

**Final Investigation Report on Serious Incident to M/s Mesco Aerospace Ltd. AS 350 BA Helicopter VT- MAB on 08-04-2014 at Chakwali Village, Near Saharanpur, U.P.**

1.	Helicopter	Type	Ecureuil AS 350 BA
		Nationality	Indian
		Registration	VT-MAB
2.	Owner		M/s Mesco Aerospace Ltd. New Delhi.
3.	Operator		M/s Mesco Aerospace Ltd. New Delhi.
4.	Pilot – in –Command		CPL (H) Holder
	Extent of injuries		NIL
5.	Co-Pilot		CPL (H) Holder
	Extent of injuries		NIL
6.	Date & Time of Incident		08-04-2014; 0610 UTC.
7.	Place of Incident		Chakwali Village, Near Saharanpur, U.P.
8.	Last point of Departure		Muradnagar, Dist. Ghaziabad, U.P.
9.	Intended landing place		Manakmau, Dist. Saharanpur, U.P.
10.	No. of Passengers on board		03
	Extent of injuries		NIL
11.	Type of Operation		Charter flight (NSOP Operations)
12.	Phase of Operation		Cruise
13.	Type of Incident		Forced landing due to Tail Rotor Pitch link failure
14.	Co-ordinates of Incident Site		Lat 29° 46' 21" N, Long 77° 30 ' 33" E AMSL 850 feet

(All timings in the report is in UTC)

## **SYNOPSIS:**

M/s Mesco Aerospace Ltd. (formally known as Mesco Airlines limited) Ecureuil AS 350 BA helicopter VT- MAB was engaged in a charter flight (NSOP Operations Election flying) from Greater Noida- Muradnagar - Manakmau on 8<sup>th</sup> April 2014. The helicopter was under the command of PIC and co-pilot having valid CPL (H). Helicopter departed from Greater Noida with 01 AME on board and landed at Muradnagar in the morning. Helicopter took off again from Muradnagar to Manakmau with PIC, Co-pilot and 03 passengers (01 UP State Minister). While flying at approx. 2000 feet AGL after 39 minutes of flight, pilot experienced severe vibrations. The vibration kept on increasing and TGB and Door warning light illuminated. The PIC carried out straight – in – autorotation landing in an open agricultural field at Chakwali village near Saharanpur (U.P.), 12 Nm short of Manakmau. There was no injury to any person on board or any person on ground. There was no pre or post impact fire. Helicopter sustained damages during forced landing. Examination of the helicopter revealed that one of the tail rotor pitch change link had fractured, resulting in lateral movement of the tail rotor and damage to the tail rotor blade, tail boom and tail cone.

Ministry of Civil Aviation constituted a committee of inquiry to investigate the cause of the Serious Incident under Rule 11 (1) of Aircraft (Investigation of Accidents and Incidents), Rules 2012 comprising of Sh. Amit Gupta, Deputy Director (AED) as Chairman , Capt. S. K. S. Panwar, FOI, DGCA and Sh. K. Ramachandran, ASO,AAIB as members.

The Committee of Inquiry determines the probable cause of serious incident as:

“The incident was caused because of failure of one of the tail rotor pitch link due to fatigue.

Contributory factor:

The pilot was unable to reduce the speed as recommended for autorotation because of severe vibrations and hence carried out autorotation at a higher speed which resulted in damage to tail rotor, tail boom and the structure.”

## **1. FACTUAL INFORMATION:**

### **1.1 History of Flight:**

M/s Mesco Aerospace Ltd. (formally known as Mesco Airlines limited) Ecureuil AS 350 BA helicopter VT- MAB was engaged in an NSOP flight (Election flying) from Greater Noida- Muradnagar - Manakmau on 8<sup>th</sup> April 2014. The helicopter was under the command of PIC and co-pilot having CPL (H). PIC filed flight plan with Delhi FIR for the flight and obtained necessary FIC, ADC clearances. Helicopter was inspected by AME and refueling was carried out at Greater Noida. Helicopter departed from Greater Noida at 0440 UTC with 01 AME on board and landed at Muradnagar at 0500 UTC. The flight was uneventful. Helicopter took off again at 0530 UTC from Muradnagar to Manakmau with PIC, Co-pilot and 03 passengers (including one UP State Minister). Enroute helicopter was flying at approx. 2000 feet AGL at speed 110 knots. At around 0609 UTC and 14 Nm short of Manakmau, pilot experienced severe vibrations. The vibration was kept on increasing and TGB, Door open warning light illuminated. Thereafter, PIC carried out straight – in – autorotation force landing in a wheat field at Chakwali village near Saharanpur (U.P.) approx. 12 Nm from Manakmau at 0610 UTC. The Helicopter skidded and bounced forward after impact and thereafter settled backwards. Helicopter sustained damages during forced landing. Examination of the helicopter revealed that one of the tail rotor pitch change links had fractured, resulting in lateral movement of the tail rotor and damage to the tail rotor blade, tail boom and tail cone. There was no injury to any person on board. There was no pre or post impact fire after landing. No other damage sustained by objects other than the helicopter.



**Google Earth Map of Flight Path and Forced Landing Site of VT-MAB**

**1.2 Injuries to Persons :**

<b>Injuries</b>	<b>Crew</b>	<b>Passengers</b>	<b>Others</b>
Fatal	NIL	NIL	NIL
Serious	NIL	NIL	NIL
Minor/None	02	03	NIL

**1.3 Damage to Helicopter:**

The helicopter sustained damages while carrying out forced landing.

Following main damages were observed on the helicopter:-

1. Crack marks on one tail rotor blade at approx. 5" from the root section.
2. Tail rotor pitch change link of the same blade was broken from the swivel bearing side and the broken portion was missing.
3. The pitch change link swivel bearing was found excessively damaged. However the bolt of the damaged swivel bearing was found intact.
4. Two dents were observed on the lower part of vertical stabilizer approx. 10" from the root section.

5. On the left side, the tail boom ski was ruptured pointing outward at distance of 4 ft from tail cone.
6. Multiple wrinkles were found on tail boom near to tail 2<sup>nd</sup> row of rivet from tail boom attachment upto 8 ft. 3 inch.
7. There were butting marks on the spider and blade attachment.
8. A scratch of 6 inches on the right side of the tail boom measuring 33inches from center of the TGB.
9. Metal particles were found on the TGB chip detector.
10. Tail light was found missing.

**1.4 Other Damages : Nil**

**1.5 Personnel Information:**

**1.5.1 Pilot- in- Command**

AGE	24 Yrs 06 Months
License	CPL(H)
Date of License Issue and Valid up to	01/07/ 2010 and 30/06/ 2015
Category	Helicopter
Class	Single Engine Land
Endorsements as PIC	Robinson R22 and AS 350 BA
Date of Joining Company	18/09/ 2010
Date of Endorsement as PIC on AS 350 BA	24/08/2011
Instrument Rating	NIL
Date of RTR Issue and Valid up to	09/04/2010 and 3/10/2069
Date of FRTOL issue & validity	01/07/2010 and 30/06/2015
Date of Med. Exam & validity	13/08/2013 and 12/08/2014
Date of Route Check	22/11/2013
Date of Last Proficiency Check	22/11/2013
Date of English language Proficiency & Valid up to	02/05/2011 and 01/05/2017
Date of last CRM	14/05/2013
Date of last Monsoon training	18/06/2013

Date of Dangerous Goods Awareness Training	24/08/2013
Date of last Refresher/Simulator	27-28 October 2013
Simulator Training for Critical Emergencies	27-28 October 2013
Familiarity with Route/ Airport flown for last 12 months and since joining the company.	Flew this route for the first time
Total flying experience	599:55 Hrs
Total Experience on type	326:45 Hrs
Total Experience as PIC on type	162:05 Hrs
Last flown on type	08/04/2014
Total flying experience during last 01 Year	112:20 Hrs
Total flying experience during last 180 days	69:40 Hrs
Total flying experience during last 90 days	56:35 Hrs
Total flying experience during last 30 days	22:05 Hrs
Total flying experience during last 07 Days	11:40 Hrs
Total flying experience during last 24 Hours	02:40 Hrs
Rest period before the flight	14 Hrs

The PIC was not involved in any Accident/ Serious Incident previously.

### 1.5.2 Co-Pilot

AGE	44 Yrs
License	CPL(H)
Date of License Issue and Valid up to	29/01/ 2010 and 28/01/ 2015
Category	Helicopter
Class	Single Engine Land
Endorsements as PIC	Schweitzer 300 C and AS 350 BA
Date of Joining Company	11/04/ 2011
Date of Endorsement as PIC on AS 350 BA	26/08/2011
Instrument Rating	NIL
Date of RTR Issue and Valid up to	08/01/2012 and 7/1/2032
Date of FRTOL issue & validity	29/01/2010 and 28/01/2015
Date of Med. Exam & validity	04/02/2014 and 03/08/2014

Date of Route Check	22/11/2013
Date of Last Proficiency Check	22/11/2013
Date of English language Proficiency & Valid up to	14/05/2011 and 13/05/2014
Date of last CRM	14/05/2013
Date of last Monsoon training	18/06/2013
Date of Dangerous Goods Awareness Training	24/08/2013
Date of last Refresher/Simulator	27-28 October 2013
Simulator Training for Critical Emergencies	27-28 October 2013
Familiarity with Route/ Airport flown for last 12 months and since joining the company.	Flew this route for the first time
Total flying experience	365:10 Hrs
Total Experience on type	169:20 Hrs
Total Experience as PIC on type	26:55 Hrs
Last flown on type	08/04/2014
Total flying experience during last 01 Year	118:20 Hrs
Total flying experience during last 180 days	65:20 Hrs
Total flying experience during last 90 days	51:35 Hrs
Total flying experience during last 30 days	22:05 Hrs
Total flying experience during last 07 Days	11:40Hrs
Total flying experience during last 24 Hours	02:40 Hrs
Rest period before the flight	14 Hrs

The Co-pilot was not involved in any Accident/ Serious Incident previously.

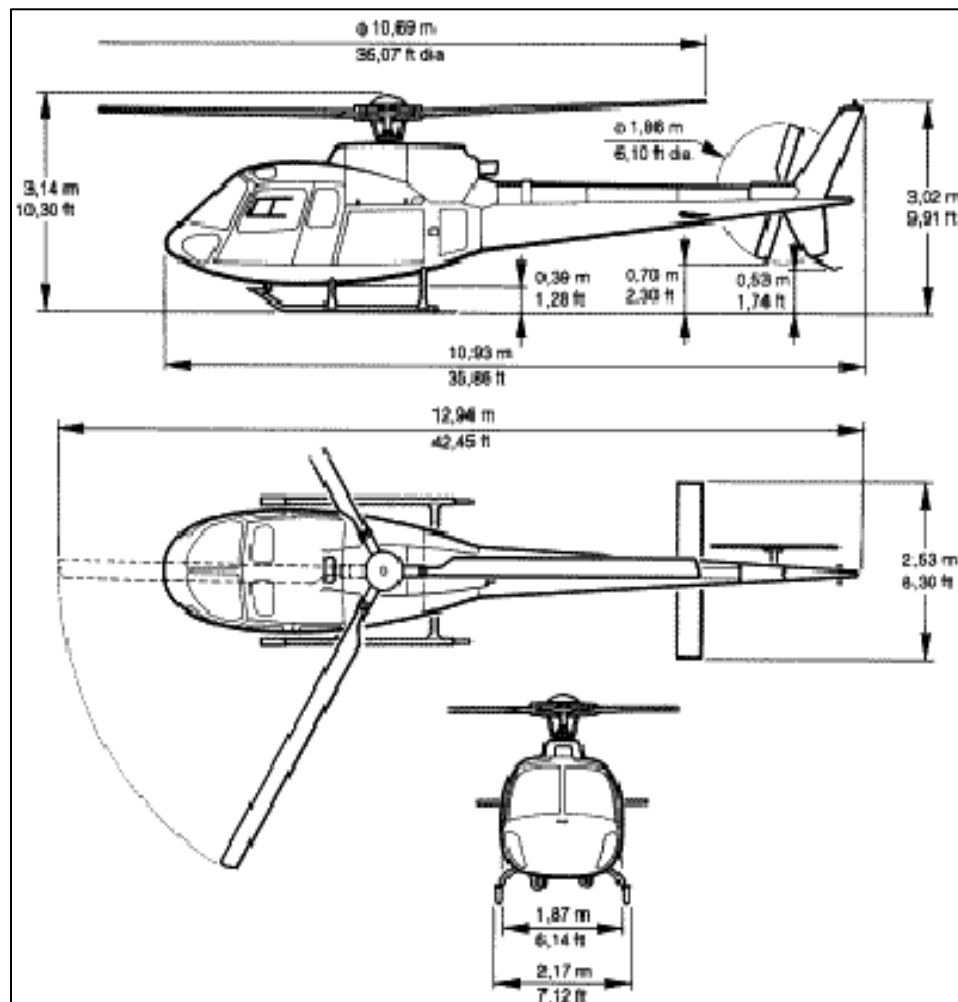
## **1.6 Helicopter Information :**

### **1.6.1 General Description**

AS350 BA Ecureuil helicopter VT-MAB is a single engine helicopter manufactured by M/s Eurocopter, France (now Airbus Helicopters). The helicopter is certified in transport category, for day operation under VFR. The maximum operating altitude of this helicopter is 16,000 feet density altitude and maximum take-off weight is 2100 Kgs. Helicopter length is 10.93 meter and width is 1.87 meter, height of this helicopter is 3.14 meter. The standard helicopter

seating configuration is 01 Pilot and 06 passengers. Helicopter was having three main rotor blades, two tail rotor blades.

The structure of the helicopter AS350 BA is based on Rigid Hexahedron. Main structure supports main transmission components (Main Gear Box and Rotor), landing gear, cabin floor, rear structure and encloses the fuel tank. Entire canopy is made of poly- carbonates. The Bottom structure, supporting the cabin, is of the Canti-lever type and forms an extension of the body structure. Beams reinforced by cross members are bolted on main structure lateral beams and support the landing gear at forward end. The rear structure consists of 3 frames connected by beams. The rear and forward frames support the engine. The tail boom is bolted to junction frame no 3 and can be easily removed. The rear structure also contains a baggage compartment. The tail boom is made of Aluminum Alloy, consists of circular frames covered by an outer skin. Assembly rigidity is ensured by sheet metal stiffeners.



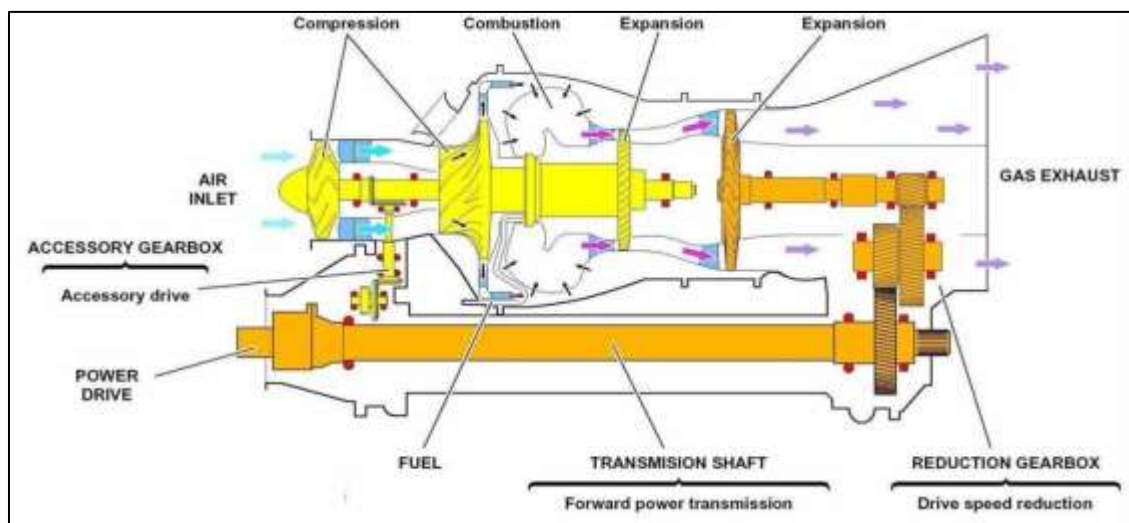
**Three- view drawing of AS 350 BA**



AS 350 BA Helicopter is powered by a single Turbomeca Arriel 1B free-turbine turbo shaft engine having maximum take-off power of 478 kW (641 hp) and features a modular design. It is located in a separate fireproof compartment after MGB and above the rear cargo compartment. It is connected to the MGB by a shaft mounted between two flexible couplings. The gas generator section consists of a one-stage axial, a one-stage centrifugal compressor, an annular combustor with centrifugal fuel injection, and a two-stage gas generator turbine. The rotational speed of the gas generator is determined by the rate at which fuel is burned in the combustor. Gas generator exhaust gases drive a single-stage power (free) turbine, which drives a reduction gear assembly. Torque is transferred forward through a power turbine shaft to an accessory gearbox mounted at the front of the engine.

The Turbomeca Arriel 1B engine is modular free-wheel composed of five modules

1. Axial Compressor Module (single-stage with bleed valve)
2. Gas Generator Module
  - A centrifugal compressor
  - An annular combustion chamber
  - A single-stage gas generator turbine
3. Free Turbine Module
4. Reduction Gear Module (reduces the free turbine speed from 39156 down to 6000 rpm)
5. Output Shaft Module ( Transmits power to the MGB and accessory drive couplings and contain free wheel)



**View of Turbomeca Arriel 1B Engine**

## 1.6.2 Helicopter Information

AS350 BA helicopter VT-MAB S/No. 2776 was manufactured on 10-11-1994. The helicopter is owned and operated by M/s Mesco Aerospace Ltd. Certificate of Registration No.2653, under Category 'A' which initially issued in name of M/s Mesco Airlines on 02-02-1995. Later on 18-09-2014, C of R was re-issued in the name of Mesco Aerospace Ltd.

The certificate of Airworthiness Number 2141 was issued under "normal" category sub-division "passenger" issued by DGCA on 02-02-1995 and specifying minimum crew as one. C of A was re- issued on 05<sup>th</sup> Feb 2014 and valid upto 04<sup>th</sup> Feb 2015. ARC Ref No. MAB/2141/ARC 2<sup>ND</sup>/2014/43 was valid upto 04-02-2015. Helicopter VT-MAB has logged 4877:36 A/F Hrs. and 7021 landings before incident.

The helicopter and its Engine are being maintained under continuous maintenance as per maintenance program consisting of calendar period based maintenance and Flying Hours / Cycles based maintenance as per maintenance program approved by Office of DDG, DGCA, Mumbai.

Last major inspection 1200 Hrs/ 48 Months Inspection schedule was carried out at 4827:31 Hrs on 01-02-2014 at Mumbai for issue of C of A/ Renewal of ARC. C of A was issued on 05<sup>th</sup> Feb 2014 and valid upto 04<sup>th</sup> Feb 2015. After C of A, the helicopter flew 50:05 hrs before the incident flight. Helicopter was having Aeromobile License No. L-14012/96/2009-RLO (NR)-1650 and valid up to 31-12-2014. However ELT Artex C 406-2HM, P/No. 453-5001-419 , S/No. 13649 installed on helicopter was not mentioned in Aeromobile License.

ELT annual inspection is valid up to 06-12-2014 and life of ELT battery is valid up to October 2015. As per DGCA CAR Section -2, Series- R, Part III para 4.1 "ELT shall be subjected to periodic inspections in accordance with manufacturers recommendation and approved maintenance programme". It was found during investigation that the monthly functional check recommended by the manufacturer Artex Aircraft supplies, Oregon, USA on the ELT was not being carried out by the operator.

As per log book 50 hrs /06 Months check on TRH pitch change unit bearing carried out as per 65.20.00.601 at 4866:11 A/ F hrs on 04-04-2014.

The helicopter was last weighed on 22-04-2010 at Mumbai and the weight schedule was recomputed on 22-04-2010 and duly approved by DAW, DGCA, Mumbai. As per the approved weight schedule the Empty weight is 1248 kgs. Maximum Fuel capacity is 540 ltrs. Maximum permissible load with 1 Pilot, Fuel and Oil tank full is 340 kgs. Empty weight CG is 3.561 meter aft of reference in land configuration. As there has not been any major modification affecting weight & balance since last weighing, hence the next weighing is due on 22-04-2015. The last fuel microbiological test was carried out on 31-08-2013 and was within acceptable limits.

First flight Daily inspection Schedule was carried out on 08-04-2014 at Greater Noida by AME before flight. Helicopter carried out uneventful 00:20 hrs of flight & 01 landing before the incident flight. Refueling was carried out at Greater Noida and 240 liter fuel was uplifted. At time of takeoff from Greater Noida there was total of 485 liters of fuel for the flight and fuel gauge in the cockpit shows approx. 90%. Helicopter was having endurance for 02 hrs 50 mins. Load and trim sheet of flight was prepared and center of gravity found within limit.

Turn Around Inspections are carried out by AME as per approved Turn Around Inspection schedules and all the higher inspection includes checks/inspection as per the manufacturer's guidelines as specified in "PRE" (Maintenance Program) and are approved by the CAM (WR).

As per store records submitted by Operator, last component replaced on helicopter VT- MAB was Cabin fire extinguisher which was replaced on 06-01-2013. However as airframe log book all three (03) Main Rotor Blades were replaced on 03-09-2013. Also, there is lot of cutting in log book entries and whitener fluid was used in airframe & Engine log book.

## **ENGINE**

The AS350BA helicopter VT-MAB is fitted with one Arriel 1B engine manufactured by Turbomeca having Engine S/No. 4501. This Engine had logged with 4424:36 Engine Hrs and 5662.30 cycles respectively as on 8<sup>th</sup> April 2014. The last major inspection carried out on Engine was 600 Hrs/24 Months. It was carried out on 01-02-2014 at 4374:31 Engine Hours.

## **MAIN ROTOR BLADES**

The AS350 BA helicopter VT-MAB is fitted with 03 Main Rotor Blades, details are as below:

S/N	PART NO.	SERIAL NO.	COMPONENT HRS
1.	AS355A110020	4584	3286:50
2.	AS355A110020	4606	3284:50
3.	AS355A110020	4610	3286:50

## **TAIL ROTOR BLADE**

S/N	PART NO.	SERIAL NO.	COMPONENT HRS
1.	355A12-0040-08	11634	401:55

## **BRAKES**

There are No parking brakes or pedal brakes installed for helicopter operation.

Main Rotor Brake is installed for stopping of the Main Rotor Blades at a predetermined operation during shutting down of engine.

## **TAIL ROTOR PITCH CHANGE LINKS**

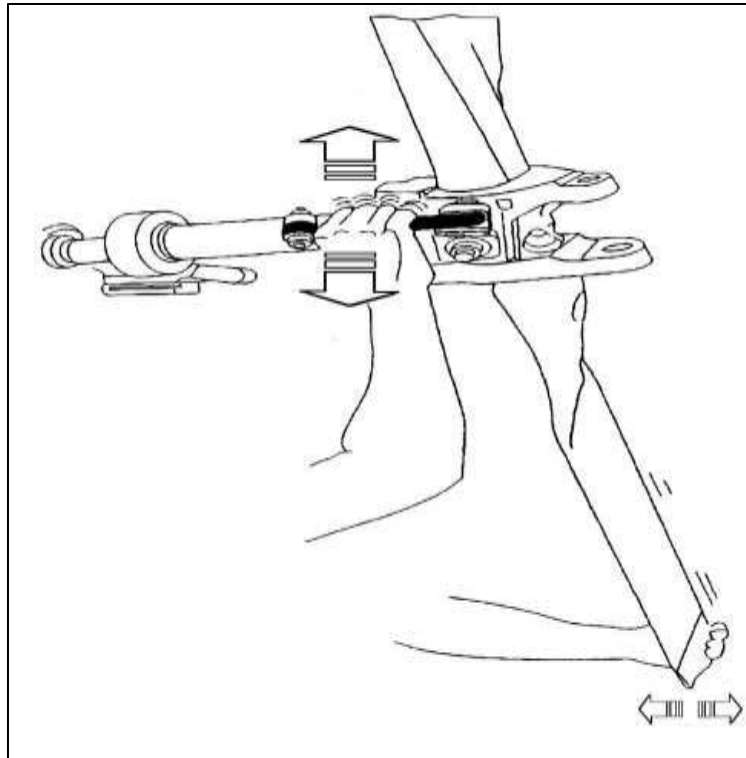
The tail rotor pitch change links (02) were made of aluminum and consisted of a swivel swaged-in, self-lubricating spherical bearing at one end and an elastomer-damped sleeve-type bearing at the opposite end. The bearing is made of steel or tungsten carbide in steel race. The inner surface of bearing is lined with fiberglass impregnated with Teflon to reduce friction. The normal functional stresses including control input and centrifugal forces applied to pitch link bearing lead to wear of inner race Teflon. If preventive maintenance inspection not followed, the bearing exceed the current wear limit and allow metal-to-metal contact leading to load on tail rotor pitch change link and onset of fatigue crack in material which propagate until link fails.

Pitch links P/No. 350A33.2145.01 are not service life limited components. The aircraft had accumulated 4877:36 hrs at the time of pitch link failure. The pitch links and bearings were therefore considered to have accumulated approximately 4877:36 hrs hours since new.

The links were subject to inspection in accordance with the AMM at 600-hour/24Month intervals as well as during the ALF inspection nearest to 30 aircraft hours.

The ALF checks, per section 05.21.00.603 of the maintenance manual, consisted of a visual inspection similar to the 600-hour service check, as well as a tactile check to confirm there was no play in the spherical bearing. The tactile check carried out by imparting an oscillating axial load on the bearing, while applying a low-amplitude, see-saw motion to the blades.

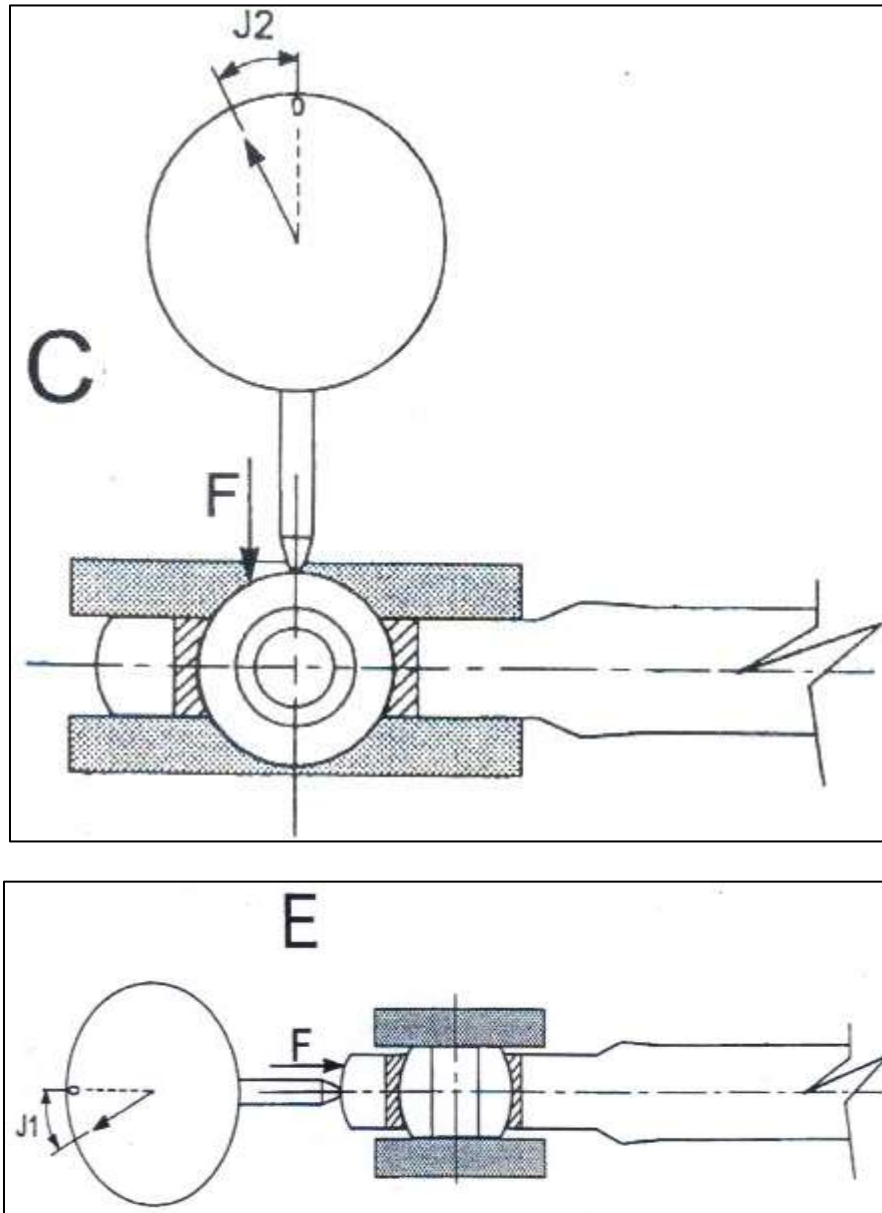
As per operator maintenance program, inspection of tail rotor Pitch Change Link and Swivel Bearing were carried out at After Last Flight / 10 hours inspection task card. There is no specific inspection of tail rotor Pitch Change Link in BFF.



#### **ALF Method to check for bearing play**

The 600-hour inspection required a check of the pitch change link in accordance with section 65.20.00.601 paragraph 4.2.1 of the maintenance manual. This involved the removal of both links and a detailed visual inspection and measurement of axial and radial play in the spherical bearing. The play was checked as per para 4.2.1.1 with the help dial gauge.

The 600-hourly inspection was carried out on 01-02-2014 when the aircraft had accumulated 4827:31Hrs hours total time in service and the links were inspected at that time with no defects recorded. As per inspection the play found was 0.0095 inch for Detail 'C' and 0.0043 inch for Detail 'E' which was within limit.



As per para 4.2.1 of Chapter 65.20.00.601, following limits was mentioned on Swivel bearing:-

The links were to be discarded if axial or radial play was measured outside of prescribed limits, the Teflon fabric was extruded from the bearing, there was persistent discoloration of the ball, or if there was any scoring of the ball.

Discard the link if Axial Play (Detail C) is equal to or greater than 0.0157 inch or Radial play (Detail E) is equal to or greater than 0.0078 inch.

Inspection requirements for the elastomeric dampers involved a visual check to ensure the rubber was free of significant cracks and bonding separation.

The ALF inspection was to be carried out by qualified AME on 07-04-2014 after last flight. As per approved ALF / 10 hours Inspection Task card of Ecureuil AS 350 BA Helicopter Sl. No. 04 (d) regarding Pitch Change Link and Swivel Bearing – Check, following inspection to be carried out.

- i) For no play of swivel bearing.
- ii) The condition of swivel bearing visually, no extrusion of Teflon fabric, discoloration and/or scoring on the ball.
- iii) For absence of play of the pitch change links

### **1.7 Meteorological Information:**

There was no Meteorological Office situated in Muradnagar. PIC has taken Met information on telephone from WSO, Delhi and ATC Hindon Air force, Ghaziabad. As per pilot weather was fine, sky clear, visibility 5 Kms and approx.08- 10 knots headwind.

### **1.8 Aids to Navigation:**

The helicopter is only VFR cleared and is equipped with ADF, VOR, DME, ILS, ATC Transponder, GPS and an ELT. Helicopter was flying from Muradnagar to Manakmau using Jeppesen Map, Ground references and GPS.

### **1.9 Communication:**

Helicopter took off from Muradnagar after taking permission from WSO, Delhi on telephone and was in contact with Hindon Air force ATC on RT. At the time of incident helicopter was not in contact with any ATC as it was not in range of any ATC. However, after landing PIC informed WSO, Delhi on telephone regarding incident.

### **1.10 Aerodrome Information:**

Temporary helipad was made at Muradnagar and Manakmau with the help of State Administration.



### **1.11 Flight Recorders:**

Cockpit Voice Recorder (CVR) and Digital Flight Data Recorder (DFDR) were not fitted on helicopter neither required as per existing Civil Aviation Requirements.

### **1.12 Wreckage & Impact Information:**

While flying at approx. 2000 feet AGL, PIC experienced severe helicopter vibrations. PIC decided to carry out straight –in autorotation force landing in mode in a wheat field. During landing Helicopter bounced forward then settled backwards and sustained damage. The helicopter was confined to final resting position on the wet ground in upright position. There was inflight disintegration of part of tail rotor pitch link swivel bearing side , which could not be located.

The tail rotor blade and tail boom, vertical stabilizer exhibited damage. On the left side, the tail boom multiple wrinkles were found & a scratch of 6 inches on the right side .Crack marks visible on one tail rotor blade at approx. 5 inches from the root section and butting marks on the spider and blade attachment was found.

The pitch change link swivel bearing was found excessively damaged. Tail rotor pitch change link of the same blade was broken from the swivel bearing side and found attached. The broken portion Tail rotor pitch change link could not be located. Metal particles were found on the TGB chip detector.

The damaged helicopter was shifted from site to Juhu Airport, Mumbai. Detail examination of damaged helicopter was carried out with AAIB, Mesco, Airbus Helicopter and Terbomeca representative on 29-30 July 2014.

ELT was not activated after forced landing.

### **1.13 Medical & Pathological Information:**

Pilots carried out Preflight Medical at Greater Noida before flight. However, after the incident no medical was carried out for PIC & Co- Pilot.

#### **1.14 Fire:**

There was no pre or post impact fire.

#### **1.15 Survival Aspects:**

The incident was survivable.

#### **1.16 Test and Research:**

Following components were sent to BEA, France (French Accident Investigation Agency) for failure analysis.

1. Tail Rotor Blades.
2. Both damaged and undamaged Tail Rotor Pitch Rods along with Bearing.

##### **1.16.1 Examination of Tail Rotor Blades**

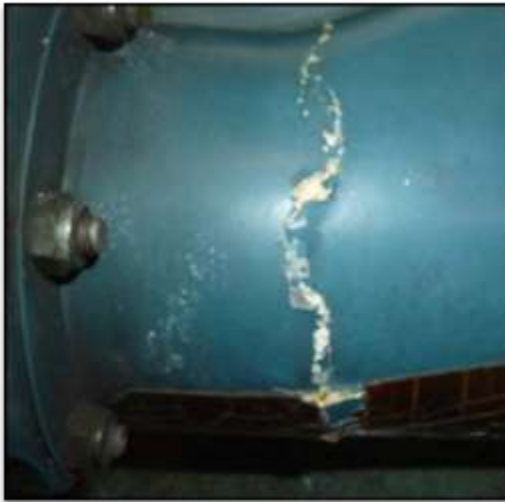
The damaged blade exhibited a compressive crack (blade flapping toward the tail boom) at the junction with the chin weight. The damaged blade exhibited some marks of contact with very soft object compatible with vegetation. The impact finger was bent which is consistent with the blade contact with the tail boom due a significant flapping of the blades.

The internal half-laminated bearing of the damaged blade chin weight exhibited damages consistent with several significant blade flapping toward the tail boom. The metallic support allowing the junction on the chin weight of the internal half laminated bearing of the damaged chin weight exhibited contact marks with the hub yoke which are consistent with a significant flapping toward the tail boom.

The chin weight horn of the damaged blade was missing. The chin weight of the damaged blade exhibited contact marks with tail rotor mast and the seesaw screw exhibited contact marks with the hub yoke which are consistent with a significant blade flapping toward the tail boom.

The undamaged blade didn't exhibit damages (including the impact finger) except some marks of contact with very soft object compatible with vegetation. The undamaged blade exhibited a repair in its pressure surface close to the leading edge which is not in relation

with the event. The chin weight (including half laminated bearings) of the undamaged blade didn't exhibit damages.



### **Damaged Tail Rotor Blade**

#### **1.16.2 Examination of Tail Rotor Pitch Rods along with Bearing**

The failed pitch rod exhibited rupture on its housing at two different locations but didn't exhibit deformations which are consistent with a fatigue rupture.

The bearing ball of the failed pitch rod exhibited wear damages consistent with a long use with play in the ball bearing.

The ball bearing cage of the failed pitch rod exhibited significant wear damages (material is missing) consistent with a long use with play in the ball bearing.



### **Failed pitch rod**

The undamaged pitch rod and ball bearing has been examined and showed the following observations:-

- a) No Teflon Extrusion. Light Damages of Teflon (that might be caused by some painting on the ball)
- b) No specific damage to the ball and light traces of painting on the ball.
- c) Axial play observed is 0.06 mm up to 0.08 mm depending to the position of the ball. According to AMM 65-21-00, 6-11a, this value must remain below 0.4 mm.

#### **1.17. Organizational & Management Information:**

M/s Mesco Aerospace Ltd (earlier known as M/s Mesco Airlines Ltd.) is a Non-Scheduled Operator situated at Delhi. The company is having Non- Scheduled Operating Permit (NSOP) No. 01/1993 and valid upto 04-06-2015. At present company has 02 helicopters registered in the permit.

The helicopter VT- MAB was maintained by M/s Mesco Airlines Ltd. which is a CAR 145 approved organization.

## **1.18 Additional Information:**

### **1.18.1 Technical Publications on Tail Rotor Pitch Link**

A Letter-Service LS-1367-64-98 has been issued By M/s Eurocopter in 1998 because of an incident involving a failure of a tail rotor pitch control link. This Letter-Service was on “Tail Rotor Pitch Change Bearing Inspection /Check” reminding the importance to performing the required inspections to assure there is no play beyond the defined limits on the pitch link swivel bearing.

The manual check for play of the tail rotor pitch change link bearing was to be accomplished on the aircraft during ALF in accordance with the Flight Manual or during the ALF nearest to the 30 flying hour (FH) limit in accordance with the Aircraft Maintenance Manual.

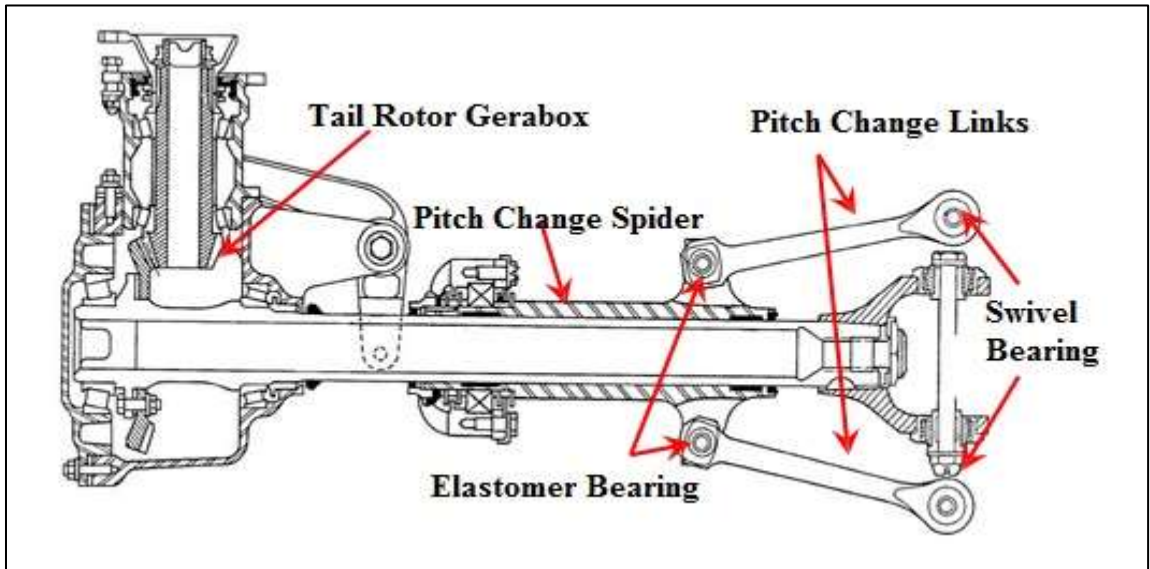
A SIN No. 2000-S-65 has been issued in 2008 following an emergency landing of an AS350BA helicopter due to heavy vibrations originating from the tail rotor.

An ASB ASB-05-00-60 has been issued in 2009 in order to make the periodicity of the check for no play in tail rotor pitch change links, mandatory, to prevent any pitch change failure and to provide some detailed information concerning the existing procedure to enable easier detection of play.

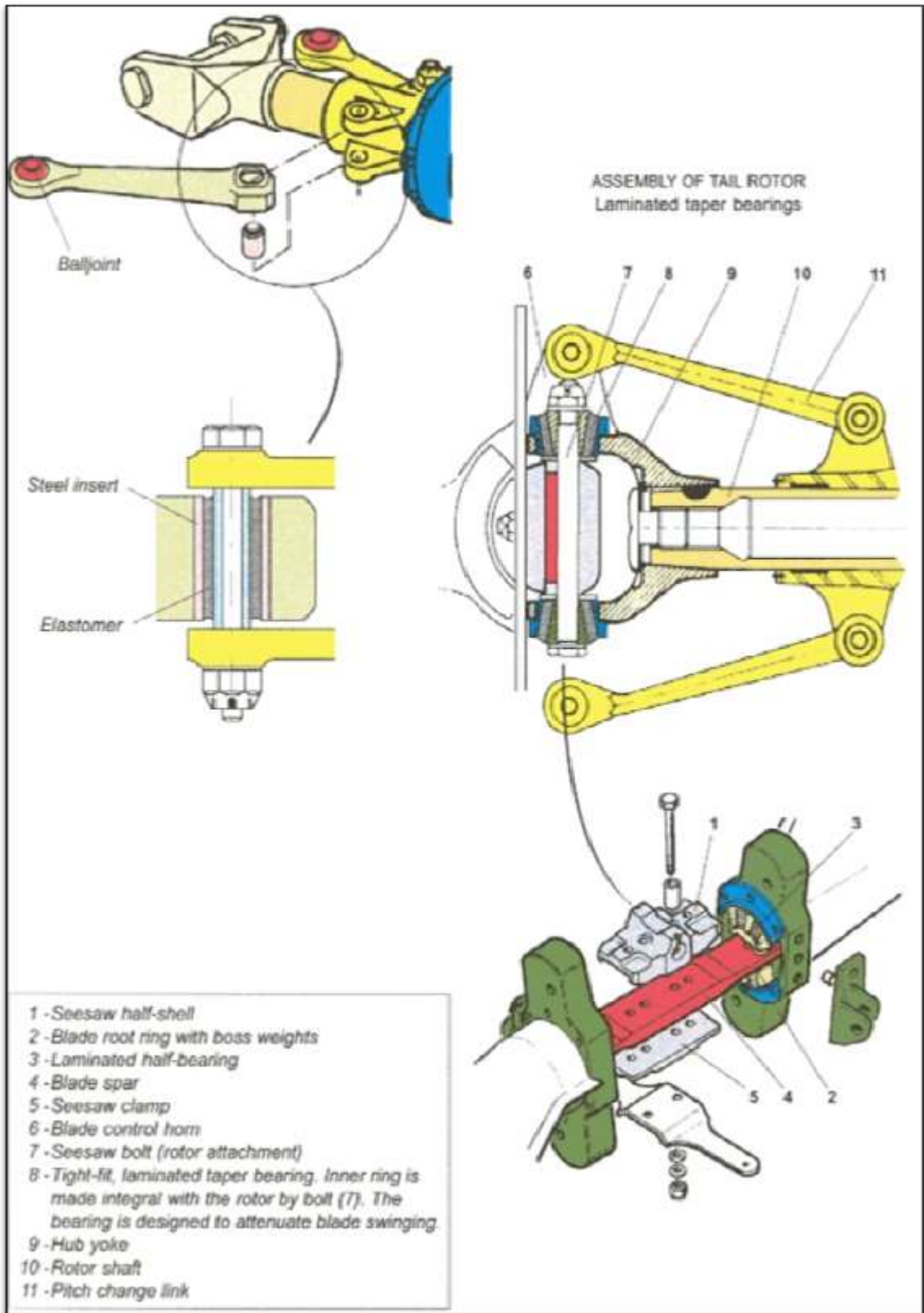
Following the ASB, EASA has issued in 2010 the Airworthiness Directive AD-2010- 0006 requiring the application of the ASB-05-00-60.

DGCA has issued a mandatory Modification DGCA /AS-350 Series /119 applicable to AS 350 and AS 355 Series Helicopters regarding “Time Limits/Maintenance Checks- Tail Rotor (T/R) Pitch Change links Inspection as per EASA AD No. 2010-0006.

As per records provided by operator, the DGCA mandatory Modification was compiled 07-01-2010.



**Tail Rotor Drive Assembly**



**Tail Rotor Drive Assembly**

### **1.18.2 Pilot in Command & Co-Pilot Statement**

As per PIC, while flying at 2000 feet at 110 knots speed around 0609 UTC, helicopter started vibrating with high frequency. He lowered the collective and reduced the speed to 95-100 knots. The vibrations increased and asked co-pilot to look for the landing place. Door light and TGB chip light illuminated and vibrations kept on increasing. Engine parameters were normal. He advised copilot to put hand on FFCL and Fuel Shut off valve. Pilot entered straight –in autorotation at 1700-1800 feet at speed 95-100 knots which he later reduced to 80 knots. After flare, PIC pulled up collective to have smooth landing. But as speed is higher, helicopter hit the ground hard, bounced forward and settled backwards. Co-pilot switched off FFCL and Fuel Shut off valve. PIC pulled rotor brakes. Later, PIC carried out post flight inspection and found damage to tail boom and skids.

As per co-pilot while flying at 2000 feet, helicopter started vibration with abnormal sound. The vibration kept on increasing and instrument panel was shaking. PIC advised him that they are going for an auto-rotative landing which was agreed by her. Co-pilot report an open field ahead without wires for landing. PIC put helicopter in straight –in autorotation and lowered the speed to 80 knots. In auto (1<sup>st</sup> stage, glide) helicopter was not coming down smoothly. PIC flared hard helicopter at 70 feet and pulled collective to level the helicopter. He advised co-pilot to close FFCL & fuel shut off valve after landing. After switch off, co-pilot came out of helicopter and informed to AME on telephone.

### **1.18.3 Flight Manual**

Flight Manual Ecureuil AS 350 BA Helicopter Section 3.1 “Emergency procedures” para 2.4 regarding Autorotation Landing Training procedure states:

1. Reduce the collective pitch to establish autorotation configuration.
2. Monitor and control rotor RPM.
3. During final approach, shut down the engine, or reduce power maintaining the Ng above 67%.
4. After touch down still at low collective pitch apply the normal starting procedure.



However, in the case the helicopter entered in auto rotation at 90-100 knots approx., against the recommended speed for executing auto rotation at 65 knots.

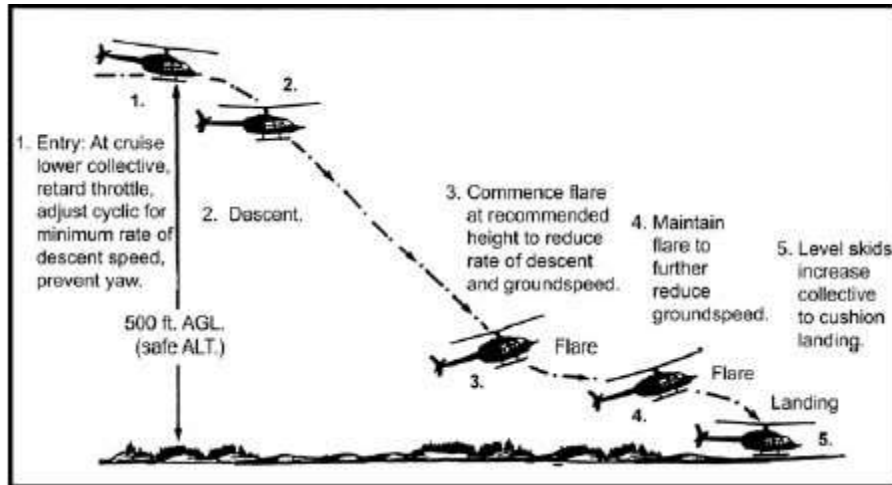
#### **1.18.4 Autorotation Landing**

Autorotation is a state of flight where the main rotor system of a helicopter turns by the action of air moving up through the rotor rather than engine power driving the rotor. In normal powered flight, air is drawn into the main rotor system from above and exhausted downward, but during autorotation, air moves up into the rotor system from below as the helicopter descends. The upward flow of air through the rotor provides sufficient thrust to maintain  $N_R$  throughout the descend. The PIC controls the  $N_R$  by adjusting the position of collective lever. The descend is arrested by raising the collective lever to increase the main rotor AOA and to use inertia stored in the main rotor blades to again produce lift, allowing the helicopter to land safely or minimize an impact.

A straight-in autorotation implies an autorotation from altitude with no turns. The speed at touchdown and the resulting ground run depends on the rate and amount of flare. The greater the degree of flare and the longer it is held, the slower the touchdown speed and the shorter the ground run. The slower the speed desired at touchdown, the more accurate the timing and speed of the flare must be, especially in helicopters with low inertia rotor systems.

A successful autorotation landing depends on the helicopter's height and velocity at the commencement of autorotation

Several factors affect the rate of descend in autorotation: density altitude, gross weight, rotor rpm, and forward airspeed. The PIC primary control of the rate of descend is airspeed. Higher or lower airspeeds are obtained with the cyclic pitch control just as in normal flight. When landing from an autorotation, the kinetic energy stored in the rotating blades is used to decrease the rate of descend and make a soft landing. A greater amount of rotor energy is required to stop a helicopter with a high rate of descend than is required to stop a helicopter that is descending more slowly. Therefore, autorotative descends at very low or very high airspeeds are more critical than those performed at the minimum rate of descend airspeed. Failure to maintain ground track in the air and keeping the landing gear aligned with the direction of travel during touchdown and ground contact.



### Straight-in Autorotation Landing

**1.19 Useful and Effective Techniques: NIL**

**2. ANALYSIS:**

#### **2.1 Serviceability of Helicopter**

The helicopter Ecureuil AS 350 BAS No. 2776 was manufactured by M/s Eurocopter, France in year 1994. The helicopter was issued with Indian Certificate of Registration (C of R) no. 2653 on 02-02-1995 under category 'A' in the name of M/s Mesco Airlines. Later on 18-09-2014, C of R was re-issued in name of M/s Mesco Aerospace Ltd. It holds valid Indian certificate of Airworthiness no. 2141 issued on 02-02-1995 under category Normal, Sub-Division Passenger. The C of A was valid renewed on 05-02-1014 and valid till 04-02-2015. Airworthiness Review Certificate was issued on 05-02-2014 and was valid till 04-02-2015. The helicopter had done 4877:36 airframe hrs and 7021 landings. Engine had done 4424:36 Hrs and 5662:30 cycles. Last major Inspection carried was 1200 Hrs. /48 Months at 4827:31 Hrs on 01-02-2014. After C of A, the helicopter flew 50:05 hrs before the incident flight. Load and trim sheet of flight was prepared and center of gravity found within limit.

As per store records submitted by Operator, last component replaced on helicopter VT- MAB was Cabin fire extinguisher which was replaced on 06-01-2013. However as airframe log book all three (03) Main Rotor Blades were replaced on 03-09-2013. Also, there is lot of cutting and whitener fluid is used in airframe & Engine log book entries. Artex ELT C 406-2HM, P/No. 453-5001-419 , S/No. 13649 installed on helicopter was not entered in

Aeromobile License. Monthly functional check on ELT as recommended by the manufacturer was not carried out by operator.

On 08-04-2014, helicopter VT-MAB had carried out a total of 00:20 hours of flying and 01 landings before forced landing. Examination of the helicopter revealed that one of the tail rotor pitch change links had fractured, resulting in lateral movement of the tail rotor and damage to the tail rotor blade, tail boom and tail cone.

The failed pitch rod exhibited rupture on its housing at two different locations but didn't exhibit deformations which are consistent with a fatigue rupture. The bearing ball of the failed pitch rod exhibited wear damages consistent with a long use with play in the ball bearing. The ball bearing cage of the failed pitch rod exhibited significant wear damages (material was missing) consistent with a long use with play in the ball bearing.

The undamaged pitch rod had light damages of Teflon (that might be caused by some painting on the ball) and the axial play was within limit.

## **2.2 Inspection of Tail Rotor Pitch Link**

M/s Eurocopter issued a Service letter (SL) in year 1998 regarding inspection of of tail rotor pitch link to assure that there is no play beyond the defined limits on the pitch link swivel bearing.

In year, 2008 a Safety Information Notice (SIN) was issued followed by ASB in year 2009 in order to make mandatory check for no play in tail rotor pitch change links

Following the ASB, EASA has issued Airworthiness Directive in year 2010 the. DGCA has issued a mandatory Modification DGCA/ AS-350 Series /119 regarding "Time Limits/Maintenance Checks- Tail Rotor (T/R) Pitch Change links Inspection as per EASA AD.

As per records provided by operator, the DGCA mandatory Modification was compiled 07-01-2010.

The Aircraft Maintenance Manual requires visual inspection pitch rod ball bearing play during the After Last Flight (ALF) nearest to the 30 flying hours and detailed examination using Dial gauge at 600 Hrs / 24 Months. This check is meant to prevent from fatigue failure of the tail rotor pitch rod.

The as per 600 hrs / 24 months inspection were carried out at 4827:31 Hrs on 01-02-2014, whereas ALF inspection was to be carried out on 07-04-2014 after last flight.

No discrepancies were detected during the inspection.

### **2.3 Failure Examination of Tail Rotor, Tail Rotor Pitch Link and Swivel Bearing**

The failed Tail Rotor, Tail Rotor Pitch Link and Swivel Bearing were send to BEA, France for detailed examination.

The damaged blade exhibited a compressive crack (blade flapping toward the tail boom) at the junction with the chin weight. The damaged blade exhibited some marks of contact with very soft object compatible with vegetation. The impact finger was bent which is consistent with the blade contact with the tail boom due a significant flapping of the blades.

The bearing ball of the failed pitch rod exhibited wear damages consistent with a long use with play in the ball bearing. The ball bearing cage of the failed pitch rod exhibited significant wear damages (material is missing) consistent with a long use with play in the ball bearing. The failed pitch rod exhibited rupture on its housing at two different locations but didn't exhibit deformations which are consistent with a fatigue rupture. The other tail rotor pitch link shows axial play, which was within limit.

The fatigue rupture of the pitch rod is probably due to a long use of the helicopter in presence of a play into one of the tail rotor pitch rod ball bearing.

### **2.4 Weather**

The weather at the time of incident was fine, sky clear, visibility 5 Kms and approx.08- 10 knots headwind.

### **2.5 Pilot Factor**

While flying at 2000 feet at 110 knots speed helicopter started vibrating with high frequency. PIC lowered the collective and reduced the speed to 95-100 knots. The vibrations kept on increasing with door light and TGB chip light illuminated. PIC instructed co-pilot to look for a field for forced landing. Pilot entered straight –in autorotation at 1700-1800 feet at speed 95-100 knots which he later reduced to 80 knots. After flare, PIC pulled up collective to have

smooth landing. But as speed is higher, helicopter hit the ground hard, bounced forward and settled backwards. Co-pilot switched off Fuel Flow control lever (FFCL) and Fuel Shut off valve. PIC pulled rotor brakes. Later, PIC carried out post flight inspection and found damage to tail boom and skids.

As per flight manual recommended speed to carryout autorotation is 65 knots. However, in this case it was around 80 knots resulted in improper approach and hard landing.

PIC had 326:45 hrs and co-pilot had 169:25 hrs on AS350 BA helicopter. The total cockpit crew experience on type was less than 500 hrs.

## **2.6 Circumstances Leading to Incident.**

While flying at approx. 2000 feet AGL during flight from Muradnagar to Manakmau, helicopter experienced severe vibrations due failure of one of the tail rotor pitch change links, resulting in lateral movement of the tail rotor and the tail rotor blade cracked. The vibrations kept on increasing with door light and TGB chip light illuminated. Pilot entered straight –in autorotation at 1700-1800 feet at speed 95-100 knots which he later reduced to 80 knots. After flare, PIC pulled up collective to have smooth landing. But as speed was higher than the recommended speed to carryout autorotation, it resulted into improper approach and hit the ground hard which eventually resulted into the incident.

## **3. CONCLUSION :**

### **3.1 Findings :**

1. The Certificate of Airworthiness, Certificate of Registration & Certificate of flight release of the helicopter was valid on the date of incident.
2. The helicopter and Engines were being maintained under continuous maintenance approved by Office of DDG (WR), DGCA, Mumbai.
3. The PIC & Co-Pilot was having valid license, medical and in the employment of M/s Mesco Aerospace ltd.
4. The total cockpit crew experience on AS 350 BA helicopter was less than 500 hrs.
5. Helicopter took off from Muradnagar to Manakmau at 0530 UTC on 8<sup>th</sup> April 2014 with PIC, Co-pilot and 03 passengers.

6. While flying at approx. 2000 feet AGL pilot experienced severe vibrations. The vibration was kept on increasing and TGB, Door warning light illuminated.
7. PIC carried out straight –in-autorotation landing in an open field at Chakwali village near Saharanpur (U.P.), 12 Nm short from Manakmau.
8. There was no injury to any person on board. There was no pre or post impact fire.
9. Helicopter sustained damages during forced landing. Examination of the helicopter revealed that one of the tail rotor pitch change links had fractured, resulting in lateral movement of the tail rotor and damage to the tail rotor blade, tail boom and tail cone.
10. The bearing ball of the failed pitch rod exhibited wear damages consistent with a long use with play in the ball bearing. The ball bearing cage of the failed pitch rod exhibited significant wear damages (material is missing) consistent with a long use with play in the ball bearing. The failed pitch rod exhibited rupture on its housing at two different locations but didn't exhibit deformations which are consistent with a fatigue rupture.
11. The undamaged pitch rod had light damages of Teflon (that might be caused by some painting on the ball) and the axial play was within limit as per AMM.
12. The fatigue rupture of the pitch rod is probably due to a long use of the helicopter in presence of a play into one of the tail rotor pitch rod ball bearing.
13. Pitch links are not service life limited components and had accumulated 4877:36 hrs hours at the time of failure. The pitch links were inspected as per 600 hrs / 24 months inspection were carried out at 4827:31 Hrs on 01-02-2014 and ALF inspection was carried out on 07-04-2014.
14. After 600 hrs / 24 months inspection, helicopter flew around 50:05 hrs and after ALF helicopter flew 00:20 hrs.
15. The recommended speed to carryout autorotation was 65 knots but pilot couldn't reduce the speed of helicopter and landed with higher speed resulted in improper approach and hard landing.
16. As per Airframe log book all three (03) Main Rotor Blades were replaced on 03-09-2013 but no entry was shown in Store records. Also, there was lot of cutting and whitener fluid was used in airframe & Engine log book entries.

17. Artex ELT C 406-2HM, P/No. 453-5001-419, S/No. 13649 installed on helicopter was not entered in Aeromobile License Also, monthly functional check of ELT was not carried out by operator.

### 3.2 Probable Cause of Serious Incident :

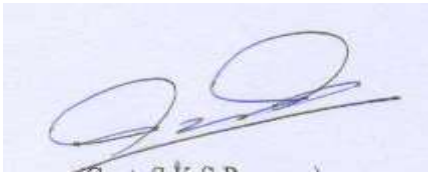
The incident was caused because of failure of one of the tail rotor pitch link due to fatigue.

Contributory factor:

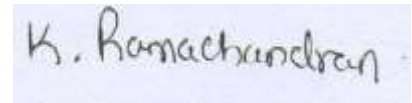
The pilot was unable to reduce the speed as recommended for autorotation because of severe vibrations and hence carried out autorotation at a higher speed which resulted in damage to tail rotor, tail boom and the structure.

### 4. Safety Recommendations :

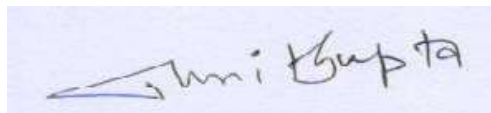
1. Safety Audit of Maintenance activities of Operator may be carried out by DGCA.
2. Pilot and co-pilot to given appropriate corrective training.



(Capt. S K S Panwar )  
FOI (H), DGCA  
Member



(K. Ramachandran)  
Air Safety Officer (E), AAIB  
Member



( Amit Gupta)  
Deputy Director (AED), DGCA Hqrs.  
Chairman

Date : 30.10.2015

Place: New Delhi