Final Investigation Report on accident involving Aryan Aviation Private Limited's Bell 407 helicopter bearing registration VT-RPN near Kedarnath Helipad on 18 Oct 2022.

Aircraft Accident Investigation Bureau

Government of India

Ministry of Civil Aviation

FOREWORD

In accordance with Annex 13 to the Convention on International Civil Aviation Organization (ICAO) and Rule 3 of Aircraft (Investigation of Accidents and Incidents), Rules 2017, the sole objective of the investigation of an Accident/Incident shall be the prevention of accidents and incidents and not to apportion blame or liability. The investigation conducted in accordance with the provisions of the above said rules shall be separate from any judicial or administrative proceedings to apportion blame or liability.

This document has been prepared based upon the evidences collected during the investigation, opinion obtained from the experts and laboratory examination of various components. Consequently, the use of this report for any purpose other than for the prevention of future accidents or incidents could lead to erroneous interpretations.

Contents

GLOSSARY

AAIB	Aircraft Accident Investigation Bureau
AMSL	Above Mean Sea Level
AOP	Air Operator Permit
ARC	Airworthiness Review Certificate
ATC	Air Traffic Control
ATPL	Airline Transport Pilot License
AUW	All Up Weight
C of A	Certificate of Airworthiness
CAR	Civil Aviation Requirements
CoA	Certificate of Airworthiness
CVR	Cockpit Voice Recorder
DFDR	Digital Flight Data Recorder
DGCA	Directorate General of Civil Aviation
EEC	Electronic Engine Controller
FADEC	Full Authority Digital Engine Control System
FTROL	Flight Radio Telephony Operators License
GMVN	Garhwal Mandal Vikas Nigam
GPS	Global Positioning System
Hrs/hrs	Hours
Kgs	Kilograms
Kts	Knots
LH	Left Hand
m	meter
MEL	Minimum Equipment List
MHz	Megahertz
MLG	Main Landing Gear
MTOW	Maximum Take Off Weight
NM	Nautical Miles
NSOP	Non Scheduled Operator Permit
PIC	Pilot in Command
QRH	Quick Reference Handbook
RFM	Rotorcraft Flight Manual
RH	Right Hand
SB	Service Bulletin
TRE/TRI	Type Rated Examiner / Type Rated Instructor
UCADA	Uttrakhand Civil Aviation Development Authority
VHF	Very high frequency
VOR	VHF Omnidirectional Range

SYNOPSIS

On 18th October 2022, a Bell 407 helicopter, VT-RPN operated by M/s Aryan Aviation met with a fatal accident near Kedarnath while operating shuttle flight from Kedarnath to Guptkashi. The flight was being operated under agreement with Uttrakhand Civil Aviation Development Authority (UCADA) to provide Helicopter Shuttle Services for pilgrims to Kedarnath Shrine.

The helicopter VT-RPN had operated 04 uneventful shuttles in the time slot 0825-0935 hrs earlier that day and carried out 08 landings. After a break of one hour, the operation resumed and VT-RPN was prepared for shuttle flying to be carried out in the time slot 1130 - 1230 hrs. The helicopter took off earlier than the planned slot and landed at Kedarnath with 05 passengers at 1121 hrs as per the log maintained by GMVN and took off again for Guptkashi with 06 passengers at 1122 hrs.

Thereafter, helicopter flew in to Kedarnath from Guptkashi with 05 passengers and landed at 1137 hrs. After exchange of passengers, the helicopter took-off again and at about 1141 Hrs, the helicopter impacted the ridge about 1.2 Km from the helipad and toppled down the slope while breaking into pieces. All 07 occupants lost their lives in the accident.

The occurrence was classified as an Accident as per Aircraft (Investigation of Accidents and Incidents) Rules, 2017 and Shri Jasbir Singh Larhga, Deputy Director, was appointed IIC along with Shri K Ramachandran, Assistant Director as Investigator to carry out investigation into circumstances of this accident vide order no. INV-11011/13/2022-AAIB dated 19 Oct 2022, under Rule 11(1) of Aircraft (Investigation of Accidents and Incidents) Rules, 2017.

SUMMARY

Accident involving Aryan Aviation Private Limited's Bell 407 helicopter bearing registration VT-RPN near Kedarnath Helipad on 18 Oct 2022			
1.	**Aircraft**	**Type**	Bell-407
		Nationality	Indian
		Registration	VT-RPN
2.	**Owner**		M/s Aryan Aviation Pvt. Ltd.
3.	**Operator**		M/s Aryan Aviation Pvt. Ltd.
4.	**Pilot in Command**		ATPL(H)
5.	**No. of Persons on board**		01 Crew and 06 Pax
6.	**Date & Time of Accident**		18 Oct 2022, 1141 IST
7.	**Place of Accident**		Garud Chatti, Near Kedarnath District: Rudrapryag
8.	**Co-ordinates of Accident Site**		30° 43' 07.01"N, 079° 04' 03.25"E
9.	**Last point of Departure**		Kedarnath Helipad
10.	**Intended Destination**		Guptkashi Helipad
11.	**Type of Operation**		Helicopter Shuttle Services
12.	**Phase of operation**		Take-off/Climb
13.	**Type of Occurrence**		Controlled Flight into Terrain
14.	**Extent of Injuries**		07 Fatalities

(All the timings in this report are in Indian Standard Time unless otherwise specified.)

1. Factual Information

1.1 History of Flight

On 18th October 2022, a Bell 407 helicopter VT-RPN operated by M/s Aryan Aviation Private Limited met with a fatal accident near Kedarnath while operating a shuttle flight from Kedarnath to Guptkashi. The flight was being operated under agreement with Uttrakhand Civil Aviation Development Authority (UCADA) to provide Helicopter Shuttle Services for pilgrims to Kedarnath Shrine.

Aryan Aviation had engaged 02 helicopters for operating shuttles on Guptkashi - Kedarnath - Guptkashi sector. The operations at Kedarnath are carried out as per the time slots provided by UCADA in accordance with SOP for regulation of air traffic in the Kedarnath Valley. On 18th October 2022, UCADA had given Aryan Aviation, time slots of one hour each, starting 0730 hrs. There was a break of one hour after two consecutive slots. The operations were to continue till 1730 hrs.

On the day of accident, operator had operated shuttles in the first slot using their other helicopter VT-ARB. The shuttles in second slot were operated by VT-RPN between 0825-0935 hrs. Four uneventful shuttles were operated during this slot with eight landings.

After a break of one hour, the operation resumed and VT-RPN was prepared for shuttle flying to be carried out in the time slot 1130 – 1230 hrs. The helicopter took off earlier than the planned slot and landed at Kedarnath with 05 passengers at 1121 hrs as per the log maintained by Garhwal Mandal Vikas Nigam (GMVN) and took off again for Guptkashi with 06 passengers at 1122 hrs.

Thereafter, helicopter flew in to Kedarnath from Guptkashi with 05 passengers and landed at 1137 hrs. As per the Log maintained by GMVN, six helicopters had landed and taken-off from Kedarnath between 1135 and 1138 hrs. As per the statement of Pilot of another Bell 407 helicopter (VT-JIB) that took off from Kedarnath just ahead of VT-RPN, the weather was cloudy when he entered the Kedarnath Valley and he could see clouding on top of the ridges of Garud Chatti and Lincholi. VT-RPN was behind it and he was able to hear RT calls from VT-RPN.

The clouds had started to come down but the approach path was clear, and VT-JIB landed at Kedarnath. After de-boarding and boarding of passengers, VT-JIB waited before take-off as VT-RPN was on short finals. The weather was deteriorating and clouds were moving very fast. However, departure path was clear till then and VT-JIB took off.

At about 1138 hrs as per the GMVN's log, VT-RPN also took off from Kedarnath for Guptkashi with 06 passengers. As per statement of pilot of VT-JIB, he did not hear the take-off call from VT-RPN as he crossed Garud Chatti and tried calling VT-RPN on RT but did not get any response.

VT-RPN was visible to witnesses at Kedarnath Helipad for about 5-10 seconds before disappearing out of sight. The weather was reported to be deteriorating and clouds descending. As the clouds cleared after some time, smoke was observed rising near Garud Chatti by witnesses from the Helipad. As per witnesses, the helicopter had impacted the ridge near Garud Chatti in less than a minute after take-off.

The helicopter broke due impact, rolled down the ridge and got engulfed in fire. All occupants received fatal injuries in the crash. SDRF team got information about the crash at 1145 Hrs and launched two teams to search for the helicopter. The team dispatched towards Garud Chatti located

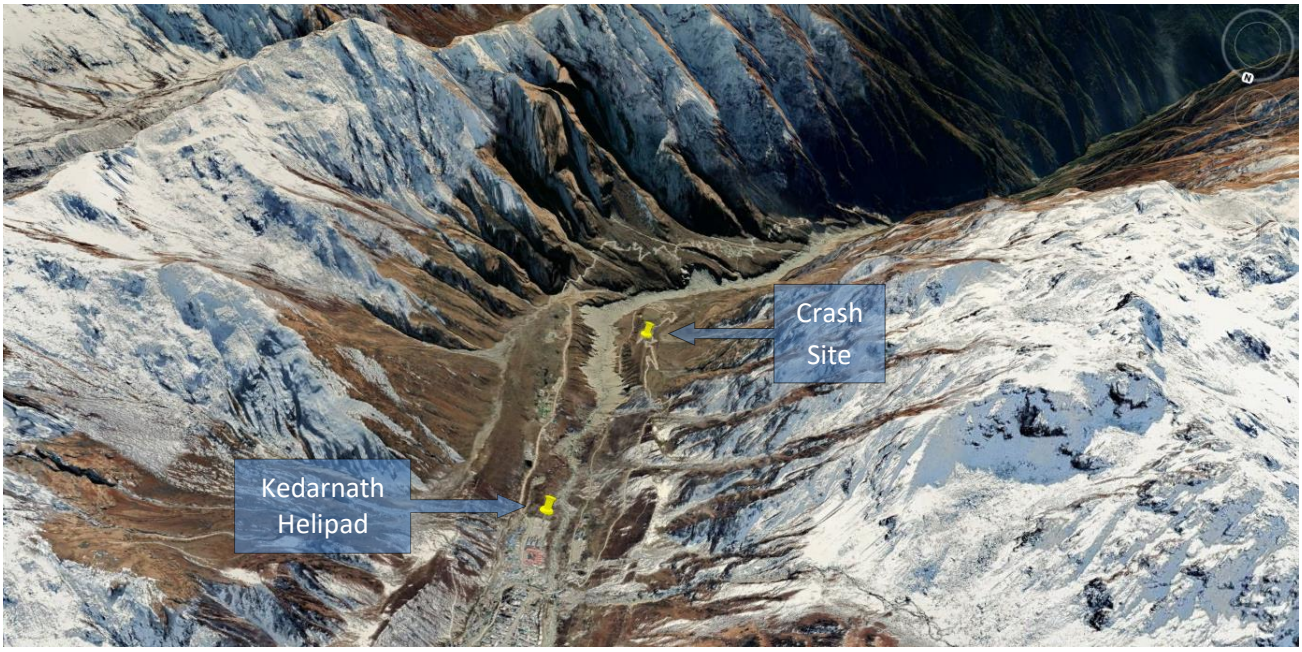

Figure 1: Location of Helipad and Crash Site

the helicopter and started rescue and retrieval activity. The SDRF team reported that the helicopter had burned for significant time before the fire could be put off.

The mortal remains of all occupants were found scattered on the slope away from the burning wreckage and retrieved by the SDRF team. Four helicopters were deployed to bring the mortal remains to Rudraprayag. The mortal remains were flown out from Kedarnath between 1618 hrs - 1643 hrs on the same day and shifted to Rudraprayag for post mortem.

The ELT of the helicopter had got activated and its signal was captured by satellite at 1141 hrs. The co-ordinates of Accident Site are 30° 43’ 07.01" N, 79° 04’ 03.25" E. The aerial distance of crash site from the Kedarnath helipad is approximately 1.2 km.

1.2 Injuries to Persons

Injuries	Crew	Passengers	Others
Fatal	01	06	Nil
Serious	Nil	Nil	Nil
Minor	Nil	Nil	Nil

1.3 Damage to Aircraft

The helicopter had impacted the terrain and shattered before catching fire.

1.4 Other Damage

There was no other damage.

1.5 Personnel Information – Pilot-in-Command

Nationality	Indian
Date of Joining Organisation	Aug 2022
Age	58 Yrs
License	ATPL(H)
Date of Issue	20 June 2012
Valid up to	19 June 2026
Date of Class I Med. Exam	26 July 2022
Class I Medical Valid up to	27 July 2023
Date of issue FRTOL License	17 July 2008
FRTO License Valid up to	16 July 2023
Endorsements as PIC	Bell 407, ENF 480, AS365/EC155, SA316/315
Total flying experience (as on 17 Oct 2022)	8956 Hrs
Total PIC flying experience on type	373:35 Hrs
Total flying experience during last 1 year	586:11 Hrs
Total flying experience during last 6 Months	272:00 Hrs
Total flying experience during last 30 days	73:10 Hrs
Total flying experience during last 07 Days	28:05 Hrs
Total flying experience during last 24 Hours	03:55 Hrs

Above details are based on information available with previous employer and current Log Book of the Pilot that was retrieved from his personal belongings. The current Log Book is for the period Sept 2017 till day of accident. Log books before that could not be made available to AAIB by operator or the family of the deceased pilot.

The deceased pilot was an ex-military pilot with total flying experience of 8956 hrs as on the date of accident. Apart from military, the pilot had earlier flown for different Non-Scheduled Operators before joining Aryan Aviation in Aug 2022. He had undergone type traininig on Bell 407 in Jan 2019 and had flown Bell 407 helicopter till Mar 2020 with another operator.

Just prior to joining Aryan Aviation, he was flying with an operator involved in off-shore flying on Dauphin N3 helicopters. As per the details made available by Aryan Aviation, the PIC had 383:05 Hrs of flying experience on Bell 407 helicopters, out of which about 105 Hrs were gained while operating helicopter shuttles services in Kedarnath during Sept – Oct 2022.

As per the details available from the current logbook, it is observed that PIC had previous Hill/Mountain shuttle flying experience of about 17 Hrs in Bharmour-Mani-Bharmour sector in Sept 2019 while flying for another NSOP holder. So he had a gap of nearly 03 years in Hill/Mountain Flying when he started flying for Aryan Aviation in Aug 2022.

Hence, he underwent mandatory Ground Training, Recency Flying Training and Release Check as per Para 10.3 and 11 of CAR 8/H/II, and started operating shuttle flights on Guptkashi-Kedarnath-Guptkashi sector from 06 Sept 2022.

1.6 Aircraft Information

1.6.1 General Description: Bell 407 Helicopter

Bell 407 Model is a single engine light helicopter with standard configuration that provides for one pilot and six passengers. The fuselage consists of three main sections, the Forward Section, the Intermediate Section, and the Tail boom Section. The forward section utilizes aluminum honeycomb and carbon graphite structure and provides the major load carrying elements of the forward cabin. The intermediate section is a semi-monocoque structure which uses bulkheads, longerons and carbon fiber composite side skins. The tail boom is an aluminium monocoque construction which transmits all stresses through its external skins.

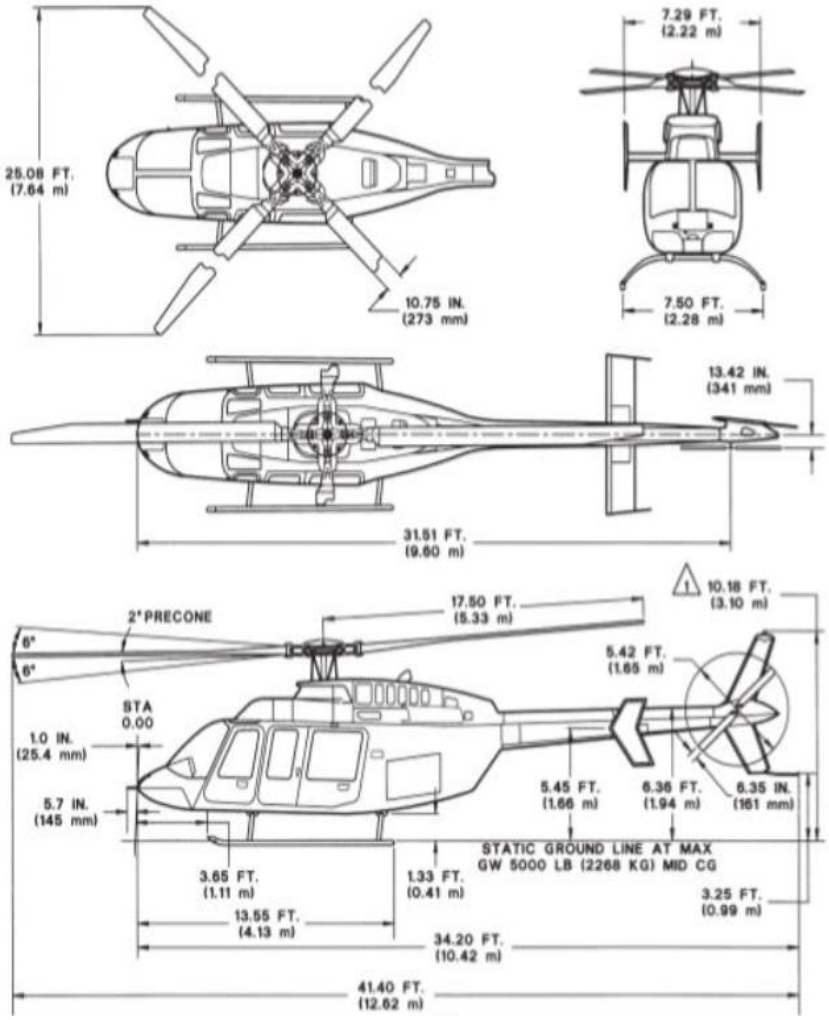

Figure 2: Principal Dimensions

The helicopter is powered by a Rolls-Royce, Model 250-C47B engine. The main rotor is a four-bladed, soft-in-plane design with a composite hub and individually interchangeable blades. The tail rotor is a two-bladed teetering rotor that provides directional control. Basic helicopter landing gear is the low skid type, however, VT-RPN was equipped with high skid gear. Principal exterior dimensions are shown in Figure 2. All height dimensions must be considered approximate due to variations in loading and landing gear deflection.

1.6.2 VT-RPN Specific Information

The involved helicopter was manufactured in 2007 and had flown 3733 Hrs and carried out 13538 landings till the date of accident. The helicopter was equipped with Rolls Royce M250-C47B engine which had done 5554 hrs and 6843 cycles. The aircraft specific details are tabulated below:

Aircraft Model	Bell 407
Aircraft Serial Number	53802
Year of Manufacturer	2007
Name of Owner	Aryan Aviation Private Limited
C of R	Issued on 27 Jan 2020

C of A	Issued on 12 Mar 2008, valid subject to validity of ARC
Category	Normal/Passenger
ARC issued on	11 Mar 2022
ARC valid up to	11 Mar 2023
Empty weight CG	3.348 m aft of Datum for Single Pilot Control Configuration
	3.339 m aft of Datum for Dual Pilot Control Configuration
Maximum Take-off weight	2381 Kg
Date of Aircraft Weighment	24 Mar 2021
Empty Weight	1407.90 Kg
Max Usable Fuel	446.54 Kg
Max Payload with full fuel	446.86 Kg with Single Pilot Control Configuration
	356.56 Kg with Dual Pilot Control Configuration
Next Weighing due	19 Feb 2023
Total Aircraft Hours	3734 Hrs
Last major inspection	100 Hrs carried on 04 Oct 2022 at 3683 Hrs
Engine Type	Rolls Royce 250-C47B
Engine Sl. No.	CAE 848067
Last major inspection	150 Hrs on 06 Sept 2022 at 5413:05 Hrs
Total Engine Hours/Cycles	5555:15 Hrs / 6844 Cycles

1.7 Meteorological Information

There is no Aviation Meteorological Station or Office at Kedarnath Helipad. It was informed that the weather (MET info) from the nearest airport i.e., Dehradun is taken for operations. Additionally, all operators have their personnel positioned at helipads to observe the weather visually from the helipad and communicate the same to their pilots. Further, the pilots also communicate the prevailing weather on common frequency to update all operating in that sector. This is also part of joint SOP. The statements from various witnesses indicate that, on the day of accident, the weather had started to deteriorate with clouds descending at a significant rate.

1.8 Aids to Navigation

The helipads at Kedarnath does not have any navigation aids.

1.9 Communications

There is no ATC at Kedarnath Helipad. VHF communication is used by the operator and pilots to communicate.

1.10 Aerodrome Information

Kedarnath Helipad is located in District Rudrapryag, Uttrakhand at an altitude of about 11000 feet near Kedarnath Shrine. The helipad is used primarily for seasonal shuttle operations during Kedarnath Pilgrimage, which happens during the months of May-June and Sept-October every year. The helipad is maintained by UCADA. The co-ordinates of Helipad are 30° 43’ 53” N, 079° 04’ 00” E. The helipad dimensions are 30 m X 45 m. The Take-off and approach path is along the valley and one way approach and reciprocal take-off is available.

Figure 3: Kedarnath Helipad

The operations are carried out as per a Joint SOP approved by DGCA. As per the SOP operator is required to have an independent Helipad meeting the guidelines of CAR Section 4, Series B, Part V for Helipads in Regular Use. Aryan Aviation operates from their Helipad located at Guptkashi at an elevation of 4600 ft. The co-ordinates of Guptkashi Helipad are 30° 32' 23" N, 79° 04' 43" E. The Take-off and Approach Direction is 150°/280°. Helipad Dimension is 65 m X 29 m.

There are 7 operators engaged in providing shuttle services for the pilgrims from different helipads to Kedarnath Helipad. The helipad is not licensed by DGCA as a Heliport but covered under *"CAR Section 4, Series B, Part V - Minimum Safety Requirements for Helicopter Landing Areas used on Regular Basis"*

Helipad is equipped with CCTV cameras, but on the day of accident the cameras were said to be unserviceable and no footage from the camera facing helipad was made available to AAIB by UCADA.

1.11 Flight Recorders

The helicopter was not required to be equipped with any Flight Recorders as per the prevailing regulations. The helicopter did not have any CVR or DFDR fitted on board.

1.12 Wreckage and Impact Information

The helicopter had hit the ridge and rolled down the slope. The impact shattered the structure and helicopter broke into multiple fragments. The wreckage was scattered all over the slope with main fuselage having rolled down the furthest. The picture taken from top, close to the point of impact showing the wreckage scattered on the slope is shown in Figure 4. The wreckage spread was concentrated within an area

Figure 4: Crash site

of about 40m X 50m on a slope. Initial wreckage examination was carried out at the site and the wreckage was then gathered and transported to a storage facility near Delhi where detailed examination of wreckage was carried out in association with representatives from Bell Textron Inc. and Rolls Royce Engines. The observations and findings of examination are as follows: -

Airframe/Fuselage

Figure 5: Burnt fuselage

As the fuel tanks are contained in centre section, most of the the center and aft main fuselage sections were consumed by post-crash fire. The cockpit and nose sections were not as badly fire damaged but exhibited fragmentation and crushing consistent with impact forces. The roof section was mostly consumed by fire. The doors and cowlings on the right side exhibited more damage and had fractured into several pieces, whereas, the left side doors were almost intact. Most of the doors and cowlings had separated from the helicopter during impact and hence did not suffer from fire damage.

Tailboom

Figure 6: Tailboom fractured aft of intercoastal support

The tail boom was largely undamaged, but had separated from the fuselage just behind the intercostal support at the front of the tailboom (Figure 6-L). The tail boom was found near the initial point of ground impact, and remained some distance from the fuselage's final location on left side of wreckage trail. The forward section of tailboom was fire damaged but remained solidly attached to the aft fuselage through the four attach bolts (Figure 6-R). The tailboom fracture was consistent with overload impact forces.

Tail boom did not have any main rotor strike marks. The horizontal stabilizer was relatively intact with the top of the right end plate bent inboard towards the tailboom during impact. The left side of the aft tailboom exhibited an impact crease caused by hard non-rotating contact with a tail rotor blade during the impact sequence (Fig 7).

Figure 7: Tail Rotor contact marks on left side of tailboom

The vertical fin exhibited little impact damage to the top leading edge and limited contact forces to the bottom mounted tail skid. During the examination carried out on wreckage, the tail rotor drive was found continuous from the blades to the fractured drive shaft near the base of the tail boom. The entire assembly turned easily by hand, and the blades articulated normally.

Main Drive System

Figure 8: Burnt Main Transmission casing, Intact Planetary Gears and Spiral Bevel Gear (L) Input Quill Gear (R)

No pre-accident impediments to main drive continuity were observed. The main drive system exhibited impact and post-crash fire damage. The main transmission case exhibited melting by the post-crash fire and the transmission internal gearing was exposed (Fig 8 - L). All internal transmission gears and bearings exhibited substantial fire damage and melted aluminum and melted magnesium case material was observed on gear and bearing surfaces. The main input quill was mechanically intact but was fire damaged (Fig 8 - R) and remained connected to the forward end of the KaFlex main driveshaft with intact, but fire damaged, quill bearings (Fig 9). The mating spiral bevel gear exhibited intact teeth (Fig 8 - L). The planetary gears would not rotate by hand due to extensive bearing fire damage. The mast was bent at the top of the transmission near the mast

bearing's installed location in the top case, consistent with occurring during impact. The mast remained connected to the main rotor hub at its top with an intact mast nut. The four elastomeric corner mounts exhibited melted and consumed inner elastomer and aluminum outer housing, but the nut and cotter pin on each mount was intact. The aluminum "A-frame" mount legs were not found, but several large slags of melted aluminum were observed at the accident site.

Figure 9: KaFlex main driveshaft and Nub

The helicopter was equipped with a KaFlex main driveshaft that does not require greasing at either the transmission or engine end couplings. The KaFlex driveshaft accommodates normal driveshaft misalignment through the flexing of steel flexures between the engine and main transmission during operation to accommodate continued drive continuity as the main transmission moves slightly within its elastomeric mounts during changes in power and main rotor disk orientation. The forward transmission end of the KaFlex main driveshaft remained attached to the main input quill assembly (Fig 9). All of the steel flexures on the forward transmission end were intact. The driveshaft tube fractured near the engine end consistent with overload impact forces as the airframe fragmented after first impact. The engine end flexures exhibited numerous overload fractures, but all fractures were in the body of the flexures and not at bolted joints. The outer diameter of the fail-safe inner "nub" that is attached to the engine end attachment fitting at the engine gearbox did not show evidence of contacting the driveshaft tube inner diameter, which it fits into concentrically with limited tolerance (Fig 9).

This lack of operational contact between the nub and the engine end driveshaft tube is evidence that the engine end flexures did not fracture in-flight, but their fractures occurred as result of impact forces. Therefore, the main driveshaft was connected to both the forward transmission end and to the rear engine end during operation, providing drive to the main transmission from the engine. All observed flexure bolts and nuts exhibited intact connections.

Main Rotor Blades

Figure 10: Main Rotor Blades

No pre-impact anomalies were observed in the main rotor blades. All fractures were consistent with occurring at impact. Each blade exhibited evidence of significant impact damage (Fig 10). Damage on Blade after body was noted on all four blades. Additionally, leading edge impacts were observed consistent with striking rocks. The Green main rotor blade was found right side up and away from the main wreckage near the location of first helicopter impact and a large boulder. The Green blade had impact damage, but the fiberglass spar was intact, and the outboard

half of the blade was stuck in mud. The Green blade grip was fractured through the four attachment arms consistent with overload forces and remained attached to the blade through both blade bolt holes. The other three blades were found with the main wreckage. The Red blade exhibited an intact spar to the blade tip. The Blue and Orange blades exhibited outboard spar fractures consistent with impact forces and were missing significant afterbody (blade skins and Nomex honeycomb) material from impact forces. The Orange blade was heavily fire damage.

Main Rotor Hub

No pre-impact anomalies were observed in the main rotor hub. The main rotor hub was extensively damaged due to impact and fire but remained attached to the mast. The Red and Orange composite fiberglass yoke flexure arms were both fractured at about mid-span consistent with overload impact forces. The Green and Blue yoke arms exhibited significant delaminations and some fractured portions. The elastomeric bearings on all yoke arms were damaged. The main rotor pitch change horns were attached to all the respective blade grips on each blade except the Green blade. All four aluminum main rotor pitch change links exhibited overload fracture evidence in the top of each aluminum pitch link tube near the steel insert that mates the attachment clevis to the pitch horn. All upper pitch link clevises remained attached to their respective pitch horns through the universal bearing joints. Three of the pitch change link aluminum tubes (Blue, Orange, and Red) were melted by fire and the upper clevises and lower rod ends for these were damaged by fire. The Green pitch change link (minus the fractured upper clevis) was not fire damaged and the lower rod end remained attached. All bolts and nuts to the upper clevises and lower rod ends remained joined with intact cotter pins also.

Figure 11: Main Rotor Hub

Figure 12: Green main rotor pitch horn and upper pitch link (L) and Melted and Fractured Pitch Links (R)

Tail Rotor Drive System and Tail Rotor Assembly

Figure 13: Fractured flexible Thomas Coupling (L) and aft end of fire damaged steel tail rotor drive shaft (R)

The tail rotor drive system and tail rotor assembly did not exhibit any pre-impact anomalies. Drive continuity was established in the tail rotor drive system. The tail rotor drive system exhibited fire damage to the steel drive shafts and hanger bearings in the aft fuselage and the forward fractured section of the tailboom. The steel shaft under the engine exhibited an overload impact fracture separation of the flexible steel plates (i.e., “Thomas” coupling) at the interface with the engine gearbox at the forward end of the shaft (Fig 13-L). The splined coupling at the aft end of the steel shaft had separated from the forward end of the steel oil cooler driveshaft consistent with disconnecting during the impact sequence and the driveshaft female splines were intact (Fig 13-R) The steel oil cooler shaft was fire damaged but the male splines on both forward and aft ends were intact. The steel oil cooler shaft would not rotate by hand because of the fire damage to its bearings.

Figure 14: Aft Aluminium driveshaft (L) and Overload Fractured coupling ears (R)

The aluminum shaft between the oil cooler (forward end of shaft) and the hanger bearing (aft end of shaft) at the front end of the tailboom was not fire damaged. The aluminum shaft on the aft fuselage exhibited intact female splines that were disconnected from the oil cooler aft male splines (Fig 14-L).

The shaft's aft end also exhibited overload fractured adapter ears to the Thomas coupling at the tailboom attach hanger bearing (Fig 14-R) consistent with fracturing when the tailboom fractured nearby at the intercostal support during the impact sequence. The most forward tail rotor driveshaft on the tailboom exhibited a disconnect from its coupling adaptor to the tailboom attach hanger bearing as result of sheared rivets when the tailboom fractured (Fig 15-L).

The remainder of the tail rotor driveshafts on the tailboom were intact and rotated freely in their hanger bearings with hand manipulation. The tail rotor gearbox and tail rotor assembly also rotated freely when the tailboom tail rotor driveshafts were manipulated by hand. No chips or debris were located on the tail rotor gearbox chip detector. The tail rotor hub was intact and remained solidly connected to the tail rotor output shaft splines.

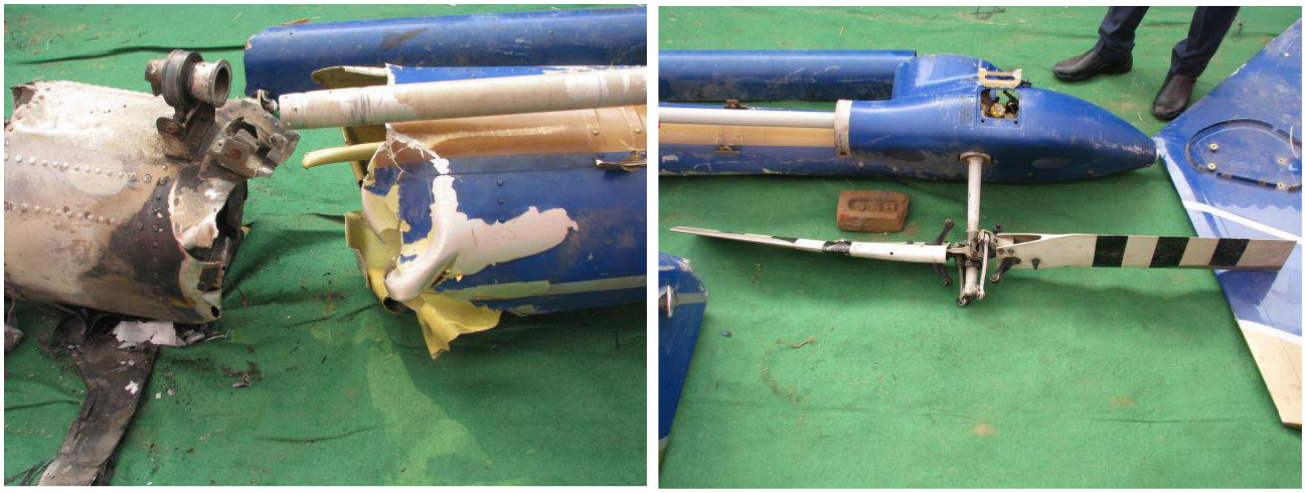

Figure 15: Forward coupling and driveshaft tube with sheared rivets (L) and Tail Rotor (R)

Free pitch change in the tail rotor hub was demonstrated through hand manipulation of the tail rotor blades. One tail rotor blade was intact. The other tail rotor blade exhibited a chordwise bend towards the tailboom and delamination damage at an approximate 1/3 span location. The blade tip section and approximately 8 inches of the outboard leading edge made hard contact and creased the tailboom on its left side. The contact crease mark on the tailboom from the tail rotor blade is consistent with little to no tail rotor rotation at the time of tail rotor blade to tailboom contact. The tail rotor blades are not able to make contact with the tailboom during a normal flight regime and the contact crease mark is consistent with occurring during the impact sequence.

Flight Controls & Hydraulic Servos

No pre-impact anomalies or flight control discontinuities were observed in the flight controls or hydraulic servos. The helicopter had single controls at the pilot right seat station. A copilot seat (left side) had a pedal lockout kit. The flight controls were badly damaged with impact fractures and melted control tubes. All observed flight control fractures were consistent with impact overload fractures. Flight control continuity could not be established because of melted control tubes from the post-crash fire, but all observed clevises and rod ends exhibited intact bolts, nuts, and cotter pins even when the control tubes or linkages were melted from the post-crash fire. The aluminum cyclic stick fractured at its base consistent with overload impact forces. The steel collective stick was bent and disconnected from its jackshaft from impact forces. The throttle position on the collective was found stuck in the "FLY" position (Fig 16-L).

The throttle did not rotate because of the bent collective. The tail rotor pedals were damaged from impact forces (Fig 16-R). Free movement of the tail rotor control system in the tailboom was shown by manipulating the tail rotor blades in the pitch direction and observing movement of the fractured

Figure 16: Throttle Position at FLY position (L) and Tail rotor pedals (R)

tail rotor control tube at the forward end of the fractured tailboom. The main rotor and tail rotor hydraulic servos exhibited fire and impact damage, melting most of the aluminum servo valve bodies, leaving the steel piston rods and servo valves (Fig 17-L).

The nuts and locking tabs between the three main rotor servo lever input arms and the servo input wiredrive rods were intact (Fig 17-R) and no pre-impact rotational movement was observed at the threaded joints.

Figure 17: Fire damaged hydraulic servos (L) and wiredrive locking tabs and nuts on a servo (R)

Intact locking tabs and nuts at servo wiredrive assemblies indicate that no incorrect control movements could be input to the servo through mismatched spool port holes. The tail rotor servo had fire and impact damage with nuts and locking tabs intact.

Landing Gear

No pre-impact anomalies were observed in the landing gear and all damage and fractures were consistent with occurring during impact. The right side of the landing gear exhibited fractures and damage, but the left side was essentially intact. The right skid toe exhibited a twisting crack from the tip to approximately 18 inches aft, consistent with getting stuck in the ground while the helicopter

was yawing or twisting during ground impact. The right forward crosstube fractured just above the saddle connection to the forward right skid. The right aft crosstube bent forward in the same location above the right aft saddle but was not fractured. The flight step attached to both right side

Figure 18: Landing Gear

crosstubes fractured at its attach points to the crosstubes and separated from the crosstubes. The rear crosstube airframe attach pivot assembly remained connected to the rear crosstube. The forward crosstube fuselage attach fittings had separated from the crosstube from impact forces and remained connected to airframe belly structure that had ripped away during impact.

Seats and Restraints

Figure 19: Crew and Pax Seats laid as per aircraft configuration

No pre-impact failures were observed in the seats or restraints. Passenger bodies were reportedly not found near their seats at the main wreckage site. The pilot was reportedly found near the main wreckage. All but one of the seat cushions was observed and one of the cockpit seat pans was missing. The missing seat cushion and seat pan were from either the pilot or copilot position. The seats were laid out during reconstruction in their approximate positions (Fig 19), but it was unclear at each seat position (cockpit, aft facing cabin, forward facing cabin) which was the left or right seat. Some seat bottom cushions and frames exhibited significant bending damage from impact forces. The fuselage exhibited fractures in the area of the seats structure. In the rear seats, all five steel

male latches were found, and they were not connected to aluminum female latches. Disconnected rear seat restraints found during the wreckage examination are consistent with the seat restraints not being connected during the short flight resulting in the passenger bodies dispersed in the wreckage trail. The pilot seat belt and two shoulder harness straps for the 4-point system were found connected together. The pilot shoulder harness straps were found separated and fractured from the inertial reel with evidence of melting at the ends of the fractured straps. The right side male latch belt remained attached to fuselage structure through the hinge attachment. The copilot shoulder harnesses were not connected, and the seat belt male latch was found disconnected.

Fuel System

No pre-impact anomalies were observed in the fuel system. The fuel tanks and surrounding structure were mostly consumed by fire. The fuel transfer pump plate was extensively fire damaged but remained located in remnants of the forward fuel tank. The boost pump plate from the main fuel tank and attached fuel feed line to the airframe fuel valve were both fire damaged. Remnants of the three fuel quantity probes and fuel system piping elbows and unions were observed with fuel lines burned away at threaded ends. The fuel valve switch in the cockpit was melted but appeared to be in the 'ON' position as required for flight.

Engine

Figure 20: Engine wreckage

During the accident sequence, the engine had remained with the fuselage as it tumbled down the steep terrain, and was exposed to intense post-crash fire. The engine exhibited extensive impact damage. The accessory gearbox housing was fractured, exposing the N1 an N2 gear trains. The exhaust duct was crushed against the turbine exhaust outlet. All engine mounts were fractured in overload. Examination of the compressor revealed all compressor blades with leading edge impact damage and evidence of foreign object ingestion during operation (FOD). Fine metallic powder, consistent with compressor shroud aluminized lining material, was found within the compressor bleed discharge duct. The compressor rotated manually with considerable resistance, which was attributed to impact, fire and FOD damage. Rotation of the compressor resulted in corresponding rotation of the N1 drive train, which was visible through the fractured accessory gearbox. There was no evidence of pre-impact failure of any of the compressor's rotating components.

Figure 21: Engine inlet (LH) and 4th Stage Power Turbine Blades (RH)

The 4th stage (power) turbine could be accessed via the exhaust duct. Manual rotation of the power turbine resulted in corresponding rotation of the N2 drive train, including the main and tail rotor output shafts. Rotation was smooth and required minimal effort. The 4th stage turbine blades exhibited no evidence of operational failure or distress(Fig 21). The fuel spray nozzle was removed from the combustion chamber. The fuel spray nozzle exhibited corrosion on the spray face (typical of having been recently exposed to water), but did not exhibit any evidence of clogging or abnormal operation. The outer combustion cannister was removed from the turbine, exposing the inner combustion liner, 1st stage turbine nozzle, shield and turbine blades.

Figure 22: Combustion Chamber

The inner combustion liner was undamaged, exhibited no cracking, thermal damage or evidence of abnormal combustion, such as streaking (Fig 22). Metallic spatter was distributed around the forward end of the combustion liner.

The 1st stage turbine nozzle, shield and turbine blades were all coated with a significant layer of metallic spray and soil. There was also minor FOD damage to the leading edges of the 1st stage turbine blades (Fig 23). There was no evidence of thermal distress or erosion of the blades. There was no evidence of pre-impact damage or failure of the turbine module. The findings within the turbine are all consistent with the compressor ingesting debris during the impact sequence: FOD liberates aluminized compressor lining within the compressor, which is transported along the gas-path, liquified by heat within the combustion chamber and then deposited on the turbine nozzle, shield and turbine blades. Additionally, soil and hard debris ingested by the compressor is carried along the gas-path, resulting in subsequent FOD damage to the turbine blades.

Figure 23: 1st Stage Turbine Blades

The internal engine oil filter housing was opened and examined. The filter housing contained clean, bright engine oil, with no entrained particulates or abnormal smell. The oil filter was removed and found to be free of any debris. The Combined Engine oil/fuel Filter Assembly (CEFA Pack) was mostly

consumed by fire. The filters were present, but fire-damaged. The Electronic Control Unit (ECU) from the Engine's FADEC system could not be found at the crash site. Two fractured pieces of the ECU housing were found within the burnt debris. The ECU was presumed to have been consumed by fire.

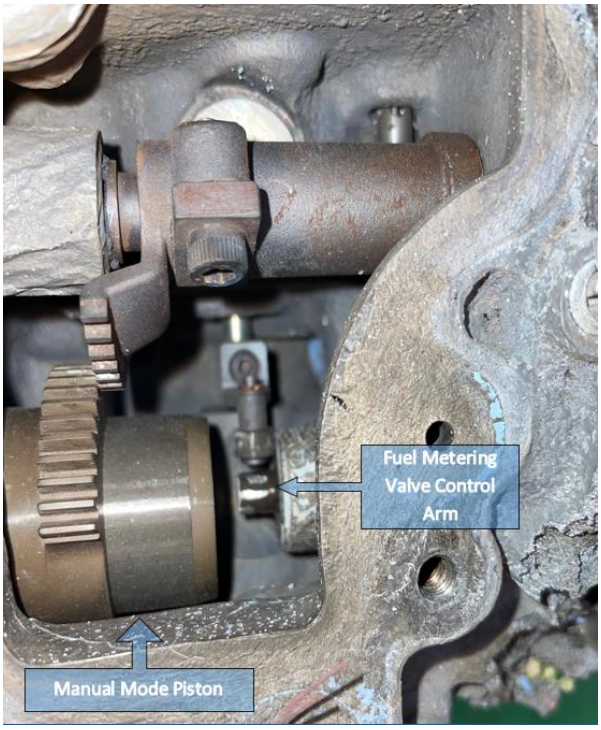

Figure 24: HMU

The Hydro-Mechanical Unit (HMU) remained in place on the engine's accessory gearbox. The HMU had been exposed to intense heat, but remained intact. Inspection covers were removed from the HMU, exposing the internal components of the HMU. Within the HMU, the manual-mode piston was found partially deployed. The piston had extended roughly 2/3 of the way necessary to fully capture the fuel metering valve(Fig 24).

If the ECU declares a hard fault and switches the FADEC system to manual mode, or if all electrical power is lost to the FADEC system, the manual mode piston is extended (by fuel pressure) to capture the fuel metering valve control arm. The manual mode piston typically takes 3-5 seconds to fully deploy. The HMU evidence suggests the FADEC system was operating in Normal Mode until the initial impact. In case of impact, numerous FADEC faults (or total loss of electrical power) would be expected to have occurred which would cause the FADEC system to transition to manual mode. During the impact sequence, the FADEC system started the process of transitioning to Manual Mode, and sufficient fuel pressure continued to be produced to extend the manual mode piston to roughly 2/3 of fully deployed. But fuel pressure was lost before the transition could be completed. The evidence suggests the engine continued to run for 1-2 seconds after initial impact.

In summary, there was no evidence of engine fire, failure or malfunction prior to initial impact. All available evidence is consistent with normal engine operation and power delivery up until the aircraft impacted terrain.

1.13 Medical and Pathological Information

PIC had undergone Breath analyzer test for alcohol in the morning at 0800 Hrs before start of operations and the result was satisfactory.

1.14 Fire

The helicopter was engulfed in fire after the accident. People on the trekking path opposite to the crash site alerted the authorities after witnessing the crash. Owing to difficult terrain, the Fire and Rescue personnel reached the site at about 1219 Hrs. The wreckage burned for a significant period before the fire could be extinguished. Although the fire and rescue personnel carried fire cylinders with them to the crash site, however, the fire cylinders were not sufficient to douse the fire as the amount of fire was significant.

1.15 Survival Aspects

The accident was not survivable.

1.16 Tests and Research

Figure 25: Ng Gauge, MGT Gauge and Torque

Three engine indicators i.e Ng Gauge, MGT Gauge and Torque Gauge were recovered from the wreckage site (Fig 25). The units contain non-volatile memory capable of recording any exceedance in parameters. Hence, assistance of the Transportation Safety Board of Canada (TSB) was sought to extract any data relevant to the occurrence.

The units had significant damage due to impact and fire and were not in position to be powered on. The units were dis-assembled and necessary repair on components and circuit boards was carried out so as to enable download of data. After requisite repairs, the circuit boards were sent to manufacturer's facility to perform data download. Data could be successfully downloaded from MGT Gauge and Torque Gauge using normal download setup, however, no data could be retrieved from the Ng Gauge. The Ng Gauge was returned to TSB facility and memory chip was removed from the circuit board. The raw data from the chip was then read out using a chip reader and examined. The data from all three gauges did not indicate any exceedance that would have been recorded in case of any malfunction.

1.17 Organizational and Management Information

1.17.1 Aryan Aviation Private Limited

Aryan Aviation is a Non-Scheduled operator and was issued Air Operator Permit on 08 Aug 2009. The permit has been revised periodically and was last re-issued on 01 Jan 2021. The AOP is valid till 07 Apr 2024. The operator had a fleet of 08 aircraft prior to accident.

M/s Aryan Aviation Pvt. Ltd. was one of the bidders who were awarded the tender for the operating helicopter shuttle services to Kedarnath. The tender was valid for period of 3 years from 2020-22. Aryan Aviation has its Helipad located at Guptkashi and operated helicopter shuttles to Kedarnath as per the slots provided by UCADA. It operated 471 shuttles during the month of Sept 2022 and 525 shuttles during the month of Oct 2022.

1.17.2 Uttrakhand Civil Aviation Development Authority (UCADA)

Uttarakhand Civil Aviation Development Authority was established by the Government of Uttrakhand as an autonomous body and its structure is as follows:-

1.Civil Aviation Minister, Uttarakhand - Ex-officio Chairman

2.Chief Secretary, Government of Uttarakhand - Ex-officio Vice President

3. Principal Secretary/Secretary Civil Aviation Department - Ex-officio Chief Executive Officer

4. Principal Secretary/Secretary Finance, Tourism, Industrial Development, Transport and Personnel- Ex-officio Member

5. Representative of the Director General of Civil Aviation, Government of India as Special Commissioner with the permission of the chairman.

6. Additional Chief Executive Officer appointed by the Government - Member Secretary

Because of mountainous geographical terrain in the state of Uttarakhand, Air routes are very important in the state for rescue operations during disasters and promotion of tourism, pilgrimages to remote shrines etc. In view of this objective, UCADA carries out construction of new helipads and maintenance of existing helipads and airstrips in the state.

To support and promote religious tourism and pilgrimages to various shrines located in the State, UCADA awards tenders based on bidding process for operating Helicopter Shuttle Services to different shrines including Kedarnath. Eight Helicopter Operators were awarded contract to operate Helicopter Shuttle services to Kedarnath. More than 10000 Helicopter Shuttles were operated during Sept – Oct 2022 as per the details made available by UCADA. The details of tickets booked for Helicopter Shuttles to be operated during Sept – Oct 2022 is as below:

Number of Tickets Booked (Single Trip, To or From Kedarnath)	101698
Number of Tickets Cancelled by Passengers	18739
Number of Tickets cancelled due bad weather or technical	20822

UCADA informed that, the technical surveillance/inspection is being carried out by DGCA and UCADA only carries out administrative inspections which includes facilities at helipads, facilities/arrangements for passengers, etc. However, whenever there is any kind of observation on operations/technical aspects they intimate it to DGCA for further necessary action.

1.17.3 Directorate General of Civil Aviation (DGCA)

As per the details available on UCADA website, a representative of the Director General of Civil Aviation, Government of India act as a Special Commissioner in UCADA with the permission of the chairman. The pilgrimage to Kedarnath Shrine is an annual affair and UCADA takes out tenders for the helicopter operations for Kedarnath Shrine every two years and the contract is granted to the L1 bidder and to the other operators who are willing to match the L1 pricing. The list of participating helicopters is then sent to DGCA by UCADA every year about one to two months prior to commencement date of pilgrimage.

Thereafter, DGCA calls for coordinating meeting of all participating operators for the current year to highlight the SOPs and to confirm the readiness of all helipads of participating helicopter operators for the inspections by DGCA team. The DGCA team after the physical inspection of all individual operator's helipads and UCADA's helipads gives the observations noticed in situ to all operators and confirms on ground its rectification by all operators. After successful submission of the ATRs and after rectification of all observations, permission/approval is granted to participating operators prior to commencement of shuttle operations at Kedarnath Shrine. During the year 2022, as per details provided by DGCA, the operations were audited during 03-06 May 2022, 19-20 Sept 2022 and 14-15 Oct 2022.

They also carry out inspection during the operations to check if the regulatory requirements are maintained. An SOP for joint operations by different Operators at Kedarnath Shrine has been issued by DGCA and all operators involved in operations at Kedarnath are required to incorporate the SOP in their Operatons Manual.

The copy of DGCA approved Joint SOP for Kedarnath Operations was sought from DGCA. DGCA provided a copy of the joint SOP titled "*Joint SOP: VFR Helicopter Shuttle Operations to Kedarnath Shrine, Revision 7, dated 01 Oct 2020"*. DGCA also issues Civil Aviation requirements on different subject for compliance of concerned operators and stakeholders. The Joint SOP and some of the requirements relevant to the case are discussed in the following paras.

1.17.3.1 Joint SOP : VFR Helicopter Shuttle Operations to Shri Kedarnath Shrine.

The Joint SOP has been necessitated due to absence of common air traffic controller to control dense air traffic in confined airspace in the Kedarnath Valley. Operator are allotted time block for operating shuttle services by UCADA and operators are strictly required to adhere to the time blocks.

All operations are required to be carried out as per Day VFR conditions only. Base Managers/ Flight Crew are required to ensure that flight plans are filed with FIC Delhi and FIC/ADC clearance obtained prior to flight.

Each Helicopter operator undertaking operations in Kedarnath, is required to have independent Helipad meeting requirements of CAR Section 4, Series B, Part V. The helipad at Kedarnath is provided by UCADA. Despite huge passenger traffic and shuttles that the helipad handles, it is not a DGCA licensed helipad and responsibility of ensuring availability of personnel, safety/firefighting equipment, etc lies with the air operators. Different Approach and Departure from helipad have been designed and generally right-hand pattern is followed wherein helicopters approaches from one side of the valley and departs from the other side.

MET briefing is to be taken from IMD online or on telephone from Jolly Grant Airport Dehradun or Air Force Station, Sarsawa. Due attention is to be paid to current satellite picture and prevailing weather. Prior to flight actual weather conditions of the region and helipads are required to be ascertained and assessed by the crew. These being short shuttle flights, the crew is required to keep continuous watch on weather conditions especially during weather transition to ensure that they are not caught in bad weather in the valley.

As per the SOP, the crew are required to keep continuous watch on the weather in the valley, and in-case of any doubt it is advisable to return back and wait at the Helipad. The pilot first encountering bad weather is to give call on RT regarding the decision to call off due bad weather, and this has to be acknowledged on RT and is binding on all helicopters airborne at the time. All helicopters operating in the valley operate on 122.9 Mhz (Main) and 122.7 Mhz (Stby) frequency.

1.17.3.2 Civil Aviation Requirements for Hill/Mountain Flying laid by DGCA

Mountain / Hill Flying is defined in the DGCA CAR Section 8, Series O, Part IV as *"Operations to / from a helipad which is at or above 4000 feet AMSL and with surrounding terrain above 4000 feet*

AMSL within a 10 nm radius.". The DGCA CAR Section 8, Series H, Part II gives Pilot Qualifications and Recurrent Training Requirement for Hill/Mountain Flying operations.

For a pilot who has no hill/mountain flying experience, CAR lays requirement to operate as co-pilot for minimum 1 year and 100 Hrs, whichever is later after completion of below mentioned training. Thereafter he shall undergo a Hill Ops Release Check with TRE/TRI before being cleared to operate as PIC in Hills.

Total Flying Hours	**No previous experience**
Less than 1000 hrs total flying experience including 250 hrs PIC on helicopters.	Ground Training + 15 hrs Flying training with TRE/TRI + Hill Ops Release Check 0:45 hrs.
1000 hrs and above total flying experience including 250 hrs PIC on helicopters.	Ground Training + 10 hrs Flying training with TRE/TRI + Hill Ops Release Check 0:45 hrs.

The said training can be carried out on Helicopter as well as on FFS B/C/D or FTD 6/7. Upto 50% of flying training is permitted to be carried out on FFS B/C/D or FTD 6/7 (FAA Designation) specifically cleared for the purpose. However, Hill Ops Release Checks shall be carried out only on the helicopter and minimum 03 landings shall be carried out on at least 03 different helipads at/above 4000 Feet AMSL. For a pilot with previous experience in Hill/Mountain flying, the training requirements are given below:

Total Flying Hours	**Experienced in Hills/Mtns**
Less than 1000 hrs total flying experience including 250 hrs PIC on helicopters.	2 hrs Flying training with TRE/TRI + Hill Ops Release Check 0:45 hrs.
1000 hrs and above total flying experience including 250 hrs PIC on helicopters.	1 hr flying training with TRI/TRE + Hill Ops Release Check 0:45 hr.

In addition to flying training, CAR also prescribes Ground Training of minimum 04 Hours at a DGCA approved GTO/ATO or by a TRE/TRI/Check Pilot/Chief Pilot. CAR also lays requirement for Recent Experience to mandate that a previously cleared pilot who has not carried out Hill/Mountain Flying in the last 12 months preceding the date of operations shall fly a Hill Ops training sortie of 0:45 hr followed by Check sortie of minimum 0:45 hr duration, with a TRE/TRI before being permitted for independent operations.

Similarly, a previously cleared pilot who has not carried out Hill/Mountain Flying in the last 24 months or more shall undergo ground refresher of 2:00 hrs duration followed by training flight with TRE/TRI of 1:00 hr, followed by a Hill Ops Check of 0:45 hr on the helicopter with a TRE/TRI.

1.17.3.3 Minimum Safety Requirements for Helicopter Landing Areas used on Regular basis.

As per CAR Section 4, Series B, Part V, there are certain helicopters landing areas which are not constructed as Heliport, however, are being used for regular operation for passenger transportation. Such helicopter landing areas are generally located and used extensively at places where helicopter transportation is preferred mode over the other modes of transportation due to geographical and other constraints.

Such sites are normally owned by state government or other entities which are having their limited use. However, such owners extend its use on regular basis to helicopter operator without assuming the responsibility for operational aspects/ facilities at the landing area. As per the CAR, regulatory

oversight cannot be performed over such areas due to various factors e.g. periodicity of operation, geographical location, large number of such areas. Such usage of helicopter landing site is permitted by the owner with or without assuming any responsibility regarding the availability of minimum facilities.

The CAR puts the onus of ensuring availability of minimum facilities required for safe helicopter operations on the Helicopter Operator and further quote from CAR, Section 8, Series 'O' Part IV & V, to say that a flight will not be commenced unless it has been ascertained by every reasonable means available that the ground and/or water facilities available and directly required on such flight, for the safe operation of the helicopter and the protection of the passengers, are available and adequate.

The CAR Section 4, Series B, Part V lays down the minimum safety requirements for helicopters operating to/from such helicopter landing areas within the Indian Territory outside a licensed aerodrome/ heliports and procedures to be followed by Helicopter operators for such operations. CAR, therefore does not make it binding on the owner of helipad or landing areas to ensure that minimum safety requirements are met irrespective of the frequency of operations, or passenger loads.

1.18 Additional Information

No further information.

1.19 Useful or Effective Investigation Techniques

No further information.

2. Analysis

2.1 Serviceability of Aircraft

On the day of accident, the aircraft held a valid certificate of airworthiness. The helicopter was maintained as per the maintenance program approved by DGCA and all maintenance actions required as per the DGCA approved Aircraft Maintenance Programme (AMP) were carried out when due.

No snag or defect was reported in any of the flights preceding the accident flight on the day of accident. The examination of helicopter wreckage including engine did not indicate any malfunction or problem with the helicopter or its engine that would have affected the ability of the helicopter to sustain a safe flight. Serviceability of the aircraft was not a causal or contributory factor in the accident.

2.2 Standard Operating Procedure for operations at Kedarnath

2.2.1 Weather Watch

As per the SOP, the crew are required to keep continuous watch on the weather in the valley, and in-case of any doubt it is advisable to return back and wait at the Helipad. The pilot first encountering bad weather is to give call on RT regarding the decision to call off due bad weather, and this shall be acknowledged on RT and binding on all helicopters airborne at the time.

The operators/crew are required to obtain weather through IMD from Dehradun before commencement of flight, however, there is a considerable difference in weather in the valley to that of Dehradun. The SOP also contains various other procedures which requires pilots to continuously have a Weather watch and to ensure that prior to flight actual weather conditions of the region and the helipads shall be ascertained and assessed. Most of these procedures can be adopted only when actual weather conditions and trend is known to the crew before they decide to conduct the flight or not. However, in the absence of any MET facility in the valley everything is dependent on the individual pilot's perception. Most of these shuttle operations are single pilot operations and the pilot is entrusted with additional responsibility of conveying the weather on RT, i.e., apart from performing the duties of PF & PM, the pilot is to ensure that the weather update is also conveyed on RT. With frequent change in weather conditions in the valley this procedure of total dependency on pilots' perception cannot be relied upon every time.

Further, in the SOP it is mentioned that there should be personnel from each operator who mans the Kedarnath helipad and provide weather updates to the respective pilots. The operators have their personnel manned at Kedarnath helipad, however, these personnel are not MET expert they are the ground handlers who are used mainly for assisting in boarding/de-boarding of passengers. They just visually observe the weather as far as they can observe in the valley and report it to the pilot. Hence, it is not sufficient to rely on these personnel to give correct weather update which is a specialized task. This requires specialized MET facility and dedicated manpower to have continuous watch on prevailing weather and trend.

2.2.2 Responsibility of Operations

As per the joint SOP, each helicopter operator operating to Kedarnath, is required to have independent Helipad meeting requirements of CAR Section 4, Series B, Part V. The helipad at Kedarnath is provided by UCADA. Despite huge passenger traffic that the Kedarnath helipad handles, it is not a DGCA licensed helipad and responsibility of ensuring availability of personnel, safety/firefighting equipment, etc. lies with respective air operator. The various helipads from where the shuttle services are provided are located at Guptkashi, Phata, and Sersi etc. Each operator has their own independent helipads in these locations from where they provide shuttle services to Kedarnath Shrine.

Further, in the SOP it is given that the safety and firefighting facilities at Kedarnath helipad will be provided by the UCADA in coordination with helicopter operators. The operators are to coordinate availability of these services at Kedarnath helipad before commencement of operations. Each operator shall position a team at Kedarnath Helipad with a nominated helipad shift "In-Charge" for conduct of operations. It is understood that the technical surveillance/inspection is being carried out by DGCA. It was informed by UCADA that they only carry out administrative inspections which includes facilities at helipads, facilities/arrangements for passengers, etc. However, whenever there is any kind of observation on operations/technical aspects they intimate it to DGCA for further necessary action. It was further informed that the operations in every season is started only after the inspection/surveillance of DGCA is carried out and UCADA ensures that the observations therein are actioned. They also carry out inspection in-between during the operations to check if the requirements are maintained. Most of the requirements have been made part of joint SOP.

From the above, it is clear that as per the CAR Section 4, Series B, Part V and Joint SOP, the responsibility of operations in the Kedarnath valley lies with individual operator conducting operations at Kedarnath Shrine. Owing to the fact that multiple helicopter operator are involved in carrying out shuttle flights at Kedarnath helipad, the responsibility is also shared jointly.

Even though the helipad at Kedarnath is provided by UCADA, the responsibility of ensuring safety and availability of firefighting facilities at helipad has also been entrusted to the operators. Hence, each and every responsibility for safe conduct of flight in the region lies with the operators which means operators are allowed to conduct the flights at their own discretion without any clarity and supervision of operations. This provision is vague and not conducive for safe operations from Kedarnath Helipad as each operator gives emphases to their own operations and there is lack of proper co-ordination between the operators in absence of a single responsible entity for safe operation of the shuttle flights at Kedarnath helipad.

The provision of giving responsibility to individual operator may be effective for the helipad from where they are operating shuttle services to Kedarnath Shrine, but it is not effective for Kedarnath helipad which is common for all operators. As per procedure each operator has positioned a team with a designated in-charge at Kedarnath Helipad but it is not clear as to who is the overall in-charge of the operations being conducted from Kedarnath Helipad. Owing to the fact that no responsibility has been designated to a particular organisation or to an individual, there is no clarity regarding who is responsible for safe conduct of flights from Kedarnath Helipad and what is the role and responsibility of individuals involved in conduct of these shuttle flights. This is further evident from the series of accidents which occurred in the Kedarnath helipad over the years. The latest fatal accident in the month of April 2023 wherein a passenger came in contact of rotating tail rotors.

There is a need for designating responsibility to a particular organisation for overall supervision and to ensure safe conduct of flights from Kedarnath helipad. This will also ensure that there is no ambiguity among operators regarding their roles and responsibilities.

2.2.3 Air Traffic Control in Kedarnath Valley

Apart from not being a DGCA licensed helipad, Kedarnath Helipad does not have any ATC as well despite huge passenger traffic and high numbers of landings that the helipad handles. As in case of other areas of operating the shuttle flights in the valley, the joint SOP provides procedures wherein responsibility of controlling the air traffic in the valley also lies with the operators themselves.

As per the joint SOP the pilot are to follow a certain route and altitude for operating into Kedarnath Helipad. The routes and altitude are defined separately for operator's helipad to Kedarnath and from Kedarnath to operator's helipad respectively. The pilots are required to call out on RT regarding their flight status starting from take-off from either helipad and at various positions enroute. The entire flying in the valley is dependent on the RT calls made by the operating pilots including call out made for weather update. There is no procedure of readback or to ensure that all the pilots operating in the region received the RT call. Hence this system itself is not a fool proof system and there is always chance of someone missing the RT call made by any pilot. The same could have been the case in the subject accident wherein the pilot who just took-off before VT-RPN stated that he gave a call out on RT regarding the prevailing weather just after he took-off from Kedarnath Helipad. If that was the case then the deceased pilot could have received the RT call and

may have acted according to the reported weather conditions or if he had heard the call and still decided to take-off reflects that the pilot operate at their own discretion and there is no controlling of the traffic.

2.3 Circumstances leading to the Accident

The PIC was flying with an off-shore operator till July 2022 and joined Aryan Aviation in Aug 2022. The PIC had not carried out hill/mountain flying for more than 24 months and was hence provided training as per Para 10.3 and 11 of CAR Section 8, Series H, Part II.

PIC operated regularly during the months of Sept – Oct 2022 and carried out about 105 hours of flying at Kedarnath. On the day of accident the PIC had earlier operated 04 Shuttles and carried out 08 landings safely during the time slot 0825 – 0935 Hrs. After break of one hour the VT-RPN was prepared to operate shuttle during the time slot 1130 – 1230 Hrs. Helicopter operated one shuttle uneventfully and flew back to Kedarnath with 05 passengers to land at Kedarnath at 1137 Hrs.

As per the Log maintained by GMVN, six helicopters had landed and taken-off from Kedarnath between 1135 and 1138 Hrs. Another Bell 407 helicopter, VT-JIB, was ready for take-off from Kedarnath while VT-RPN was at Finals. The weather was continuously deteriorating, but the approach/departure path was reported to be clear. After VT-RPN landed, VT-JIB took off and called VT-RPN as it crossed Garud Chhatti. However, it did not receive any response.

VT-RPN took off after exchange of passengers and was reportedly visible to witnesses at Kedarnath Helipad for about 5-10 seconds before disappearing out of sight. The PIC misjudged the weather and took off assuming the departure path will remain clear. However, the descending clouds closed the escape path. At about 1141 Hrs, VT-RPN hit the ridge about 1.25 km from the Kedarnath helipad and rolled down the slope leading to seven fatalities.

3. Conclusion

3.1 Findings

3.1.1 The aircraft had valid CoA and was maintained in accordance with DGCA approved AMP.

3.1.2 The PIC had a gap of more than 02 years, since he had carried out Hill/Mountan Flying when he joined Aryan Aviation. He was provided minimum training as required by CAR Section 8, Series H, Part II in such cases.

3.1.3 The CCTV cameras overlooking the Kedarnath Helipad were available, however, the footage from cameras was not made available and it was informed that the cameras were not serviceable. There was hence no way to verify the statement given by the witnesses.

3.1.4 Operations at Kedarnath helipad are carried out as per CAR Section 4, Series B, Part V which lays provisions for helicopter landing areas used for regular basis. There is no requirement for such helipads to be licensed and the responsibility of ensuring that helipad meet the requirements for safe conduct of operation lies with the helipad operator.

3.1.5 During Sept-Oct 2022, more than 10,000 shuttles were operated by eight operators and more than 100,000 passengers were flown in and out of Kedarnath Helipad.

3.1.6 The helipad does not have any meteorological station or Met personnel who can provide weather updates.

3.1.7 There is no ATC at the helipad, the operations are carried out as per slots provided by UCADA and operator co-ordinate amongst themselves over VHF to ensure adequate separation between helicopters.

3.1.8 The VHF coverage in the valley is reported to be inadequate with many blind spots because of terrain and lack of any repeater stations.

3.2 Probable Cause of the Accident

The accident was caused due to error of judgment on part of crew to correctly assess deteriorating weather situation for a safe take-off and flight.

Fast descending clouds closed the departure path that may have been available to the preceding helicopter and VT-RPN impacted the ridge due to obscured visibility.

4. Safety Recommendations

4.1 UCADA should set up an Aviation Met Station manned by qualified Met experts at Kedarnath to provide more accurate weather updates to all operators flying into Kedarnath. UCADA may approach Indian Meteorological Department for providing such services at Kedarnath.

4.2 DGCA should ensure that provisions of CAR Section 4, Series B, Part V are restricted to Helipads where operations are regularly undertaken, but the applicability should be defined in terms of number of sorties to be operated or passengers being handled. DGCA should ensure that Helipads at Shrines like Kedarnath, which handles high number of sorties and passenger loads on daily basis should be licensed and Helipad operator is individually responsible for safety and security of helipad operations.

4.3 All operators file Flight Plan at Delhi ACC and obtain FIC/ADC before taking off from their Helipads. The operations in the valley are however, in an uncontrolled environment as there is no ATC. UCADA should establish ATC at Kedarnath for better control and monitoring of operations by Helicopter Operators.

4.4 UCADA in co-ordination with all helicopter operators should study availability of adequate VHF coverage in the valley and ensure installation of VHF repeaters to cover all blind spots.

4.5 DGCA should ensure that the operational areas at Kedarnath helipad should have adequate CCTV coverage and availability of recordings should be checked during all audits and surveillances.

Date: 12 Nov 2023