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FINAL INVESTIGATION REPORT
OF
ACCIDENT TO AS350 B3e HELICOPTER VT-UTC AT SHRI KEDARNATH JI ON 23/09/2019

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 2017 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 in preventing such incidents in future.

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1 FACTUAL INFORMATION

1.1 History of Flight

AS350 B3e helicopter VT-UTC was involved in an accident on 23rd September 2019 at Shri Kedarnath ji while operating flight (shuttle) from Phata to Shri Kedarnath ji. There were six passengers on board. The flight was under the command of a CHPL holder (PIC). There was no injury to any person on board or on ground. The helicopter was substantially damaged.

The PIC was operating shuttles from phata helipad to Shri Kedarnath ji helipad. At 0615 hours IST, in the morning of 23rd September 2019, he was offered the helicopter VT-UTC at Phata for operating shuttles to Shri Kedarnath ji. He had accepted the helicopter and operated 03 shuttles satisfactorily. As per him during fourth shuttle, the rudders were found to be sluggish during take-off from Shri Kedarnath ji helipad. After reaching Phata, he discontinued the shuttle operation and switched off the engine. Upon switch off "GOV" light was found flashing on the CWP.

During discussions with the PIC, after the accident, he informed that, failure report on the VEMD showed "RUDDER PEDALS", though no snag was expressly reported or documented anywhere. Sr. AME was contacted over phone by the attending AME, who confirmed that there was no mechanical problem with the helicopter. The tail rotors had been replaced a few days back followed by rigging of the controls.

The helicopter thereafter operated a flight Phata-Shri Badrinath ji-Sahasardhara by another CHPL holder. Prior to take-off from Phata for Shri Badrinathji, PIC had briefed this pilot about failure report on VEMD. There was no problem with controls or otherwise with the helicopter during the flight check carried over Phata helipad. He commenced the Charter and upon completion returned to Phata helipad at about 1030. As per him everything was normal.

After refuelling at Phata, the helicopter once again started the shuttle operations under the command of PIC. The helicopter took off from Phata with 240L of fuel and all the parameters were normal. Landing at helipad 3 of Shri Kedarnath ji was normal. Winds at that time were 5 knots tail wind and the temperature was 16°C.

Passengers were offloaded and with engine running, six passengers (390 kgs.) boarded the helicopter. Lift off was commenced as all the parameters were normal. A spot left turn was commenced to initiate take off into winds. Thereafter the helicopter started to yaw to the left of its own. To control the yaw, PIC applied right rudder but as per him, there was no response from the tail rudder. The yaw to the left continued and entered into increasing vicious spin. The helicopter impacted the ground on the right skid, while the pilot tried to control the yaw and put the helicopter down. It was an uncontrolled hard landing. Skid got bent inwards by around 90 degrees. An amateur video showed that even after the helicopter settling down on ground, both main rotor and tail rotors were rotating. The tail rotor assembly along with the TGB broke away from the mountings.

PIC switched off the engine and applied rotor brake. No one was injured and all the passengers and PIC came out of the helicopter. They were examined by the medical doctor from Shri Kedarnath ji shrine board.

1.2 Injuries to Persons

Injuries	Crew	Passengers	Others
Fatal	NIL	NIL	NIL
Serious	NIL	NIL	NIL
Minor/ None	01	06	NIL

1.3 Damage to Aircraft

- The helicopter wreckage was self contained barring the tail rotor assembly which had completely separated from the helicopter during the accident.
- Right hand side skid got damaged and bent. The cross section got deformed.
- The tail boom had wrinkled/ buckled at its joint with central fuselage.
- The lower vertical fin had bent to left.
- The lower fin skin had torn due to rotating tail rotor blade.
- The tail transmission cowling got torn at places. There was no evidence of any pre-accident failure.

1.4 Other Damage

Nil

1.5 Personnel Information

1.5.1 Pilot – In – Command

Age	49 years
License	CHPL
Date of Issue	23.11.2009
Valid up to12	22.11.2019
Category	Passenger
Date of Class I Med. Exam.	12.04.2019
Class I Medical Validity	Valid
Date of issue FRTOL License	23.11.2009
FRTO License Valid up to	22.11.2019
Endorsements as PIC	Bell-407, AS350B3
Total flying experience	4109:00 hrs.
On type	2904:55 hrs.
during last 1 year	386:32 hrs.
during last 180 days	227:42 hrs.
during last 30 days	13:22 hrs.
during last 07 Days	06:40 hrs.
during last 24 Hours	04:15 hrs.
Involved in Accident/ Incident earlier	No

1.6 Helicopter Information

1.6.1 General

AS350 B3 helicopter is a single engine helicopter manufactured by M/s Eurocopter, France (now Airbus Helicopters). The helicopter is certified in transport category, for day operation under VFR. The maximum all up weight is 2250 Kgs. The helicopter is powered by a Turboméca Arriel 2D engine. Engine governing is insured by a dual channel FADEC. Emergency Back-up system gets automatically activated in case of total FADEC failure.

The body structure of the helicopter is a Rigid Box Structure, which supports flight loads and landing loads. Baggage holds are installed on each side of the body structure. Front and Rear structures are attached on the front and rear bulkheads of the body structure.

Rear structure provides attachment point for tail boom and also include the rear baggage compartment. Top is the stainless steel engine deck. Tail boom supports the tail transmission shaft. Horizontal stabilizer, upper and lower fins and a tail cone, with ballast plates mounted inside to correct c.g. position of the empty helicopter are attached to the tail.

The landing gear comprises of two tubular steel cross tubes (front and rear) clamped on the lateral beams of the body structure with rubber devices inside attachments points, and two light alloy skids. Two Shock absorbers are fitted to the front cross tubes, one on each side of the cabin. Top portion is attached to the front bulkhead and the bottom is fitted on the cross tube. It damps out vibration when the helicopter is on the ground with the rotor spinning.

The tail rotor is a flexible seesaw type, mainly made of composites (carbon, fibreglass, Kevlar, etc.) with only a few metal connecting parts. It is actuated by a pitch change bellcrank, and (a spider a stationary plate and a rotating plate separated by a ball-bearing) is equipped with two pitch change links, which are free to slide along the rotor shaft. The ball-joints hinges are self-lubricated.

The Tail Rotor drive system consists of a forward drive shaft, a rear drive shaft and the tail gear box. The shafts are connected to each other, to the engine and to the TGB by 3 flexible couplings. The tail rotor drive shaft is supported by 5 ball bearing support assemblies mounted on rubber bushes that damp out the vibrations. The Tail Gear Box is basically an angle reduction gear mounted in and protected by a light alloy casing. TGB is splash lubricated.

The tail rotor control pedals are interconnected by a rocker arm below the cabin floor so that when one pedal moves forward the other moves backward. Down-line of the rocker arm, the control linkage includes: a control rod, a bellcrank, a flexible-ball-type control at the tail-servo output, a rod actuating the bellcrank of the tail rotor pitch change spider.

1.6.2 Vehicle & Engine Multifunction Display (VEMD)

To optimize the engine and vehicle (helicopter) monitoring and the mission parameters calculation, LCD dual screen Vehicle & Engine Multifunction Display is used in flight mode in normal operation. VEMD comprises of 02 computing modules LANE 1 and LANE 2 & One screen module which comprises two screens and control pushbuttons. This mode displays Engine, Vehicle, First Limitation Instrument, Flight report and Engine Power Check pages.

On the vehicle page, PERFORMANCE page is used to calculate aircraft weight and performance in terms of take-off weights both in and out of ground effect (IGE & OGE). After the flight, at the shut-down phase, when NG descends below 10 % and NR is below 70 rpm, the FLIGHT REPORT page appears automatically on the vehicle page.

On ground with engine not running, two others modes are accessible on the VEMD: MAINTENANCE and CONFIGURATION modes. The VEMD stores the report pages of the last 31 flights.

1.6.3 Specific

Aircraft Model	:	Ecureuil AS350 B3
Aircraft S. No.	:	7585
Year of Manufacturer	:	2013
Name of Owner	:	M/s PL Panorama Leasing Ltd.
C of R	:	4424/3, valid up to 30/04/2027
C of A	:	6533 issued on 03/06/2013
Category	:	Normal
C of A validity	:	Unlimited
A R C issued on	:	25/06/2019
A R C valid up to	:	26/06/2020
Aircraft Empty Weight	:	1345.28 kgs.
Maximum Take-off weight	:	2250 kg.
Date of Aircraft weighment	:	19/03/2018
Max Usable Fuel	:	426 kgs
Empty weight C.G	:	3.546 meters aft of datum
Next Weighing due	:	19/03/2023
Total Aircraft Hours	:	2818:43
Last major inspection	:	At 2778:00 a/f hrs on 21/6/2019

<u>Engine</u>

Engine Type	:	Turbomeca Arriel 2D
Date of Manufacture	:	28/12/2011
Engine SI. No.	:	50092
Last major inspection	:	At 3736.10 engine hrs on 25/06/2019

1.6.4 Maintenance

On 14/07/2019, snag of negative torque was reported on the helicopter and after rectification it was offered for health check. However, during health check it was found that the snag of negative torque still existed and the helicopter was grounded.

While the helicopter continued to be grounded, on 05/08/2019, the tail rotor blade assembly was replaced as per the schedule maintenance. As per the schedule carried out after replacement of tail rotor blade assembly, tail rotor balancing, free rocking of the blade assembly with respect to rotor hub was carried out. Independent inspection was carried out after installation of tail rotor blade assembly. Ground run was performed for checking of tail rotor vibrations and was found within limits.

As the snag of negative torque had persisted, engine change was carried out (completed) on 20/09/2019 followed by ground run on the same day. The ground run was found satisfactory. The helicopter was offered for test flight. As per the available records, test flight was satisfactory. On 21st September the helicopter had flown for 07:45 hrs and on 22nd September, it flew for 06:35 hrs. The flights on 21st and 22nd September included approximately 100 landings. No snag either on engine or on any of the controls was reported. In the morning of 23.09.2019, the PIC after carrying out 4 sorties (8 landings) had verbally reported that rudders were sluggish. As per the PIC, AMEs have intimated that it may be due to rigging and there is no mechanical problem.

1.7 Meterological Information

For the whole area, Meteorological information is taken by the flight crew from IMD online / on telephone from Jolly Grant Airport, Dehradun / Air Force Station, Sarsawa. Current satellite picture and prevailing weather is also accounted for. Prior to flight, actual weather conditions of the area and the helipads is ascertained and assessed by crew. As the flights are of very short duration, the crew has to keep a continuous watch on weather conditions especially during weather transition.

The weather was fine on the day of accident.

1.8 Aids to Navigation

There are no aids installed in the area. However DGCA has issued an SOP which covers the Route as given below:-

Route Phata Helipad to Shri Kedarnath ji:-

After takeoff from respective helipad the helicopter is to climb so as to reach 8500 ft by valley entry. The helicopters shall maintain right side of the valley and give standard calls at reporting points. There are few helipads / open spaces enroute to make emergency landing in case of an exigency. On reaching Sonprayag the helicopter will turn to the right and follow the valley past Gaurikund till it reaches Shri Kedarnath helipad. The helicopter is to positively achieve 9000 Feet by Gaurikund and 10000 Feet by Bhimballi. The helicopter will then continue climb towards Lincholi and thereafter make a visual approach and land at Shri Kedarnath helipad.

Shri Kedarnath ji to Phata:-

The return path is through the same valley ensuring a comfortable speed during descent and maintain minimum of 10500 Feet at Bhimballi and 9500 Feet at Gaurikund, finally vacating the valley at 9000 Feet. Thereafter turn left and maintain on right side of valley. The helicopter shall not descend below 7500 feet till it has positively crossed Mike. This is to ensure separation from inbound traffic airborne from Sersi and Sitapur.

1.9 Communication

There is no ATC to control the helicopter traffic in the valley. DGCA has issued a joint SOP to obviate any conflict and enhance flight safety.

The helicopter was not in contact with any of the ground stations/ ATC units at the time of accident. Standard call outs were being given as per the SOP.

1.10 Aerodrome Information

The helipad is located at Shri Kedarnath ji Shrine in Uttarakhand at an elevation of 11,000 Feet AMSL (approx). There are presently two helipad locations. A new helipad behind the shrine is used for VIPs landing (on case to case basis) as approved by UCADA.

<u>HELIPAD DETAILS</u>

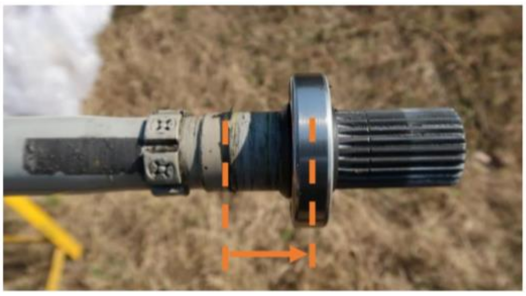
Kedarnath (Behind Shrine)	N 30 44 11 E079 04 01	150 x 80 Mtr	Cleared for VIPs Landing only
Kedarnath (Old Location)	N 30 43 53 E079 04 00	30 x 45 Mtr	All commercial operations

1.11 Flight Recorders

Neither required, nor installed

1.12 Wreckage and Impact Information

The helicopter wreckage was self contained barring the tail rotor assembly which had completely separated from the helicopter during the accident.



There was no damage to "engine to MGB assembly" except buckling was observed on the flexible coupling located on engine side. The tail gearbox and tail rotor assembly have got separated from the tail boom after the impact. The tail rotor blades were rotating even after the landing. It got separated most probably due to an unbalance effect and a weakening of the tail gear box attachments after the impact. Resultantly, tail rotor blade got damaged.

Rubbing marks were observed under the right hand side skid, consistent with a lateral displacement at the time of the impact with the ground. The skid also suffered deformation of its section in the vicinity of the rubbing marks consistent with the impact.

The tail boom exhibited wrinkles/ buckling, at attachment with the central fuselage. The lower vertical fin was bent as a result of a contact with the ground. This was due to the impact of the tail skid causing lateral displacement leading to a load application to the left hand side. The lower fin skin got torn as a result of impact of a rotating tail rotor blade.

The tail transmission cowling exhibited external damages because of an interference between the flexible coupling installed between the forward steel drive shaft ant the light alloy drive shaft while the tail transmission was rotating. The forward steel drive shaft exhibited rotational interference marks in the area where it cross the bulkhead. The light alloy drive shaft exhibited an overload rupture at its extremity (riveted coupling between the end flange and the tube). This flange also exhibit some rotational interference marks.

The damage observed on the tail rotor drive shaft assembly confirms that the tail drive shaft was rotating at the time of the accident. The displacement of the roller bearings due to the backward displacement of the light alloy drive shaft and the overload failure of the shaft extremity (riveted coupling between the end flange and the tube) was as a result of the tail gear box and tail rotor assembly separation from the tail boom.

The tail rotor assembly was completely separated from the helicopter during the accident sequence. Its attachments were all broken by overload (tail gear box torn off from the tail boom).

The kinematic continuity between the tail gear box engine input flange and the tail rotor head was checked and found to be continuous.

The setting of the primary and secondary stops was as it should have been. The flexible ball control ends were correctly installed and secured.

The extremity of the tail gear box input pitch control rod exhibited some severe interference marks resulting in the failure of the rod. One was still attached to the control bell crank. These interference marks and the associated rupture was as a result of the contact between the tail gear box input rod and the tail gear box flexible coupling which was rotating when the tail gear box got torn off.

1.13 Medical & Pathological Information

PIC had undergone pre flight medical examination including Breathalyser (BA) test at Phata. He was found fit and BA test was negative.

1.14 Fire

Nil

1.15 Survival Aspects

The accident was survivable.

1.16 Test & Research

Nil

1.17 Organisation & Management Information

The accident helicopter belonged to a non-schedule operator. The helicopter operations were carried out as per the approval given by DGCA. The NSOP (No. 07/2010) was valid on the date of accident and the organization had 3 AS-350 helicopter endorsed on their permit. The maintenance of the helicopter was carried out by another DGCA approved CAR 145 maintenance organization. The organization had all the mandatory approvals required for operations.

1.18 Additional Information

1.18.1 Safety Management System (Incident Reporting):-

In today's scenario, one can visit internet and can have a loads of material on SMS and attain sufficient knowledge of the SMS. Knowing, only is not sufficient, unless it is imbibed in the systems and procedures of the organization. One of the basis on which the whole SMS will stand, is the data (collected proactively) and the only way of having this data is "reporting of hazards, near misses and events".

So, an organisation should have an encouraging reporting culture. By establishing a culture that reports and records proactively the safety indicators for accidents, problems can be systematically assessed and improved upon. James Reason described the reporting culture as:-

Reporting Culture – This is an organisational climate where employees are willing to report near misses, incidents and accidents openly and honestly.

Since then, studies are continuously carried out to find out the barriers preventing an open and honest reporting culture. The role of management in developing and supporting a reporting culture is paramount. The barriers relevant for a NSOP in present context are:-

- the fear of being blamed,
- unsupportive management attitudes,
- insincerity about addressing safety issues, and
- discouragement on reporting

Keeping these in mind, the organisation should be keen to embrace a reporting culture to provide an insight and measurable safety performance data. Relevant (practical in present context) hurdles are:-

- The safety aspect of effective reporting not appreciated at working level.
- Supervisors reluctant to take on additional reporting requirements due to production pressures

So, the organization becomes comfortable with accepting occurrences as normal. Occurrences are seldom reported in case there is no injury, minimum damage and little or no evidence. It may be easier or more desirable to simply ignore. As a result, employees may feel that reporting such data is a waste of time as these will not be viewed in a positive manner within the organisation.

1.18.2 Helicopter Shuttle operations – to & fro Shri Kedarnath ji

Helicopter Shuttle operations from Phata, Guptkashi & Sersi to Shri Kedarnath ji are operating since last more than 15 years. Last year, Uttrakhand Civil Aviation Development Authority (UCADA) has accorded permission for these shuttle operations to various operators through a tendering process. DGCA has issued a joint SOP for these operations wherein number of helicopters in the valley at any given time is restricted to 06 as the valley is very narrow. Due to DGCA's restriction on number of helicopters operating in the area at any given time, UCADA accorded permission to 09 operators, on the basis of Technical and Financial bidding. Though operators qualifying technically for the operation are more but only 09 operators are selected on the basis of lowest quoted ticket price.

UCADA prepares a schedule for the operators who are permitted to fly in the area by allotting time slots. The operators are required to fly within the allotted time slots, restricting them to fly their planned passengers to be carried within the stipulated time only.

1.18.3 Unanticipated Yaw

Unanticipated yaw is a flight characteristic to which all types of single rotor helicopter (regardless of anti-torque design) can be susceptible at low speed. This is usually dependent on the direction and strength of the wind relative to the helicopter and is described as "loss of tail rotor effectiveness (LTE)" even though the tail rotor always remains fully serviceable. It is not linked to any failure and has nothing to do with the full loss of tail rotor thrust.

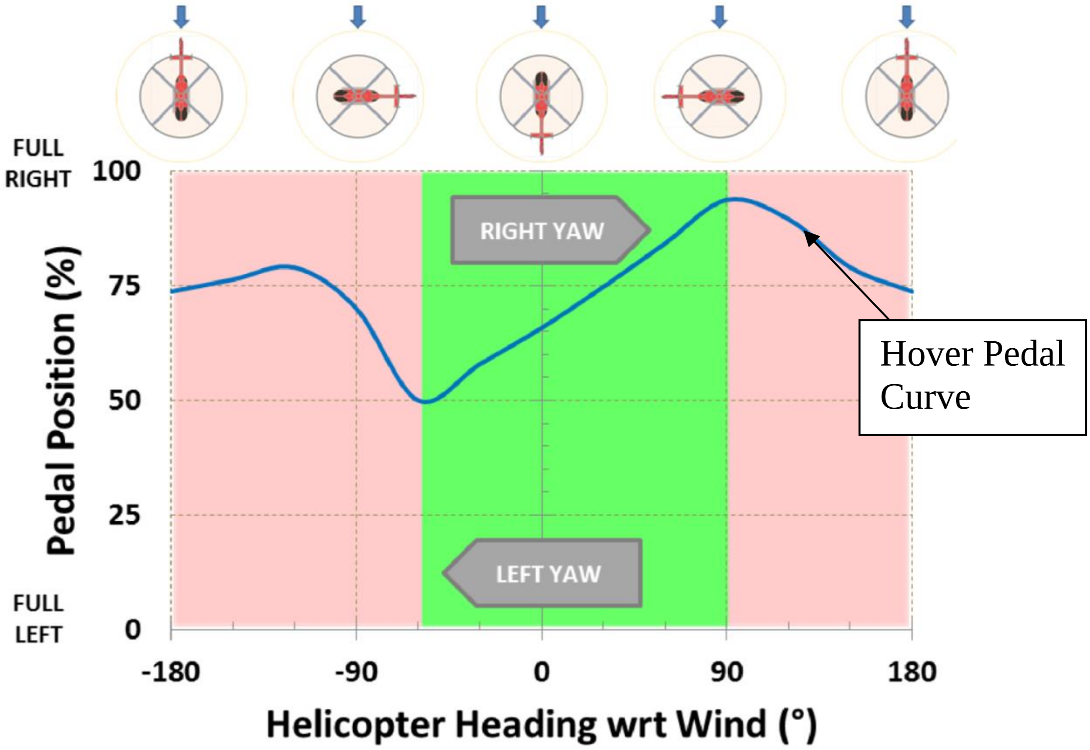
Where this type of unanticipated yaw situation is encountered, it may be rapid and most often will be in the opposite direction of the rotation of the main rotor blades (i.e. left yaw where the blades rotate clockwise). Swift corrective action is needed in response, otherwise loss of control and possible accident may result.

Use of the rudder pedal may not cause the yaw to immediately subside. The crew normally suspects that it is ineffective when, in fact, thrust capability of the tail rotor available to him remains undiminished. Understanding unanticipated yaw is important for avoiding it. Airbus has issued a Safety Information Notice" (No. 3297-S-00), which gives detailed information on

- when the situation may arise, (and how to avoid)
- why the tail rotor may wrongly appear to be ineffective, and
- how to respond in order to maintain full control / recover.

How does Unanticipated Left Yaw occur? It can be understood by plotting helicopter heading w.r.t. true wind (while at trim and in hover) v/s pedal position. An example of such a curve for a (particular) combination of weight, altitude, temperature and wind speed is given below:- (such a curve exists for each combination of weight, altitude temperature and wind speed).

Hover pedal curve



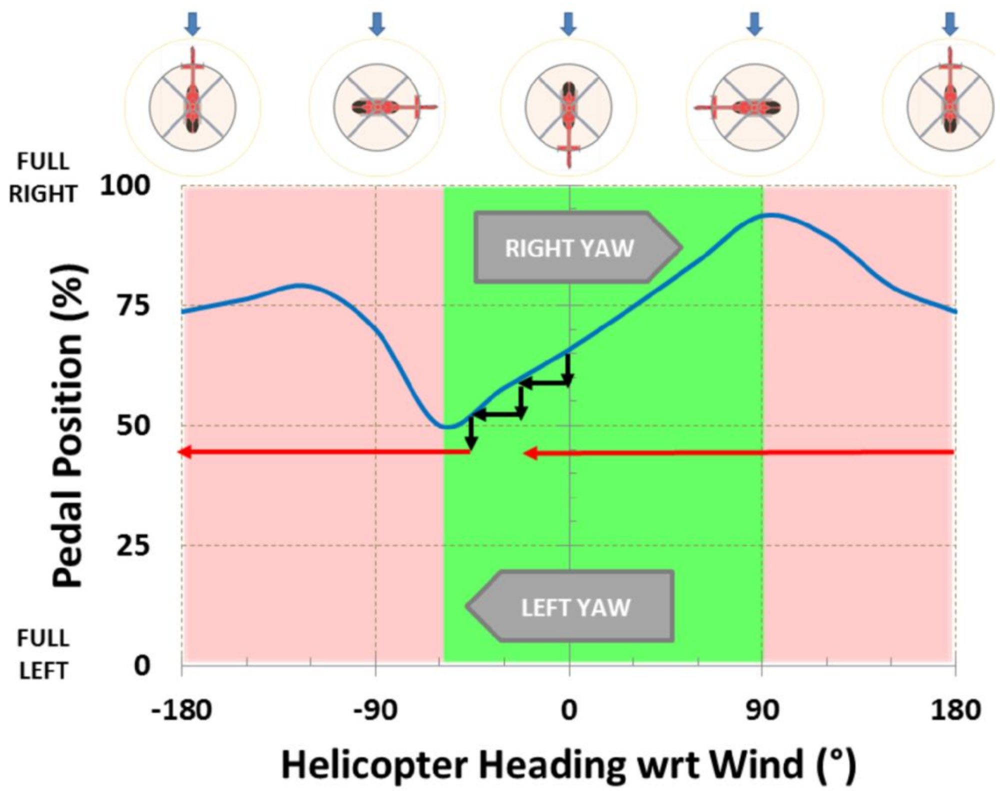
The blue curve corresponds to hover trim conditions. From there, when right pedal is added (i.e. the pedal position moves above the blue curve) the helicopter turns to the right, and when left pedal is added it turns to the left (the pedal position moves below the curve).

Where a headwind is present (green area), the helicopter is stable in yaw. If now, the heading of the helicopter, alters, say, from 0° to -10°, the pedal position reaches above the curve. The helicopter, therefore, turns to the right until it reaches 0° on trim curve.

The pink area represents an area of a yaw instability. When the helicopter is shifted from its trim position, it moves further away until a stable headwind condition is found. This tailwind instability is known to helicopter pilots who are aware that yaw must be very carefully controlled when the wind approaches from behind (tailwind).

Stabilizing surfaces are downstream of the center of gravity. In a tailwind, their position on the helicopter is not ideal. As a result, they cause yaw instability. This can be managed as long as the pilot is aware of the wind direction relative to the helicopter. It becomes more difficult when information about wind direction and strength is not available, especially when turn is required after leaving IGE conditions. The pilot can reach the lower limit of the stable range (about -60° heading) without much advance warning and, as a result, experience fully unstable yaw behavior. This can give the pilot the feeling that the helicopter rotates of its own whereas it is the result of his control inputs and the consequence of the change of wind heading on tail rotor thrust.

Starting of an unanticipated left yaw



Starting from 0° head wind, a left pedal forward step is made (indicated by a vertical black arrow). This brings the control position below the trim curve and the helicopter therefore rotates to the left and stops at the trim curve. In headwind conditions, pedal movement therefore produces a heading step.

A second left pedal step has a similar effect and produces a second heading step.

When a third (may be four etc.) left pedal movement of same magnitude is made, the same heading change in the order of -20° is anticipated, but unexpectedly this third step brings the pedal position below the lowest point of the pedal curve. This means a nose-left rotation will occur, as indicated by a red arrow. Here as the trim curve will not be reached, and spinning of the helicopter will continue unless right pedal is used.

On the basis of the earlier behavior of the helicopter, a -20° heading step with a limited yaw rate was expected but during third pedal application, spinning is encountered with strong yaw acceleration. This is the "un-commanded rapid yaw rate which does not subside of its own" and is called unanticipated yaw.

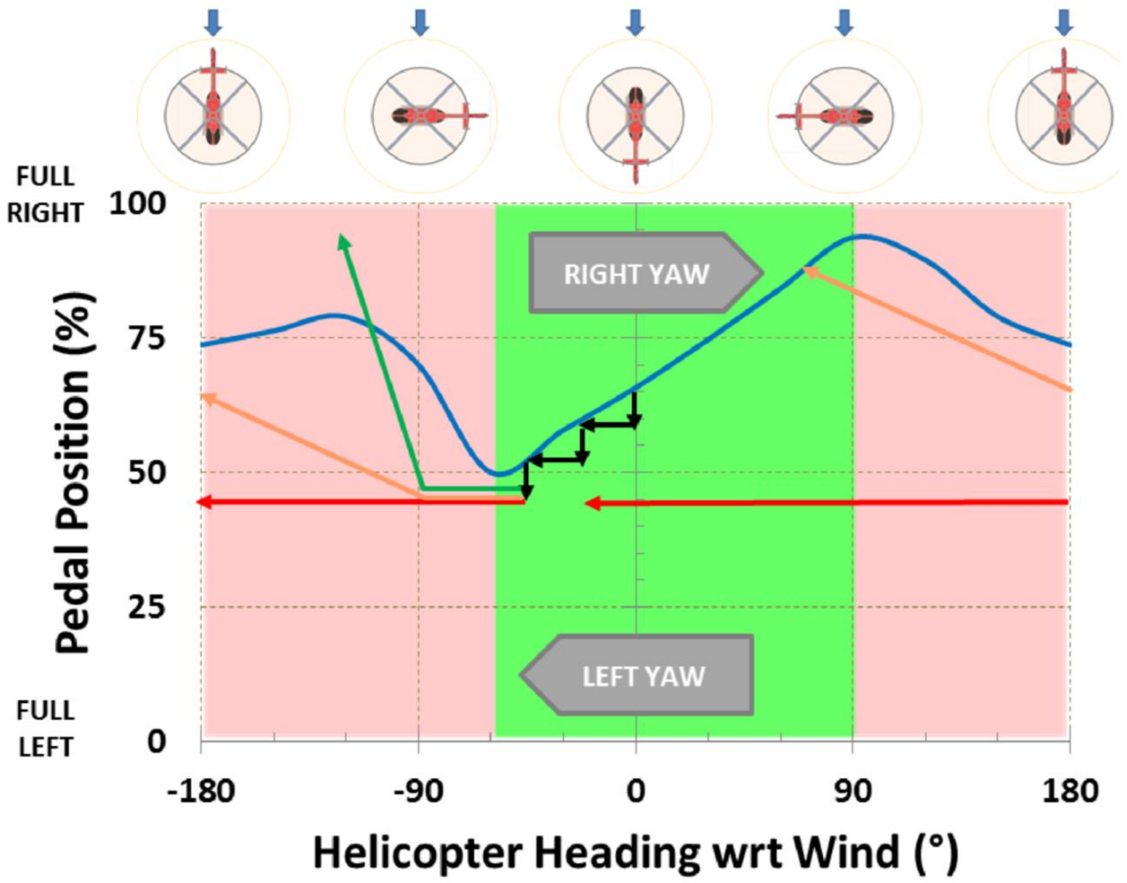
The gap between the current pedal position (red arrow) and the blue trim curve gives an indication of the encountered yaw rate. In the above figure, after passing the minimum of the blue curve (about -60° heading), that gap increases drastically. It is not due to a pedal input, but to a trim position that is moving away. The pilot has no indication of this changing trim position and the resulting yaw acceleration is therefore wrongly perceived as being un-commanded, attributable to some external factor.

This is not the only way unanticipated yaw can start. Non monitoring of the helicopter's yaw axis behavior while at low speed in tailwind conditions can lead to the same result. It would depend on the direction of the initial wind disturbance and should be equally distributed between right and left rotations.

Most instances of unanticipated yaw which lead to accidents are to the left when the main rotor rotates clockwise. This shows that the main problem is not a tailwind or wind in the vicinity of the critical azimuth, where the pedal coming close to the 100% stop gives a clear warning. The main problem area for unanticipated left yaw is on the other side of the stability range, when the pedal position is much more benign.

Controlling unanticipated Yaw

If we analyse the options available with the pilot, in case of an



Unanticipated left yaw occurrence, where pilot is caught unaware by the helicopter's behavior and he has reacted late say in the vicinity of a -90° heading.

Red line shows no control input or a very small control input (based on the tail rotor efficiency perceived), is not an option for the pilot and the helicopter continues to yaw.

Yellow line shows a large but slow input which can stop the yaw, but it will take quite some time and will be long enough for any pilot who is not able to appreciate what is happening. As a result tail rotor seems ineffective. Large but slow inputs therefore can make a clearly visible effect only at the end of a 360° rotation.

Green line shows a large and rapid input which stops the yaw much more quickly, but the trim remains in the unstable tailwind range. So the heading must be closely monitored and headwind conditions recovered as soon as practicable. There have been cases where the helicopter has been affected twice by unanticipated yaw.

KEDARNATH ji Operations

When operating at high altitudes, with this helicopter, as pilot reaches close to maximum power setting, the right rudder margin will be reduced. However, as the pilot has to take right of the valley after take-off, invariably, pilots take a spot left turn. The rate of turn (yaw) may increase due to winds and controlling the rate of yaw requires a particular attention from the pilot. Nevertheless, based on the previous experience and considering the reported wind condition on the day of accident, (5 kts.), the rudder pedal margin was sufficient to stop the spinning of the helicopter.

As per the Flight Manual of the helicopter, Chapter 5.2 (Demonstrated wind Envelope), hovering with winds from any direction up to 17 kts. Has been demonstrated over the entire flight envelope.

According to the Shri Kedarnath ji helipad altitude (11000ft) and the Outside Air Temperature on the day of the accident (13°C), the minimum guaranteed helicopter performances calculated by Airbus Helicopter were the following: -

Hover IGE (2237 kg)

Hover OGE (2087 kg)

According to weight and balance data sheet provided by the operator, the helicopter take-off weight was about 2060kg, very close to the hover OGE declared performances.

1.19 Useful or Effective Investigation Techniques

Nil

2 ANALYSIS

2.1 General

- The helicopter was having a valid Certificate of Registration (C of R) at the time of accident. It was holding a valid Indian Certificate of Airworthiness (C of A) under Normal category with Passenger/ Aerial as Sub-Division. The C of A was valid for lifetime. Airworthiness Review Certificate (ARC) was valid at the time of accident.
- All concerned Airworthiness Directives, mandatory Service Bulletins, and DGCA Mandatory Modifications were complied with as on date of accident.
- The weather at the time of accident was fine.
- The Pilot – In – Command was qualified to operate the flight. His medical and all trainings were current as on the date of occurrence. The PIC had sufficient experience in Hill flying. As per the records available, he fulfilled all qualifications and recurrent training requirements for hill flying operations as per DGCA CAR.

2.2 Maintenance of the helicopter

The helicopter was maintained by a DGCA approved maintenance organization. Snag of negative torque was reported on the helicopter in the month of July 2019. As the initial rectification could not rectify the snag, the helicopter was not flying and the matter was taken up with the manufacturer.

In the meantime, during scheduled maintenance, the tail rotor blade assembly was replaced. As per the schedule carried out after replacement of tail rotor blade assembly, tail rotor balancing, free rocking of the blade assembly with respect to rotor hub was carried out. Independent inspection was also carried out after installation of tail rotor blade assembly. Ground run was performed for checking of tail rotor vibrations and was found within limits.

Engine change was carried out (completed) on 20/09/2019 as the snag of negative torque persisted. The ground run and test flight, as per the available records, was satisfactory. On the following two days, i.e. 21/09/2019 & 22/09/2019, the helicopter flew for more than 14 hrs and carried out around 100 landings. No snag either on engine or on any of the controls was reported by the flight crew who operated these flights.

In the morning of 23.09.2019, the PIC after carrying out 4 sorties (8 landings) had verbally reported that rudders were sluggish. There is no record of any snag reported. Helicopter had thereafter flown for about 2.5 hours and carried out 03 landings without any defect.

As no snag was reported, (including that on controls) no maintenance action was called for. It is true that in order to have a full tail rotor efficency, one should ensure that the tail rotor is rigged in accordance with the Maintenance Manual. In view of the appropriate schedules carried out as per the helicopter Maintenance Manual and absence of any snag reported, there is no reason to believe that there was problem with tail rotor rigging as purported by the PIC.

2.3 Helicopter Shuttle operations – to & fro Shri Kedarnath ji

Helicopter Shuttle operations from Phata, Guptkashi & Sersi to Shri Kedarnath ji are operating as per the permission accorded by UCADA. 09 operators were operating from different helipads including Phata as permitted by UCADA on the basis of Technical and Financial bidding. Though operators qualifying technically for the operation are more but only 09 operators are selected on the basis of lowest quoted ticket price. DGCA has issued a joint SOP for these operations wherein number of helicopters in the valley at any given time is restricted to 06 as the valley is very narrow. The operators are required to fly within the allotted time slots given by UCADA, which in turn restricts them to fly the passengers to be carried within the stipulated time only.

Keeping the above arrangement in mind, the operators intend to maximize the number of shuttles during the given time slot. The AUW of the helicopter is also close to maximum as payload (passengers) is always available. At the same time the helicopter shuttle operations put tremendous mental pressure on the crew. It becomes further challenging as it is conducted at high altitude of 11,300 feet and is carried out under full pay load configurations in the shortest possible time. There is a very good probability of more than 06 helicopters in the valley particularly at the time of changeover of the slots and that is also the time when invariably the flight crew will be in undue haste.

The whole shuttle operations are planned and executed in such a way that maximum number of passengers are carried in the shortest possible time as any shuttle missed will result into passengers not being carried and loss of revenue. Furthermore, as the helicopters are flying in a tight sequence one after another, every actor in the sequence i.e. loader, ground handler, operations staff, marshaller and pilot has to carry out their functions quickly. Slow moving of any of these actors causes slowing down of all the six helicopters in the valley. Off loading and Loading of passengers at Shri Kedarnath ji is very critical, as the pilot is in a hurry to vacate the helipad to accommodate the helicopter behind him. The trailing helicopter is on finals and neither it has the sufficient reserved power to carry out an orbit nor it can go around and make an approach again.

Landing and Taking off from Shri Kedarnath ji helipad becomes further challenging because of unidirectional approach and landing particularly during the period of tail winds.

The above mentioned ground scenario of the shuttle operations puts undue pressure on every single individual to leave the helipads as quickly as possible. Per se this is a “operational hazard” requiring a proper risk analysis and mitigation action.

2.4 Unanticipated Yaw

The key feature of an unanticipated left yaw recovery is right pedal input. Recovery may not be immediate, but will occur if the pilot persists in maintaining right pedal. The pilot re-centering the pedal before again giving a right pedal input will only delay recovery from the yaw. If the yaw deceleration is not enough, more right pedal must be added, reaching the pedal end-stop if necessary.

During takeoff from Shri Kedarnathji, the heading of the fully loaded helicopter is maintained by using right pedal. The non control of unanticipated yaw is therefore because of the pilot having insufficient and/or not long enough right pedal input further to a voluntary quick 180 degrees turn to the left over the helipad in IGE conditions. These limitations hinders the stoppage of yaw though the tail rotor remains fully effective and provides the best chance to recover. The effectiveness of tail rotor might get reduced by wind conditions, as the blades are at constant pitch.

The apparent limited pedal input lead to misinterpretation of an unanticipated yaw as a full loss of tail rotor thrust. Only full right pedal input would have enabled the pilot to identify whether he is experiencing unanticipated yaw or full loss of tail rotor thrust. If full right pedal has no effect on the yaw, the pilot may take it as a case of full loss of thrust, necessitating an immediate landing, which was of course carried out by the PIC.

2.5 Circumstances leading to Accident

The helicopter took off in the morning to carry out shuttles from Phata to Kedarnath and back at 0615 hrs IST as per the scheduled slot of the operator. There was no problem with the helicopter during 3 shuttles (Phata-Shri Kedarnath ji – Phata each). After completion of 4th shuttle, PIC reported sluggish rudder and informed the engineer verbally about the snag. The attending engineer checked with a senior engineer who confirmed that there was nothing wrong with the helicopter. There was no written recording of the reported snag or of the rectification action taken, if any. Helicopter was offered for charter operation with other pilot for the sectors Phata-Badrinath-Sehastradara-Phata, who flew the helicopter for approximately 2.5 hrs and carried out 03 landings.

Helicopter was once again offered to the PIC for carrying out shuttle operations. He carried out normal checks and accepted the helicopter. There was no snag or any other problem observed at Phata before or after takeoff. There were six passengers on board (maximum capacity).

The flight from Phata to Shri Kedarnath ji was uneventful. After de-boarding of arriving passengers and boarding of 06 departing passengers, PIC picked up the helicopter and carried out a left turn for take-off with a aim to vacate the helipad as soon as possible for the helicopter on finals behind him.

During 01st shuttle from phata, normally sufficient fuel is uplifted for remaining shuttles supposed to be operated in the given time slot of the operator and with full passenger load. The helicopter uneventfully took off from Phata and flight from Phata to Shri Kedarnath ji was also uneventful. After de-boarding of arriving passengers and boarding of 06 departing passengers, PIC picked up the helicopter for takeoff. With close to maximum load and at an altitude of

11,300 feet, the PIC has to take almost full right rudder in order to keep the helicopter laterally stable during take-off.

The PIC carried out a left turn for take-off with an aim to vacate the helipad as soon as possible for other helicopter (on finals behind him). So, when the turn was taken to fly into the valley, the winds assisted in instant onset of unanticipated yaw. The helicopter was possibly power-limited and probably even with full pedal the helicopter could not stay inside the helicopter's performance limitations. Full right pedal at this stage may cause an over-torque.

In the present case, performance was limited & prevention of unanticipated yaw occurrence was very important. However, the helicopter went into unanticipated yaw, as the angular rate of turn at that moment was higher due to time constraint for leaving the helipad. The normal reaction of the PIC should have been to apply immediate and long enough application of right rudder pedal. Assuming that there was a loss of tail rotor (as the reaction of the helicopter was not instant), the PIC put the helicopter down immediately. The helicopter suffered damages due hard landing. There was no injury.

3 Conclusion

3.1 Findings

3.1.1 The helicopter was having a valid Certificate of Registration (C of R) and Certificate of Airworthiness (C of A) at the time of accident. Airworthiness Directives and mandatory Service Bulletins were complied with.

3.1.2 The weather at the time of accident was fine, with 5 kts of tail winds.

3.1.3 The PIC was qualified to operate the flight. His medical and all trainings were current as on the date of occurrence. He had sufficient experience in hill flying and fulfilled all qualifications for hill flying operations as per DGCA requirements.

3.1.4 Appropriate maintenance schedules were carried out as per the helicopter Maintenance Manual, No snag was reported and documented, prior to flight, thereby indicating that there was no problem with tail rotor rigging as purported by the PIC.

3.1.5 Though DGCA SOP for Shri Kedarnath Ji operations allow only 06 helicopters in the valley at any given time, but there is a very good probability of more than 06 helicopters in the valley particularly at the time of changeover of the slots and is the time when the flight crew is invariably in undue haste.

3.1.6 Off loading and loading of passengers at Shri Kedarnath ji is very critical, as the pilot is in hurry to vacate the helipad to accommodate the helicopter behind him, which is on finals and is without sufficient reserved power to carry out an orbit or going around for making another approach.

3.1.7 When operating at high altitudes, with this type of helicopter, as pilot reaches close to maximum power setting, the right rudder also has to be put close to its limit.

3.1.8 The control of unanticipated yaw if set in after take-off from Shri Kedarnath Ji, further to a 180 degrees left turn maneuver, which pilot has to take when the helicopter is still over the helipad in IGE conditions is difficult, if he does not apply enough right pedal input to stop the helicopter spin.

3.1.9 On the day of accident, the helicopter took off in the morning to carry out shuttles from Phata to Kedarnath and back. After completion of 4th shuttle, PIC informed the engineer at Phata verbally, about the sluggish rudder, but the same was not documented.

3.1.10 The attending engineer checked with a senior engineer who confirmed that there was nothing wrong with the helicopter. There was no written recording of the reported snag or of the rectification action taken, if any. Helicopter was offered for charter operation under the command of another pilot for the sectors Phata-Shri Badrinath Ji-Sehastradara-Phata, who flew the helicopter for approximately 2.5 hrs and carried out 03 landings, without any snag / observation.

3.1.11 The helicopter thereafter operated flight from Phata to Shri Kedarnath ji with the PIC in command and was uneventful. During 01st shuttle from Phata, normally sufficient fuel is uplifted for remaining shuttles supposed to be operated in the given time slot of the operator and with full passenger load.

3.1.12 After boarding of 06 passengers at Shri Kedarnath Ji, PIC picked up the helicopter and with close to maximum load during take-off, the PIC had to take almost full right rudder in order to keep the helicopter laterally stable.

3.1.13 PIC then carried out a left turn for take-off with a aim to vacate the helipad as soon as possible for the helicopter on finals behind him.

3.1.14 When the spot left turn was taken to fly into the valley, the winds assisted in instant onset of unanticipated yaw. Fortunately, the helicopter remained over the helipad.

3.1.15 The helicopter was probably power-limited and full right pedal at this stage might have caused an over-torque.

3.1.16 In the present case, performance was limited & prevention of unanticipated yaw occurrence was very important. The onset of unanticipated yaw was assisted by higher angular rate of turn at that moment than normal because, the PIC intended to leave the helipad as early as possible.

3.1.17 The normal reaction of the PIC was to control with immediate and long enough application of right pedal. Assuming that there was a loss of tail rotor as right pedal was already close to its limit, the PIC put the helicopter down immediately resulting in hard landing with consequential damages to the helicopter.

3.2 Probable Cause

Just after liftoff from Shri Kedarnath ji, while at high density altitude and with high helicopter weight, the PIC initiated a quick left turn resulting in unanticipated left yaw. The PIC did not succeed to recover the situation by applying/ maintaining enough right rudder pedal input and put the helicopter down resulting in a hard landing with substantial helicopter damage.

4 RECOMMENDATIONS

4.1 DGCA should revisit the SOP of helicopter operations at Shri Kedarnath ji and include the takeoff and landing procedures in detail for all types of helicopters operating there.

4.2 For effecting proper reporting of occurrences in operations of NSOP holders, DGCA should review the SPIs for NSOP holders and give top priority to “reporting culture” by assessing the following during surveillances & Regulatory Audits.

- Top management is visibly and practically committed to the process.
- Employees are encouraged to actively participate,
- The reporting system is flexible, and
- The reporting system is perceived as positive.

(P K Chabri)
Investigator

(R S Passi)
Investigator – In – Charge

Date: 21.10.2020
Place: New Delhi