

**REPORT OF ACCIDENT TO VT-EQL CHETAK HELICOPTER OF BSF AT FATEHPUR VILLAGE,  
NEAR MOUNT ABU, RAJASTHAN ON 13.05.2011**

(a) Helicopter

Type and Model : Chetak Helicopter

Nationality : Indian

Registration : VT-EQL

(b) Owner/Operator : Border Security Force,  
New Delhi

(c) Date of Accident : 13.05.2011

(d) Time of Accident : 0945 UTC

(e) Last Point of Departure : BSF base, Gandhinagar, Ahmedabad

(f) Point of intended Landing : Mandore, Jodhpur, Rajasthan

(g) Geographical Location of  
Accident : Lat. 24°32'33" N  
Long. 72°38'35" E

(h) Type of Operation : Non-scheduled

(i) Phase of Operation : Cruising

**(All Timings in the Report are in UTC)**

## **SYNOPSIS**

Border Security Force (BSF) Chetak Helicopter VT-EQL met with an accident while operating flight from Gandhinagar to Mandore on 13.05.2011 at Fatehpur village, near mount Abu, Rajasthan.

The accident was investigated by Committee of Inquiry appointed under Rule 74 of Aircraft Rules, 1937; vide Govt of India, Ministry of Civil Aviation, Extraordinary Gazette Notification No. AV, 15013/003/2011-DG dated 26<sup>th</sup> July 2011.

The helicopter took off from Gandhinagar, Gujarat at time 0850UTC for operating flight to Mandore, Rajasthan with a Pilot in Command (PIC), a co-pilot, one Engineer and a BSF Official on board. The flight was uneventful from Gandhinagar till the time (0940 UTC) it was in contact with Ahmedabad ATC. While it was flying through Aravali hills range near Mt. Abu, it developed serious defect in the Main Rotor System. Helicopter was on radial R- 007 at Fatehpura Village in Rajasthan.

Before impacting the ground the helicopter made a right turn and impacted the ground with high impact force. The crash site is approximately 40 metres away from the route as per the flight plan filed by the helicopter. Helicopter impacted the ground squarely i.e. vertically with no forward movement. It crashed and caught fire. All the occupants were charred to death inside the burning helicopter.

The accident was caused by the loss of rotor pitch control resulting from probable failure of Hydraulic Drag Dampers in flight which imposed excessive tensile load on the Blade Spacing System. One of the Attachment Bolts sheared off and released one Spacing Cable. The second bolt gave way and the associated Link opened up, thereby releasing the second Spacing Cable end from the same post. The severed Spacing Cable Eye-end impacted and broke the pitch control rods leading to the loss of control of the helicopter.

## History of Flight

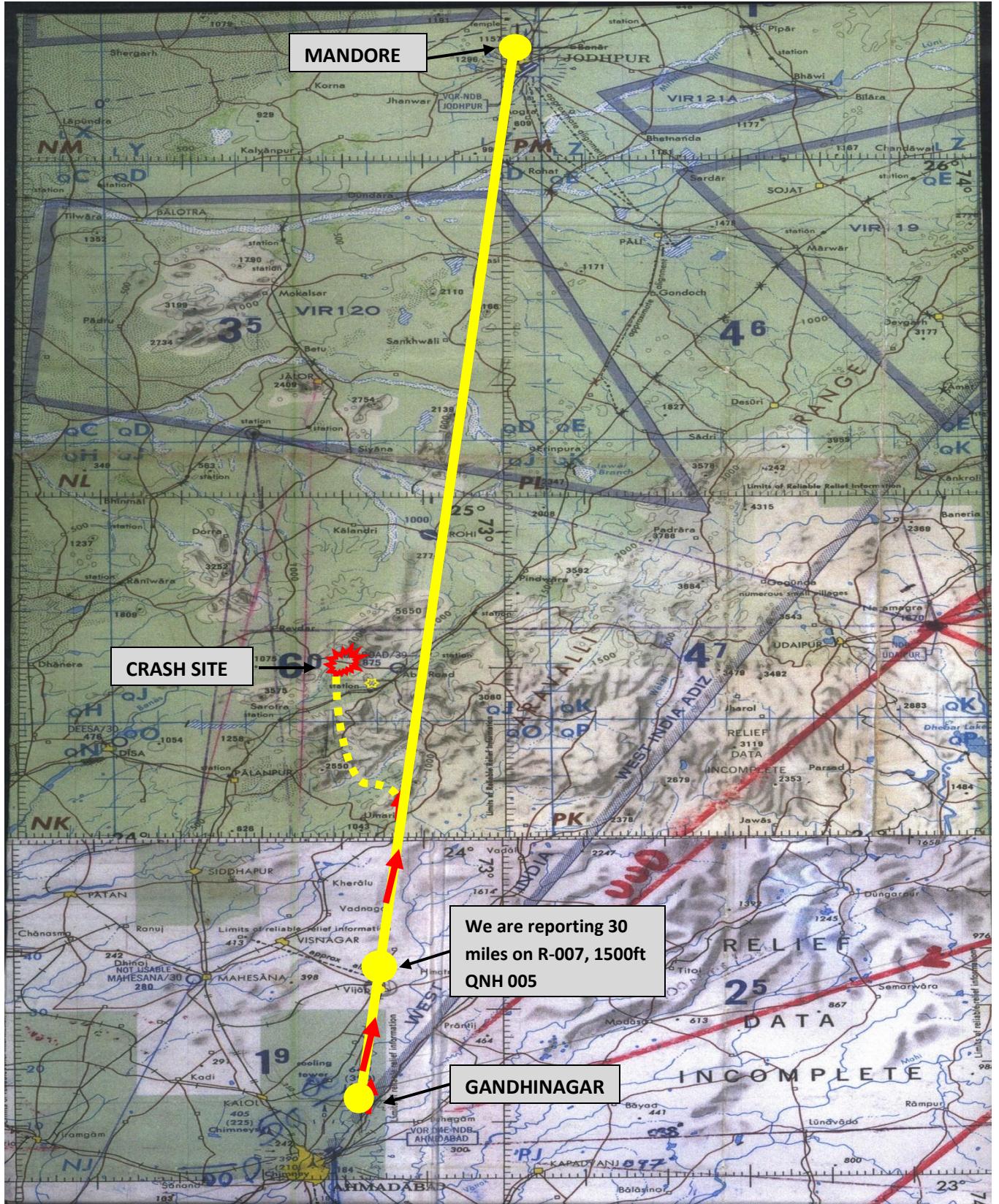
Border Security Force (BSF) Chetak Helicopter VT-EQL met with an accident at Fatehpur village, near Mount Abu, Rajasthan, while operating flight from Gandhinagar, Gujarat to Mandore, Rajasthan at 0945 UTC on 13.05.2011. There were four persons on board which included Pilot in Command, Co- Pilot, one Engineer and a BSF Official.

The Crew of the helicopter filed Flight Plan for direct routing from Gandhinagar to Mandore for an altitude of 1500 ft AGL. The telephonic clearance was taken from Area Control land line for a VFR flight. The Helicopter departed from Gandhinagar at 0850 UTC. ATC advised the pilot of the helicopter VT-EQL to maintain the preferred altitude of 1500 feet AGL on QNH 1005 hpa.

He was further advised to report 30 miles out. Pilot intimated estimates as FIR 1030 UTC and ETA destination 1155 UTC. Then the estimates were passed on to FIC at 30 miles. ATCO directed the pilot of the helicopter to change over to the frequency 123.75 MHz as the pilot did not reply, ATCO requested another aircraft to intimate VT-EQL to establish contact with Control on 123.75MHz. Soon after, the pilot was heard calling on 123.75 MHz. After being released by Approach Control, Pilot reported his position 30 NM from AAE 1500 feet on QNH 1005 HPA. He did not report any abnormality in operations of helicopter. The helicopter remained in contact with ACC on frequency 123.75 MHz till 0907 UTC reporting at 30NM on radial 007 AAE. At time 0908 UTC the helicopter called Jet Airways Aircraft 2065 to relay the position of 30NM on radial 007 AAE to Ahmedabad ACC. On Route Radar, the helicopter painted till 0911 UTC and then the target dropped off at a distance of approx 37 NM from AAE.

The Chetak helicopter VT-EQL was on route R007 from South to North and developed serious defect in Main Rotor System. As reported by the Eye-witness, a local farmer, sitting outside his hut and having direct view of the helicopter, the helicopter was producing intermittent hitting sound. After passing over the hut, it executed a sudden right turn and fell squarely on the ground and burst into

flames. The adjacent area and the bushes started burning and fire engulfed the area of the accident site. His statement was corroborated by another farmer sitting near his hut about 100 metres away from the accident site. The first Eye-witness immediately intimated the local Police Station on his mobile phone about the accident. The Police and Fire tender reached the site of the accident within half an hour and spread foam and water on the burning helicopter. All the occupants of the helicopter i.e. pilot, co-pilot, AME and the BSF Official, got burnt inside the helicopter. The accident took place during the day time at 0945 UTC.



*Fig.1 Topographic chart showing the VT-EQL departure site, the accident site, the destination and the Route cleared for.*

1.2

### **Injuries to Persons**

| INJURIES | CREW | PASSENGERS | OTHERS |
|----------|------|------------|--------|
| FATAL    | 2    | 2          | NIL    |
| SERIOUS  | 0    | 0          | NIL    |
| MINOR    | 0    | NIL        | NIL    |

1.3

### **Damage to Aircraft**

Helicopter was completely destroyed due to impact and fire.

1.4

### **Other Damages**

Nil

1.5

### **Personnel information**

#### **1.5.1 Pilot-in-Command**

##### **Details of Licence**

License type : CHPL-758

Valid up to : 18-04-2012

Date of Issue : 19-04-2007

Date of Endorsement

on type of Aircraft being flown : 19-04-2007

Date of Last Medical : 23/12/2010

Date of Birth : 12-10-1961

Details of last two IR check : IR no-229 Last IR done on 17<sup>th</sup> Dec 2009 on Bell-212

Skill Test : ST done on 5<sup>th</sup> Nov 2010 on Chetak.

ST done on 17<sup>th</sup> Dec 2010 on Chetak

## Aircraft Ratings

As PIC : Alouette III/Chetak, Bell 212  
As Co-pilot : Alouette III/Chetak, Bell 212

## Flying Experience:

|                            |   |             |
|----------------------------|---|-------------|
| Total Flying Experience    | : | 2930:00 Hrs |
| Flying during last 90 days | : | 19:15 Hrs   |
| Flying during last 30 days | : | 19:15 Hrs   |
| Experience on type         | : | 1781:00 Hrs |
| Flying during last 7 days  | : | 04:00 Hrs   |
| During last 24 hours       | : | Nil         |

He was not previously involved in any accident/serious incident.

## 1.5.2 Co-Pilot

## **License Details:**

**Aircraft Ratings:**

As PIC : 68:40 hrs on Chetak  
As Co-pilot : 78.05 hrs on Chetak  
Flying Details : Dual – 99:15 hrs  
PIC-68:40 hrs  
Co-pilot – 78:05 hrs  
Total Flying Experience : 246:00 hrs  
Experience on type : 246:00 hrs  
Flying during Last One year : 59:20 hrs  
Flying during 30 days : 22:55 hrs  
Flying during last 7 days : 02:30 hrs  
During last 24 hours : Nil

He was not previously involved in any accident/serious incident.

**1.5.3 Aircraft Maintenance Engineer**

Licence type : A&C  
Date of Issue : 29.06.1990  
Date of Endorsement of  
Aircraft type : Alloutte III B, Artouste III B, Cheetah/ Lama  
/ Approval/Authorisation  
Experience on type : January 1996 to 13<sup>th</sup> May, 2011

**Helicopter Information**

## 1.6.1

**Helicopter Information**

|                                  |  |
|----------------------------------|--|
| Manufacturer                     | Helicopter Division, Hindustan Aeronautics Limited, Bangalore                    |
| Type                             | Chetak Helicopter  |
| Constructors S.NO.               | AH-303   |
| Year of Manufacturer             | 1989   |
| Certificate of Airworthiness     | No. 1924, Date of Initial issue.28.11.1988<br>Currently Valid up to 03-04-2012   |
| Category                         | Normal   |
| Sub Division                     | Private  |
| Certificate of Registration      | No. 2431/2, Issued on 11/10/1990   |
| Owner (with Address)             | Director General, Border Security Force, 'F' Wing Hall, Nirman Bhawan, New Delhi |
| Minimum Crew Required            | One  |
| Maximum Authorised All Up Weight | 2200 Kgs.  |
| Last Major Inspection            | 100 hrs on 21/03/2011  |
| Last Inspection                  | 25 hrs on 16/04/2011   |
| Air frame Hrs. Since New         | 4019 :20 hrs. (up to 10/05/2011)   |
| Air frame Hrs. Since last C of A | 43 hrs 55 minutes  |

|                                   |   |
|-----------------------------------|---|
| <b>Engine</b>                     | <b>Single</b>                             |
| Manufacturer                      | Turbomecca / HAL Engine Division          |
| Type                              | Artouste-III B                            |
| Serial No.                        | H-55484                                   |
| TSO                               | 432 hrs. 40 minutes                       |
| Last Inspection Carried Out       | 25 hrs on 16/04/2011                      |
| Last Major Inspection Carried out | 100 hrs/180 days inspection on 21/03/2011 |
| Average Fuel Consumption          | 182 kgs/hr (as on 09/02/2011)             |
| Average Oil Consumption           | 45.313 mg /hr (as on 09/02/2011)          |

### 1.6.2                   **Scrutiny of records**

- The last major inspection 100 hrs/180 days was carried out on 21<sup>st</sup> March, 2011 at 3975.35 A/F hrs. The helicopter had flown 43 hrs 20 minutes after this inspection till the day of accident.
- The Vertical stabilizer was replaced with new one on 6<sup>th</sup> January, 2011, due to suspected crack in the removed stabilizer.
- No significant snag had been recorded on this helicopter since its last C of A renewal i.e. on 4<sup>th</sup> April, 2011 except a snag about the RPM indicator not registering at Gandhinagar, Ahmedabad. The RPM indication snag was rectified by re-soldering connector wires as the same was found to have come out of the connector. The standard troubleshooting procedure was not followed. The RPM indicator was found recording the RPM satisfactorily on ground run given at Gandhinagar prior to take off from BSF helipad.
- The Scrutiny of old records revealed that the helicopter was involved in Tail hit / heavy landing on 30<sup>th</sup> January, 2005. On 29<sup>th</sup> Jan, 2005 crew had reported “severe

vertical and lateral vibrations". As a rectification, drag dampers were checked for play, MGB, transmission platform and main rotor head mounting, spacing cable along with bolt and the links were also checked. The helicopter after this inspection reported vibrations at high speed and high collective pitch. Necessary rectification action was carried out on drag dampers. On 30<sup>th</sup> January, 2005, during vibrex check severe vibrations were encountered and helicopter made a emergency landing about half a kilometre from the Mandore helipad. During inspection, following damages were observed:

- Spacing cable Attachment bolt had sheared off on the yellow sleeve of the main rotor head.
- Spacing cable end had become free and impacted the trailing edge of red main rotor blade at about 12 inches from blade root and caused damage to trailing edge 10 inches in length and 5 inches in width.
- Following the incident, Main Gear Box (Serial No. CH435), Main Rotor Shaft (Serial No. AH 184), Free Wheel and Drive Shaft Assembly (CH211), Clutch Unit (Sr.No. 402) and Hydraulic Drag Dampers were sent to HAL for heavy landing checks. It is found that two separate Defect Reports have been raised by the maintenance agency for the removal of drag dampers.
  - a) DIR dated 10.05.2005, which states that Hydraulic Drag Damper Sr. No CH 802, CH1779, CH1780 were replaced as their calendar life was near to completion.
  - b) DIR dated 11.05.2005, which states that Hydraulic Drag Dampers Sr. No CH 924, CH925, CH926 were replaced for onward dispatch to HAL for inspection after heavy landing made by the helicopter on 30<sup>th</sup> Jan, 2005. The on numbers were CH733, CH734, and CH735. However these Sr. No(s) are not available in the Inventory of BSF.

On 23/12/2008 Hydraulic Drag Damper Sr. No CH 924, CH925, CH926 were replaced due “Timing out of limits”.

As per log cards of hydraulic drag dampers Sr. No CH 802, CH 1779, CH 1780 were installed on 22/12/2008. These were overhauled at HAL on 06/12/2005 and matched. Thereafter, there is no record of replacement of the drag dampers.

Drag dampers Sr. No CH 802, CH 1779 matched with the drag dampers recovered from the accident site. However, the Serial No. of the third drag damper could not be identified as its body had burnt.

### 1.6.3           **General Description**

The Chetak helicopter is a three bladed lifting rotor with an anti torque tail rotor powered by Turbomeca Artouste IIIB Turbo shaft engine developing 550 S.H.P. at 33,500 R.P.M. The fuselage comprises of two distinct assemblies, the body structure and the tail boom. The Main Rotor has three foldable, metal covered blades that are articulated on the hub by means of horizontal and vertical pins. The equal spacing among the Main Rotor Blades is maintained by three spacing cables and three hydraulic drag dampers. The anti torque tail rotor is mounted on the starboard side at the end of the tail boom. The engine output shaft, the speed of which is already stepped down to 5770 R.P.M. by the engine reduction gear, drives the main rotor at 355 R.P.M. through the Main Gear Box. The Main Rotor collective and cyclic pitch variation is controlled through a Swash Plate assembly. The helicopter has conventional cockpit.

The Main Rotor System consists essentially of Hub which carries three Main Rotor Sleeves. The blade pitch change is controlled by means of rods connected at one end to the Blade Horns carried by the Blade Sleeves and at the other end to the Rotating Star/Upper Swash Plate.

The Flapping hinge is designed to limit the bending loads applied at the blade roots as a result of the lift forces acting on the blades. The drag hinge is designed to limit the bending loads applied at the blade roots as a result of Coriolis acceleration forces. Oscillations are damped by means of three Hydraulic Dampers mounted on the vertical drag hinge pin.

Blade Link is a steel forging with two holes at right angles to each other. The horizontal hole allows vertical movement about the hub through flap hinge pin. Horizontal movement of the blade spindle is achieved through the drag hinge pin fitted in the vertical hole.

Main Rotor Head Operation:

- A. Centrifugal loads resulting from the rotation of the blades are carried by the Tension-Torsion strips in the blade sleeve.
- B. If, during rotor operation, the horizontal motion of a blade is disturbed, two distinct components are used to overcome the disturbance.  
The cable spacing equalizer system corrects transient disturbance affecting inter blade spacing to ensure proper 120° angular distribution among the three blades. The Hydraulic Drag Dampers limit the horizontal oscillations of the blade by taking up the loads developed about the drag hinge axis and so facilitate the action of the blade spacing cables.
- C. In the event of vertical flapping being set up, it is automatically aerodynamically damped by the attendant Coriolis forces.
- D. Through contact of their restrained ring, the Centrifugal Droop Restrainers prevent the blades from drooping low, when the blades are at rest or rotating at low speed.

#### **1.6.4 Load and Trim Sheet**

There were four persons onboard including the crew. 309.6 kg. (400 lt.) of fuel was uplifted at Ahmedabad. Total fuel on board was 565 lt. at take-off. Trim was within limits.

#### **1.7 Met Information**

##### **1.7.1 Met Report from Ahmedabad Airport (Just Before Take-off)**

|             |          |                   |
|-------------|----------|-------------------|
| <b>Time</b> | <b>:</b> | <b>0840 UTC</b>   |
| S/WIND      | :        | VRB/2 kts         |
| Visibility  | :        | 6 km.             |
| Clouds      | :        | NSC               |
| Temp.       | :        | 39 deg. C         |
| Dew Point   | :        | 16                |
| QNH         | :        | 1005 hPa 2968 INS |
| QFE         | :        | 998 hPa 2949 INS  |
| Trend       | :        | NOSIG             |

#### **1.8**

#### **Aids to Navigation**

N/A

**ATC Communication record of Ahmedabad**

The start up was approved by Area control (ACC) at 084815 UTC. The PIC was advised to contact at frequency 119.8 MHz after getting airborne. At 085848 UTC, Area communicated to FIC the airborne time as 0850, FIR estimate was given as 1030 UTC and ETA Mandore as 1155 UTC. At 085326 UTC the helicopter VT-EQL established contact with TAR controller at frequency 119.8 Mhz. At 085519 UTC, the helicopter was cleared to climb to 1500 ft and further advised to report after reaching the altitude. At 085528 UTC the helicopter confirmed having reached 1500 ft height and transmitted the ETA Jodhpur at 1040 with 1155 QNH. At 090642 UTC, the ASR advised helicopter to report its position at 30 miles north of AAE and establish contact with the Control on 123.75 MHz. At 090740 UTC, the helicopter relayed its position to ACC as 30 NM on R-007 at 1500 ft on QNH 1005 hPa. The helicopter was not responding to the call. ASR relayed the message through JAI 2065. At 090805 UTC, JAI relayed the message and confirmed that the helicopter was in contact with the Control on 123.75 MHz and reporting at 30 NM at radial 007 AAE. PIC did not report any sort of abnormality / technical malfunction during the operations.

The helicopter remained in contact with ACC on frequency 123.75 Mhz till 0907 UTC. ON Route Radar the helicopter painted till 0911 UTC and then the target dropped off at a distance of approximately 37 NM from Ahmedabad (AAE).

CVR and FDR were not installed on the helicopter as these are not required as per the regulations.

The accident site is approximately 25 km West of Abu Road. The coordinates of accident site are 24°32'33" N, 72°38'35" E.

The accident site is a hilly barren land with slight slope and embedded with stones. As per the Eye witness No. 1 helicopter made a right turn before impacting the ground at approximately 40 meters from the flight path. The helicopter impacted the accident site in a squarely manner i.e. vertically. There was no forward motion of the helicopter after the impact. Wreckage of the Helicopter was found confined at one place approximately in a radius of 20 feet. Due to impact its fuel tank burst and fuel spread all over the area, resulting in fire which consumed entire cockpit area. Observations made at the accident site are as given below:

- One of the Spacing cable was found attached to its Posts on both sides (Fig.3). The two other Spacing cables, though anchored to one end of their respective Cable Posts, had got detached from the link chains attached to the third Cable Post (Fig.3). The Attachment bolt of one Chain Link had sheared off and the free end of the detached cable was found near the engine RG casing end. The Attachment bolt of its second Chain Link though still intact had been pulled out from its nut end. The link had opened outwards thereby, letting the Spacing Cable end to come out. This free end of the second Spacing cable had lost its bush insert and was found lying beneath the Rotor Assembly.
- One of the three Hydraulic Drag Dampers had got burnt and the other two were found badly damaged due to impact.



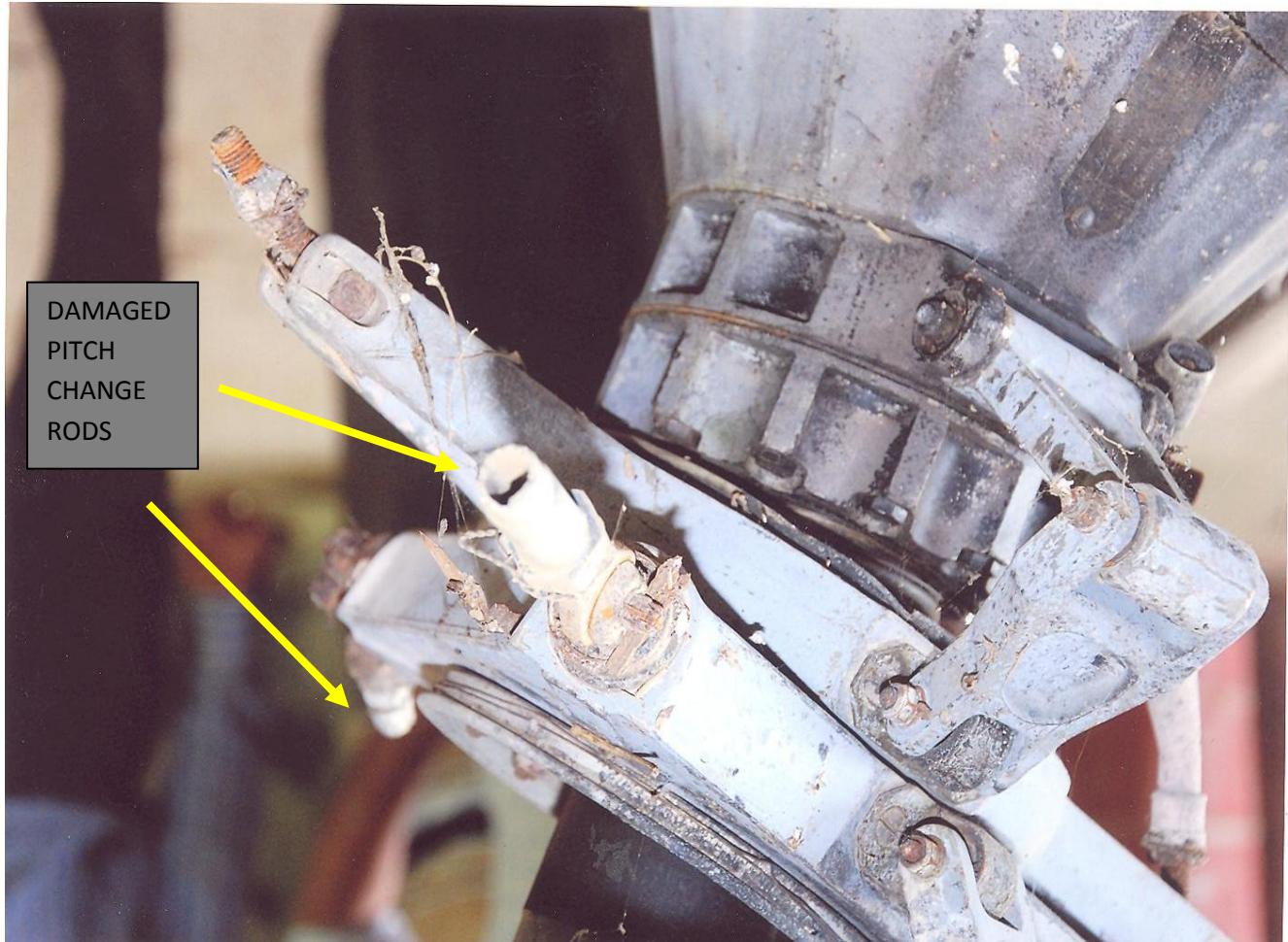
**Fig.No 2 View of the Accident Site with the Direction of Approach to the site**

- ⊕ One Main rotor blade (MRB) had sheared off due to clean shear, approximately 2 ft from its root end. The other portion of the Main rotor blade was also lying nearby. Being on the sloppy ground, it had escaped fire damage to great extent. The other two MRB's were partially destroyed in fire and there was no indication that these blades had rotated (cart wheeled) and grazed after hitting the ground.
- ⊕ All the three Pitch Change Rods were found broken but attached at both the upper as well as the lower ends. The Pitch Change Tubes were found completely burnt off.
- ⊕ The Freewheel/Drive Shaft and Clutch Unit were found damaged internally by fire.
- ⊕ The Inclined Drive Shaft & universal Joint were found fire damaged



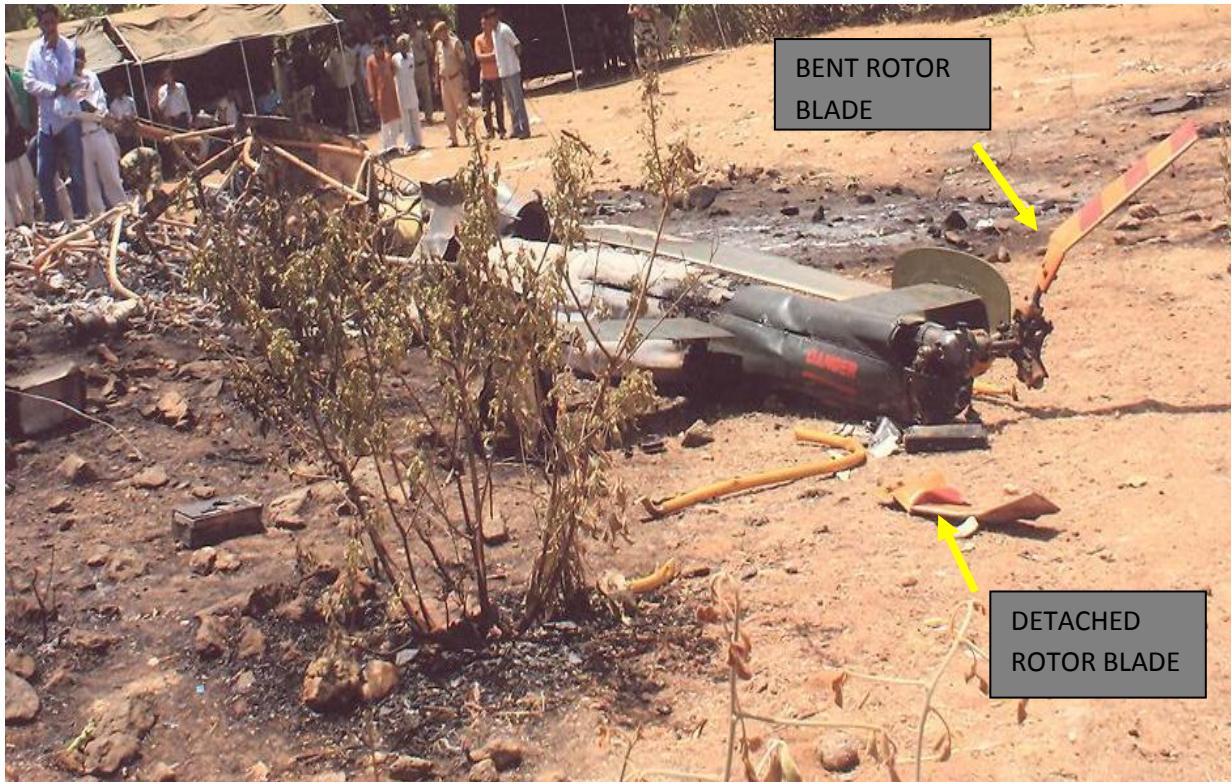
**Fig-3 Main Rotor Hub Assembly with the severed spacing cables**

- ✚ The Tail Boom up to the Horizontal stabilizer stage was found burnt. The Tail drive shaft was found attached to the tail boom and the TGB but the fire damaged near the Tail Boom attachment side.
- ✚ Tail Gear Box, Spider Mechanism and Tail Rotor Hub were found intact but ceased may be due to heavy impact.
- ✚ Two Tail Rotor Blades (TRB) were found attached with Tail Rotor Shaft and third Blade was found to have sheared off near its root end. No TRB had any sign of grazing the ground due to impact while in rotation.



***Fig.4 MGB Transmission showing the damaged pitch change rods***

- ✚ Only a couple of pieces of Tail Rotor Guard were left on the ground.
- ✚ The Power cable of the Portable Refueling Pump was found lying approximately 100 feet away in the front side of main wreckage thereby indicating that it got detached from the pump and was thrown out of the cabin when the Perspex of the cabin shattered due to heavy impact with the ground.



**Fig. 5 Tail Portion of the Helicopter showing the Tail rotor Blades**

- ✚ Portable Refueling Rubber Hose & Nozzle was found lying at approximately 60 feet away in the front side of main wreckage. Two HF Communication boxes were recovered from about 60 ft on the front side of the wreckage.
- ✚ Large number Plexi-glass pieces of the wind Screen were found lying scattered on the front side of the wreckage area.
- ✚ The entire Cockpit with its Instrument Panel, Control sticks, Seats and the occupants, Tech Log Book, Aircraft documents, Log Book of the Co-pilot and the Air borne toolbox were reduced to ashes due to the intense fire.
- ✚ The Transmission Platform with the Fuel Tank under it and the entire Baggage hold compartment in the Aft -Section of the fuselage together with the Communication Equipment and the Alkaline Battery were completely destroyed in the fire.

### **1.11.1 Examination of the Wreckage in the Hangar**

The wreckage of the helicopter was relocated to BSF hangar at Safdurjung airport for the purpose of post accident examination. Following are the observations:

#### **State of Airframe**

##### **(a) Cockpit**

Cockpit portion was totally destroyed in fire. **OAT ('S')** & ADE Receivers (two) were picked up at 50 feet from the main wreckage. All the instruments were destroyed in fire. Portable fire extinguisher and portable refueller were also destroyed in fire.

##### **(b) Central Section**

Totally destroyed in fire.

##### **(c) Aft Section**

Battery (Battery/radio composition) Radio equipment (VFH/UHF) all destroyed in fire. Fuel Tank – no trace left other than fiber glass outer covering as bits and pieces had scattered within 50 feet from the main wreckage.

##### **(d) Tail boom**

Forward portion completely destroyed in fire. Tail section including horizontal stabilizer was intact. Vertical fin was damaged due to impact. Tail rotor had broken. Tail rotor (TR) guard had

broken. Tail Gear box was intact with two TR blades, and was bent due to impact. One TRB sheered off at the cuff due to impact. No grazing of TRB tips on ground indicating either they were freely rotating at a very low rpm or had stopped rotating.

**(e) Aero-engine**

RG casing fully destroyed in fire. Power Output shaft engaged and visible. Speed Governor, oil pump partially destroyed in fire. Compressor housing, air intake destroyed in fire. Combustion Chamber casing intact. Turbine casing intact. No rubbing marks inside the casing. Exhaust Jet pipe intact – partially dented due impact. Dual coil ignition, AC Box and starter generator, Particle separator were completely destroyed in fire. Torch igniters in position.

**(f) M.R. Transmission**

Free wheel & shaft partially destroyed in fire. Clutch Unit intact but seized.

**i) Main Gear Box**

Magnesium casting was totally destroyed in fire along with external monitoring like tachometer, oil pump. Lower bevel gear intact. No signs of wear /broken teeth or metal deposition. Crown worm gear intact, no signs of abnormal wear or breakage of teeth.

**ii) Main Rotor Shaft**

No damage was observed to the shaft.

## **1.12        Medical and Pathological Information**

The post mortem examination of crew and passengers was carried out. The cause of death has been given to be shock due to whole body injuries and burns. All injuries were ante mortem in nature.

## **1.13        Fire**

Entire cockpit area was consumed in fire. Examination of the wreckage indicated the fire to be post impact. Due to impact the fuel tank burst. This caused spillage of the fuel and fire.

## **1.14        Survival Aspects**

The post mortem examination of crew and passengers indicated the cause of death to be shock resulting from burns and multiple injuries. The helicopter impacted the ground in squarely manner from a height. This was followed by the intense fire which consumed the entire cockpit. The accident was not survivable.

- The Eye-witness immediately intimated the police about the accident. The police and fire tender reached the site of the accident within half an hour, and spread foam and water on the burning helicopter. All the occupants of the helicopter (pilot & co-pilot, AME and the BSF official) were charred inside the helicopter.
- At time 1209 UTC, a telephone call received at Aerodrome Control Tower from the office of IG, BSF, Jodhpur that VT-EQL had not reached the destination.
- At time 1215 UTC, Area Controller Tower was informed by BSF about a possible crash of helicopter near Sirohi and that the helicopter could be VT-EQL taken off from Gandhinagar for Mandore departed at 0855 UTC estimate FIR 1030UTC and ETA Mandore 1155 UTC (as per FPS).

- ➡ WSO, Ahmedabad, immediately initiated search and rescue alerting actions and informed all concerned including RCC Mumbai and Delhi due to the proximity of the probable crash site being in the border of Delhi/Mumbai FIR.
- ➡ At time 1357 UTC SP, Sirohi, Rajasthan was contacted by Jt GM (ATM) who confirmed that helicopter VT-EQL had crashed in Bhimhguda in Fatehpura village in Bahadurpura Gram Panchayat in Girwar Police Chowki, 25 Km from Abu Road and BSF rescue team had also reached the site.
- ➡ The crash site was at 25 Km west of Abu Road at radial 275/72 NM from UUD VOR and radial 360/98 NM from AAE VOR which was approx 61 NM further from the last point of two way communication with ACC Ahmedabad.

## 1.15 Tests and Research

### 1.15.1 Tear down inspection of Main Gear Box

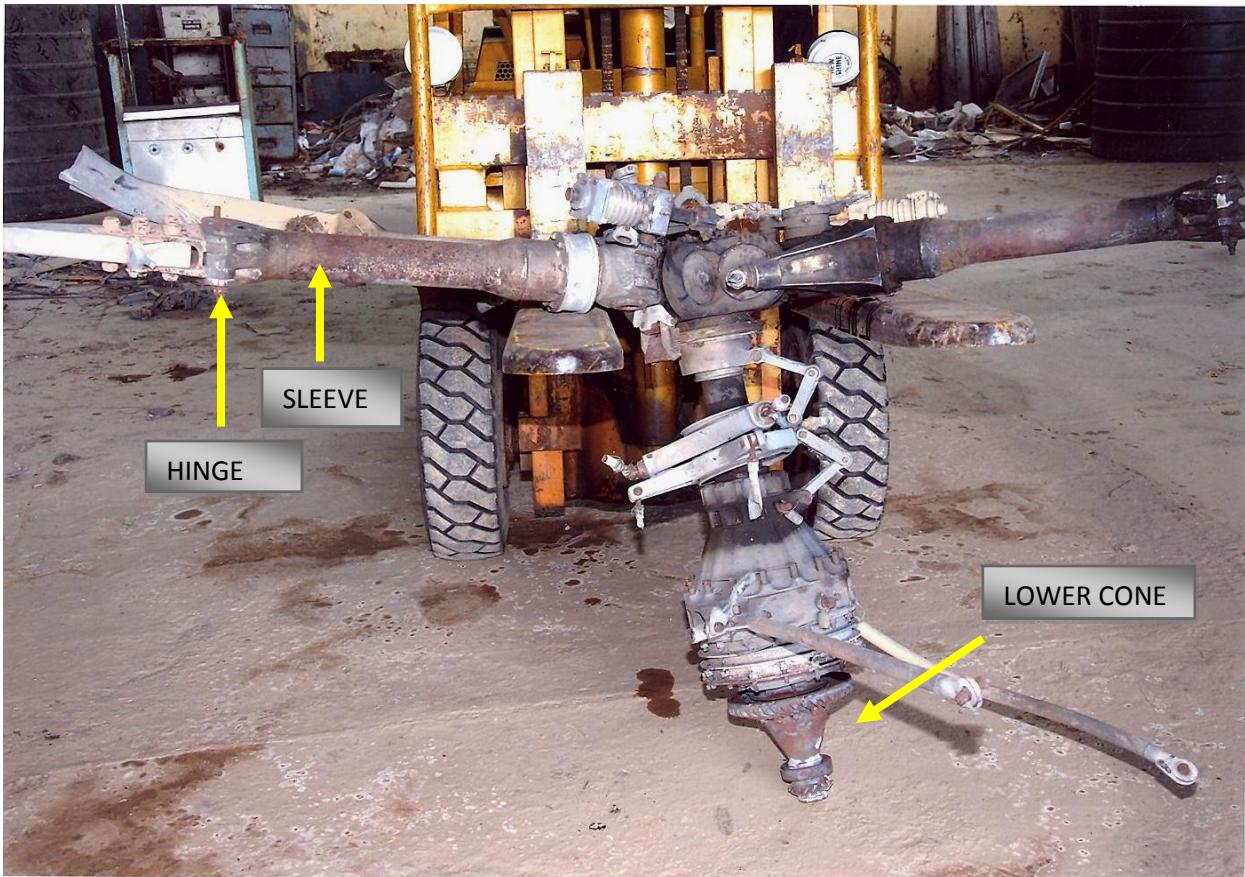
Tear down inspection was carried out at BSF hangar under the supervision of Committee of Inquiry.

#### History and related Data

Part No. : 319A.62.00.000.3  
Serial No. : CH-435  
TSO : 512:55 hrs.

#### External Observations

- ➡ No damage was observed on the upper portion of Main Gear Box (MGB), Main Rotor Shaft and Main Rotor Head Assembly. The lower portion (Magnesium casting) of MGB was completely burnt /melted away exposing the Crown and worm gear.



**Fig. 6 View of Transmission**

### **Examination on Disassembly**

The MR Head & Shaft were removed from the Assembly. The top case was removed, which exposed the carrier and ring gear. All the male splines on the root end of the MRS and female splines on the mating gear head were found undamaged.

The Ring gear together with Planetary gears were found undamaged and freely rotating even after the huge impact and the violent fire. All the eight gears were intact (Fig. 7). They were freely rotating with no sign of seizure or breakage of teeth. Central gear was intact. No signs of abnormal wear or breakage of teeth were observed.

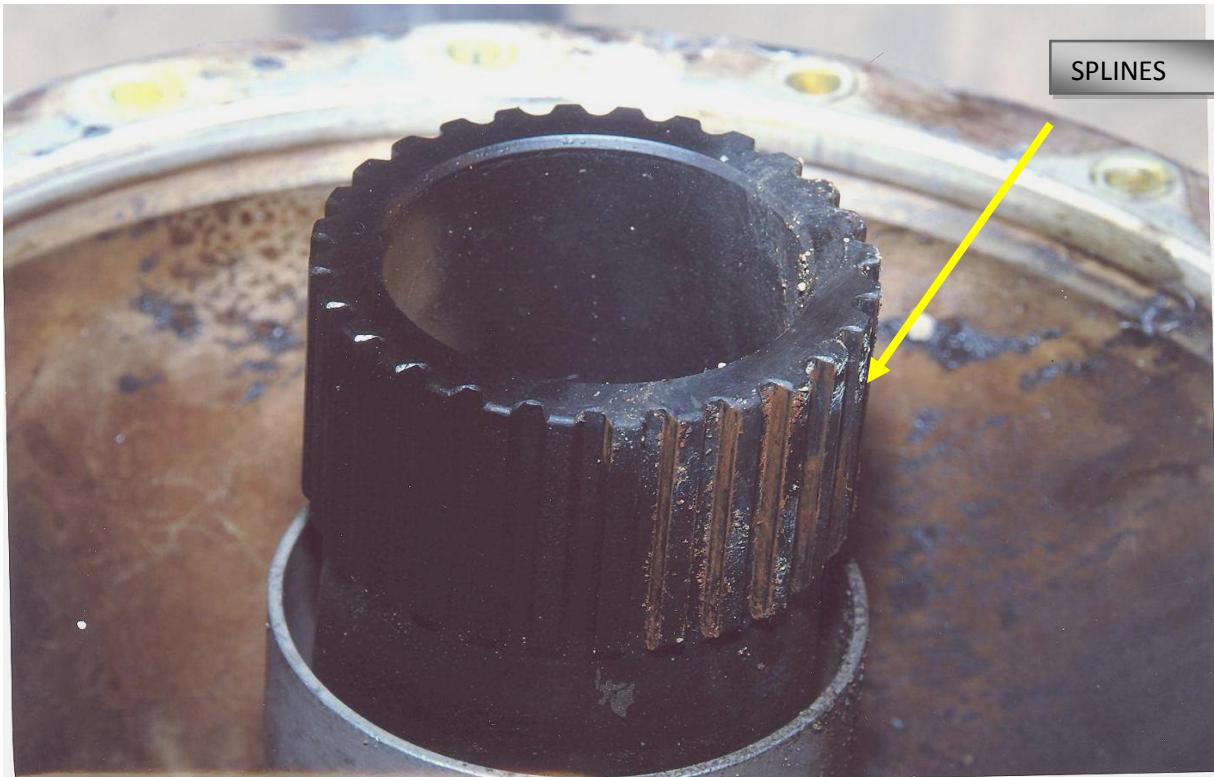
The Crown & Worm gear teeth also did not exhibit any damage, galling or pitting.

**Conclusion:**

The transmission gears were in good condition. No breakage, pitting, galling was observed. The gears in the transmission were capable of smooth transmission of power.



*Fig. 7 Ring Gear*



***Fig. 8 Main Rotor Drive Shaft***



***Fig. 9 Planetary Gears***

### 1.15.2 Main Rotor Head

MRH Sr. No. AH 116

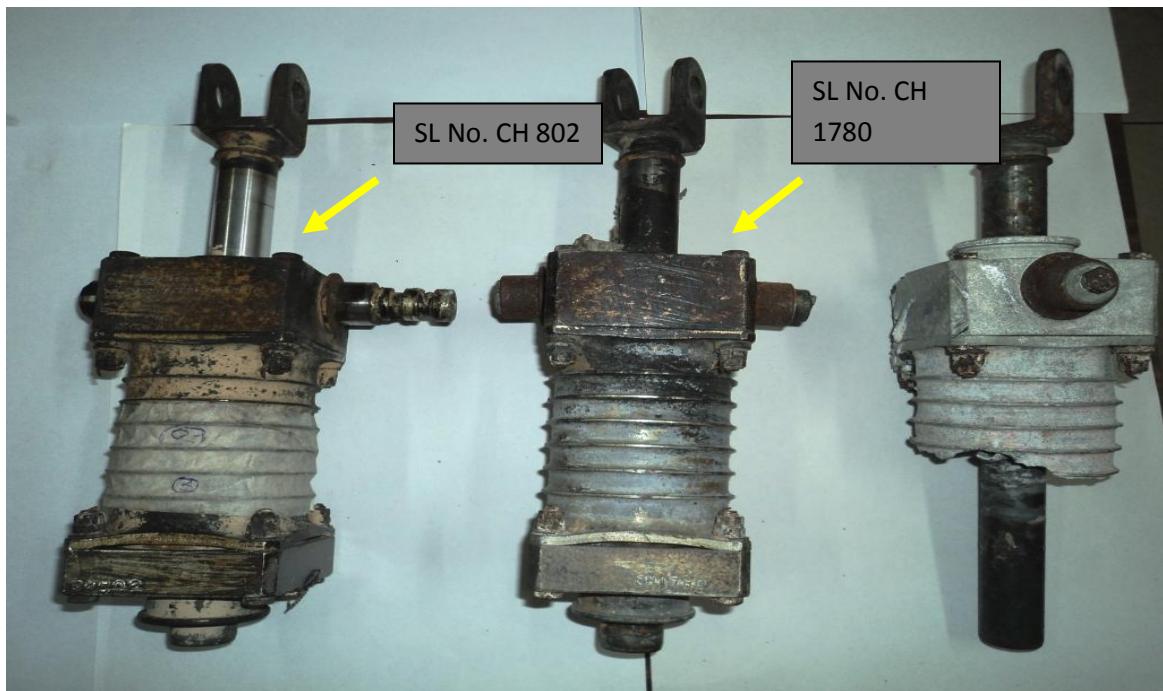
Spacing Cable Sr. No's

- a) 30172
- b) 30324
- c) 30203.

One Attachment Bolt was found to have sheared off, and the link bent outwards, thereby letting the Cable to get disengaged from the post. The second Attachment Bolt was found to have come out of the Link after bending the Link outward through 90 degrees and disengaging the cable end from the post. Deep scoring marks were found on the swaged end of the cable Sr. No. 30172. The inner bushes of eye-ends of the cables Sr. No. 30172 & 30324 were missing.

### 1.15.3 Hydraulic Drag Damper Assemblies (SI No(s). CH-802, CH-1779 & CH-1780)

Damper SI No. Ch 802 & 1780 were found mounted on the Drag Hinge Pins of MRH. The sight gauges were found to have broken and pistons of two dampers had ceased. The body of the third Damper was found to have burnt off. Therefore, the serial no. of the third damper could not be ascertained.



**Fig. 10 Hydraulic Drag Dampers**

#### 1.15.4 Inspection of Engine

The Artouste IIIB Aero Engine Sr No.H-55484 was found intact. It exhibited impact and fire damage.

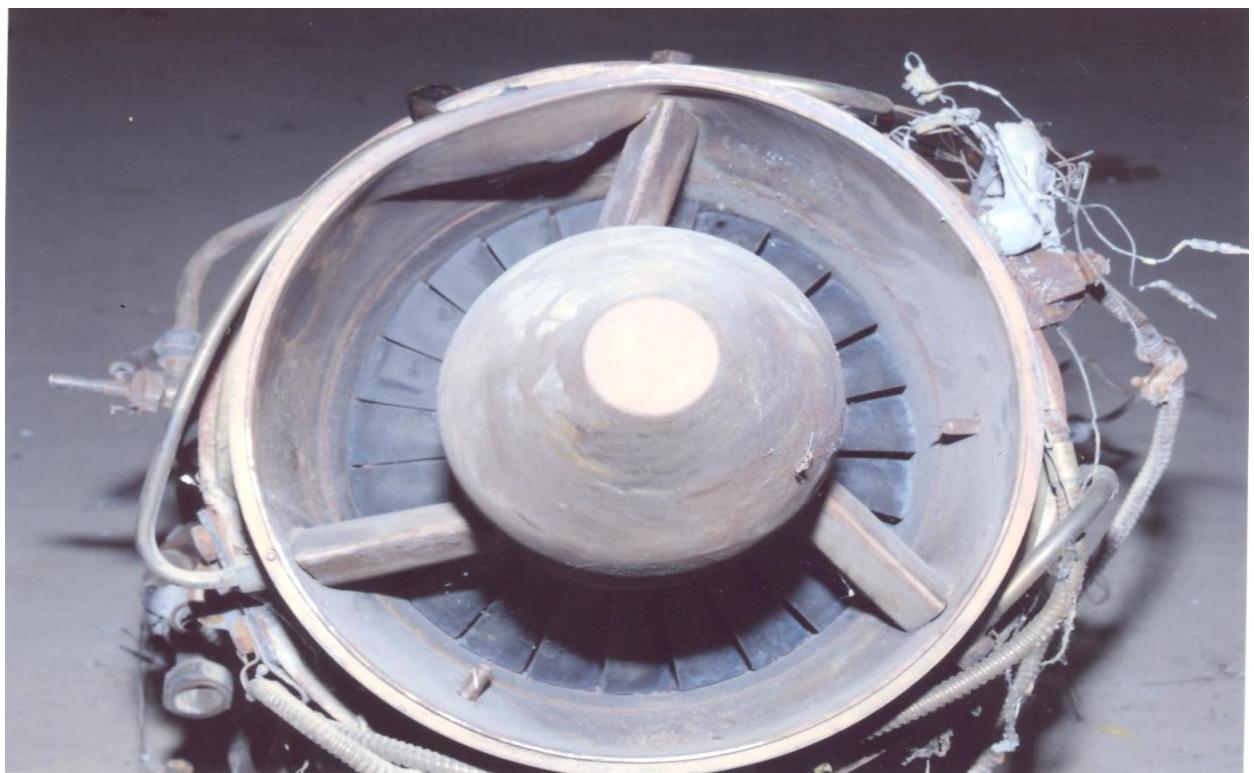


***Fig. 11 Right Side view of the engine***

- ⊕ The Magnesium Reduction Gear Casing of the Engine had got completely burnt /melted, with all the gear train in position. The Fuel Pump, Governor Assemblies etc had partially got melted.
- ⊕ The Compressors & its housing, Combustion Chamber, the Turbine discs were found to be intact.(Fig. 11)
- ⊕ None of the blades of 1st stage centrifugal compressor exhibited breakage, impact or foreign object damage. (Fig. 12)
- ⊕ There was no evidence of the Turbine blades having grazed the turbine casing. ( Fig. 13 )
- ⊕ The exhaust section of the engine was found unburnt and attached to the Engine Turbine casing.



***Fig. 12 Inlet to 1st Stage Compressor***



***Fig. 13 Last Stage Turbine Blades***

## **Conclusion:**

There was no failure of the engine or the bearings.

### **1.15.5 Metallurgical Examination.**

- 1.15.5.1 The Spacing Cables, Mounting Posts (Spindle) and Attachment Bolts & Links had been removed by the Inspector of Accidents appointed by the DGCA for Material Failure Analysis at DGCA R&D Laboratory. These parts were recovered from the Lab together with the Initial Report and sent to NAL for material Failure Analysis for second opinion.
- 1.15.5.2 Three fractured pitch change rods and the components belonging to the Spacing Cable Assembly of Chetak helicopter VT-EQL were forwarded to NAL laboratory for establishing the mode of failure. NAL carried out the fractographic examination and they have given following conclusions:

Fractographic analysis confirmed that the pitch change rods and the Bolts/bushes of the attachment links with the trunnion as well as the cables had broken by overload fracture. The failure of the bushes of the bolt of the attachment link with the trunnion indicates that the bolt had experienced very high load. This in turn indicates that there was excessive load on the attachment link. This is further substantiated by the deformation marks on the shank of the fractured bolt and also, bending of one of the fork arms of both the attachment links. The deformation pattern on the fork of the links suggests that excessive tension in the spacing cables was responsible for the fracturing of the bolt. In the sequence of failure, fracture had occurred first at the bolt-head end. Following this fracture, the whole load on the spacing cable was supported by one of the arms of the links, leading to bending in a direction out of the loading plane. The

bending of one of the fork arms along with the fractured part of the bolt would also allow the cable anchoring end to come out of the attachment link.

Examination of pitch change rods revealed bending of the pitch change rods preceded the fracture. This indicates that rods were acted upon by bending load during the fracture. There were no evidences of progressive failure such as fatigue or stress corrosion or cracking in any of the pitch change rods.

**1.15.5.3** Visual and macro examination of failed Spacing Cable bolt was carried out at Metallurgical examination laboratory of the DGCA. The report concludes as follows:

“Presence of the equiaxed dimples and shear dimples on the fractured surface of the shank portion of the threaded end and head end of the failed bolt respectively indicated that bolt had failed under overload condition.”

#### **1.15.6      Examination of fuel samples**

A sample of fuel of the same barrel as was used on the helicopter was obtained and subjected to examination at Indian oil Laboratory at Ahmedabad. As per the examination report received there was no abnormality in the sample.

### **1.16            Organisation and Management Information**

#### **1.16.1        Border Security Force (BSF)**

BSF Air Wing was established in the year 1969. Presently, BSF Air Wing is maintaining and operating 01 Embraer, 02 Avro, 01 SKA B200 Aircraft, 08 Dhruv (out of which 07 have been delivered to BSF by HAL manufacturer) and 01 Cheetah Helicopter at different location under civil registration as per DGCA. Whereas, 06 MI IV Helicopter are under military registration.

BSF Air Wing was approved under CAR 145/ CAR-M on 11<sup>th</sup> July, 2011 for maintenance and operation of aircraft in airworthy standard. The line maintenance on Embraer, Avro & SKA B200 aircraft is carried out by BSF. Whereas, Major Maintenance work is carried out by CAR-145 AMOs. The maintenance of Dhruv, Chetak/Cheetah helicopter is carried out by HAL/PHHL on contract basis.

### **Operational Control**

BSF has operations and maintenance contract with M/s Pawan Hans Helicopters Ltd w.e.f. 29<sup>th</sup> Sept., 2010. After studying the O&M contract between the two parties, the relevant clauses of the contract can be stated as:

- ⊕ To maintain records in respect of consumption of stock, spares, POL authorization books and other such documents as prescribed by Government (DGCA/AAI) and will send monthly statement/return to BSF air wing and concerned BSF Headquarters.
- ⊕ Operation and maintenance agency will provide consultancy services on aviation matter, which are incidental for maintenance and operation of helicopters.
- ⊕ To maintain complete flying records, manifest returns and any other returns required from time to time for flying and maintenance of the helicopters as per the requirements of DGCA/AAI/IAF/ Government and maintenance manuals.

However it was found that neither of the parties was exercising any operational control and due to which no crew related records/ documents were maintained by any of the party. Although both the organisations have elaborate operations setup, the BSF assigns operational task to PHHL for making the aircraft and the crew available. However neither of the

parties was monitoring the FDTL of the crew, currency of their rating and qualification before operation of the flight.

### **Maintenance control**

#### **1.16.2      Summit Aviation Limited**

For the period from 1989 to 2010, the maintenance of the helicopter was with M/s Summit Aviation. A review of the maintenance record indicates the following discrepancies:

- The log cards were not maintained properly. In a few instances the original log cards were missing.
- A few log cards were raised without the authentication by concerned AME or without the certificate/label from the OEM/Overhaul agency (HAL).
- The airframe hours at which the component has been fitted on the aircraft have not been entered.
- After the tail rotor strike incident on 30.01.2005, a set of the drag dampers earlier installed were not found in the inventory of the BSF or issued to them by the BSF.

#### **1.16.3      Pawan Hans Helicopter Limited (PHHL)**

PHHL signed a contract with BSF for O&M of Cheetah and Chetak Helicopter on 29th Sept 2010. The scope of the contract included "to arrange suitable/qualified pilots, engineers and technicians for undertaking operation and maintenance activities including quality control of Cheetah and Chetak Helicopters within the framework of DGCA rules at Srinagar and Jodhpur". The routine contract was for maintenance up to 400hrs/2 yearly inspection for which PHHL was approved vide DGCA Letter ref PHHL/F-APP/2876 dated

29.12.2010 under A3 Rating for Jodhpur Sub Base after due inspection of the base. The following discrepancies were observed:

- ⊕ Aircraft log books for the year 2005 to 2010 were not available.
- ⊕ It appears that M/s PHHL did not exercise any quality control over the maintenance activities of their AME.
- ⊕ They did not possess copies of the maintenance manual and other technical literature for preparing and updating the aircraft maintenance program on the basis of which call outs are required to be issued.
- ⊕ There was frequent rotation (weekly/fortnightly) of the technicians at the outstation maintenance Bases. The rotation of the personnel was carried out without any consideration for the relevant skill, level of experience and to ensure the continuity in the maintenance activity.
- ⊕ M/s PHHL while taking over the O& M contract did not exercise due diligence. There was no handing over and taking over or inspection of the records, facilities and spares.
- ⊕ Inventory of rotables/special equipments and consumables was under the charge of BSF but were being utilized by PHHL. The inventory control was found to be deficient in terms of:
  - a) Curing dates and the shelf life of the hoses were not mentioned.
  - b) The list of components was not complete and updated.
  - c) There was no tracking of the components sent to HAL for the purpose of maintenance/investigation of the components for e.g. drag damper serial no. CH-524, CH-525, CH-526 removed on 23/12/2008 were sent to M/s HAL for maintenance. The same have not yet been received back as per the inventory.
  - d) Calibration record of special tools and testers were not made available to the committee for the verification purposes. Apparently the calibration records are not being maintained.

#### **1.16.4 Surveillance of maintenance activities by BSF**

VT-EQL was based at Jodhpur. BSF has never carried out the surveillance/audit inspection of the Jodhpur base and the maintenance activities by the AMO on their helicopter. They have a Quality Manager; however as per the organisation his scope of work was limited to the fixed wing aircraft. The oversight of the maintenance activity of helicopter was left to the service provider.

After signing of O& M contract with M/S PHHL, BSF did not exercise due diligence in handing over of documents and equipments to the AMO formally.

#### **1.17 Additional Information**

1.17.1 Chetek Helicopter accidents that occurred in the Indian Air force in the year 1978 and 1979 respectively.

| Sno | Date                           | Brief description   |
|-----|--------------------------------|---|
| 1.  | 3 <sup>rd</sup> November, 1978 | This accident was probably due to failure of hydraulic Drag Damper in Flight thus imposing excessive load on the blade spacing system resulting in the breakage of links.   |
| 2.  | 01 <sup>st</sup> May, 1979     | This accident was probably due to failure of hydraulic Drag Damper in Flight thus imposing excessive load on the blade spacing system resulting in the breakage of links and the broken spacing cable cut through the two pitch control rods leading of loss of control of Helicopters. |

**1.17.2** Issue regarding diversion from the flight path while flying on direct routing on Gandhinagar-Jodhpur sector was discussed with the pilots who have earlier been flying the same helicopter on the same sector. They have suggested as follows:

On a direct route from Gandhinagar to Jodhpur, especially in the afternoon hours during summer months, the visibility in the Aravalli Hills (Mount Abu area) reduces to between 1000 to 2000 meters. In addition, this area does not have enough open fields, where a helicopter can be landed safely, in case of any emergency. Whereas, the area slightly west of the route, has much better visibility and far lower hills with sufficient number of fields, suitable for putting the helicopter down, in case an emergency action may so require.

Considering the above factors, it is most prudent, in the interest of safety, to stay slightly west of track in this area, especially during the summer season during the afternoon period.

## 2. Analysis

### 2.1 Maintenance Aspects

#### 2.1.1 Airworthiness of the Helicopter

 The Certificate of Airworthiness of the helicopter was current and valid. Periodicity of all scheduled maintenance task were maintained. As per the available records no significant snag has been recorded on this helicopter since its last C of A renewal on 4<sup>th</sup> April, 2011 except a snag about the RPM indicator at Gandhinagar. The R.P.M. indication snag was rectified by re-soldering cable wire as the same has come out of the connector. The RPM indicator was found recording the RPM satisfactorily on ground run given at Gandhinagar prior to take off from BSF Helipad. The aircraft was under the maintenance of CAR-145 approved maintenance organisation. Aircraft Maintenance Engineer who carried out Daily inspection on the day of

accident held A&C Licence and held full scope approval for maintenance of this type of helicopter. During Gandhinagar-Mandore flight of the day no snag was reported before the accident took place.

- ⊕ Examination of the wreckage site had revealed that helicopter approached the accident site after making a right turn and had impacted the ground in squarely manner i.e. vertically. The force of impact is indicated by the shattering of front plexi glass at impact. The main wreckage was approximately 40 meters from the flight path being flown by the helicopter.
- ⊕ Therefore to detect any malfunction of the Main Gear Box (MGB) its disassembly was carried out. During inspection it was observed that Planetary gear system was undamaged and freely rotating. All the eight gears were intact. They were freely rotating with no sign of seizure or breakage of teeth. Central gear was intact. No signs of abnormal wear of breakage of teeth was observed. The Crown, Worm gear teeth also did not exhibit any damage, galling or pitting. The gears in the transmission were capable of smooth transmission of power.
- ⊕ To detect any failure of the engine, a detailed inspection of the engine was carried out. The inspection of the engine revealed the following:

- The Magnesium Reduction Gear Casing of the Engine had completely melted with all the gear train in position. The Fuel Pump, Governor Unit etc had partially got melted.
- None of the blades of 1st stage centrifugal compressor exhibited breakage, impact or foreign object damage.
- There was no evidence of the Turbine blades having grazed the turbine casing.

**It indicates that there was not any failure of the engine or the bearings.**

-  The damage to the helicopter structure and its systems was due to impact and fire.
-  As per CAR Section 2 Series F Part V, *the Certificate of Airworthiness of an aircraft shall be deemed to be suspended when an aircraft ceases or fails to conform with condition stipulated in the Type Certificate or C of A, airworthiness requirements in respect of operation, maintenance, modification, repair, replacement, overhaul, process or inspection applicable to that aircraft, or is modified or repaired otherwise than in accordance with approved procedure, or suffers major/substantial damage (which requires replacement or extensive repair of any major component), or develop a major defect which would affect the safety of the aircraft or its occupants in subsequent flights.*
-  The Helicopter was maintained as per the approved maintenance programme. The snag reported before the accidental flight was rectified at Gandhinagar prior to take-off for Mandore. Thus it can be safely concluded that the aircraft was in airworthy condition to undertake the flight.

### **2.1.2 Failure of Spacing cable and attachment bolts**

Examination of wreckage at the accident site revealed that one of the spacing cables was attached to its Posts on both sides. The two other spacing cables, though anchored to one end of their respective Cable Posts, had got detached from the link chains attached to the third Cable Post. The Attachment bolt of one Chain Link had sheared off and the free end of the detached cable was found near the engine RG casing end. The attachment bolt of its second Chain Link though still intact had been pulled out from its nut end. Both the links had opened outwards thereby, letting the Spacing Cable ends to come out. This free

end of the second Spacing cable had lost its bush insert and was found lying beneath the Rotor Assembly. Further all the three Pitch Change Rods were found broken but attached at both the upper as well as the lower ends. Attachment end of one of the swaged end of the severed spacing cable Sl. No. 30172 indicated deep scoring marks.

For establishing the mode of failure the pitch change rods and the components belonging to the spacing cable post assembly were examined at NAL laboratory. NAL carried out the fractographic examination and they have given following conclusions:

**"Bolts/bushes of the attachment links with the trunnion as well as the cables had broken by overload fracture.** The failure of the bushes of the bolt of the attachment link with the trunnion **indicates that the bolt had experienced very high load.** This in turn indicates that there was excessive load on the attachment link. This is further substantiated by the deformation marks on the shank of the fractured bolt and also, bending of one of the fork arms of both the attachment links. **The deformation pattern on the fork of the links suggests that excessive tension in the spacing cables** was responsible for the fracturing of the bolt. In the sequence of failure, fracture had occurred first at the bolt-head end. Following this fracture, the whole load on the spacing cable was supported by one of the arms of the links, leading to bending in a direction out of the loading plane. The bending of one fork arm of both the attached links along with the fractured part of the bolt had allowed the cable anchoring end to come out of the attachment link.

Examination of pitch change rods revealed bending of the pitch change rods preceded the fracture. **This indicates that rods were acted upon by bending load during the fracture. There were no evidences of progressive failure such as fatigue or stress corrosion or cracking in any of the pitch change rods."**

The above result of the metallurgical examination lends credence to the fact that there was excessive tension in the Spacing Cables which led to the failure of the Attachment Bolts. As one of the cables was released from the post, it became free and started hunting thus caused failure of the pitch change rods. Failure of the Pitch Change Rods was probably due to the hit by the Spacing Cable end.

The cable spacing equalizer system corrects transient disturbance affecting inter blade spacing to ensure proper 120° angular distribution of the three blades. Therefore release of one of the spacing cable resulted in imbalance in the rotor system and led to the release of the other spacing cable from the same post. The other spacing cable does not indicate much hit marks indicating that it was released shortly before the impact of the helicopter with the ground.

Centrifugal loads resulting from the rotation of the blades are carried by the tension-torsion strips in the blade sleeve. If, during rotor operation, the horizontal motion of a blade is disturbed, two distinct components are used to overcome the disturbance.

- ⊕ The cable spacing equalizer system corrects transient disturbance affecting inter blade spacing to ensure proper 120° angular distribution of the three blades.
- ⊕ The drag hinge dampers limit the horizontal oscillations of the blade by taking up the loads developed about the drag hinge axis and so facilitate the action of the blade spacing cables.

The metallurgical examination has indicated excessive tension in the spacing cable. This excessive tension in the spacing cable may be due to the malfunction of the hydraulic drag damper. The set of drag dampers recovered from the accident site were installed on this helicopter on 22/12/2008. These were installed after the previous set was found to have “Timing out of limits”. The set had been overhauled at HAL on 06/12/2005 and matched. Two of the Drag dampers recovered from the site were identified while the third drag damper due to damage could not be identified as its body had got burnt. However due to the damage, the three drag dampers could not be subjected to bench check.

Inspection of the BSF store inventory indicated that they do not have equipment for the drag damper timing check. Neither there was any record of their procuring such equipment. This indicates that their assessment of drag damper timing was based on estimation and not actual measurements. Therefore snag may not have been detected at its initiations.

The Hydraulic Drag Damper malfunction in flight would cause severe vibrations that could not be damped. The imbalance or hunting movements of the advancing / retreating Blades would cause transmission of excessive tensile loads from the Rotor Blade System to the Spacing Cable Posts. This would result in excessive tensile load which might cause failure of Attachment Bolts /Links.

Review of the similar accidents to the Chetak Helicopters operated by Indian Air force in the year 1978 and 1979 respectively indicated that these accidents had occurred probably due to failure of Hydraulic Drag Dampers in Flight thus imposing excessive load on the blade spacing system resulting in the breakage of links and the broken spacing cable cut through the two pitch control rods leading of loss of control of Helicopter.

**Thus Malfuction of Drag Dampers caused excessive vibrations, transmitting tensile load on the spacing Cable system and resulting in breakage of Link attachment bolt. The spacing cable eye-end got released; whip lashed the pitch control rods and broke them in quick succession.**

### **2.1.3 Management of maintenance records**

Scrutiny of records revealed that the helicopter was involved an incident on 30<sup>th</sup> January, 2005. Following the incident among other parts of rotor hydraulic drag damper assembly were sent to HAL for inspection on heavy landing checks. For the removal of drag damper two Defect reports were raised.

- 1)** Dated 10.05.2005, which states that Hydraulic Drag Damper Sr. No CH 802, CH1779, CH1780 were replaced due as their calendar life was near to completion.
- 2)** Dated 11.05.2005, which states that Hydraulic Drag Damper Sr. No CH 924, CH925, CH926 were replaced due incident for inspection purposes. The on numbers were CH733, CH734, and CH735. **However these Sr. No(s) are not available in the Inventory of BSF.**

Neither of Summit Aviation, nor PHHL nor the BSF could provide the Defect Investigation report of the removed drag dampers.

Neither BSF nor PHHL could provide aircraft logbooks of the helicopter from the year 2005 to 2010.

Log cards of the components have been locally raised and entries have not been signed by any authorized person.

**Thus from above it appears that for all the years the helicopter was operating without any review of the maintenance activities of the certifying personnel by the AMO. No system existed for the upkeep of the maintenance literature, documents, log books and the stock in the bonded store. In other words Maintenance Quality Control was non-existent.**

## **2.2 Operation Aspect**

### **2.2.1 Crew Qualification**

Both the crew held valid license and were qualified on type. The PIC had a total flying experience of 2930:00 Hrs out of which 1781:00 Hrs were on Alouette III/Chetak type of helicopter. The co pilot had total flying Experience of 246 hrs. all of which was on the type of the helicopter being flown.

CAR Section 7 Series B Part XIV requires as under

- a) **Proficiency Checks.** All pilots engaged in commercial operations carrying passengers shall undergo proficiency checks covering aspects as applicable for type of helicopter and operator's role. The proficiency check will be carried out by DGCA approved examiner twice in a year with not less than four months and not more than eight months between any two checks.
- b) **Route/Line/LOFT Check.** These checks will be carried out once a year to cover exercises as applicable to the type of helicopter(s).

For the Co pilot the Proficiency check was carried out on 30<sup>th</sup> April 2010 and then on 27 January 2011, the next became due on 30<sup>th</sup> April 2011. However the same has not been carried out. Also the check carried out on 27<sup>th</sup> January 2011 should have been carried out by 30<sup>th</sup> of December 2010.

**Thus there is discrepancy in the currency of the licence of the Co Pilot.**

## 2.2.2 Conduct of the flight

The Crew of the helicopter filed Flight Plan for direct routing from Gandhinagar to Mandore for an altitude of 1500 ft AGL. The telephonic clearance was taken from Area Control land line for a VFR flight. The Helicopter departed from Gandhinagar at 0850 UTC. ATC advised the pilot of the helicopter VT-EQL to maintain the preferred altitude of 1500 feet AGL on QNH 1005 hpa. He was further advised to report 30 miles out. Pilot intimated estimates as FIR 1030 UTC and ETA destination 1155 UTC. Then the estimates were passed on to FIC at 30 miles. The helicopter remained in contact with ACC on frequency 123.75 MHz till 0907 UTC reporting at 30NM on radial 007 AAE. At time 0908 UTC the helicopter called JAI 2065 to relay the position of 30NM on radial 007 AAE to Ahmedabad ACC. On route radar, the helicopter painted till 0911 UTC and then the target dropped at distance of approx. 37 NM from AAE. The accident site was towards

the west of the track by almost 12 miles. Apparently the helicopter was following west of the route. The highest hill in the region on the route was the Mt Abu at 5650 ft. To ascertain the reasons for the deviation, views of the pilots who had earlier flown the helicopter of type in this region/route was obtained. As per their opinion

*"On a direct route from Gandhinagar to Jodhpur, especially in the afternoon hours during summer months, the visibility in the Aravalli Hills (Mount Abu area) reduces between 1000 to 2000 meters. In addition, this area does not have enough open fields, where a helicopter can be landed safely, in case of any emergency. Whereas, the area slightly west of the route, has much better visibility and far lower hills with sufficient number of fields, suitable for putting the helicopter down, in case an emergency action may so require.*

*Considering the above factors, it is most prudent, in the interest of safety, to stay slightly west of track in this area, especially during the summer season during the afternoon period."*

**Thus deviation of the helicopter to the West of the route was carried out in the interest of safety as this region has much better visibility and far lower hills with sufficient number of fields, suitable for putting the helicopter down in case an emergency action may so require.**

### 2.2.3 Handling of Emergency

While the aircraft was flying in the Aravalli hill range, to the West of the cleared route, it experienced the failure of the spacing cable. The released spacing cable impacted the pitch change rods successively. Due to the load asymmetry in the rotor system the other spacing cable was also released from its attachment point.

The blade pitch change is controlled by means of rods connected at one end to the blade horns carried by the blade sleeves and at the other end to the rotating star or upper swash plate.

As the pitch change rods gave way, the pilot lost collective and cyclic control. Pilot could not put the helicopter in autorotation and flare it for cushioning its landing. The helicopter virtually stood still in air before falling squarely on the ground with no tilt towards any side. Before approaching the accident site the helicopter made a right turn and impacted the ground with high impact force at approximately 40 metres from the route being flown. This indicates that the impact with the ground was after falling from a substantial height which resulted in the burst of fuel tank and helicopter caught fire.

**Though the engines were producing power, and transmitting to the rotor assembly, the crew could not cushion the landing due to loss of control.**

### **3. CONCLUSION**

#### **3.1 Findings**

- 3.1.1 The Helicopter was maintained as per the approved maintenance programme. No snag related to Engine or Tail Transmission system was reported before the accidental flight. The MGB, TGB, Engine and associated drives were checked after the crash and no abnormality was observed. Thus the helicopter apparently was in airworthy condition to undertake the flight.
- 3.1.2 The deformation pattern on the fork ends of two links suggests excessive tension in the Spacing Cables.
- 3.1.3 Bolts/bushes of the attachment links with the trunnion as well as the cables had broken by overload fracture caused due to excessive tension in the spacing cables.
- 3.1.4 Pitch change rods were acted upon by bending load during the fracture imposed probably by hitting of the released spacing cable. There were no evidences of

progressive failure such as fatigue or stress corrosion or cracking in any of the pitch change rods.

- 3.1.5 Probable malfunction of Drag Dampers resulted in excessive vibrations, transmitting tensile load on the spacing Cable system and resulting in breakage of Link attachment bolt. The spacing cable end got released; probably whip lashed hard the pitch control rods and broke them in quick succession. Pilot lost the Cyclic & Collective control of the Helicopter which resulted in crash landing without any auto-rotative cushioning available to it.
- 3.1.6 The helicopter was operating without review of the maintenance activities of the Certifying personnel by the Quality control of the AMOs. There was no review of the maintenance literature, documents, log books and the stock in the bonded store. **In other words Maintenance Quality Control was nonexistent.**
- 3.1.7 Both the Pilots had valid endorsement on the type of the helicopter.
- 3.1.8 There was a discrepancy in the currency of the licence of the Co pilot. The Proficiency check was carried out on 30<sup>th</sup> April 2010 and then on 27<sup>th</sup> January 2011, the next became due on 30<sup>th</sup> April 2011. However the same has not been carried out. Also the check carried out on 27<sup>th</sup> January 2011 should have been carried out by 30<sup>th</sup> of December 2010.
- 3.1.9 Helicopter deviated to the West of the route while flying in the Arravalli range. The deviation was carried out in the interest of safety as this region has much better visibility and far lower hills with sufficient number of fields, suitable for putting the helicopter down, in case an emergency action may so require.
- 3.1.10 Before approaching the accident site the helicopter made a right turn and impacted the ground with high impact force at approximately 40 metres from the route being flown. Helicopter impacted the ground in the squarely manner i.e. vertically and with no forward movement.

**3.1.11** As the pitch change rods broke, the collective and cyclic control was lost. **Though the engines was producing power and transmitting to the Rotor Assembly, the crew could not cushion the landing due to loss of control.**

**3.1.12** Neither the BSF nor M/s PHHL were monitoring the FDTL of the crew, currency of their rating and qualification before operation of the flight. This is how despite the lapse of proficiency check Co Pilot was allowed to operate this flight. **Thus neither BSF nor M/s PHHL was exercising any operational control.**

**3.1.13** Following incident on 11.05.2005 a Defect Investigation Report was raised, which stated that Hydraulic Drag Dampers Sr. No CH 924, CH925, CH926 were replaced and sent to HAL for inspection. The “ON” numbers were CH733, CH734, and CH735. **However these “ON” Sr. No(s) are not available in the Inventory of BSF.**

### **3.2 Cause of Accident**

The accident occurred due to loss of control resulting from probable failure of Hydraulic Drag Dampers in flight which imposed excessive loads on the Blade Spacing System resulting in the failure of bolts/links. The severed spacing cable impacted and broke the pitch control rods, leading to loss of control of Helicopter.

Lack of oversight of Maintenance Activities of the AMOs was the contributory factor.

### **4. RECOMMENDATIONS**

- 4.1 HAL may review the line maintenance practices of the Hydraulic Drag Dampers in view of a number of malfunctions of the Drag Dampers in the past.
- 4.2 In majority of fatal accidents involving the private/NSOPs operator unlike the scheduled operators, the flying and training records of the crew are not completely available. DGCA may consider issuing necessary instructions to the industry to ensure that organisations maintain these records independent of the individual flight crew.
- 4.3 Action as deemed fit may be taken against concerned AMOs and the operator for the lack of supervision of the operational and maintenance activities in view of findings 3.1.6, 3.1.8 & 3.1.12, 3.1.13.

**(S.S. Nat)**

**MEMBER**

**(Captain P.K. Chabri)**

**MEMBER**

**(Group Captain M.K. Labroo (Retd.))**

**CHAIRMAN**