(K. Ramachandran)
Member

Date: 30th December 2017
Place: New Delhi